हर कदम, हर डगर
किसानों का हमसफर
भारतीय कृषि अनुसंधान परिषद
Agrisearch with a human touch

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

BELHATTI-5 (4D4A3I1e) MICROWATERSHED

Shirhatti Taluk, Gadag District, Karnataka

Karnataka Watershed Development Project – II

SUJALA – III

World Bank funded Project

The World Bank

ICAR – NATIONAL BUREAU OF SOIL SURVEY AND LAND USE PLANNING

ICAR - NBSS & LUP

WATERSHED DEVELOPMENT DEPARTMENT
GOVT. OF KARNATAKA, BANGALORE

About ICAR - NBSS&LUP

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

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

Citation: Rajendra Hegde, Ramesh Kumar, S.C., K.V. Niranjana, S. Srinivas, M.Lalitha, B.A. Dhanorkar, R.S. Reddy and S.K. Singh (2019). “Land Resource Inventory and Socio-Economic Status of Farm Households for Watershed Planning and Development of Belhatti-5 (4D4A3I1e) Microwatershed, Shirhatti Taluk, Gadag District, Karnataka”, ICAR-NBSS&LUP Sujala MWS Publ.51, ICAR – NBSS & LUP, RC, Bangalore. p.97 & 31.

TO OBTAIN COPIES,

Please write to:
Director, ICAR - NBSS & LUP,

Amaravati Road, NAGPUR - 440 033, India

Phone : (0712) 2500386, 2500664, 2500545 (O)

Telefax : 0712-2522534

E-Mail : director@nbsslup.ernet.in

Website URL : nbsslup.in

Or

Head, Regional Centre, ICAR - NBSS&LUP, Hebbal, Bangalore - 560 024

Phone : (080) 23412242, 23510350 (O)

Telefax : 080-23510350

E-Mail : nbssrcb@gmail.com

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

BELHATTI-5 (4D4A3I1e) MICROWATERSHED

Shirahatti Taluk, Gadag District, Karnataka

Karnataka Watershed Development Project – II

Sujala-III

World Bank funded Project

THE WORLD BANK

ICAR – NATIONAL BUREAU OF SOIL SURVEY AND LAND USE PLANNING

ICAR - NBSS & LUP

WATERSHED DEVELOPMENT DEPARTMENT, GOVT. OF KARNATAKA, BANGALORE

PREFACE

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

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

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

The natural resources (land, water and vegetation) of the state need adequate and constant care and management, backed by site-specific technological interventions and

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

ICAR-NBSS&LUP, Regional Centre, Bangalore has taken up a project sponsored by the Karnataka Watershed Development Project-II, (Sujala-III), Government of Karnataka funded by the World Bank under Component -1 Land Resource Inventry. This study was taken up to demonstrate the utility of such a database in reviewing, monitoring and evaluating all the land based watershed development programs on a scientific footing. To meet the requirements of various land use planners at grassroots level, the present study on "Land Resource Inventory and Socio-Economic Status of Farm Households for Watershed Planning and Development of for Belhatti-5 microwatershed in Shirahatti Taluk, Gadag District, Karnataka" for integrated development was taken up in collaboration with the State Agricutural Universities, IISC, KSRSAC, KSNDMC as Consortia partners. The project provides detailed land resource information at cadastral level (1:7920 scale) for all the plots and socio-economic status of farm households covering thirty per cent farmers randomely selected representing landed and landless class of farmers in the micowatershed. The project report with the accompanying maps for the microwatershed will provide required detailed database for evolving effective land use plan, alternative land use options and conservation plans for the planners, administrators, agricutural extention personnel, KVK officials, developmental departments and other land users to manage the land resources in a sustainable manner.

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

Nagpur
Date: 11.01.2018

S.K. SINGH
Director, ICAR - NBSS&LUP, Nagpur

Contributors

Dr. Rajendra Hegde Principal Scientist, Head & Project Leader, Sujala-III Project ICAR-NBSS&LUP, Regional Centre, Bangalore	**Dr. S.K.Singh** Director, ICAR-NBSS&LUP Coordinator, Sujala-III Project Nagpur
Soil Survey, Mapping & Report Preparation	
Dr. K.V. Niranjana	Sh. R.S. Reddy
Dr. B.A. Dhanorkar	Sh. Venkata Giriyappa
	Dr. Gayathri, B.
	Smt. Chaitra, S.P.
	Sh. Nagendra, B.R.
	Dr. Savitha, H.R.
	Dr. Gopali Bardhan
	Sh. Somashekar T.N
Field Work	
Sh. C.Bache Gowda	Sh. Sandesh Shastri
Sh. Somashekar	Sh. Rajeev, G.S.
Sh. M. Jayaramaiah	Sh. Balasubramanyam, M.G.
Sh. Paramesha, K.	Sh. Vijaya Kumar
Sh Narayana Reddy B. M.	Sh. Kamalesh K. Avate
	Sh. Bharat Raj, B.
GIS Work	
Dr. S.Srinivas	Sh. A.G.Devendra Prasad
Sh. D.H.Venkatesh	Sh. Mahamad Ali, M.
Smt.K.Sujatha	Sh. Avinash
Smt. K.V.Archana	Sh. Amar Suputhra, S
Sh. N.Maddileti	Sh. Abhijith Sastry, N.S.
	Smt. K.Karunya Lakshmi
	Ms. Shwetha. N.
	Smt. K.Swetha
Laboratory Analysis	
Dr. K.M.Nair	Smt. Thara, V.R.
Smt. Arti Koyal	Smt. Steffi Peter
Smt. Parvathy, S.	Smt. Roopa, G.

	Ms. Shwetha, N.K.
	Smt. Ishrat Haji
	Ms. Pavana Kumari, P.
	Sh. Shanthaveeraswamy, H.M.
	Sh. Ramesh, K.
	Ms. Padmaja, S.
	Ms. Veena, M.
Soil & Water Conservation	
Sh. Sunil P. Maske	
Socio-Economic Analysis	
Dr. S.C. Ramesh Kumar	Sh. M. K. Prakashanaik
	Ms. Sowmya K.B
	Sh.Manjunath M
	Sh.Veerabhadraswamy R
	Sh.Lankesh RS
	Sh.Kalaveerachari R Kammar
	Sh.Pradyumma U
	Sh.Yogesha HN
	Sh.Vijay kumar lamani
	Sh.Arun N Kambar
	Sh.Vinay
	Sh.Basavaraj.Biradar
	Sh.Vinod R
	Sh.Praveenkumar P Achalkar
	Sh.Rajendra D
Watershed Development Department, GoK, Bangalore	
Sh. Rajeev Ranjan IFS Project Director & Commissioner, WDD	Dr. A. Natarajan NRM Consultant, Sujala-III Project
Dr. S.D. Pathak IFS Executive Director & Chief Conservator of Forests, WDD	

PART-A

LAND RESOURCE INVENTORY

Contents

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

The land resource inventory of Belhatti-5 microwatershed was conducted using village cadastral maps and IRS satellite imagery on 1:7920 scale. The false colour composites of IRS imagery were interpreted for physiography and these physiographic delineations were used as base for mapping soils. The soils were studied in several transects and a soil map was prepared with phases of soil series as mapping units. Random checks were made all over the area outside the transects to confirm and validate the soil map unit boundaries. The soil map shows the geographic distribution and extent, characteristics, classification, behaviour and use potentials of the soils in the microwartershed.

The present study covers an area of 532 ha in Shirahatti taluk of Gadag district, Karnataka. The climate is semiarid and categorized as drought-prone with an average annual rainfall of 633 mm, of which about 363 mm is received during south –west monsoon, 165 mm during north-east and the remaining 105 mm during the rest of the year. An area of about 81 per cent is covered by soils and 19 per cent is covered by rock lands and others. The salient findings from the land resource inventory are summarized briefly below.

- *The soils belong to 15 soil series and 29 soil phases (management units) and 9 land use classes.*
- *The length of crop growing period is about 150 days starting from the 3rd week of June to 1st week of October.*
- *From the master soil map, several interpretative and thematic maps like land capability, soil depth, surface soil texture, soil gravelliness, available water capacity, soil slope and soil erosion were generated.*
- *Soil fertility status maps for macro and micronutrients were generated based on the surface soil samples collected at every 250 m grid interval.*
- *Land suitability for growing major agricultural and horticultural crops were assessed and maps showing the degree of suitability along with constraints were generated.*
- *About 81 per cent area is suitable for agriculture and 19 per cent is not suitable for agriculture.*
- *About 45 per cent of the soils are very shallow (<250 cm) to moderately shallow (50-75 cm) and about 37 per cent are moderately deep (75-100 cm) to very deep (>150 cm) soils.*
- *About 62 per cent of the area has loamy, 8 per cent sandy and 11 per cent of the area has clayey soils at the surface.*
- *About 19 per cent of the area has non-gravelly soils, 43 per cent gravelly soils (15-35 % gravel), 15 per cent very gravelly (35- 60% gravel) soils and 4% of the soils are extremely gravelly.*
- *About 61 per cent low (51-100 mm/m) to very low (<50mm/m) and 20 per cent medium (101-150 mm/m) in available water capacity.*
- *About 63 per cent area has very gently sloping (1-3%) lands, 3 per cent gently sloping (3-5%) and 16 per cent nearly level (0-1%) lands.*
- *An area of about 27 per cent has soils that are slightly eroded (e1) and 54 per cent moderately eroded (e2).*
- *An area of about 34 per cent has soils that are moderately alkaline (pH 7.8 to 8.4), 21 per cent slightly alkaline (pH 7.3-7.8), 18 per cent neutral (pH 6.5-7.3) and 7 per cent strongly alkaline (pH 8.4-9.0).*

- *The Electrical Conductivity (EC) of the soils are dominantly <2 dsm-1indicating that the soils are non-saline.*
- *About 38 per cent of the soils are medium (0.5-0.75%), 11 per cent high (>0.75%) and 32 per cent low in organic carbon.*
- *An area of about 18 per cent low (<23 kg/ha), 62 per cent medium (23-57 kg/ha)) and one per cent high (>57 kg/ha) in available phosphorus.*
- *Available potassium content is medium (145-337 kg/ha) in an area of about 48 per cent and 33 per cent high (>337 kg/ha) in the microwatershed.*
- *Available sulphur is medium (10-20 ppm) in about 45 per cent, low (<10 ppm) in 32 per cent and high in 4 per cent area of the microwatershed.*
- *Available boron is low (0.5 ppm) in about 5 per cent, medium (0.5-1.0 ppm) in 74 per cent and 3 per cent high (>1.0 ppm).*
- *Available iron is deficient in about 27 per cent and sufficient in 54 per cent area.*
- *Available manganese is sufficient in the entire microwatershed area.*
- *Available copper is sufficient in the entire microwatershed area.*
- *Available zinc is sufficient (>0.6 ppm) in 1 per cent and deficient (<0.6 ppm) in 80per cent area of the microwatershed.*
- *The land suitability for 23 major crops grown in the microwatershed were assessed and the areas that are highly suitable (S1) and moderately suitable (S2) are given below. It is however to be noted that a given soil may be suitable for various crops but what specific crop to be grown may be decided by the farmer looking to his capacity to invest on various inputs, marketing infrastructure, 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	133(25)	136(26)		Sapota	27(5)	119(22)
Maize	107(20)	136(26)		Jackfruit	12(2)	69(13)
Cotton	81(15)	189(35)		Jamun	12(2)	69(13)
Sunflower	81(15)	128(24)		Musambi	12(2)	69(13)
Onion	82(15)	161(30)		Lime	12(2)	69(13)
Groundnut	131(24)	177(33)		Cashew	12(2)	156(29)
Chilli	97(18)	172(32)		Custard apple	81(15)	272(51)
Sugarcane	81(15)	68(13)		Amla	81(15)	272(51)
Pomegranate	81(15)	92(17)		Tamarind	12(2)	69(13)
Tomato	97(18)	199 (37)		Marigold	97(18)	221(41)
Guava	66(12)	80(15)		Chrysanthemum	97(18)	221(41)
Mango	12(2)	69(13)				

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

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

Chapter 1

INTRODUCTION

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

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

The soil and land resource inventories made so far in Karnataka had limited utility because the surveys were of different types, scales and intensities carried out at different times with specific objectives. Hence, there is an urgent need to generate detailed site-

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

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

The land resource inventory aims to provide site specific data base for Belhatti-5 microwatershed in Shirahatti Taluk, Gadag District, Karnataka State for the Karnataka Watershed Development Department. The data base 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 Belhatti-5 Microwatershed (Belhatti subwatershed) is located in the central part of northern Karnataka in Shirahatti Taluk, Gadag District, Karnataka State (Fig.2.1). It comprises parts of Belhatti, Narayanpur, Chikksavanur, Rantur and Konchigeri villages. It lies between 15^0 03' and 15^0 06' North latitudes and 75^0 37' and 75^0 39' East longitudes and covers an area of 532 ha. It is about 60 km south of Gadag town and is surrounded by Rantur village on north, Chikksavanur village on the west, Narayanpur village on the east and Konchigeri village on the southern side.

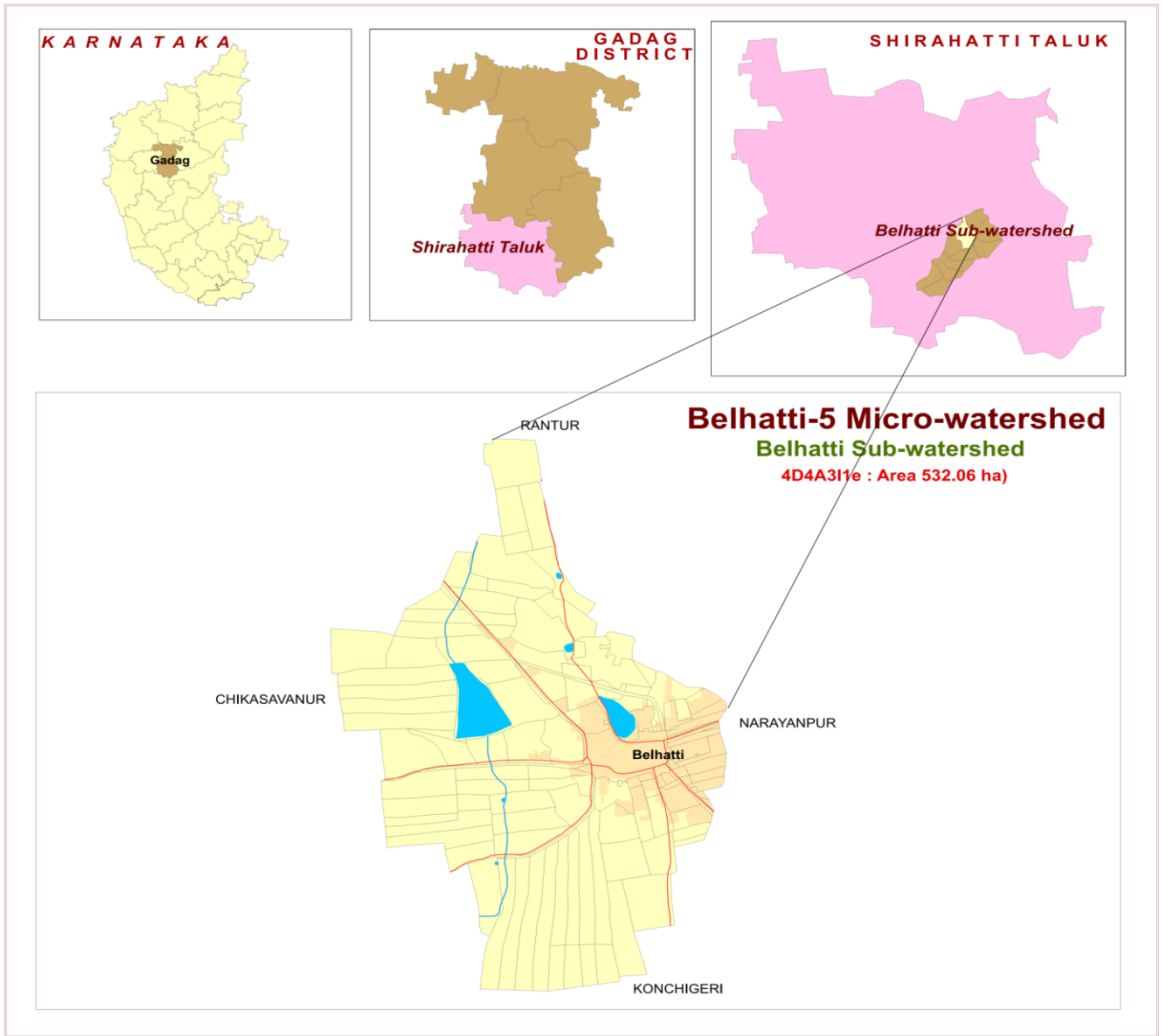


Fig.2.1 Location map of Belhatti-5 Microwatershed

2.2 Geology

Major rock formations observed in the microwatershed are granite and gneiss and Gadag Schist (Fig.2.2a & 2.2b). Granite and gneiss are essentially pink to gray and are coarse to medium grained. The gray granite gneisses are highly weathered, fractured

and fissured upto a depth of about 10 m. Schists are formed with thick coating of Banded Ferrugenous Quartzite and ridges have capping of Banded Ferrugenous Quartzite (BFQ), whereas side slopes near the streams are dominated by schist. They are fine grained and show a distinct weathering pattern similar to that of basalt. Due to fine texture of gadag schist, the soils formed from these rocks are mostly clayey in nature. The presence of iron rich banded ferrugenous quartzite is responsible for the dark red colour of the soils observed in the microwatershed.

Fig.2.2a Granite and granite gneiss rocks

Fig.2.2 b Gadag Schist rock

2.3 Physiography

Physiographically, the area has been identified as granite gneiss landscape based on geology. The microwatershed area has been further divided into mounds/ridges, summits, side slopes and very gently sloping uplands based on slope and its relief

features. The elevation ranges from 597 to 617 m in the gently sloping uplands. The mounds and ridges are mostly covered by rock outcrops.

2.4 Drainage

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

2.5 Climate

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

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

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

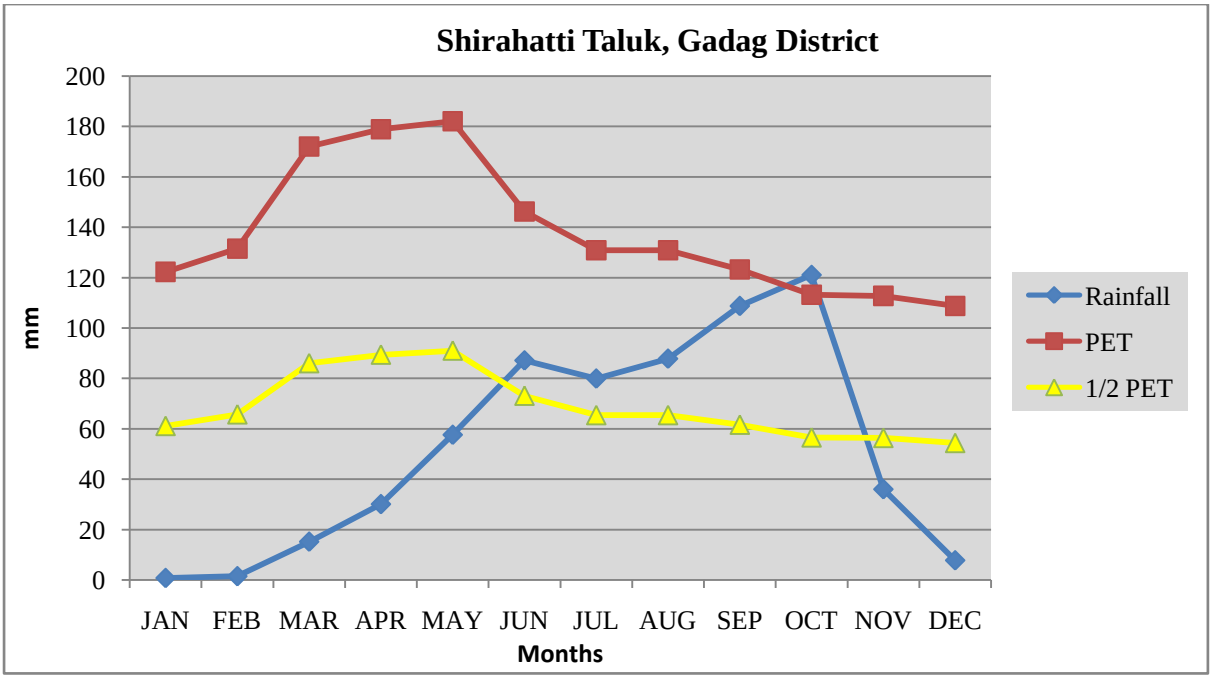


Fig. 2.3 Rainfall distribution in Shirahatti Taluk, Gadag District

2.6 Natural Vegetation

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

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

2.7 Land Utilization

About 77 per cent area (Table 2.2) in Shirahatti taluk is cultivated at present and about 14 per cent of the area is sown more than once. An area of about 17 per cent is currently barren. Forests occupy a small area of about 1.6 per cent and the tree cover is in a very poor state. Most of the mounds, ridges and bouldery areas have very poor vegetative cover. Major crops grown (Figs 2.6a &b) in the area are sorghum, maize, cotton, safflower, sunflower, red gram, horse gram, onion, mulberry, sugarcane, bengal gram, pomegranate and groundnut. While carrying out land resource inventory, the land use/land cover particulars are collected from all the survey numbers and a current land use map of the microwatershed is prepared. The current land use map prepared shows the arable and non-arable lands, other land uses and different types of crops grown in the area. The current land use map of Belhatti-5 Microwatershed is presented in Fig.2.4.

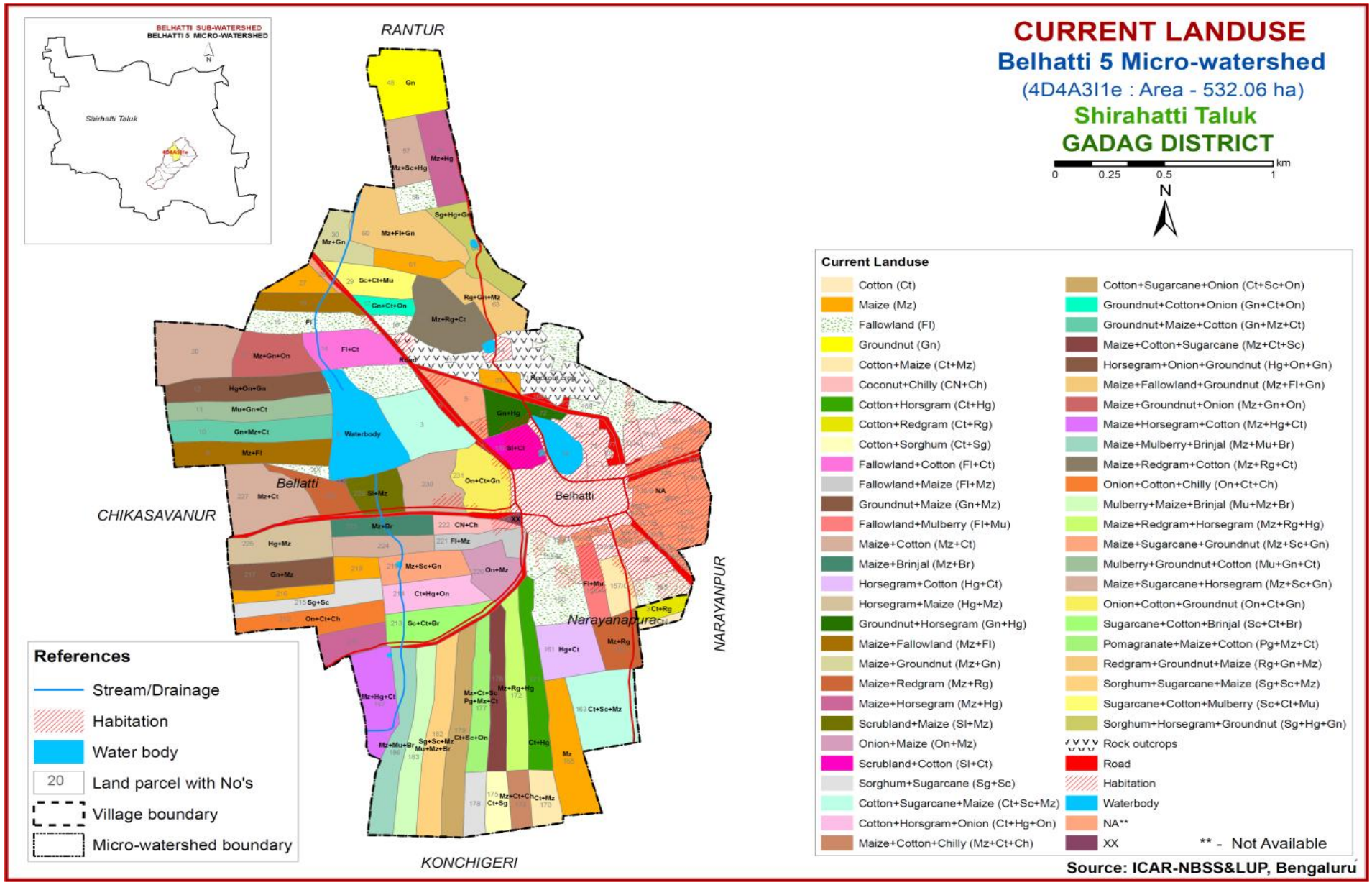


Fig.2.4 Current Land Use – Belhatti-5 Microwatershed

Simultaneously, enumeration of existing wells (bore wells and open wells) and other soil and water conservation structures in the microwatershed is made and their location in different survey numbers is located on the cadastral map. Map showing the location of wells and other water bodies in Belhatti-5 Microwatershed is given in Figure 2.5.

Table 2.2 Land Utilization in Shirahatti Taluk

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

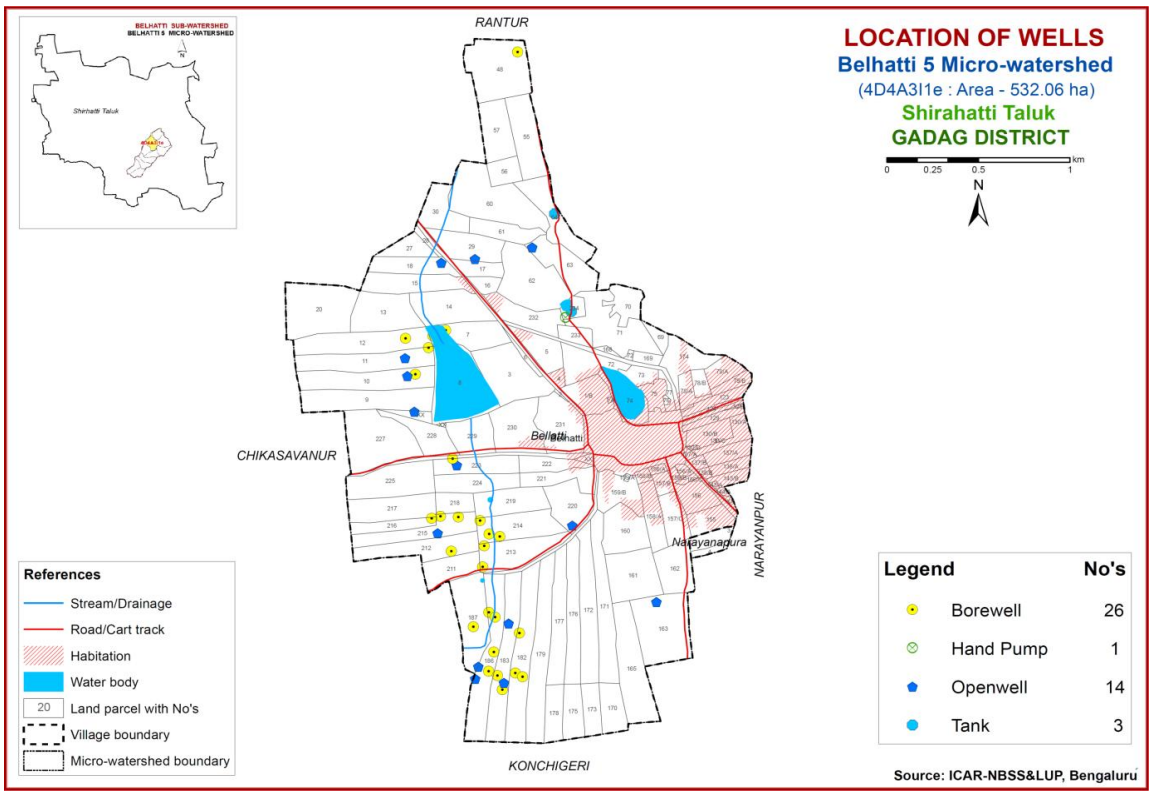


Fig.2.5 Location of Wells - Belhatti-5 Microwatershed

Fig.2.6a Different crops and cropping systems in Belhatti-5 Microwatershed

Fig.2.6 b Different crops and cropping systems in Belhatti-5 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 Belhatti-5 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, erosion, drainage, occurrence of rock fragments etc.). This was followed by grouping of similar areas based on soil-site characteristics into homogeneous (management units) units and showing their extent and geographic distribution on the microwatershed cadastral map. The detailed soil survey at 1:7920 scale was carried out in 532 ha area. The methodology followed for carrying out land resource inventory was as per the guidelines given in Soil Survey Manual (IARI, 1971; Soil Survey Staff, 2006; Natarajan *et al.,* 2015) which is briefly described below.

3.1 Base Maps

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

3.2 Image Interpretation for Physiography

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

Image Interpretation Legend for Physiography

G- Granite gneiss landscape

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

S-Schist landscape

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

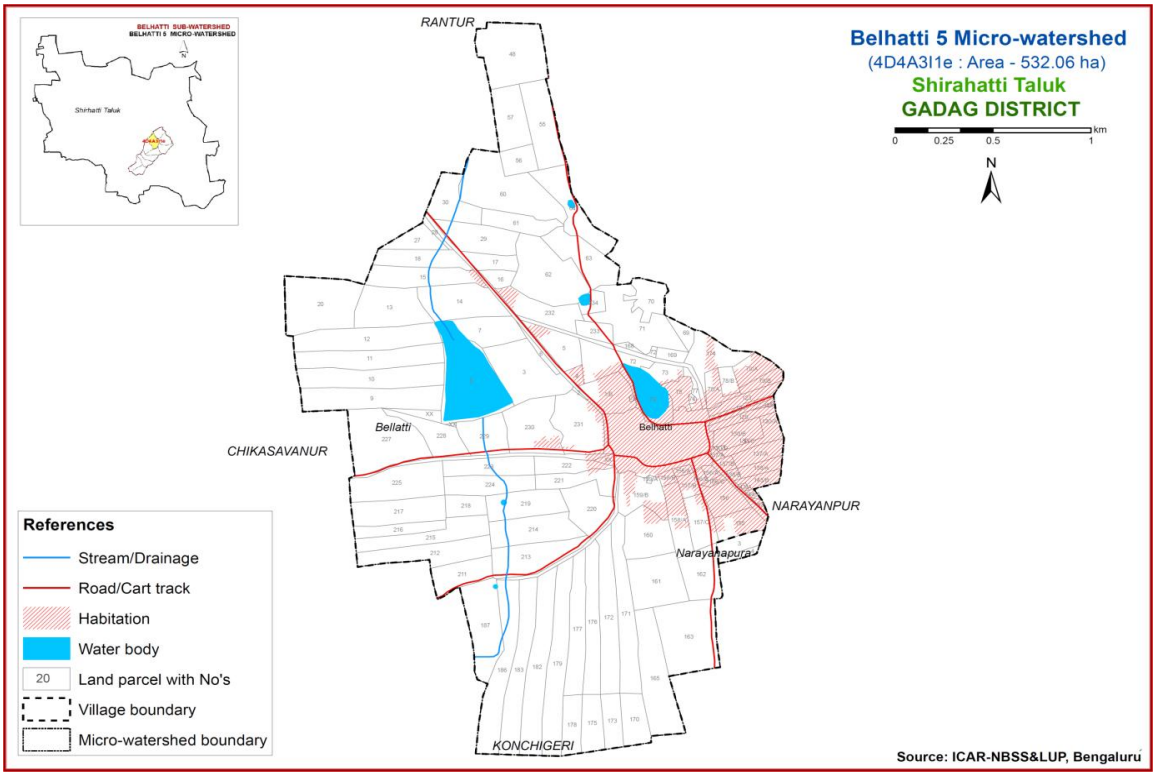


Fig 3.1 Scanned and Digitized Cadastral map of Belhatti-5 Microwatershed

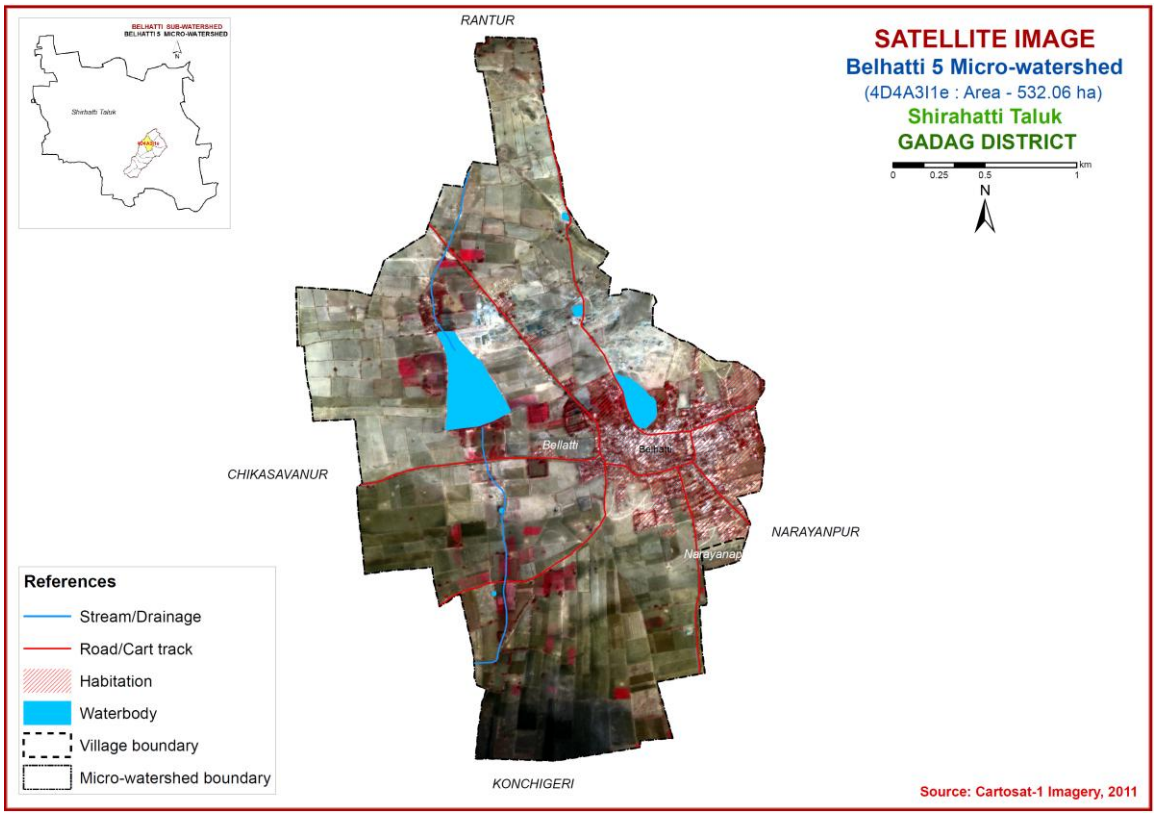


Fig.3.2 Satellite Image of Belhatti-5 Microwatershed

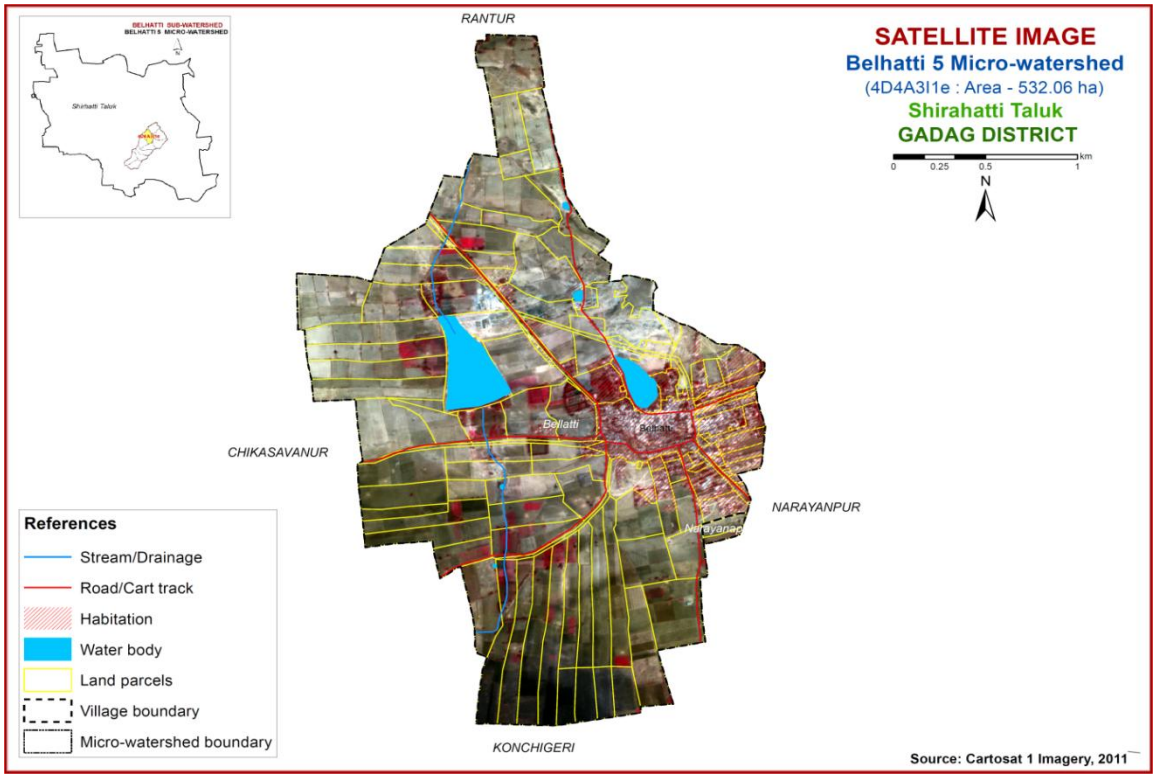


Fig.3.3 Cadastral map overlaid on IRS PAN+LISS IV merged imagery of Belhatti-5 Microwatershed

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).

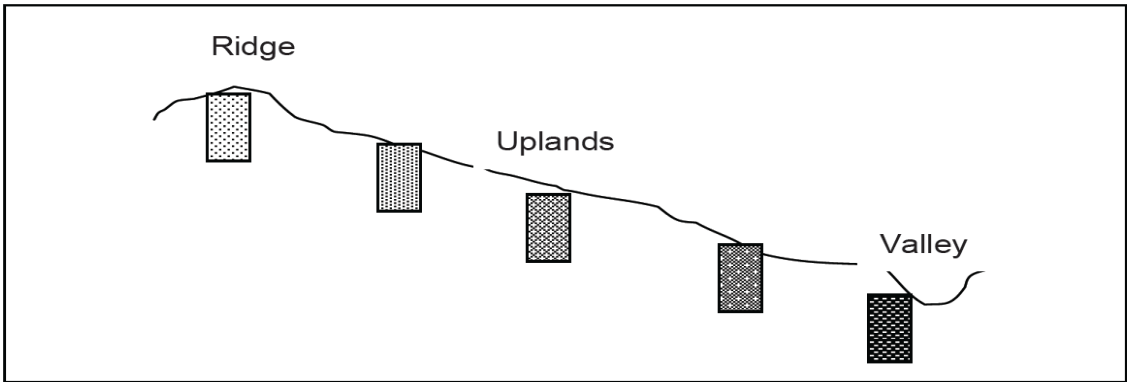


Fig: 3.4. Location of profiles in a transect

In the selected transect, soil profiles (Fig. 3.4) were located at closely spaced intervals to take care of any change in the land features like break in slope, erosion, gravel, stones etc. In the selected sites, profiles (vertical cut showing the soil layers from surface to the rock) were opened up to 200 cm or to the depth limited by rock or hard substratum and studied in detail for all their morphological and physical characteristics. The soil and site characteristics were recorded for all 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.

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 & Horizon sequence**	**Calcareousness**
1	Chikkamegheri (CKM)	75-100	2.5YR2.5/3,3/4, 3/6	sc	-	Ap-Bt-Cr	-
2	Devihal (DVH)	<25	2.5YR2.5/4 5YR3/4 ,4/6	cl	<15	Ap-Cr	-
3	Gollarahatti (GHT)	75-100	2.5YR3/4,4/6	scl	15-35	Ap-Bt-Cr	-
4	Hooradhahalli (HDH)	75-100	2.5YR2.5/4,3/4, 3/6	scl-sc	>35	Ap-Bt-Cr	-
5	Hallikere (HLK)	>150	5YR3/3,3/4 7.5YR3/3,3/4	c	<15	Ap-Bt	-
6	Honnenahalli (HNH)	50-75	7.5YR3/3,4/3 10YR3/3	sc	-	Ap-Bw-Cr	-
7	Harve (HRV)	25-50	2.5YR3/6 5YR4/4	scl	>35	Ap-Bt-Cr-	-
8	Kutegoudanahundi (KGH)	50-75	7.5YR3/2	scl	15-35	Ap-Bt-Cr	-
9	Kaggalipura (KGP)	25-50	2.5YR2.5/4	scl-sc	15-35	Ap-Bt-Cr	-
10	Kumchahalli (KMH)	100-150	2.5YR3/4, 3/6	scl-sc	<15	Ap-Bt-Cr	-
11	Kethanapura (KTP)	50-75	2.5YR3/4, 3/6	scl	15-35	Ap-Bt-Cr	-
12	Lakkur (LKR)	50-75	2.5YR3/4, 3/6	scl-sc	40-60	Ap-Bt-Bc-Cr	-
13	Thammadahalli (TDH)	50-75	2.5YR2.5/4,3/6	sc-c	-	Ap-Bt-Cr	-
14	Vaddarahalli (VDH)	100-150	7.5YR3/2,3/3,3/4	sc-c	-	Ap-Bt-Cr	-
Soils of Schist Landscape							
15	Jelligeri (JLG)	75-100	10YR2/1,2/2,3/1 7.5YR2.5/2,3/1, 3/2,3/3	c	-	Ap-Bw-Cr	-

Based on the soil characteristics, the soils were grouped into different soil series. Soil series is the most homogeneous unit having similar horizons and properties and behaves similarly for a given level of management. Soil depth, texture, colour, kind of horizon and horizon sequence, amount and nature of gravel present, 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, 15 soil series were identified in the Belhatti-5 Microwatershed.

3.4 Laboratory Characterization

Soil samples were collected from representative master profiles for laboratory characterization by following the methods outlined in the Laboratory Manual (Sarma *et al*, 1987). Surface soil samples collected from farmer's fields (70 samples) for fertility status (major and micronutrients) at 250 m grid interval were analyzed in the laboratory (Katyal and Rattan, 2003). By linking the soil fertility data to the survey numbers through GIS, soil fertility maps were generated using kriging method for the microwatershed.

3.5 Finalization of Soil Map

The area under each soil series was further separated and mapped as 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 soil map (Fig.3.5) in the form of symbols. During the survey about 20 soil 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 29 mapping units representing 15 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 29 phases mapped in the microwatershed. Each mapping unit (soil phase) delineated on the map has similar soil and site characteristics. In other words, all the farms or survey numbers included in one phase will have similar management needs and have to be treated accordingly.

The 29 soil phases identified and mapped in the microwatershed were grouped into 9 Land Use Classes (LUC's) for the purpose of preparing a proposed crop plan for sustained development of the microwatershed. The database (soil phases) generated under LRI was utilized for identifying Land Use Classes (LUCs) 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 LUCs. For Belhatti-5 Microwatershed, five soil and site characteristics, namely soil depth, soil texture, slope, erosion and gravel content have been considered for defining LUCs. The land use classes are expected to behave similarly for a given level of management.

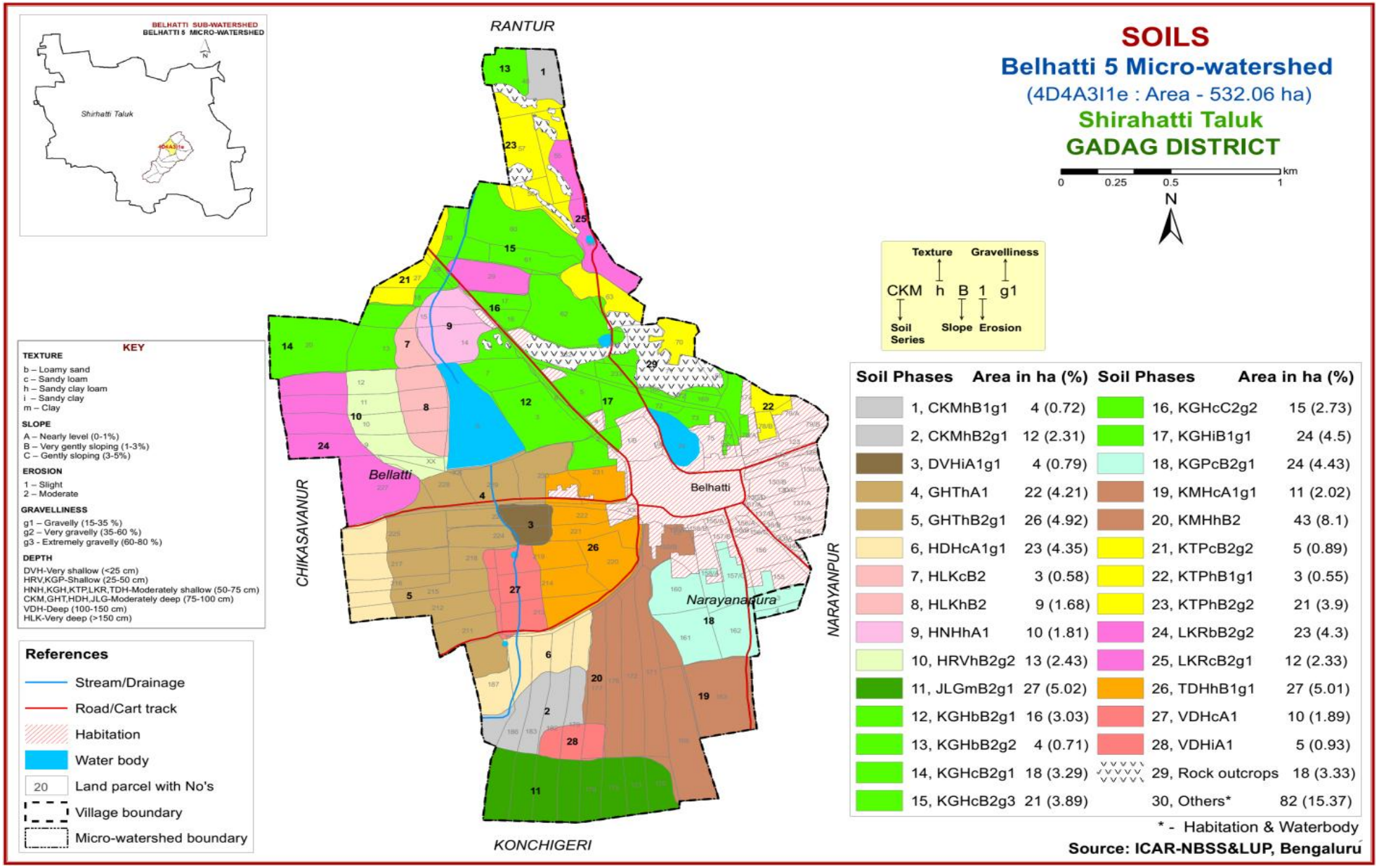


Fig 3.5 Soil Phase or Management Units- Belhatti-5 Microwatershed

Table 3.2 Soil map unit description of Belhatti-5 Microwatershed

(Soil Legend)

Sl. No.	Soil Series	Soil Phases	Mapping Unit description	Area in ha (%)
SOILS OF GRANITE GNEISS LANDSCAPE				
	CKM	Chikkamegheri soils are moderately deep (75-100 cm), well drained, have dark brown to dark reddish brown sandy clay soils occurring on nearly level to very gently sloping uplands under cultivation		**16.11 (3.03)**
1		CKMhB1g1	Sandy clay loam surface, slope 1-3%, slight erosion, gravelly (15-35%)	3.81 (0.72)
2		CKMhB2g1	Sandy clay loam surface, slope 1-3%, moderate erosion, gravelly (15-35%)	12.30 (2.31)
	DVH	Devihal soils are very shallow (< 25 cm), well drained, have dark reddish brown to yellowish red clay loam soils occurring on very gently sloping uplands under cultivation.		**4.21 (0.79)**
3		DVHiA1g1	Sandy clay surface, slope 0-1%, slight erosion, gravelly (15-35%)	4.21 (0.79)
	GHT	Gollarahatti soils are moderately deep (75-100 cm), well drained, have dark reddish brown to dark red sandy clay loam to clay soils occurring on very gently to gently sloping uplands under cultivation		**48.57 (9.13)**
4		GHThA1	Sandy clay loam surface, slope 0-1%, slight erosion	22.40 (4.21)
5		GHThB2g1	Sandy clay loam surface, slope 1-3%, moderate erosion, gravelly (15-35%)	26.17 (4.92)
	HDH	Hooradhahalli soils are moderately deep (75-100 cm), well drained, have red to dark red and reddish brown gravelly sandy clay loam to clay soils occurring on very gently to gently sloping uplands under cultivation		**23.14 (4.35)**
6		HDHcA1g1	Sandy loam surface, slope 0-1%, slight erosion, gravelly (15-35%)	23.14 (4.35)
	HLK	Hallikere soils are very deep (>150 cm), well drained, have dark brown to dark reddish brown clayey soils occurring on nearly level to very gently sloping uplands under cultivation		**12.01 (2.26)**
7		HLKcB2	Sandy loam surface, slope 1-3%, moderate erosion	3.09 (0.58)
8		HLKhB2	Sandy clay loam surface, slope 1-3%, moderate erosion	8.92 (1.68)
	HNH	Honnenahalli soils are moderately deep (50-75 cm), well drained, have brown to dark brown clay soils occurring on nearly level to very gently sloping lowlands under cultivation		**9.63 (1.18)**
9		HNHhA1	Sandy clay loam surface, slope 0-1%, slight erosion	9.63 (1.18)
	HRV	Harve soils are shallow (25-50 cm), well drained, have reddish brown to dark red sandy clay loam soils		**12.94 (2.43)**

		occurring on very gently to moderately sloping uplands under cultivation		
10		HRVhB2g2	Sandy clay loam surface, slope 1-3%, moderate erosion, very gravelly (35-60%)	12.94 (2.43)
	KGH	Kutegoudanahundi soils are moderately shallow (50-75 cm), well drained, have brown to dark brown loamy sand to sandy loam soils occurring on very gently to gently sloping uplands under cultivation		**96.52 (18.15)**
11		KGHbB2g1	Loamy sand surface, slope 1-3%, moderate erosion, gravelly (15-35%)	16.10 (3.03)
12		KGHbB2g2	Loamy sand surface, slope 1-3%, moderate erosion, very gravelly (35-60%)	3.76 (0.71)
13		KGHcB2g1	Sandy loam surface, slope 1-3%, moderate erosion, gravelly (15-35%)	17.52 (3.29)
14		KGHcB2g3	Sandy loam surface, slope 1-3%, moderate erosion, extremely gravelly (60-80%)	20.70 (3.89)
15		KGHcC2g2	Sandy loam surface, slope 3-5%, moderate erosion, very gravelly (35-60%)	14.51 (2.73)
16		KGHiB1g1	Sandy clay surface, slope 1-3%, slight erosion, gravelly (15-35%)	23.93 (4.50)
	KGP	Kaggalipura soils are shallow (25-50 cm), well drained, have brown to dark reddish brown sandy clay loam to sandy clay soils occurring on very gently sloping uplands under cultivation		**23.57 (4.43)**
17		KGPcB2g1	Sandy loam surface, slope 1-3%, moderate erosion, gravelly (15-35%)	23.57 (4.43)
	KMH	Kumchahalli soils are deep (100-150 cm), well drained, have dark reddish brown to dark red sandy clay loam to sandy clay soils occurring on nearly level to very gently sloping uplands under cultivation		**53.83 (10.12)**
18		KMHcA1g1	Sandy loam surface, slope 0-1%, slight erosion, gravelly (15-35%)	10.74 (2.02)
19		KMHhB2	Sandy clay loam surface, slope 1-3%, moderate erosion	43.09 (8.10)
	KTP	Kethanapura soils are moderately shallow (50-75 cm), well drained, have dark reddish brown gravelly sandy loam soils occurring on very gently to gently sloping uplands under cultivation		**28.46 (5.34)**
20		KTPcB2g2	Sandy loam surface, slope 1-3%, moderate erosion, very gravelly (35-60%)	4.74 (0.89)
21		KTPhB1g1	Sandy clay loam surface, slope 1-3%, slight erosion, gravelly (15-35%)	2.95 (0.55)
22		KTPhB2g2	Sandy clay loam surface, slope 1-3%, moderate erosion, very gravelly (35-	20.77 (3.90)

			60%)	
	LKR	Lakkur soils are moderately shallow (50-75 cm), well drained, have reddish brown to dark red gravelly sandy clay loam to sandy clay red soils occurring on nearly level to gently and moderately sloping uplands under cultivation		**35.26 (6.63)**
23		LKRbB2g2	Loamy sand surface, slope 1-3%, moderate erosion, gravelly (35-60%)	22.86 (4.30)
24		LKRcB2g1	Sandy loam surface, slope 1-3%, moderate erosion, gravelly (15-35%)	12.40 (2.33)
	TDH	Thammadahalli soils are moderately shallow (50–75 cm), well drained, have brown to very dark brown and dark reddish brown sandy loam to clay loam soils occurring on nearly level to gently sloping uplands under cultivation		**26.64 (5.01)**
25		TDHhB1g1	Sandy clay loam surface, slope 1-3%, slight erosion, gravelly (15-35%)	26.64 (5.01)
	VDH	Vaddarahalli soils are deep (100 - 150 cm), well drained, have dark reddish brown to dark brown clayey soils occurring on nearly level to very gently sloping uplands under cultivation		**14.97 (2.82)**
26		VDHcA1	Sandy loam surface, slope 0-1%, slight erosion	10.03 (1.89)
27		VDHiA1	Sandy clay surface, slope 0-1%, slight erosion	4.94 (0.93)
SOILS OF SCHIST LANDSCAPE				
	JLG	Jelligeri soils are moderately deep (75-100 cm), moderately well drained, very dark brown to dark brown and black cracking clay soils occurring on very gently sloping uplands under cultivation		**26.69 (5.02)**
28		JLGmB2g1	Clay surface, slope 1-3%, moderate erosion, gravelly (15-35%)	26.69 (5.02)
29	Rock outcrops	Rock lands, both massive and bouldery		49.91 (15.35)

Chapter 4

THE SOILS

Detailed information pertaining to the nature, extent and distribution of different kinds of soils occurring in Belhatti-5 Microwatershed is provided in this chapter. The microwatershed area has been identified as granite gneiss landscape based on geology. In all, 15 soil series are identified. Soil formation is the result of the combined effect of environmental and terrain factors that are reflected in soil morphology. The soil formation is dominantly influenced by the parent material, climate and relief.

A brief description of each of the 15 soil series identified followed by the soil phases (management units) identified and mapped under each series (Fig. 3.4) are furnished below. The soils in any one map unit differ from place to place in their depth, texture, slope, gravelliness, erosion or any other site characteristic that affect management. The soil phase map can be used for identifying the suitability of areas for growing specific crops or for other alternative uses and also for deciding the type of conservation structures needed. The detailed information on soil and site-characteristics like soil depth, surface soil texture, slope, erosion, gravelliness, AWC, LCC etc, with respect to each of the soil phase identified is given village/survey number wise for the microwatershed in Appendix-I.

4.1 Soils of Granite Gneiss Landscape

In this landscape, 15 soil series are identified and mapped. Of these, Kutegoudanahundi (KGH) soil series occupies maximum area of about 96 ha (18%) and Kumchahalli (KMH) 54 ha (10%) area. The brief description of each soil series identified in the microwatershed are given below.

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

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

Landscape and soil profile characteristics of Chikkamegheri (CKM) Series

4.1.2 Devihal (DVH) Series: Devihal soils are very shallow (< 25 cm), well drained, have dark reddish brown to yellowish red clay loam soils. They have developed from granite gneiss and occur on very gently sloping uplands. The Devihal series has been tentatively classified as a member of the fine, mixed, isohyperthermic family of Typic Ustorthents.

Landscape and soil profile characteristics of Devihal (DVH) Series

The thickness of the soil ranges from 11 to 25 cm. The thickness of A horizon ranges from 7 to 19 cm. Its colour is in 7.5 YR, 5YR and 2.5 YR hue with value 2.5 to 6 and chroma 3 to 6. The texture varies from sandy clay loam to clay loam with 10 to 20 per cent gravel. The available water capacity is very low (<50 mm/m). Only one phase was identified and mapped.

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

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

Landscape and soil profile characteristics of Gollarahatti (GHT) Series

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

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

4.1.5 Hallikere (HLK) Series: Hallikere soils are very deep (>150 cm), well drained, have dark brown and dark reddish brown clayey soils. They have developed from granite gneiss and occur on nearly level to very gently sloping uplands. The Hallikere series has been tentatively classified as a member of the fine, mixed, isohyperthermic family of Typic Paleustalfs.

The thickness of the solum is more than 150 cm. The thickness of A horizon ranges from 11 to 14 cm. Its colour is in 7.5 YR and 5 YR hue with value 3 to 4 and chroma 3 to 4. The texture varies from sandy loam to sandy clay loam. The thickness of B horizon is more than 150 cm. Its colour is in 7.5 YR and 5 YR hue with value and chroma 3 to 4. Its texture is clay. The available water capacity is high (150-200 mm/m). Two phases were identified and mapped.

Landscape and soil profile characteristics of Hallikere (HLK) Series

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

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

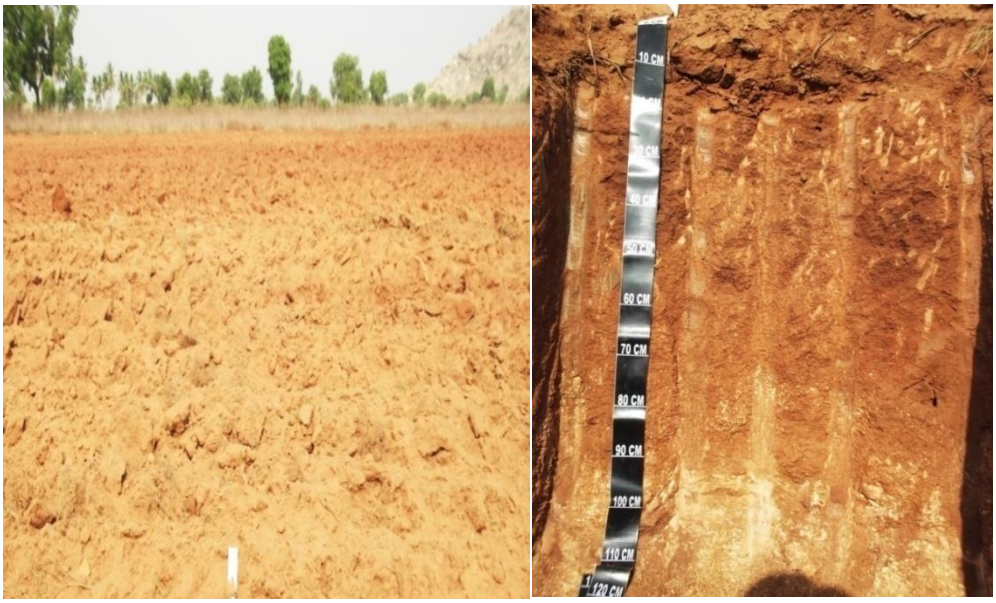
4.1.7 Harve (HRV) Series: Harve soils are shallow (25-50 cm), well drained, have reddish brown to dark red sandy clay loam soils. They have developed from granite gneiss and occur on very gently to moderately sloping uplands. The Harve series has been tentatively classified as a member of the loamy-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

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

Landscape and soil profile characteristics of Harve (HRV) Series

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

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



Landscape and soil profile characteristics of Kutegoudanahundi (KGH) Series

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

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

Landscape and soil profile characteristics of Kaggalipura (KGP) Series

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

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

Landscape and soil profile characteristics of Kumchahalli (KMH) Series

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

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

Landscape and soil profile characteristics of Kethanapura (KTP) Series

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

Landscape and soil profile characteristics of Lakkur (LKR) Series

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

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

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

Landscape and soil profile characteristics of Thammadahalli (TDH) Series

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

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

Landscape and soil profile characteristics of Vaddarahalli (VDH) Series

4.2 Soils of Schist Landscape

In this landscape, only one soil series (Jelligeri) are identified and mapped. It covers about 27 ha in the microwatershed. The brief description of Jelligeri (JLG) series identified and mapped as one soil phase is given below.

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

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

Landscape and soil profile characteristics of Jelligeri (JLG) Series

Chapter 5

INTERPRETATION FOR LAND RESOURCE MANAGEMENT

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

5.1 Land Capability Classification

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

Soil characteristics: Depth, texture, gravel content, 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 wind mills.

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

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

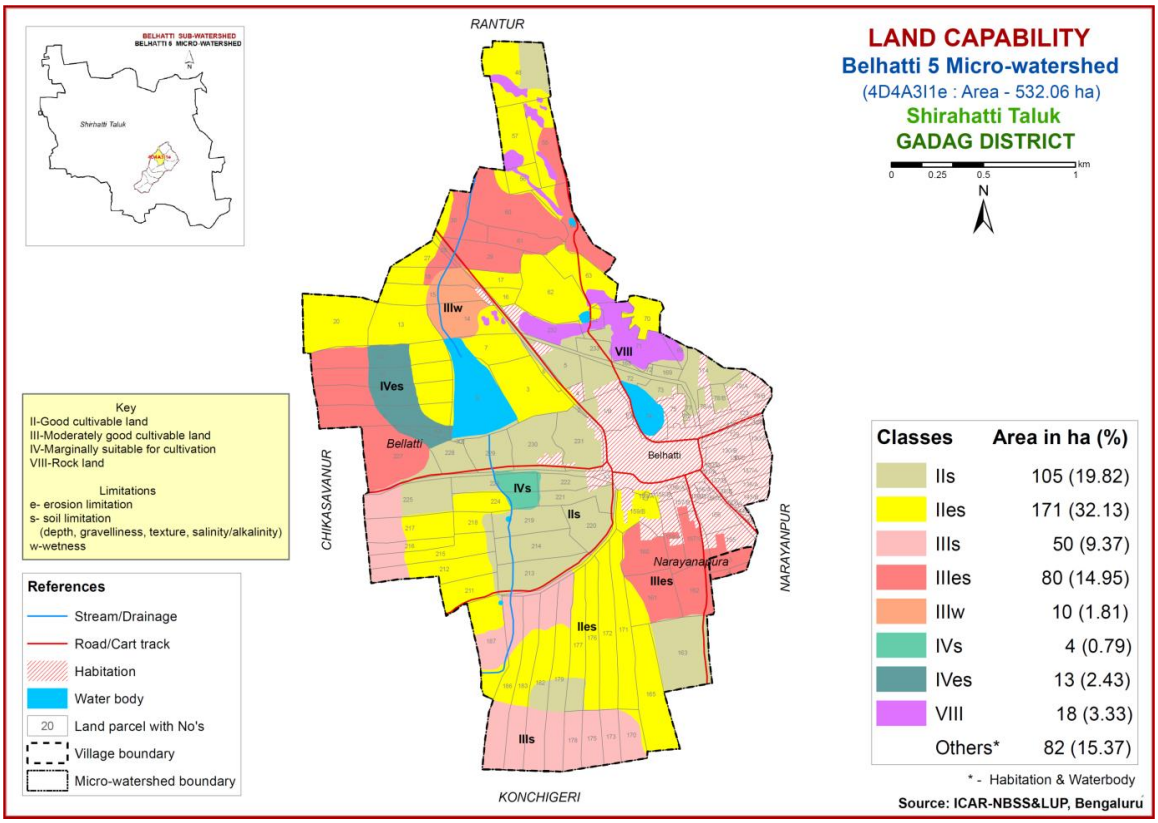


Fig. 5.1 Land Capability map of Belhatti-5 Microwatershed

The 29 soil map units identified in the Belhatti-5 microwatershed are grouped under 4 land capability classes and 8 land capability subclasses. An area of about 81per cent in the microwatershed is suitable for agriculture and 19 per cent is not suitable for agriculture (Fig. 5.1).

Good cultivable lands (Class II) cover an area of about 276 ha (52%) and are distributed in all parts of the micowatershed with minor problems of soil and erosion. Moderately good cultivable lands (Class III) cover an area of about 140 ha (26%) and are distributed in the western, northeastern, eastern and southern part of the microwatershed with moderate problems of erosion, soil and wetness. Marginally suitable (Class IV) lands occupy 17 ha (3%) and occur in the central part of the microwatershed. The Class VIII lands cover an area of about 18 ha (3%) that are miscellaneous lands (rock lands) not suitable for agriculture and occur in the northeastern part of the microwatershed.

5.2 Soil Depth

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

Very shallow soils (<25 cm) occupy a very small area of about 4 ha (1%) and occur in the central part of the microwatershed. Moderately shallow soils (50-75 cm) occupy maximum area of about 197 ha (37%) in the northern, northeastern, central, southern and western part of the microwatershed. Shallow (25-50 cm) soils occupy an area of about 37 ha (7%) and are distributed in the central and southeastern part of the microwatershed. Moderately deep (75-100 cm) soils occupy an area of about 115 ha (21%) and are distributed in the southwestern and southern part of the microwatershed. Deep (100-150 cm) soils cover about 69 ha (13%) and occur in the southeastern and central part of the microwatershed. Very deep soils (>150 cm) occupy a very small area of about 12 ha (2%) and occur in the central part of the microwatershed.

The most problem lands with an area of about 41 ha (8%) having shallow (25-50 cm) to very shallow (<25 cm) rooting depth occur in central and southeastern part of the microwatershed. They are not suitable for growing agricultural crops but well suited for pasture, forestry or other recreational purposes. Occasionally, short duration crops may be grown if rainfall is normal. The productive soils (36%) that are moderately deep to very deep (75-150 cm) have the potential for growing all climatically adopted annual and perennial crops.

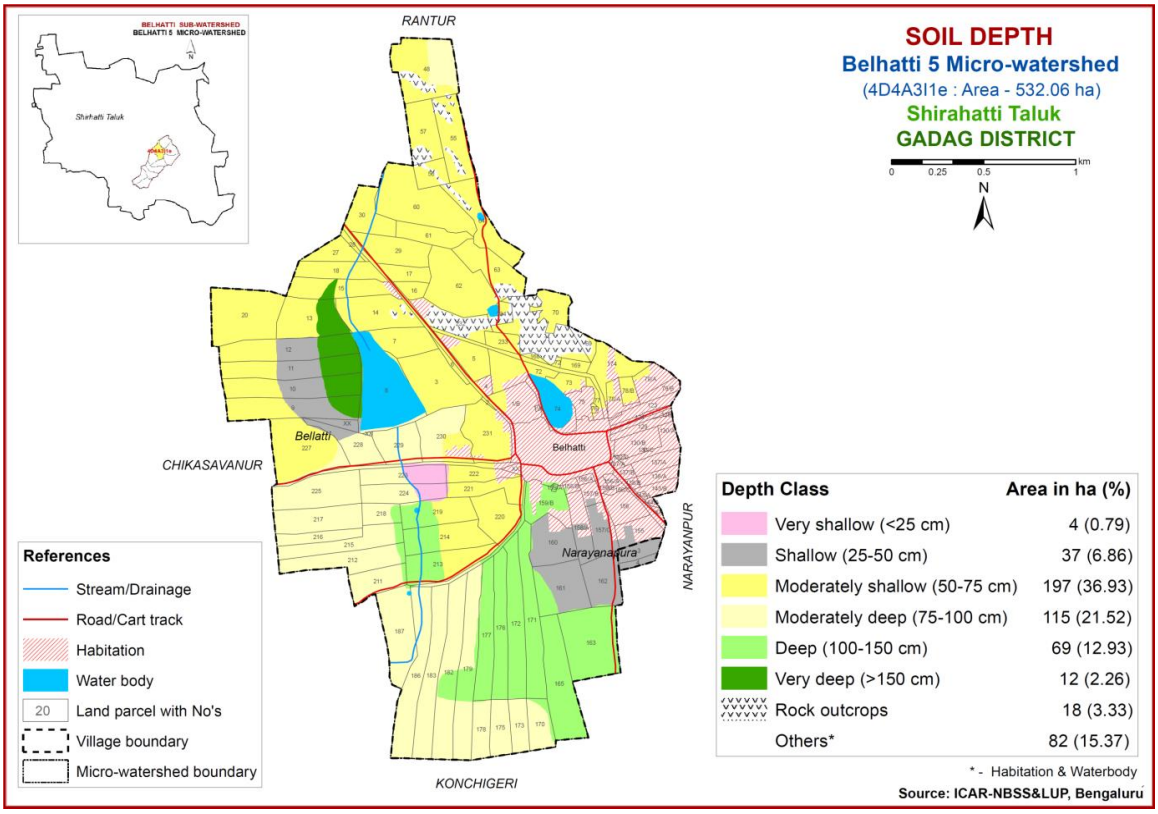


Fig. 5.2 Soil Depth map of Belhatti-5 Microwatershed

5.3 Surface Soil Texture

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

An area of about 43 ha (8%) has soils that are sandy at the surface and occur in the western, central and northern part of the microwatershed. Maximum area of 330 ha (62%) has soils that are loamy at the surface and are distributed in all parts of the microwatershed. Clayey soils occupy an area of about 60 ha (11%) and occur in the southern, central and northeastern part of the microwatershed (Fig. 5.3).

The most productive lands (73%) with respect to surface soil texture are the loamy and clayey soils that have high potential for soil-water retention and availability, and nutrient retention and availability, but clayey soils have problems of drainage, infiltration, workability and other physical problems.

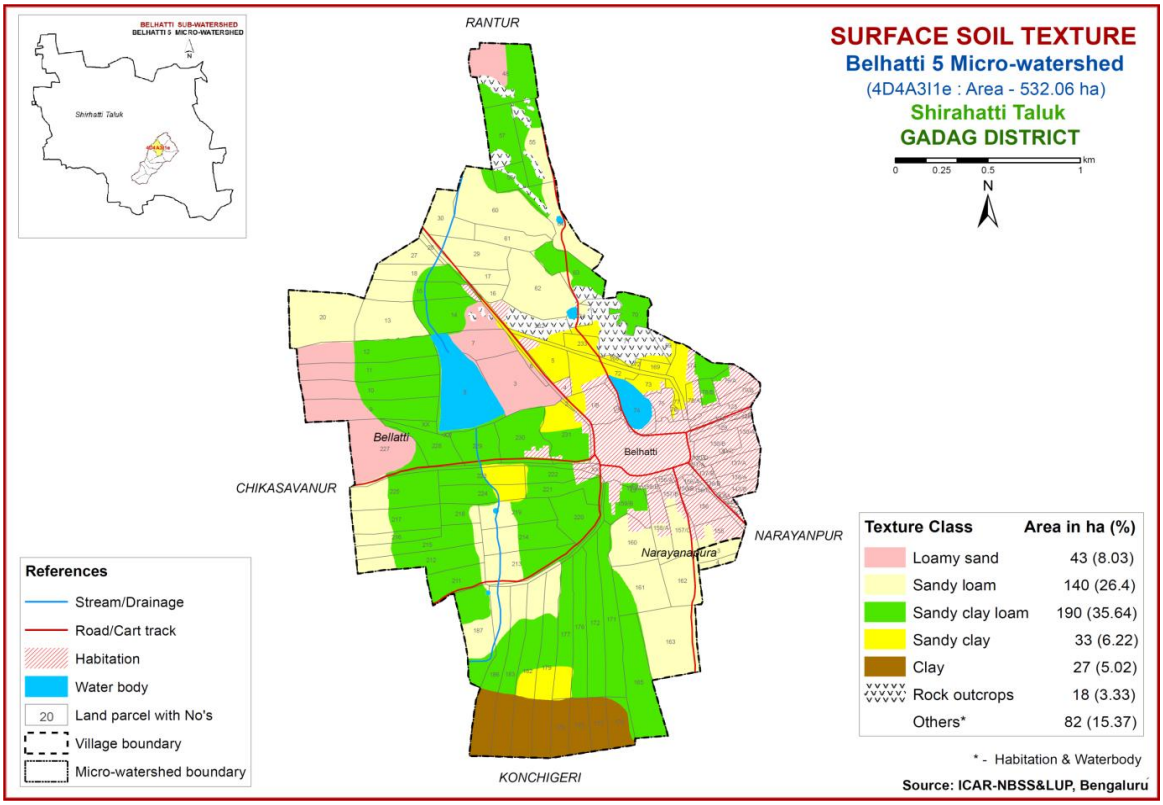


Fig. 5.3 Surface Soil Texture map of Belhatti-5 Microwatershed

5.4 Soil Gravelliness

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

About 80 ha (15%) area in the microwatershed has soils that are very gravelly (35-60%) and are distributed in the western, northwestern and northeastern part of the microwatershed (Fig. 5.4). An area of about 21 ha (4%) is extremely gravelly soils (60-80%) and occur in the northwestern part of the microwatershed. Maximum area of 230 ha (43%) is covered by gravelly (15-35%) soils and are distributed in all parts of the microwatershed. The soils that are non-gravelly (<15%) cover an area of about 102 ha (19%) and are distributed in the central and southeastern part of the microwatershed.

The most productive lands with respect to gravelliness are found to be 102 ha (19%). The problem soils that are very gravelly (35-60%) to extremely gravelly (60-80%) cover about 19 per cent where only short duration crops can be grown.

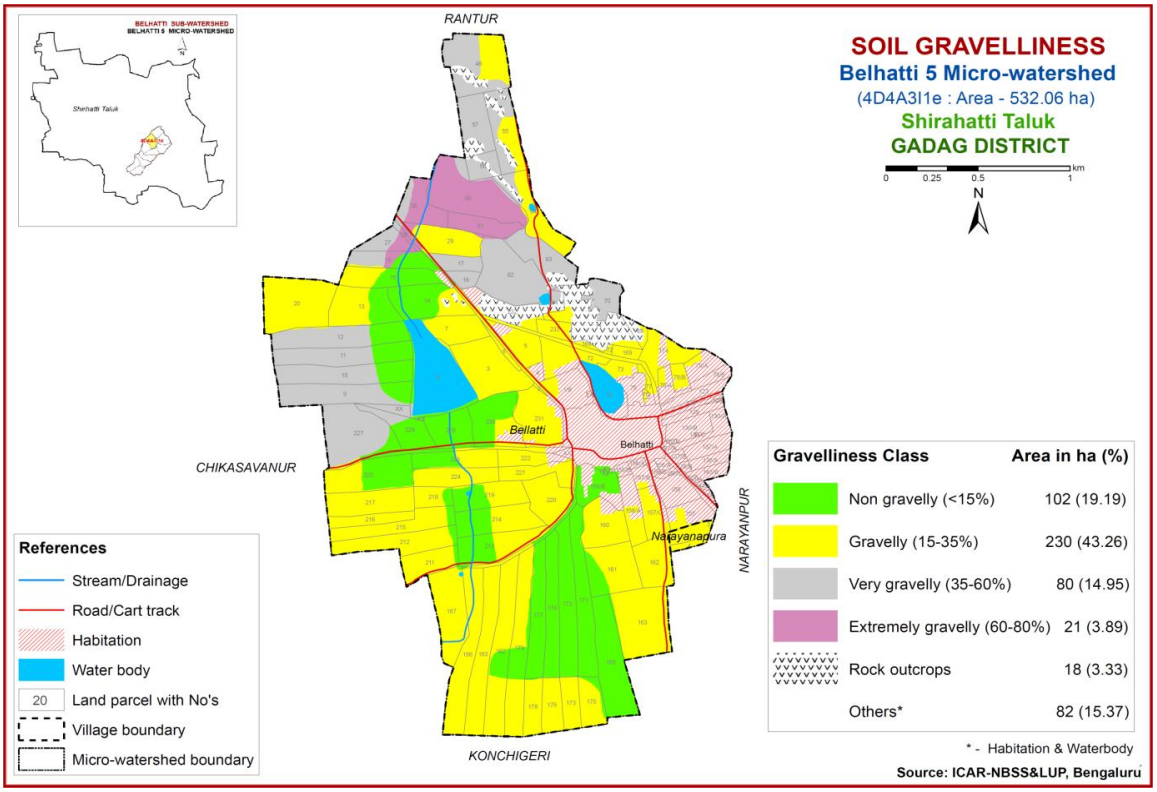


Fig. 5.4 Soil Gravelliness map of Belhatti-5 Microwatershed

5.5 Available Water Capacity

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

An area of about 99 ha (19%) in the microwatershed has soils that are very low (<50 mm/m) in available water capacity and are distributed in the western, central and southeastern part of the microwatershed. An area of about 226 ha (42%) is low (51-100 mm/m) in available water capacity and are distributed in the northwestern, northern, central and northeastern part of the microwateshed. An area of about 108 ha (20%) is medium (101-150 mm/m) in available water capacity and are distributed in the southern and central part of the microwatershed.

An area of about 325 ha (61%) in the microwatershed has soils that are problematic with regard to available water capacity. Here, only short or medium duration crops can be grown and the probability of crop failure is very high. These areas are best put for other alternative uses.

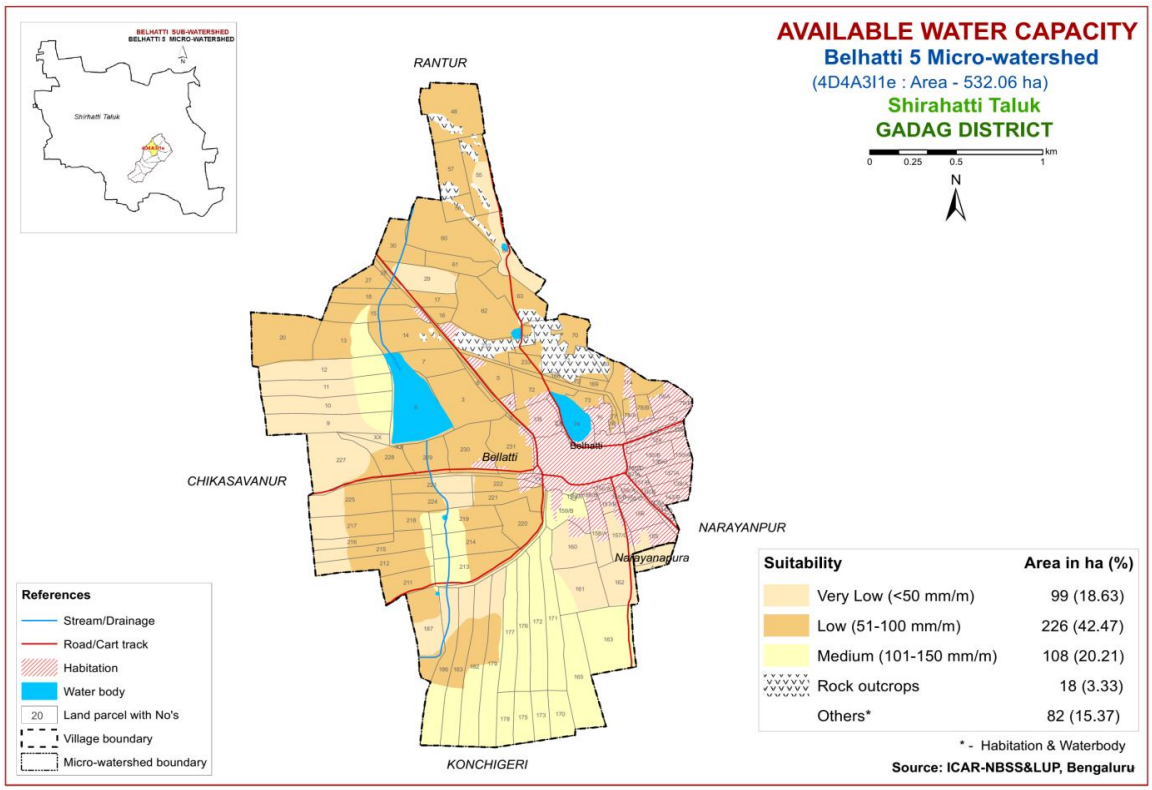


Fig. 5.5 Soil Available Water Capacity map of Belhatti-5 Microwatershed

5.6 Soil Slope

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

Maximum area of about 333 ha (63%) falls under very gently sloping (1-3% slope) lands and is distributed in all parts of the microwatershed. Gently sloping (3-5%) lands occupy an area of about 15 ha (3%) and occur in the central part of the microwatershed. An area of about 85 ha (16%) is nearly level (0-1%) lands and are distributed in the southwestern, central and southeastern part of the microwatershed.

In these very gently sloping and nearly level areas (79%), all climatically adapted annual and perennial crops can be grown without much soil and water conservation and other land development measures.

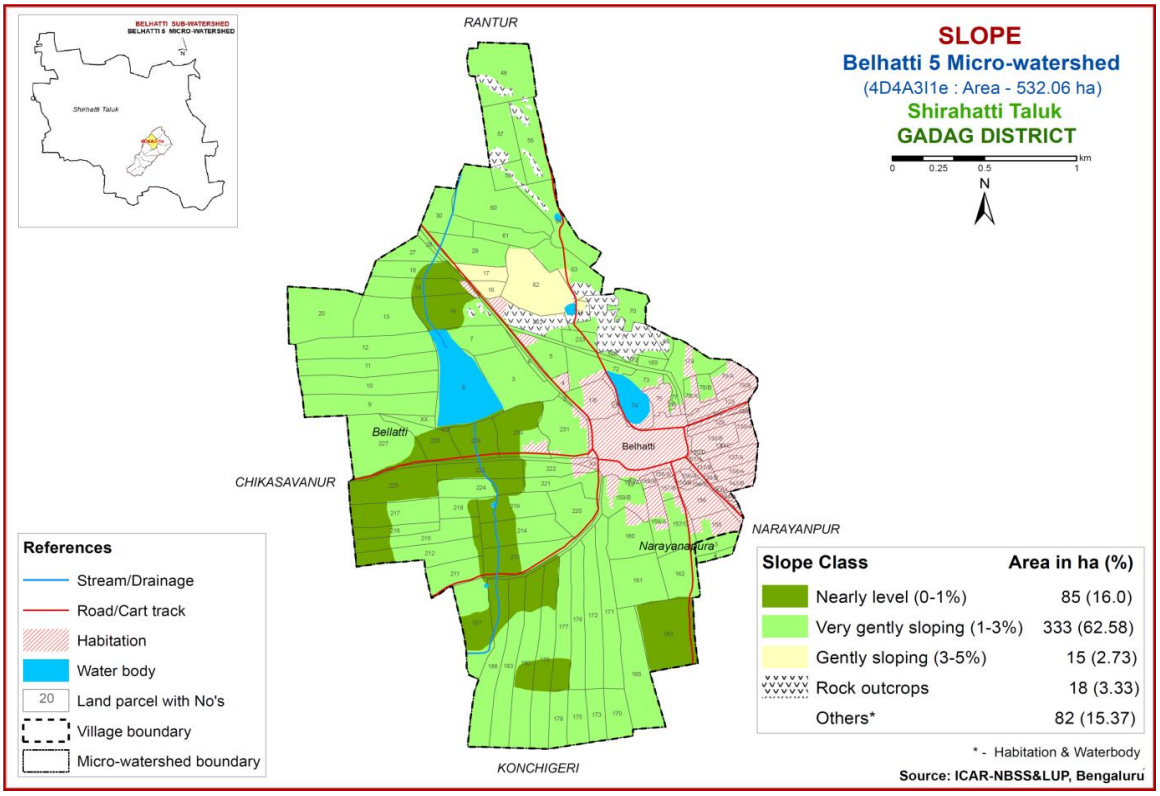


Fig. 5.6 Soil Slope map of Belhatti-5 Microwatershed

5.7 Soil Erosion

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

Soils that are moderately eroded (e2 class) cover maximum area of about 290 ha (54%) in the microwatershed. They are distributed in all part of the microwatershed. Slightly eroded (e1 class) soils cover an area of about 142 ha (27%) and are distributed in the southwestern, central, northwestern and southeastern part of the microwatershed.

The problem lands covering 290 ha (54%) with respect to erosion are moderately eroded areas. These need appropriate soil and water conservation and, other land development measures to restore soil-health.

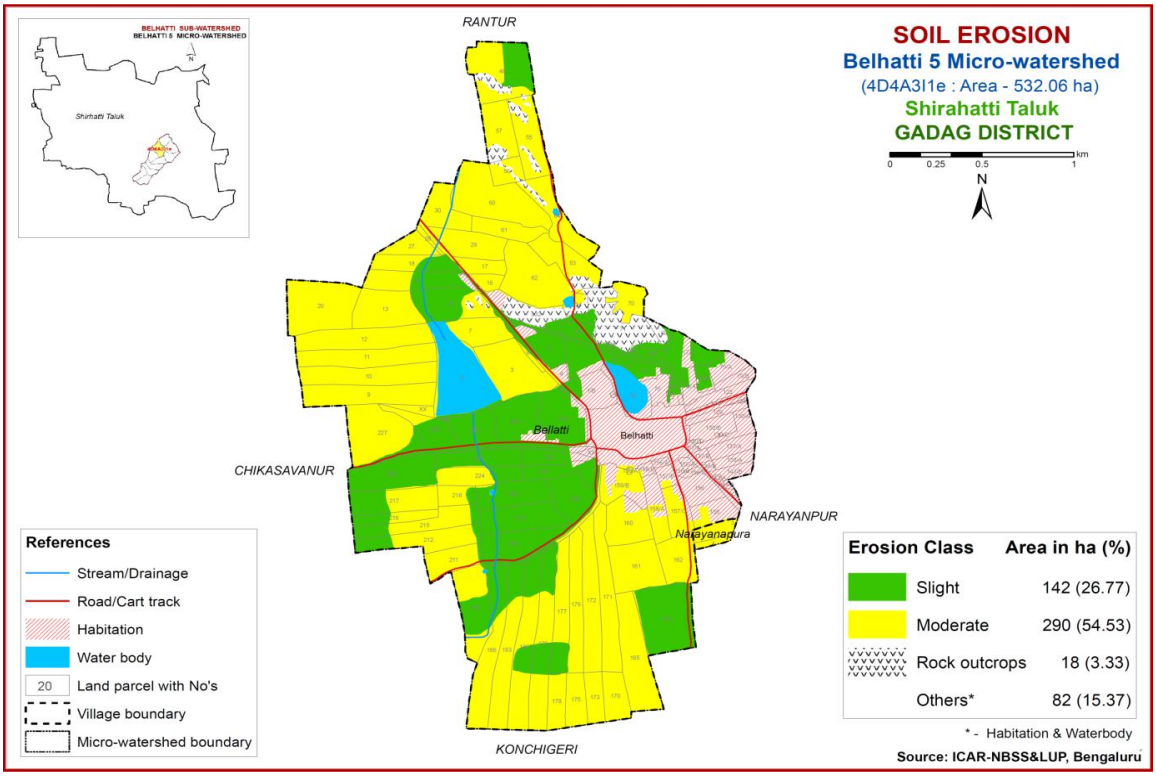


Fig. 5.7 Soil Erosion map of Belhatti-5 Microwatershed

Chapter 6

FERTILITY STATUS

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

Soil fertility data generated has been assessed and individual maps for all the nutrients for the microwatershed have been generated using krigging method under GIS.

6.1 Soil Reaction (pH)

The soil analysis of the Belhatti-5 microwatershed for soil reaction (pH) showed that an area of about 184 ha (34%) is moderately alkaline (pH 7.8-8.4) and is distributed in the northern, western, central and southern part of the microwatershed and 38 ha (7%) is under strongly alkaline (pH 8.4-9.0) and occur in the southwestern and central part of the microwatershed. An area of about 96 ha (18%) is under neutral (pH 6.5 -7.3) and occur in the western, northeastern and central part of the microwatershed. Slightly alkaline (pH 7.3-7.8) soils occupy an area of about 114 ha (21%) and are distributed in the central and southwestern part of the microwatershed (Fig.6.1).

6.2 Electrical Conductivity (EC)

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

6.3 Organic Carbon

The soil organic carbon content (an index of available Nitrogen) of the soils of the microwatershed is medium (0.5-0.75%) covering maximum area of about 203 ha (38%) and is distributed in the northern, western and central the part of the microwatershed. An area of 60 ha (11%) is high (>0.5%) in organic carbon content and occur in the southwestern and southeastern part of the microwatershed. An area of 170 ha (32%) is low in organic carbon and are distributed in the northern and western part of the microwatershed (Fig.6.3).

6.4 Available Phosphorus

Available phosphorus content of the soils is low (<23 kg/ha) in an area of about 94 ha (18%) and occur in the northern, southern and northwestern part of the microwatershed. Major area of 333 ha (62%) is medium (23-57 kg/ha) and are distributed in all parts of the microwatershed and a very small area of about 5 ha (1%) is high (>57 kg/ha) and occur in the central part of the microwatershed (Fig 6.4).

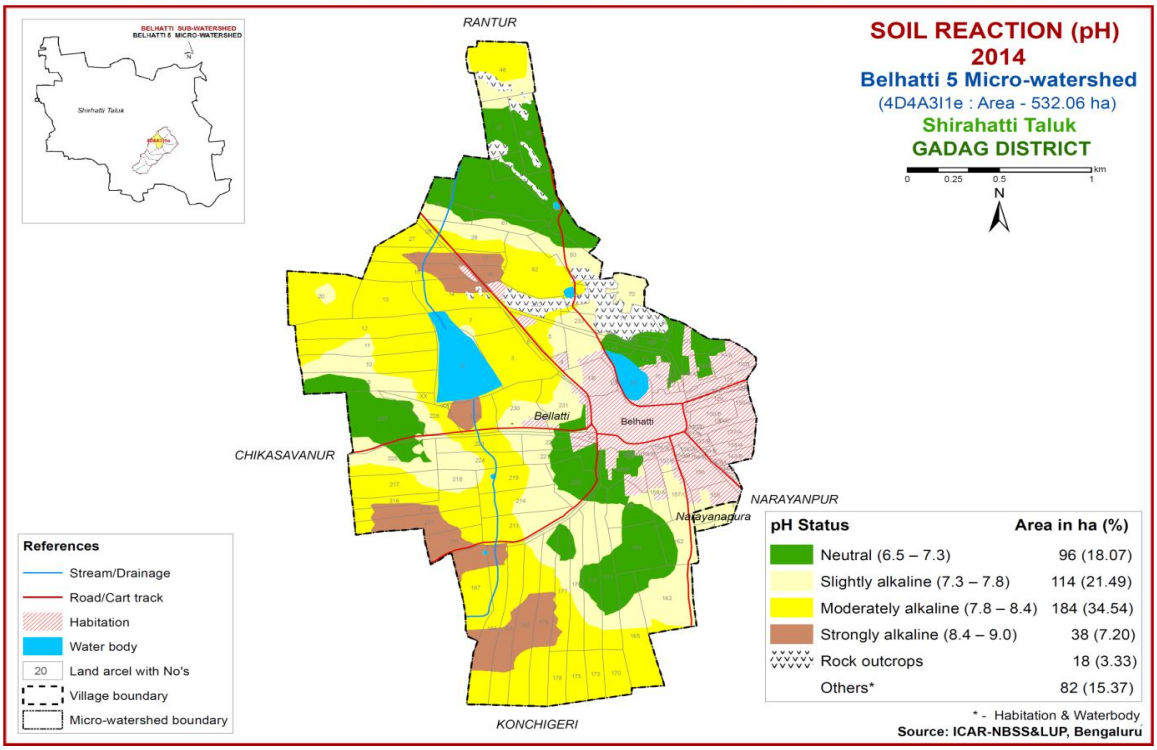


Fig.6.1 Soil Reaction (pH) map of Belhatti-5 Microwatershed

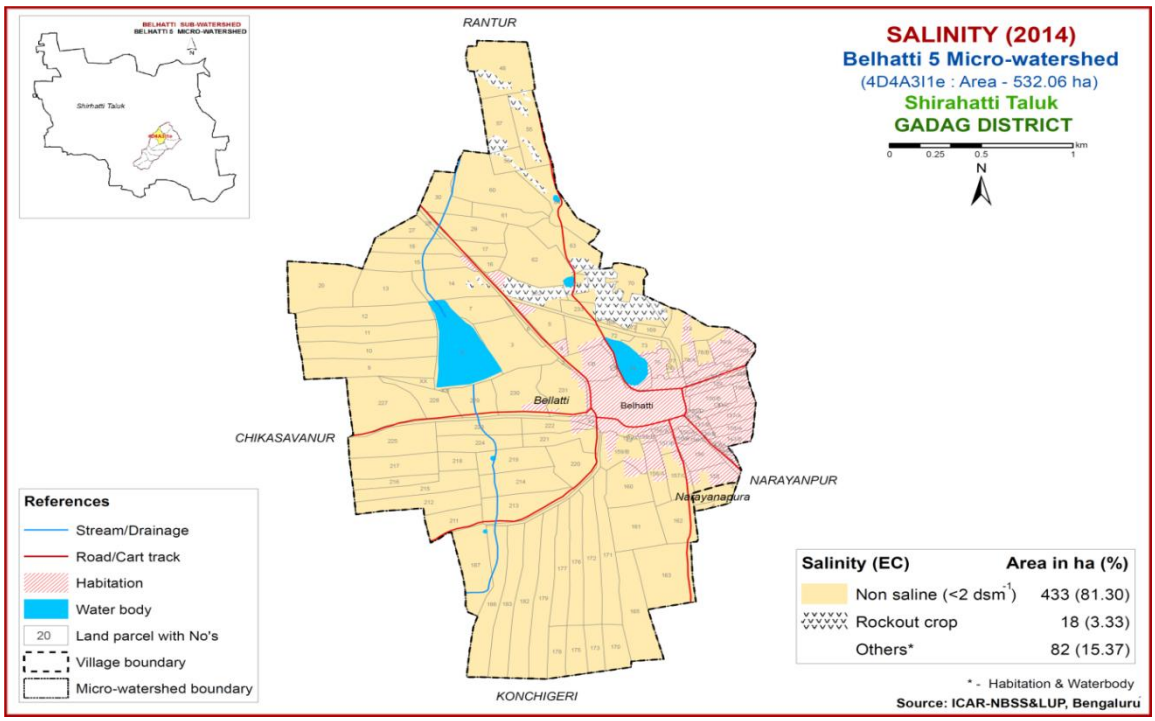


Fig.6.2 Electrical Conductivity (EC) map of Belhatti-5 Microwatershed

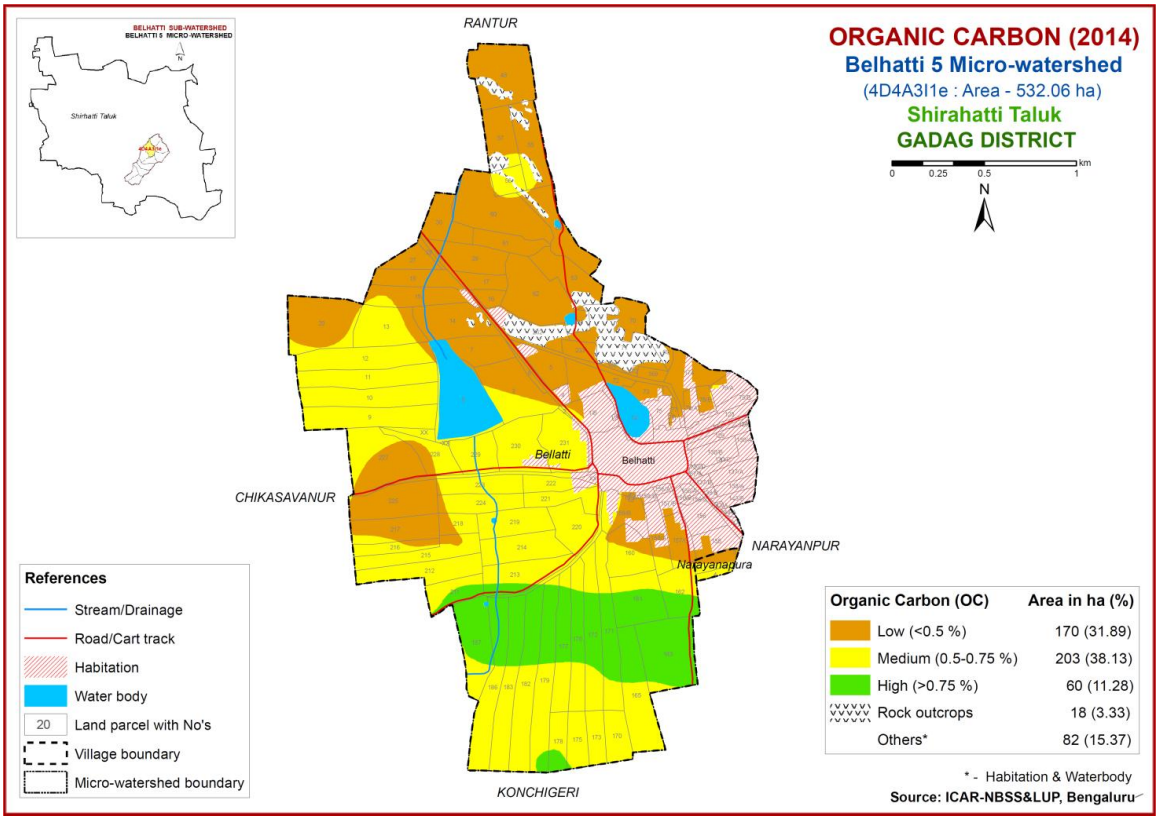


Fig.6.3 Soil Organic Carbon map of Belhatti-5 Microwatershed

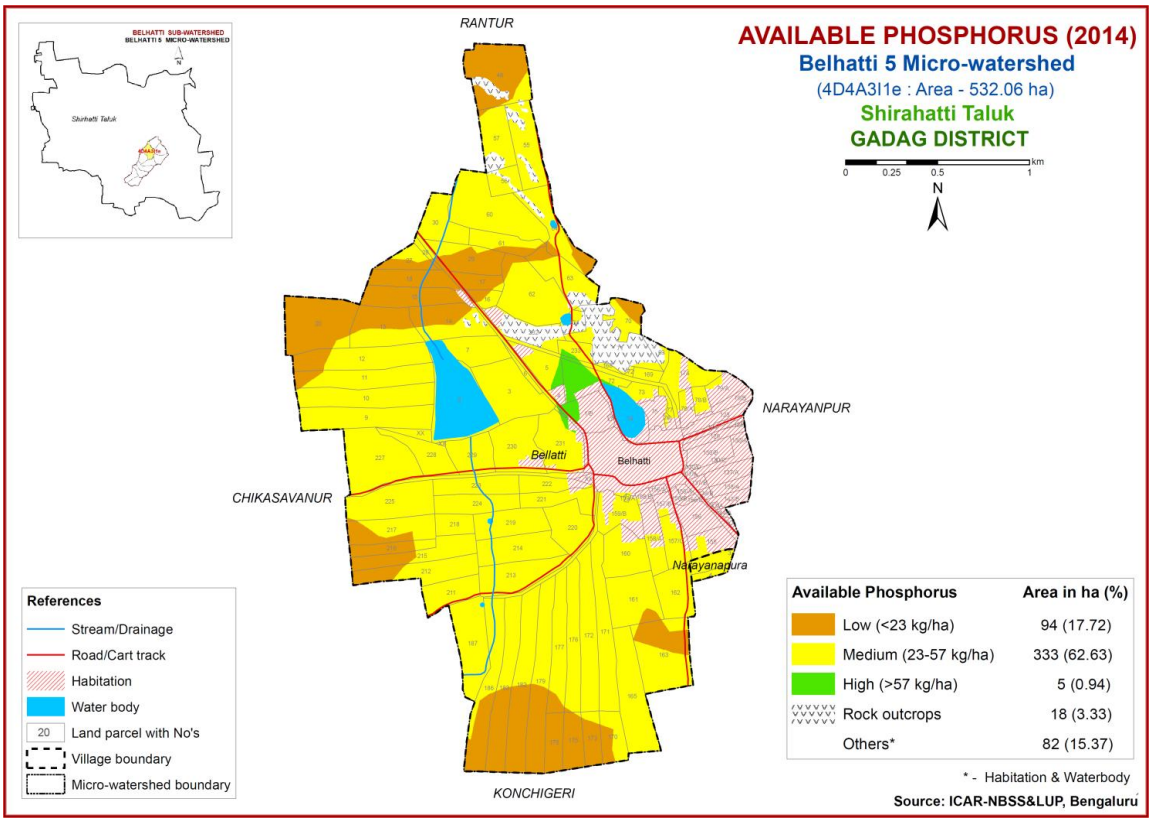


Fig.6.4 Soil Available Phosphorus map of Belhatti-5 Microwatershed

6.5 Available Potassium

Available potassium content is medium (145-337 kg/ha) in maximum area of about 257 ha (48%) and occur in major parts of the microwatershed and 176 ha (33%) is high (>337 kg/ha) and occur in the southwestern, central and northeastern part of the microwatershed (Fig.6.5).

6.6 Available Sulphur

Available sulphur is low (<10 ppm) in an area of about 170 ha (32%) and occur in the northwestern, northeastern and southeastern part of the microwatershed. Major area of about 241 ha (45%) is medium (10-20 ppm) in available sulphur and is distributed in all parts of the microwatershed. An area of about 21 ha (4%) is high (>10 ppm) and occur in the central part of the microwatershed (Fig.6.6).

6.7 Available Boron

Available boron content is medium (0.5-1.0 ppm) in maximum area of 395 ha (74%) in the microwatershed and is distributed in all parts of the microwatershed. An area of about 28 ha (5%) is low (<0.5 ppm) in available boron and occur in the central part of the microwatershed. A very small area of about 9 ha (2%) is high (>1.0 ppm) and occur in the central part of the microwatershed (Fig.6.7).

6.8 Available Iron

Available iron content is sufficient (>4.5 ppm) in maximum area of 288 ha (54%) and occur in all parts of the microwatershed. An area of about 144 ha (27%) is deficient (<4.5 ppm) in available iron content and is distributed in the southern and northeastern part of the microwatershed (Fig 6.8).

6.9 Available Manganese

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

6.10 Available Copper

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

6.11 Available Zinc

Available zinc content is sufficient (>0.6 ppm) in a very small area of 6 ha (1%) and is distributed in the central part of the microwatershed. Major area of about 427 ha (80%) is deficient (<0.6 ppm) in available zinc content and occur in all parts of the microwatershed (Fig 6.11).

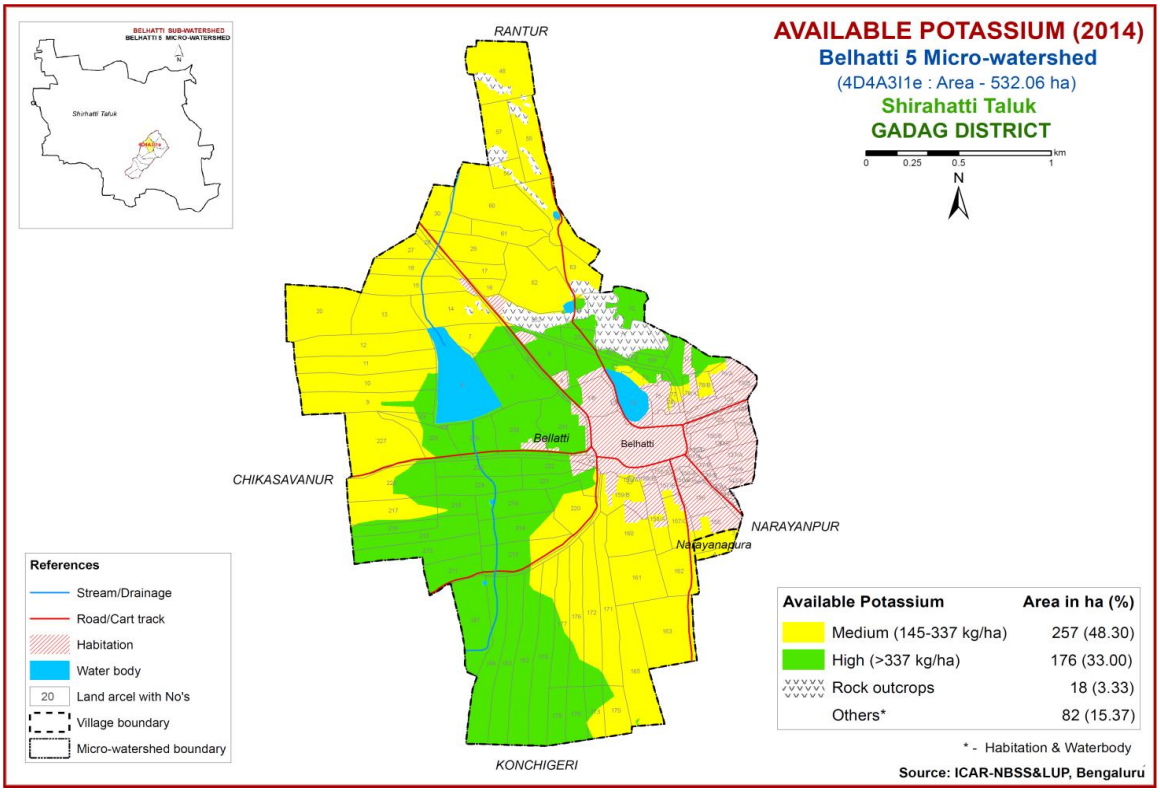


Fig.6.5 Soil Available Potassium map of Belhatti-5 Microwatershed

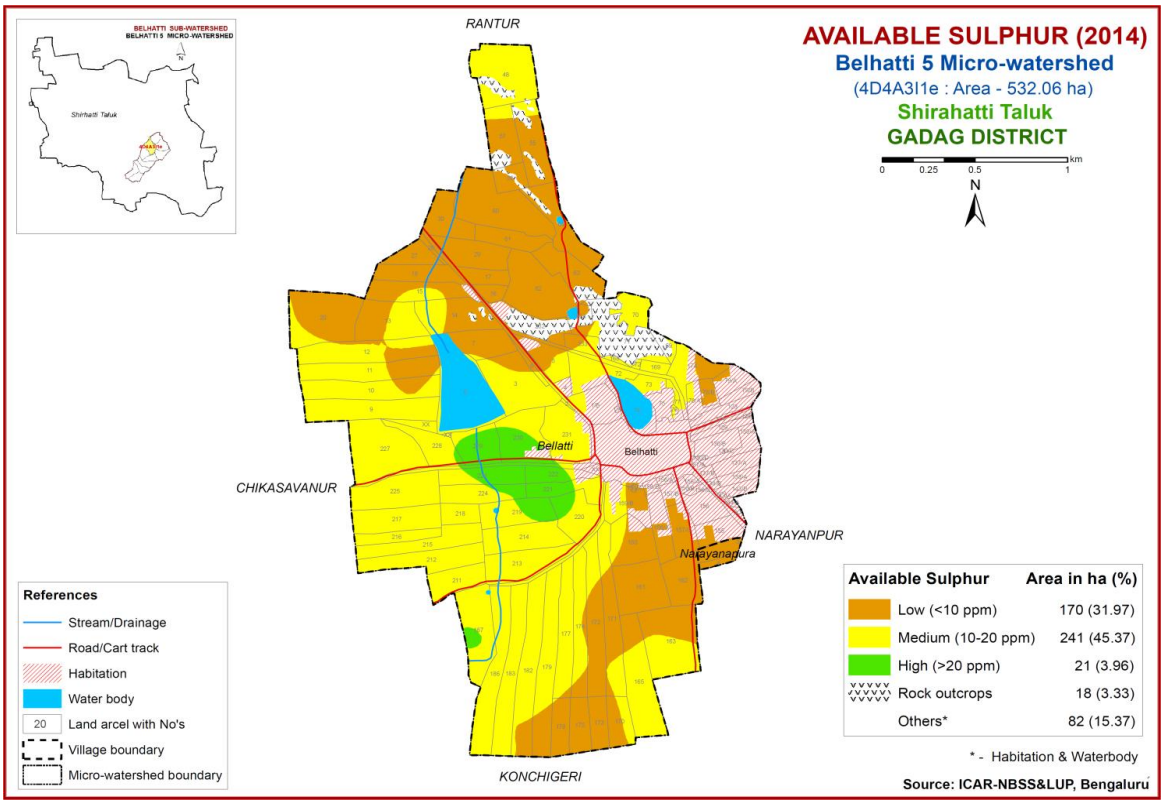


Fig.6.6 Soil Available Sulphur map of Belhatti-5 Microwatershed

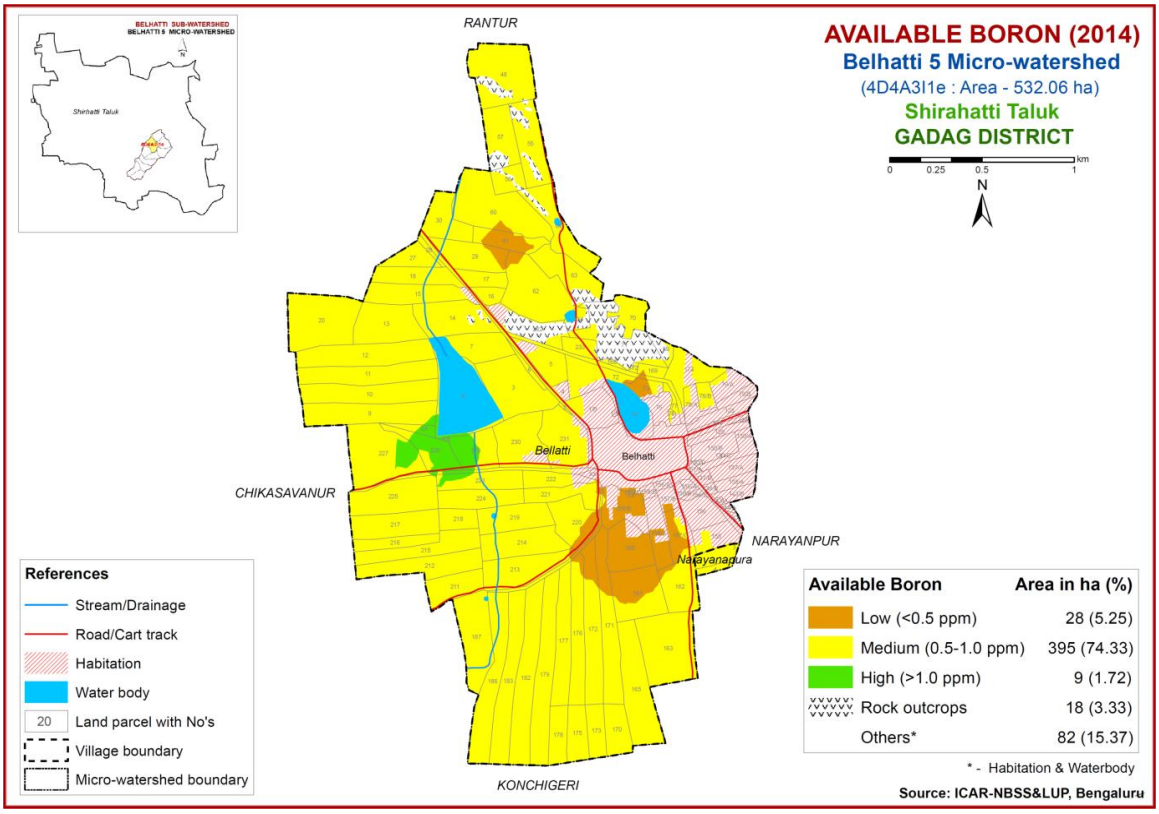


Fig.6.7 Soil Available Boron map of Belhatti-5 Microwatershed

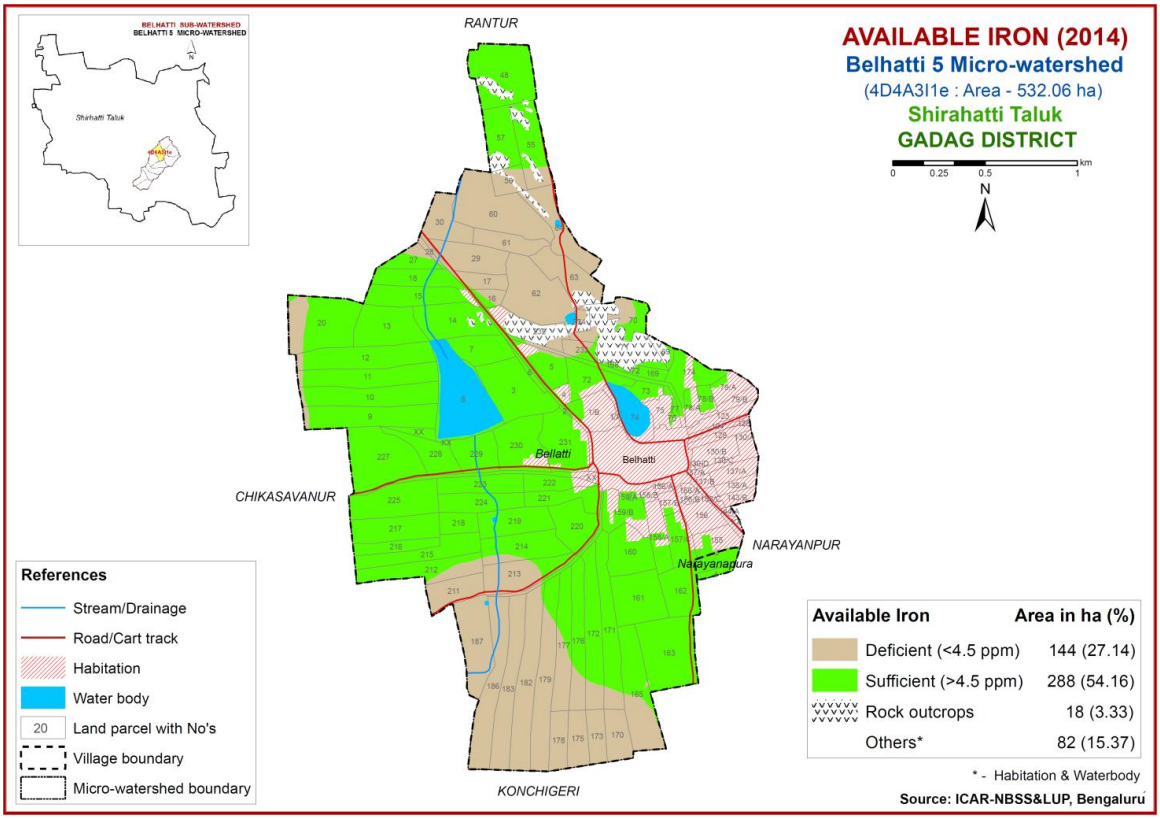


Fig.6.8 Soil Available Iron map of Belhatti-5 Microwatershed

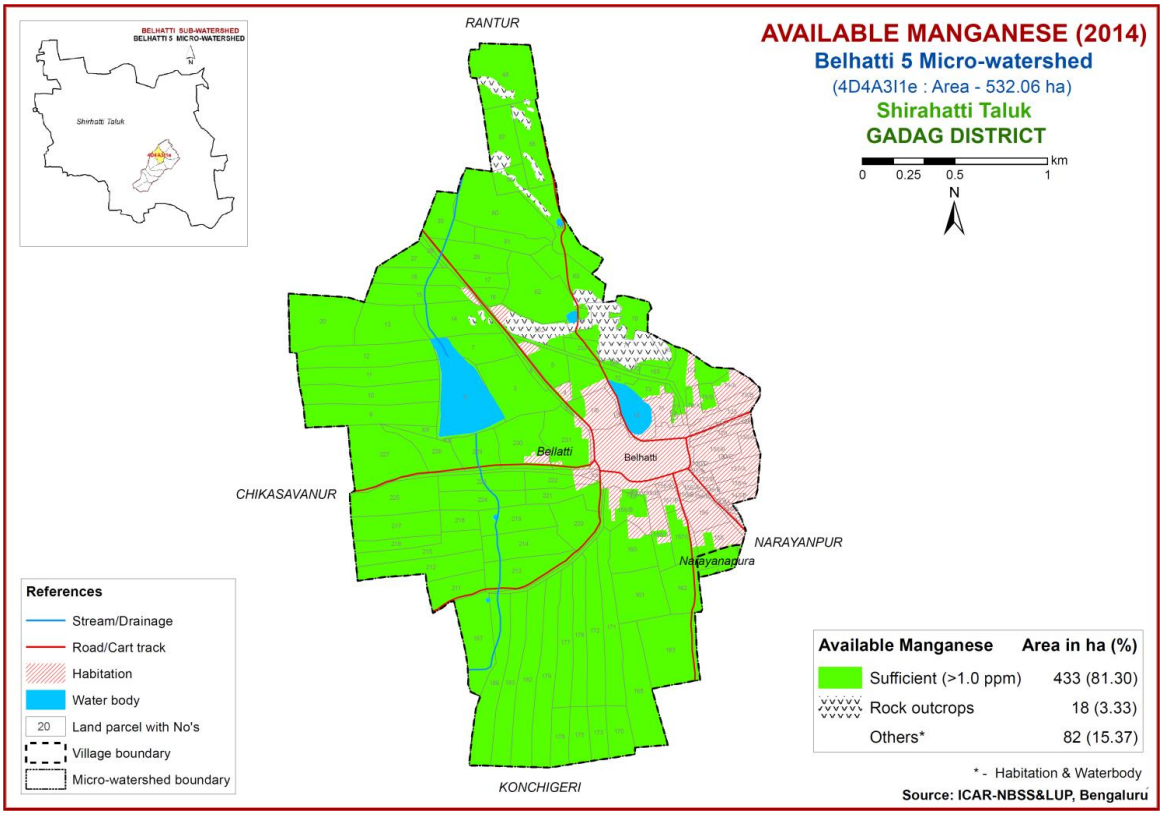


Fig.6.9 Soil Available Manganese map of Belhatti-5 Microwatershed

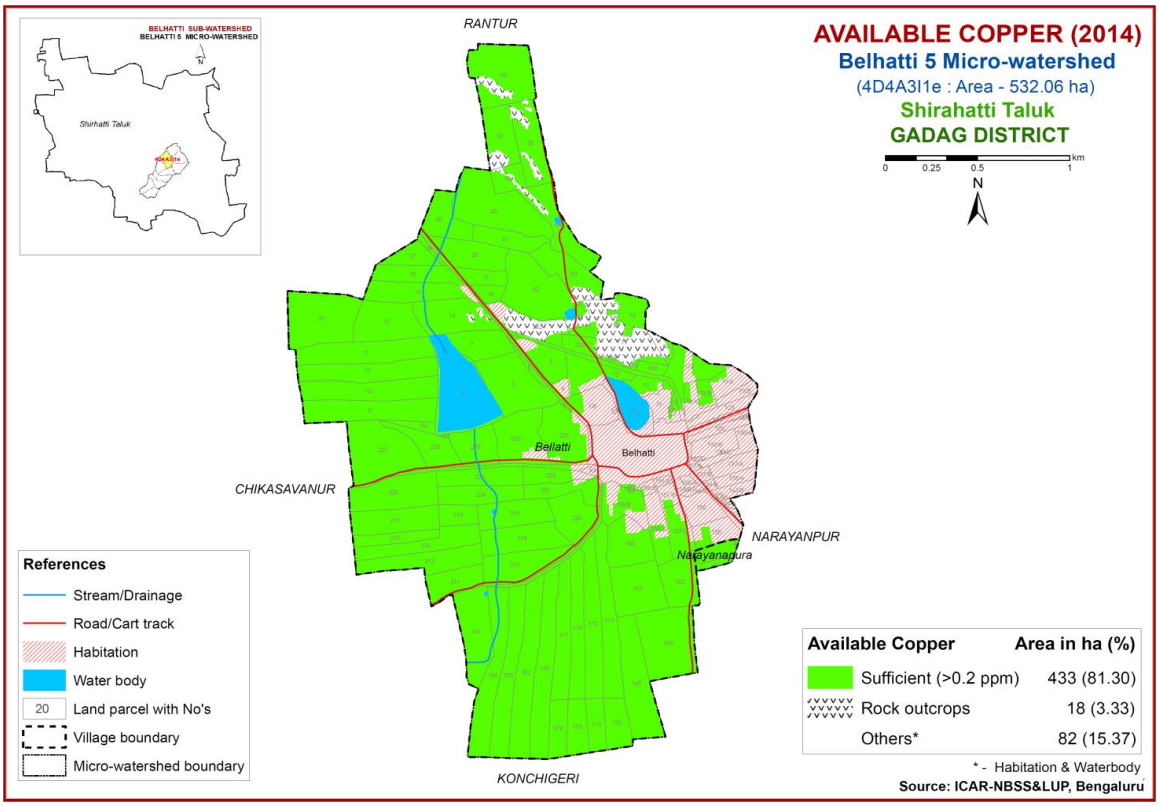


Fig.6.10 Soil Available Copper map of Belhatti-5 Microwatershed

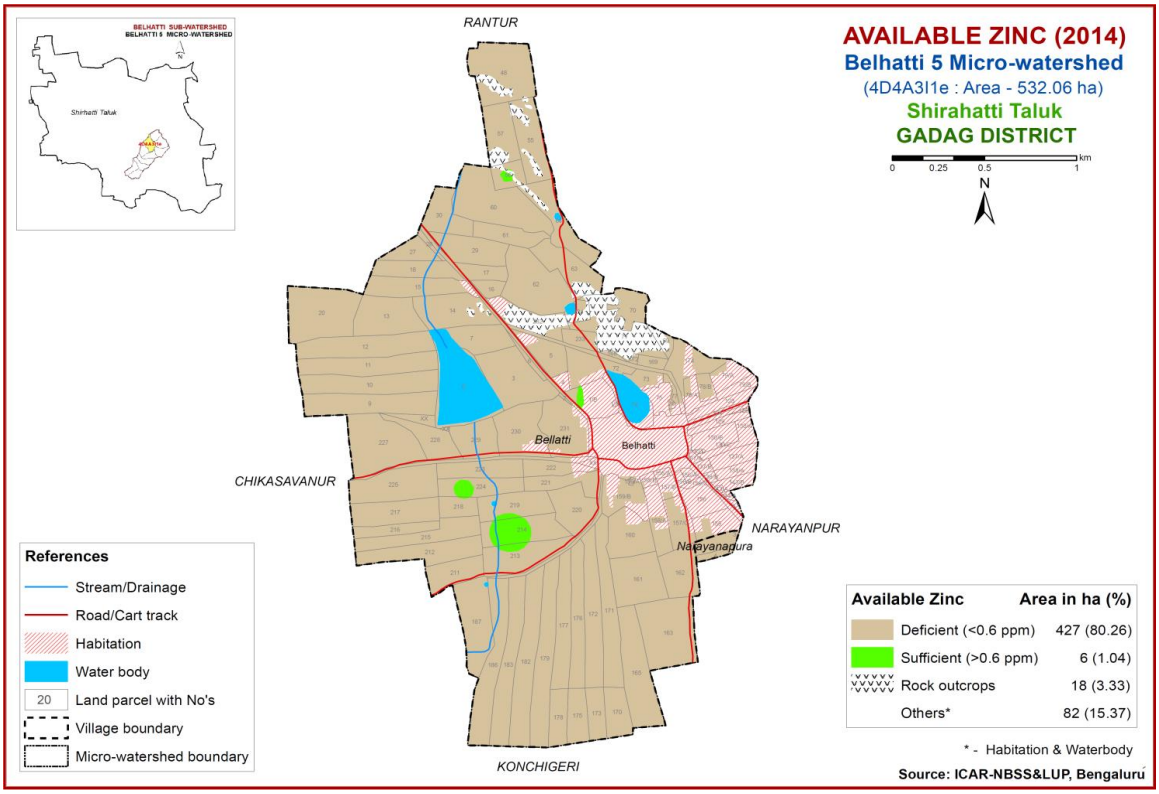


Fig.6.11 Soil Available Zinc map of Belhatti-5 Microwatershed

Chapter 7

LAND SUITABILITY FOR MAJOR CROPS

The soil and land resource units (soil phases) of Belhatti-5 Microwatershed were assessed for their suitability for growing food, fodder, fibre and other horticulture crops by following the procedure as outlined in FAO, 1976 and 1983. Crop requirements were developed for each of the crop from the available research data and also by referring to Naidu *et. al.* (2006) and Natarajan *et. al* (2015). The crop requirements were matched with the soil and land characteristics (Table 7.1) to arrive at the crop suitability. In FAO land suitability classification, two orders are recognized. Order S- Suitable and Order N- Not suitable. The orders have classes, subclasses and units. Order-S has three classes, class S1- Highly Suitable, class S2- Moderately Suitable and class S3- Marginally Suitable. Order N has two classes, N1- Currently not Suitable and N2- Permanently not Suitable. There are no subclasses within the class S1 as they will have very minor or no limitations for crop growth. Classes S2 and S3 are divided into subclasses based on the kinds of limitations encountered. The limitations that affect crop production are 'c' for erratic rainfall and its distribution and length of growing period (LGP), 'e' for erosion hazard, 'r' for rooting condition, 't' for lighter or heavy texture, 'g' for gravelliness or stoniness, 'n' for nutrient availability, 'l' for topography, 'm' for moisture availability, 'z' for calcareousness and 'w' for drainage. These limitations are indicated as lower case letters to the class symbol. For example, moderately suitable land with the limitations of soil depth and erosion is designated as S2re. For the microwatershed, the soil mapping units were evaluated and classified up to subclass level.

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

7.1 Land Suitability for Sorghum (*Sorghum bicolor*)

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

Highly suitable (Class S1) lands occupy an area of about 133 ha (25%) for growing sorghum and occur in the southern, central and northern part of the microwatershed. Maximum area of about 136 ha (26%) is moderately suitable (Class S2) for growing sorghum and are distributed in the northwestern, central and southwestern part the microwatershed.

Table 7.1 Soil-Site Characteristics of Belhatti-5 Microwatershed

Soil Map Units	Climate (P) (mm)	Growing period (Days)	Drai-nage Class	Soil depth (cm)	Soil texture		Gravelliness		AWC (mm/m)	Slope (%)	Erosion	pH	EC	ESP	CEC [Cmol $(p^+)kg^{-1}$]	BS (%)
					Surf-ace	Sub-surface	Surface (%)	Subsurface (%)								
CKMhB1g1	633	150	WD	50-75	scl	sc	15-35	-	100-150	1-3	Slight					
CKMhB2g1	633	150	WD	50-75	scl	sc	15-35	-	100-150	1-3	moderate					
DVHiA1g1	633	150	WD	<25	sc	cl	15-35	<15	<50	0-1	Slight					
GHThA1	633	150	WD	75-100	scl	scl	-	15-35	100-150	0-1	Slight					
GHThB2g1	633	150	WD	75-100	scl	scl	15-35	15-35	100-150	1-3	moderate					
HDHcA1g1	633	150	WD	75-100	sl	scl	15-35	15-35	50-100	0-1	Slight					
HLKcB2	633	150	WD	>150	sl	c	-	<15	150-200	1-3	moderate					
HLKhB2	633	150	WD	>150	scl	c	-	<15	150-200	1-3	moderate					
HNHhA1	633	150	WD	50-75	scl	sc	-	-	100-150	0-1	Slight					
HRVhB2g2	633	150	WD	25-50	scl	scl	35-60	>35	<50	1-3	moderate					
JLGmB2g1	633	150	MWD	75-100	c	c	15-35	-	150-200	1-3	moderate					
KGHbB2g1	633	150	WD	50-75	ls	scl	15-35	15-35	100-150	1-3	moderate					
KGHbB2g2	633	150	WD	50-75	ls	scl	35-60	15-35	100-150	1-3	moderate					
KGHcB2g1	633	150	WD	50-75	sl	scl	15-35	15-35	100-150	1-3	moderate					
KGHcB2g3	633	150	WD	50-75	sl	scl	60-80	15-35	100-150	1-3	moderate					
KGHcC2g2	633	150	WD	50-75	sl	scl	35-60	15-35	100-150	3-5	moderate					
KGHiB1g1	633	150	WD	50-75	sc	scl	15-35	15-35	100-150	1-3	Slight					
KGPcB2g1	633	150	WD	25-50	sl	scl-sc	15-35	15-35	50-100	1-3	moderate					
KMHcA1g1	633	150	WD	100-150	sl	scl-sc	15-35	<15	150-200	0-1	Slight					
KMHhB2	633	150	WD	100-150	scl	scl-sc	-	<15	150-200	1-3	moderate					
KTPcB2g2	633	150	WD	50-75	sl	scl	35-60	15-35	100-150	1-3	moderate					
KTPhB1g1	633	150	WD	50-75	scl	scl	15-35	15-35	100-150	1-3	Slight					
KTPhB2g2	633	150	WD	50-75	scl	scl	35-60	15-35	100-150	1-3	moderate					
LKRbB2g2	633	150	WD	50-75	ls	scl-sc	35-60	40-60	50-100	1-3	moderate					
LKRcB2g1	633	150	WD	50-75	sl	scl-sc	15-35	40-60	50-100	1-3	moderate					
TDHhB1g1	633	150	WD	50-75	scl	sc-c	15-35	-	100-150	1-3	Slight					
VDHcA1	633	150	WD	100-150	sl	sc-c	-	-	150-200	0-1	Slight					
VDHiA1	633	150	WD	100-150	sc	sc-c	-	-	150-200	0-1	Slight					

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

They have minor limitations of gravelliness and rooting depth. Marginally suitable lands (Class S3) for growing sorghum occupy an area of about 102 ha (19%) and occur in the western, central and southeastern part of the microwatershed with moderate limitations of rooting depth and gravelliness. An area of about 62 ha (12%) is not suitable (Class N) and occur in the western, central and northwestern part of the microwatershed with severe limitations ofgravelliness and rooting depth.

Table 7.2 Crop suitability criteria for Sorghum

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

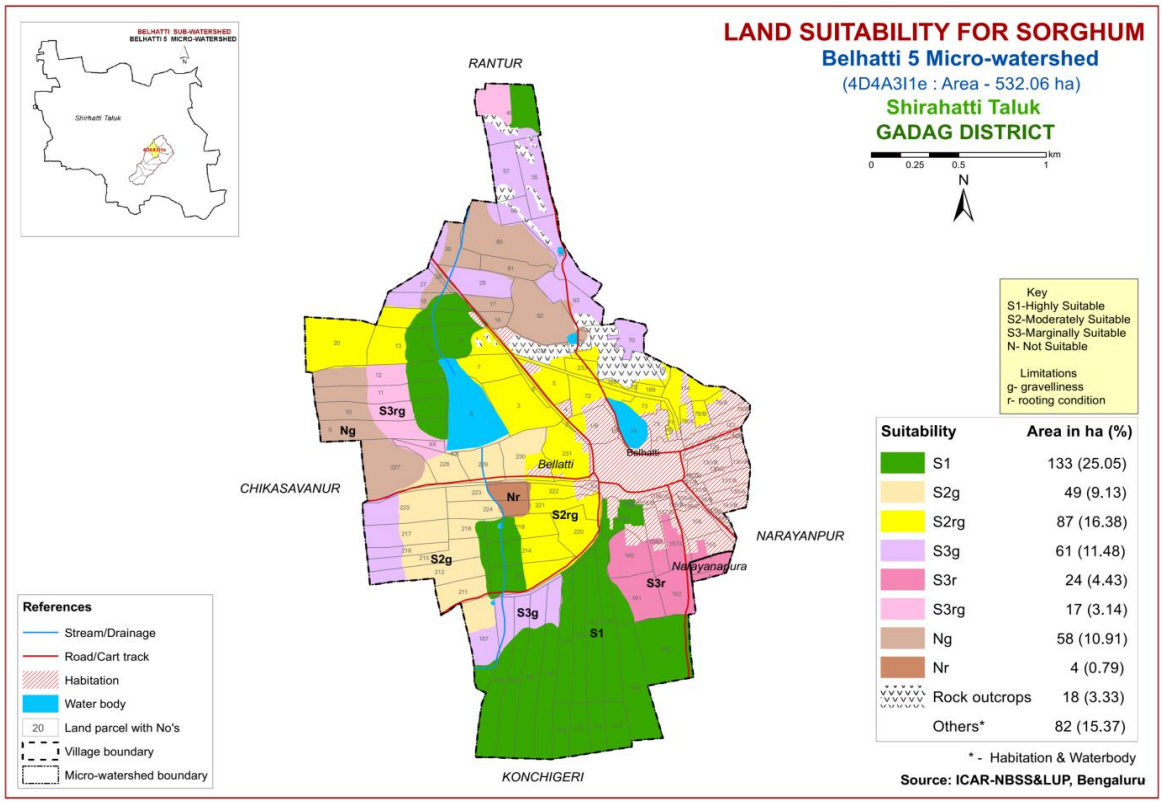


Fig. 7.1 Land Suitability map of Sorghum

7.2 Land Suitability for Maize (*Zea mays*)

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

Table 7.3 Crop suitability criteria for Maize

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

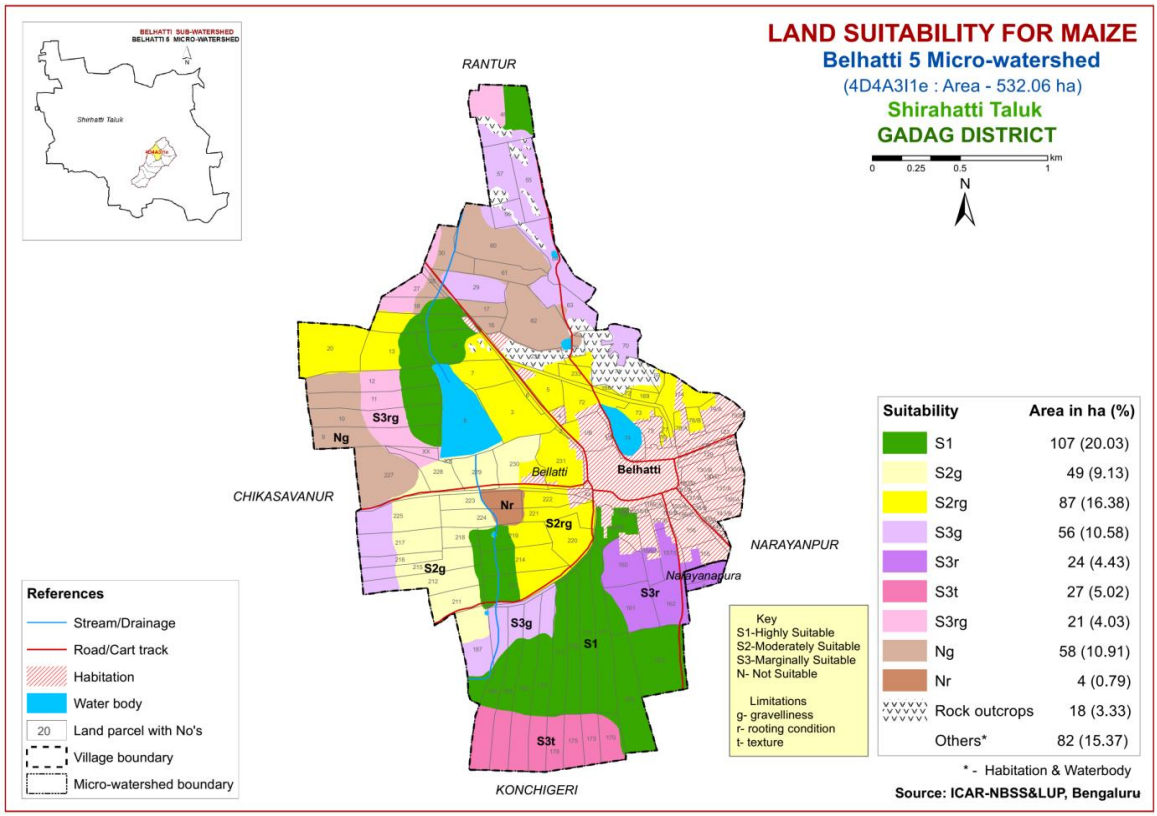


Fig. 7.2 Land Suitability map of Maize

An area of about 107 ha (20%) is highly suitable (Class S1) for growing maize and occur in the southeastern, northern and central part of the microwatershed. Moderately suitable (Class S2) lands occupy maximum area of about 136 ha (26%) and are distributed in the western, central and southwestern part the microwatershed. They have minor limitations of gravelliness and rooting depth. Marginally suitable (Class S3) for growing maize occupy an area of about 128 ha (20%) and occur in the southwestern, northern and southeastern part of the microwatershed. They have moderate limitations of gravelliness, rooting depth and texture. An area of about 62 ha (12%) is not suitable (Class N) and occur in the western, central and northwestern part of the microwatershed with severe limitations of gravelliness and rooting depth.

7.3 Land Suitability for Cotton (*Gossypium hirsutum*)

Cotton is the most important fibre crop grown in the State in about 8.75 lakh ha area in Raichur, Dharwad, Belgaum, Gulbarga, Bijapur, Bidar, Bellary, Chitradurga and Chamarajnagar districts. The crop requirements for growing cotton (Table 7.4) were matched with the soil-site characteristics (Table 7.1) and a land suitability map for growing cotton was generated. The area extent and their geographical distribution of different suitability subclasses in the microwatershed is given in Figure 7.3.

Highly suitable (Class S1) lands occupy an area of about 81 ha (15%) for growing cotton and occur in the southeastern, northern and central part of the microwatershed. Major area of about 189 ha (35%) has soils that are moderately suitable (Class S2) with minor limitations of gravelliness and rooting depth. They are distributed in the western, central, southern and southwestern part of the microwatershed. The marginally suitable (Class S3) lands cover an area of about 102 ha (19%) and occur in the central and southeastern part of the microwatershed. They have moderate limitations of gravelliness and rooting depth. An area of about 62 ha (12%) is not suitable (Class N) and occur in the western, central and northwestern part of the microwatershed with severe limitations of gravelliness and rooting depth.

Table 7.4 Crop suitability criteria for Cotton

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

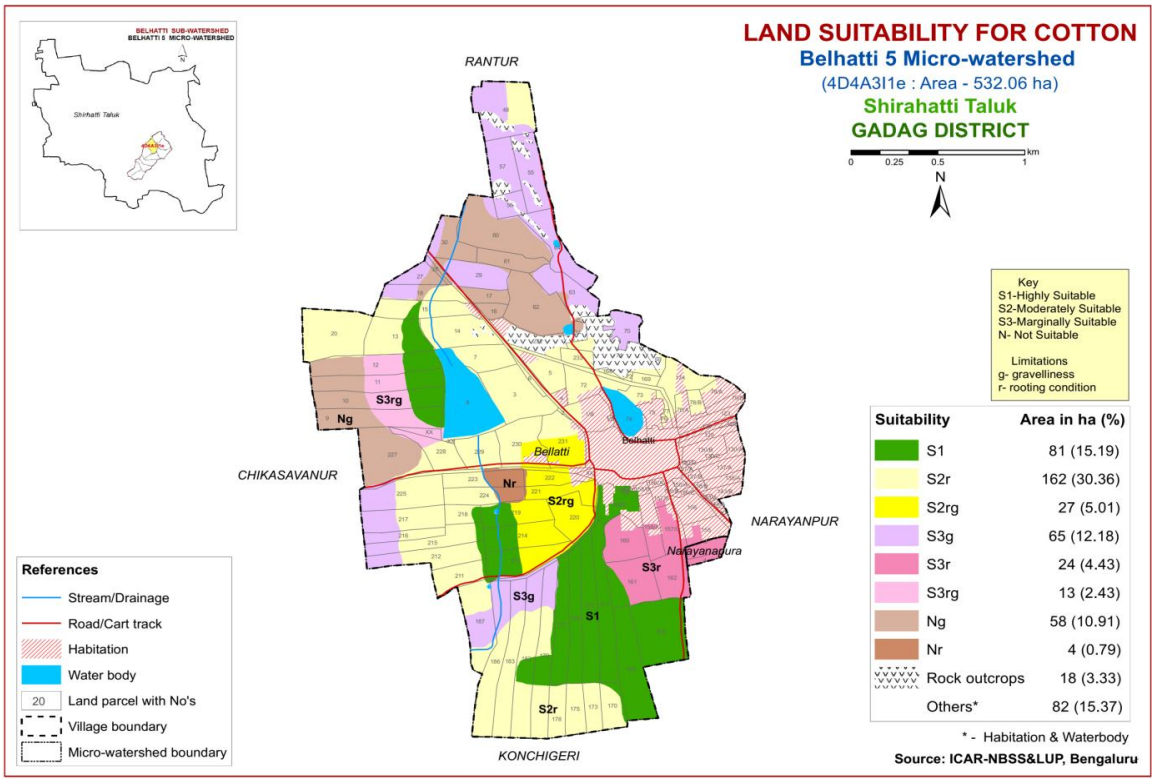


Fig. 7.3 Land Suitability map of Cotton

7.4 Land Suitability for Sunflower (*Helianthus annus*)

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

Table 7.5 Land suitability criteria for Sunflower

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

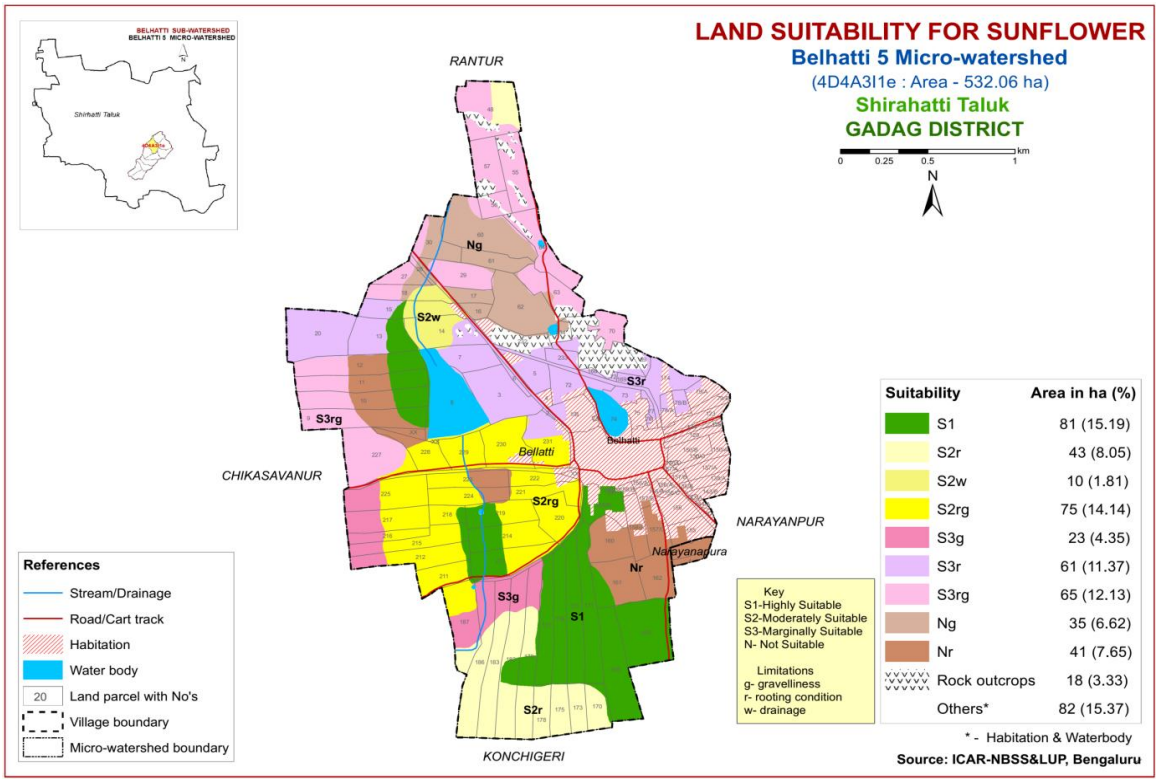


Fig. 7.4 Land Suitability map of Sunflower

Highly suitable (Class S1) lands occupy an area of about 81 ha (15%) for growing sunflower and occur in the southeastern and central part of the microwatershed. Moderately suitable (Class S2) lands occupy an area of about 128 ha (24%) and are distributed in the northern, southern, central and southwestern part of the microwatershed with minor limitations of rooting depth, wetness and gravelliness. Major area of about 149 ha (28%) is marginally suitable (Class S3) and are distributed in the western, northern, central and southwestern part of the micro watershed. They have moderate limitations of rooting depth and gravelliness. An area of about 76 ha (14%) is not suitable (Class N) and occur in the northwestern, central and southeastern part of the microwatershed with severe limitations of gravelliness and rooting depth.

7.5 Land Suitability for Onion (*Allium cepa*)

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

Highly suitable (Class S1) lands occupy an area of about 82 ha (15%) for growing onion and occur in the southeastern, northern and central part of the microwatershed. Moderately suitable (Class S2) lands occupy maximum area of about 161 ha (30%) for growing onion with minor limitations of gravelliness, texture and rooting depth. They are

distributed in the northwestern, central and southwestern part of the microwatershed. The marginally suitable (Class S3) lands cover an area of about 129 ha (24%) and occur in the northern, southern, western and southeastern part of the microwatershed. They have moderate limitations of gravellineess, rooting depth and texture. An area of about 62 ha (12%) is not suitable (Class N) and occur in the western, central and northwestern part of the microwatershed with severe limitations of gravelliness and rooting depth.

Table 7.6 Land suitability criteria for Onion

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

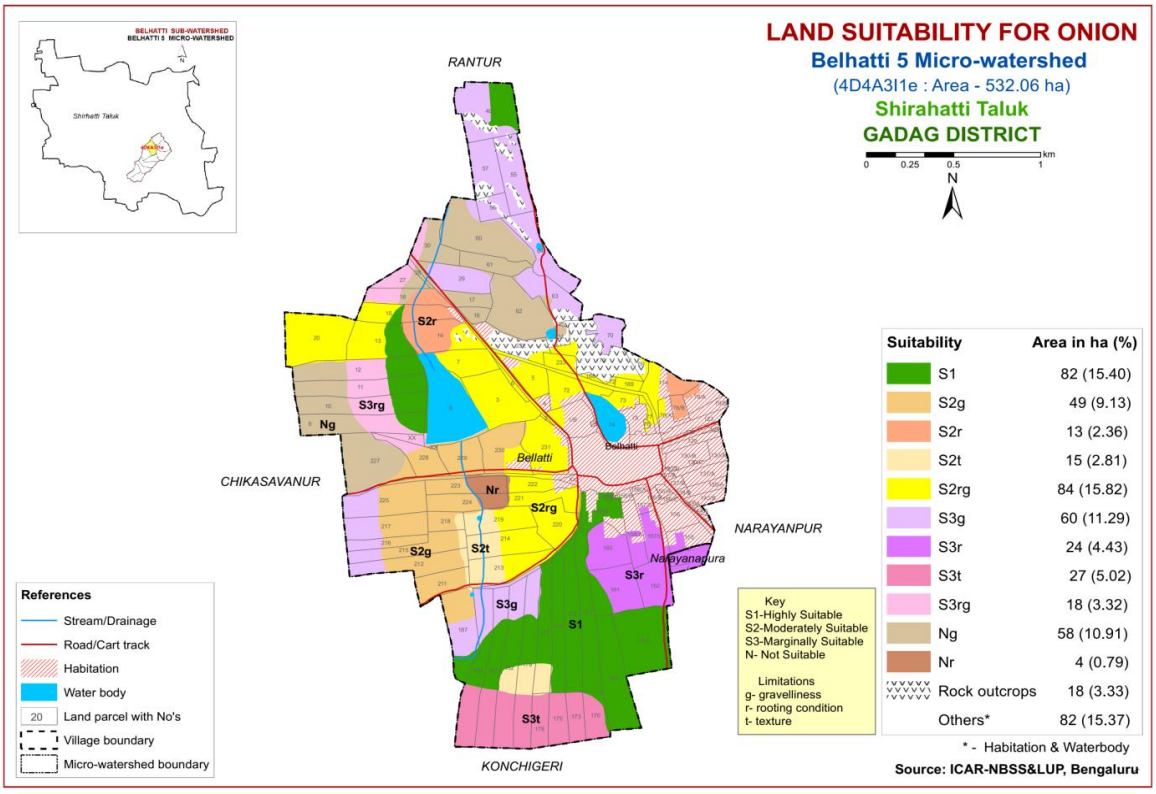


Fig. 7.5 Land Suitability map of Onion

7.6 Land Suitability for Groundnut (*Arachis hypogaea*)

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

Table 7.7 Crop suitability criteria for Groundnut

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

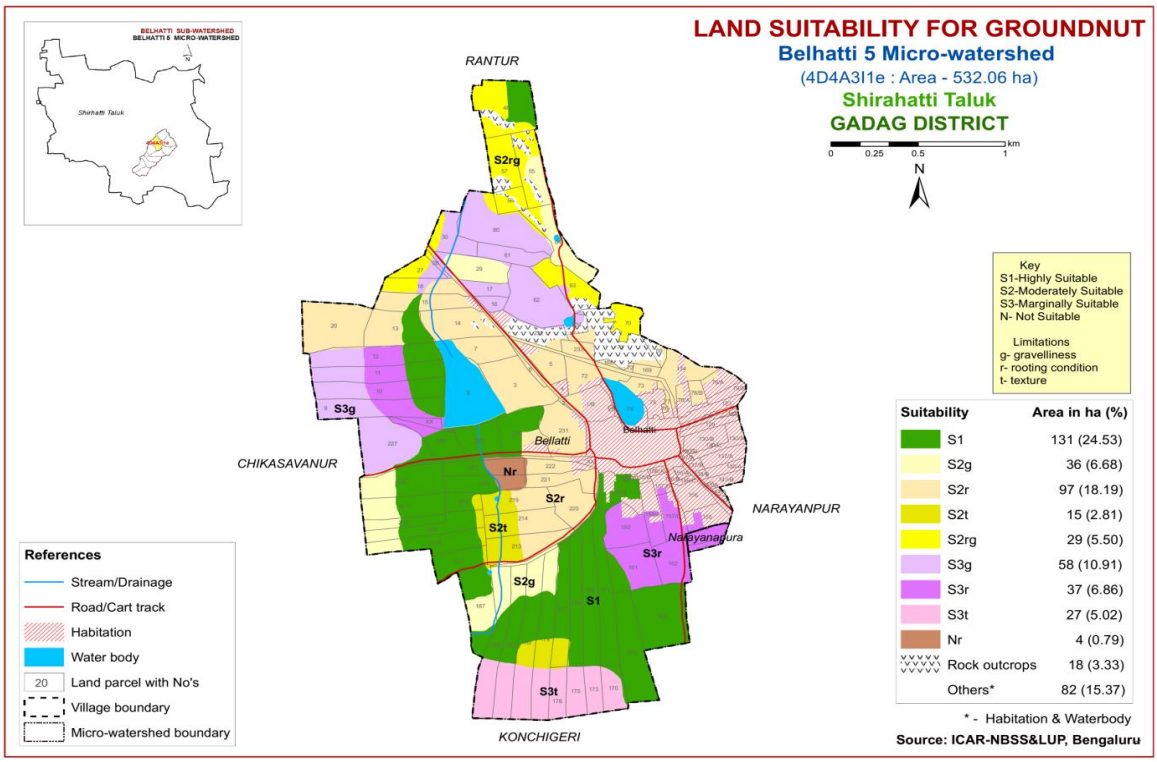


Fig. 7.6 Land Suitability map of Groundnut

An area of about 131 ha (24%) is highly suitable (Class S1) for growing groundnut. They are distributed in the southwestern, northern, central and southeastern part of the microwatershed. Moderately suitable (Class S2) lands cover major area of 177 ha (33%) and are distribuited in the northern, southwestern and northwestern part of the microwatershed. They have minor limitations of gravelliness, rooting depth and texture. Marginally suitable (Class S3) lands for growing groundnut occupy an area of about 122 ha (23%) and are distributed in the western, northwestern and southeastern part of the microwatershed. They have moderate limitations of gravelliness, rooting depth and texture. A very small area of about 4 ha (1%) is not suitable (Class N) and occur in the central part of the microwatershed. They have severe limitation of rooting depth.

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

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

Highly suitable (Class S1) lands occupy an area of about 97 ha (18%) for growing chilli and occur in the southeastern and central part of the microwatershed. Moderately suitable (Class S2) lands cover maximum area of about 172 ha (32%) and are distributed in the southwestern, southern,western and southeastern part of the microwatershed. They have minor limitations of gravelliness, rooting depth and wetness. Marginally suitable (Class S3) lands for growing chilli occupy an area of about 125 ha (23%) and are distributed in the northern, western and southeastern part of the microwatershed. An area of about 39 ha (7%) is not suitable (Class N) and occur in the northwestern and central part of the microwatershed with severe limitations of gravelliness and rooting depth.

Table 7.8 Crop suitability criteria for Chilli

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

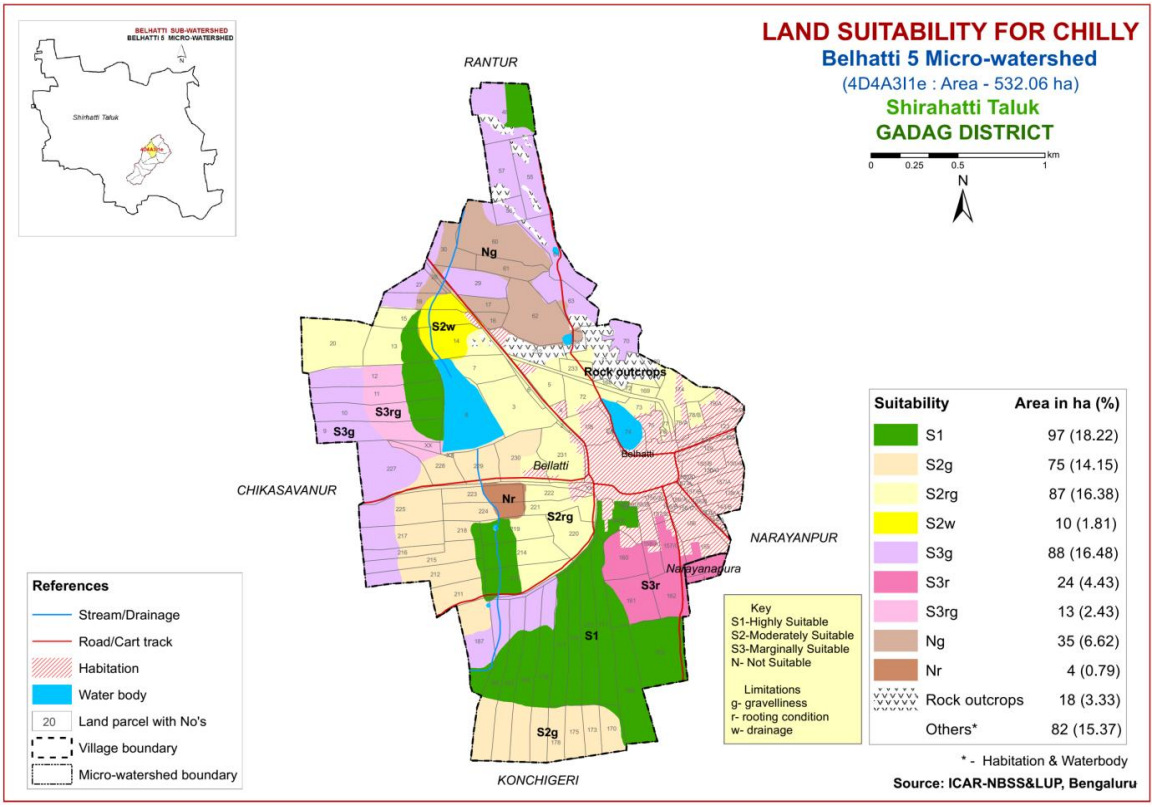


Fig. 7.7 Land Suitability map of chilli

7.8 Land Suitability for Sugarcane (*Saccharum officinarum*)

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

Table 7.9 Land suitability criteria for Sugarcane

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

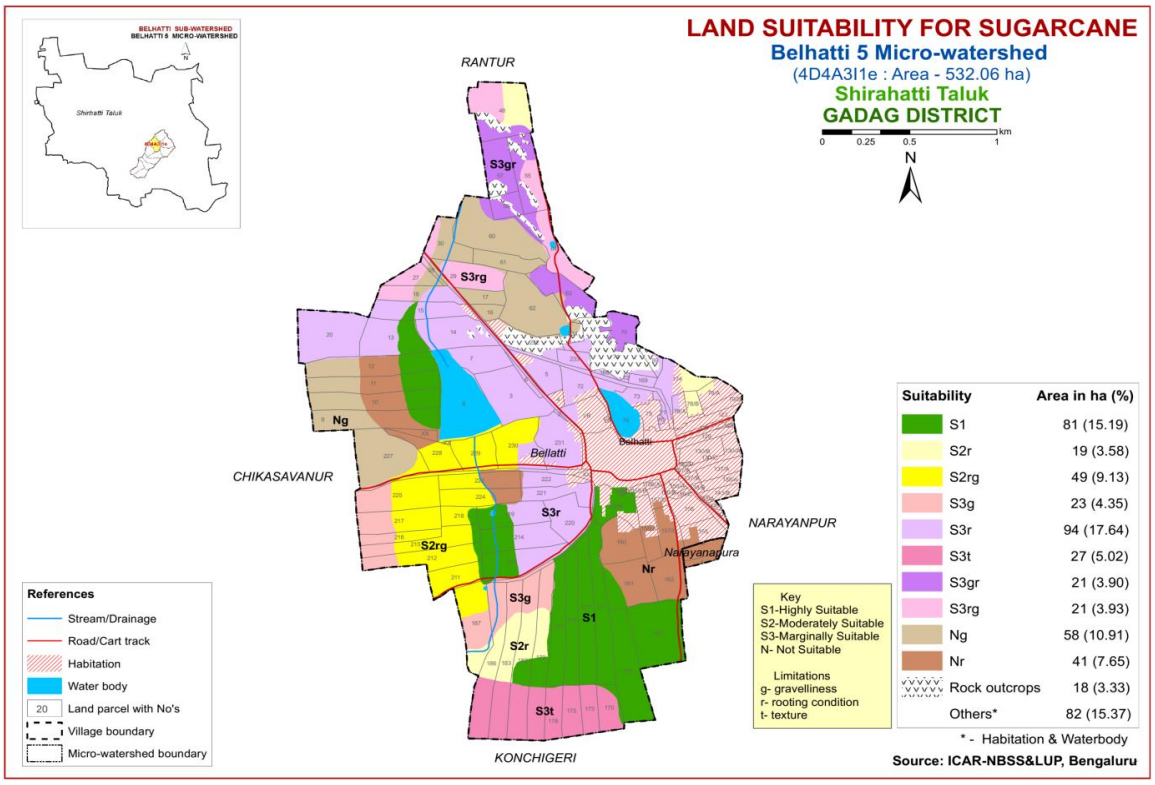


Fig. 7.8 Land Suitability map of Sugarcane

Highly suitable (Class S1) lands occupy an area of about 81 ha (15%) for growing sugarcane and occur in the southeastern and central part of the microwatershed. Moderately suitable (Class S2) lands occupy an area of about 68 ha (13%) and occur in the southwestern, northern and eastern part of the microwatershed. They have minor limitations of rooting depth and gravelliness. Marginally suitable (Class S3) lands cover a major area of about 186 ha (35%) and occur in all parts of the microwatershed. They have moderate limitations of gravelliness, rooting depth and texture. An area of about 99 ha (19%) is not suitable (Class N) and occur in the southeastern and central part of the microwatershed with severe limitations of gravelliness and rooting depth.

7.9 Land Suitability for Pomegranate (*Punica granatum*)

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

Highly suitable (Class S1) lands occupy a small area of about 81 ha (15%) and are distributed in the southeastern and central part of the microwatershed. An area of about 92 ha (17%) is moderately suitable (Class S2) for growing pomegranate and occur in the southwestern and northern part of the microwatershed with minor limitations of rooting

depth, texture and gravelliness. Marginally suitable (Class S3) lands for growing pomegranate occupy major area of about 185 ha (35%) and are distributed in all parts of the microwatershed. They have moderate limitations of rooting depth, wetness and gravelliness. An area of about 76 ha (14%) is not suitable (Class N) for growing pomegranate and occur in the central and southeastern part of the microwatershed with severe limitations of rooting depth and gravelliness.

Table 7.10 Crop suitability criteria for Pomegranate

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

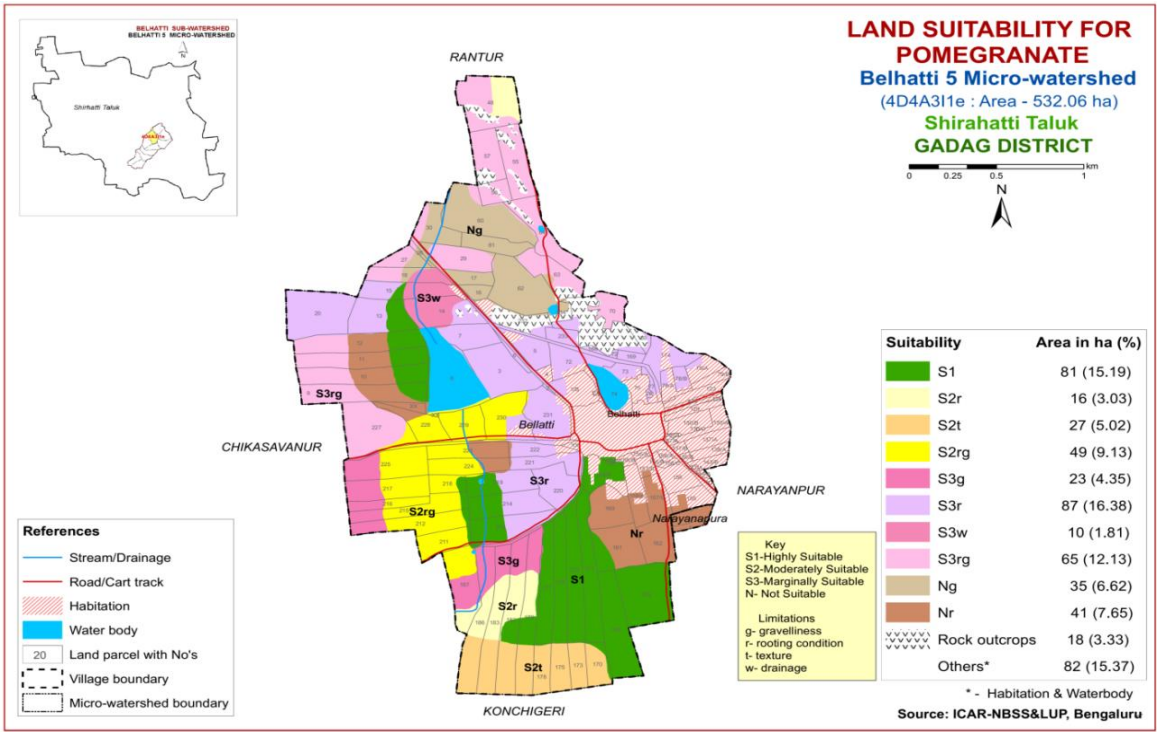


Fig. 7.9 Land Suitability map of Pomegranate

7.10 Land suitability for Tomato (*Solanum lycopersicum*)

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

An area of about 97 ha (18%) in the microwatershed is highly suitable (Class S1) for growing tomato and are distributed in the southeastern and central part of the microwatershed. Moderately suitable (Class S2) lands occupy a maximum area of about 199 ha (37%) and occur in all parts of the microwatershed. They have minor limitations of gravelliness, rooting depth and texture. The marginally suitable (Class S3) lands cover an area of about 76 ha (14%) and are distributed in the western, southeastern and northwestern part of the microwatershed with moderate limitations of rooting depth and gravelliness. An area of about 62 ha (12%) is not suitable (Class N) and occur in the western, central and northwestern part of the microwatershed with severe limitations of gravelliness and rooting depth.

Table 7.11 Crop suitability criteria for Tomato

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

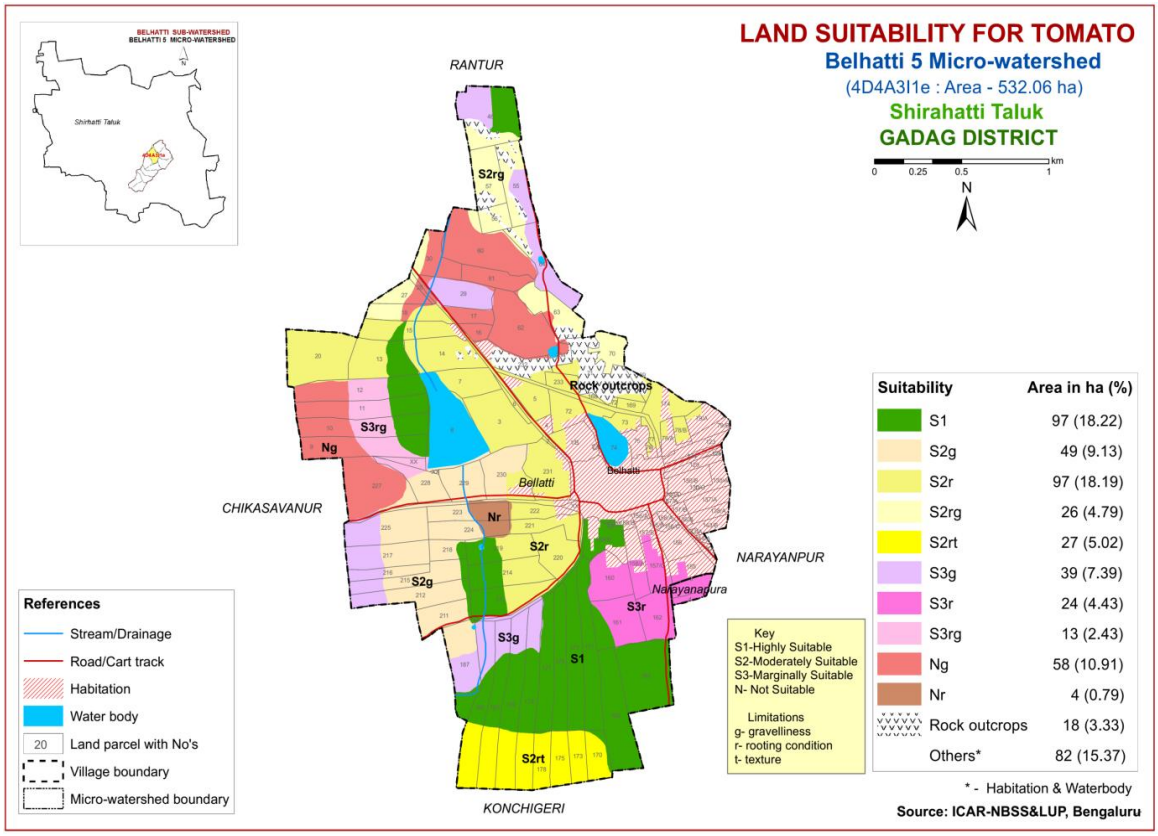


Fig. 7.10 Land Suitability map of Tomato

7.11 Land suitability for Guava (*Psidium guajava*)

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

An area of about 66 ha (12%) is highly suitable (Class S1) for growing guava in the microwatershed and occur in the southeastern and central part of the microwatershed. Moderately suitable (Class S2) lands occupy an area of about 80 ha (15%) and are distributed in the southwestern and northern part of the microwatershed and have minor limitations of texture, rooting depth and gravelliness. The marginally suitable (Class S3) lands cover maximum area of about 212 ha (35%) and are distributed in all parts of the microwatershed. They have moderate limitations of rooting depth, texture, wetness and gravelliness. An area of about 76 ha (14%) is not suitable (Class N) for growing guava and are distributed in the central, southeastern and northwestern part of the microwatershed. They have severe limitations of gravelliness and rooting depth.

Table 7.12 Crop suitability criteria for Guava

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

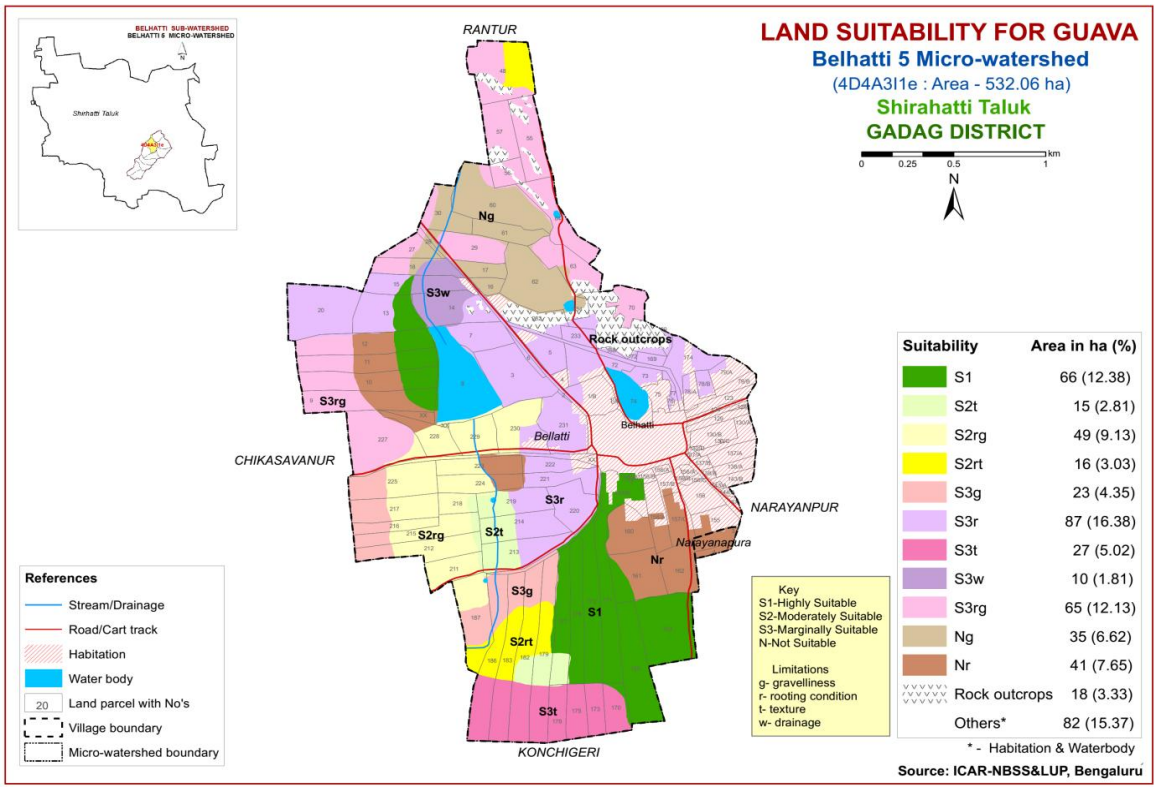


Fig. 7.11 Land Suitability map of Guava

7.12 Land suitability for Mango (*Mangifera indica*)

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

Highly suitable (Class S1) lands occupy a very small area of about 12 ha (2%) and are distributed in the central part of the microwatershed. An area of about 69 ha (13%) is moderately suitable (Class S2) for growing mango and occur in the southeastern and central part of the microwatershed. They have minor limitation of rooting depth. Marginally suitable (Class S3) lands occupy an area of about 88 ha (16%) and are distributed in the southwestern and northern part of the microwatershed. They have moderate limitations of gravelliness and rooting depth. Major area of about 264 ha (50%) is not suitable (Class N) for growing mango and occur in all parts of the microwatershed.

Table 7.13 Crop suitability criteria for Mango

Crop requirement			**Rating**			
Soil-site characteristics		**Unit**	**Highly suitable(S1)**	**Moderately suitable(S2)**	**Marginally suitable(S3)**	**Not suitable (N)**
Climate	Temp. in growing season	^{0}C	28-32	24-27 33-35	36-40	20-24
	Min. temp. before flowering	^{0}C	10-15	15-22	>22	
Soil moisture	Growing period	Days	>180	150-180	120-150	<120
Soil aeration	Soil drainage	Class	Well drained	Mod. To imperfectly drained	Poor drained	Very poorly drained
	Water table	M	>3	2.50-3.0	2.5-1.5	<1.5
Nutrient availability	Texture	Class	Sc, l, sil, cl	Sl, sc, sic, l, c	C (<60%)	C (>60%),
	pH	1:2.5	5.5-7.5	7.6-8.55.0-5.4	8.6-9.04.0-4.9	>9.0<4.0
	OC	%	High	medium	low	
	$CaCO_3$ in root zone	%	Non calcareous	<5	5-10	>10
Rooting conditions	Soil depth	cm	>200	125-200	75-125	<75
	Gravel content	%vol	Non-gravelly	<15	15-35	>35
Soil toxicity	Salinity	dS/m	Non saline	<2.0	2.0-3.0	>3.0
	Sodicity	%	Non sodic	<10	10-15	>15
Erosion	Slope	%	<3	3-5	5-10	

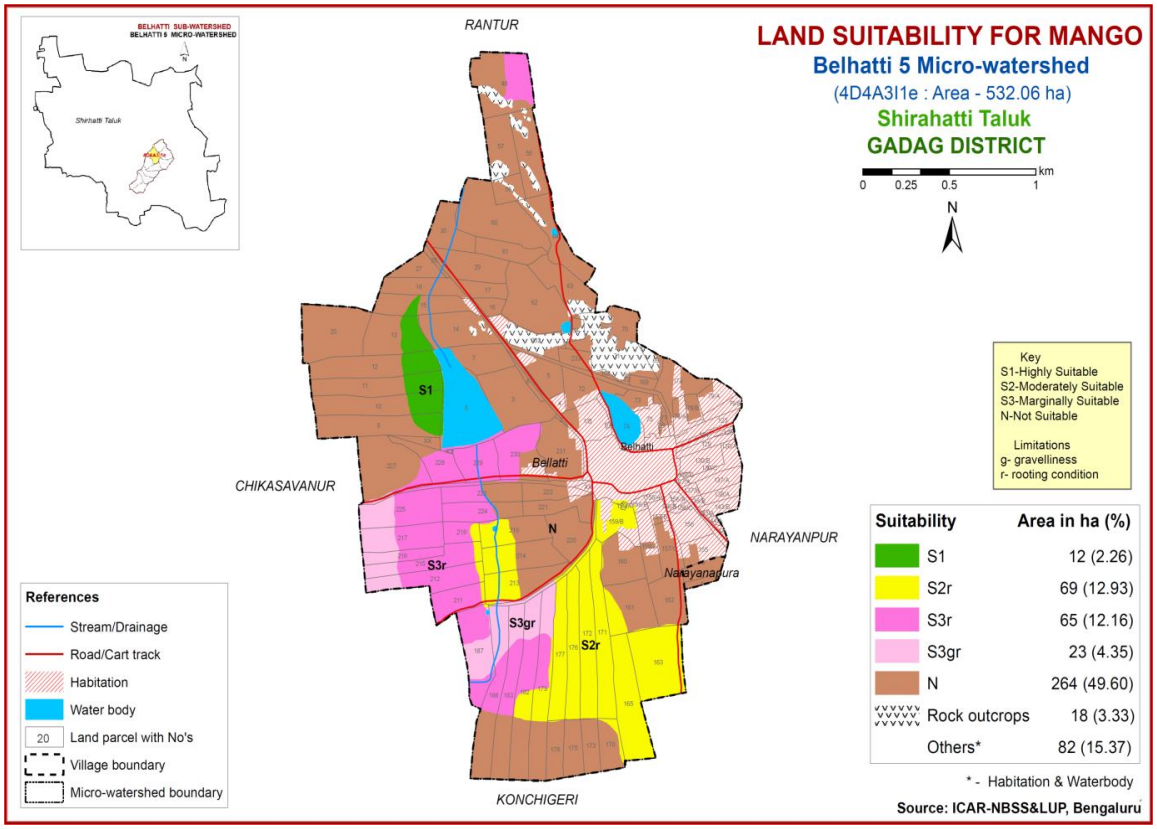


Fig. 7.12 Land Suitability map of Mango

7.13 Land suitability for Sapota (*Manilkara zapota*)

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

Highly suitable (Class S1) lands for growing sapota occupy an area of about 27 ha (5%) and are distributed in the central part of the microwatershed. An area of about 119 ha (22%) is moderately suitable (Class 2) and occur in the southwestern, central, northern and southeastern part of the microwatershed. They have minor limitations of rooting depth and gravelliness. The marginally suitable (Class S3) lands cover major area of about 212 ha (35%) and are distributed in all parts of the microwatershed with moderate limitations of gravelliness, rooting depth, texture and wetness. An area of about 76 ha (14%) is not suitable for growing sapota and are distributed in the southwestern and central part of the microwatershed and have severe limitations of rooting depth and gravelliness.

Table 7.14 Crop suitability criteria for Sapota

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

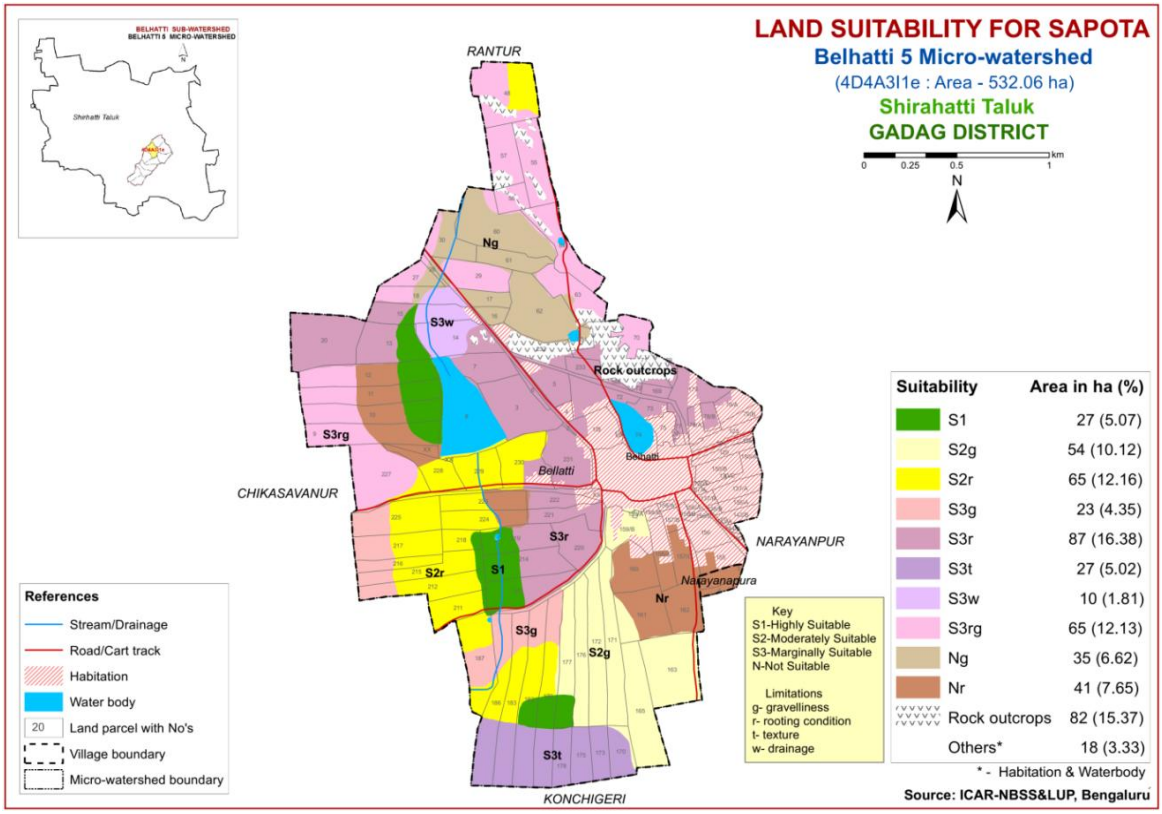


Fig. 7.13 Land Suitability map of Sapota

7.14 Land Suitability for Jackfruit (*Artocarpus heterophyllus*)

Jackfruit is the most important fruit crop grown in 5368 ha area in all the districts of the state. The crop requirements for growing jackfruit were matched with the soil-site characteristics and a land suitability map for growing jackfruit was generated. The area extent and their geographical distribution of different suitability subclasses in the microwatershed is given in Figure 7.14.

Highly suitable (Class S1) lands occupy a very small area of about 12 ha (2%) and are distributed in the central part of the microwatershed. An area of about 69 ha (13%) is moderately suitable (Class S2) for growing jackfruit and occur in the southeastern and central part of the microwatershed. They have minor limitation of rooting depth. Marginally suitable (Class S3) lands occupy an area of about 88 ha (16%) and are distributed in the southwestern and northern part of the microwatershed. They have moderate limitations of gravelliness and rooting depth. Major area of about 264 ha (50%) is not suitable (Class N) for growing jackfruit and occur in all parts of the microwatershed.

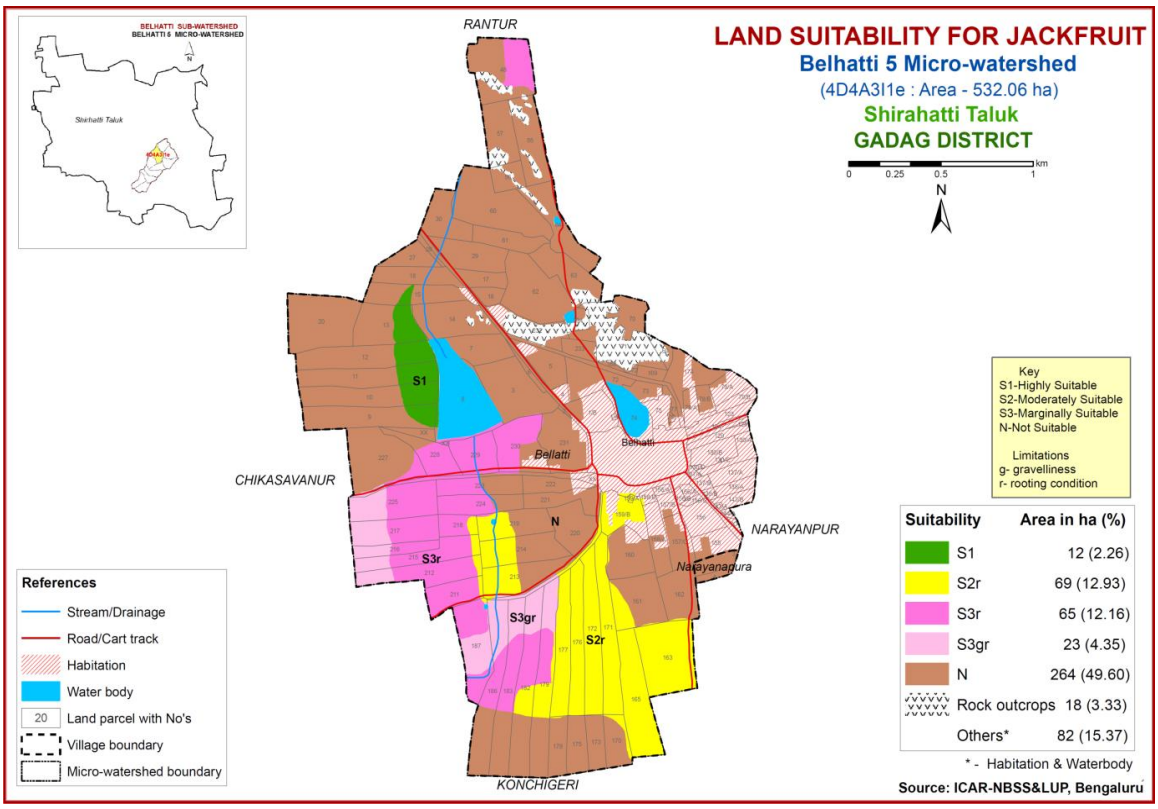


Fig. 7.14 Land Suitability map of Jackfruit

7.15 Land Suitability for Jamun (*Syzygium cumini*)

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

geographical distribution of different suitability subclasses in the microwatershed is given in Figure 7.15.

A very small area of about 12 ha (2%) is highly suitable for growing jamun and occur in the central part of the microwatershed. Moderately suitable (S2) lands occupy an area of about 69 ha (13%) and are distributed in the southeastern and central part of the microwatershed. They have minor limitation of rooting depth. Major area of about 311 ha (58%) is marginally suitable (Class S3) and is distributed in all parts of the microwatershed and have moderate limitations of gravelliness, rooting depth and texture. An area of about 41 ha (8%) is not suitable (Class N) for growing jamun and are distributed in the southeastern and central part of the microwatershed.

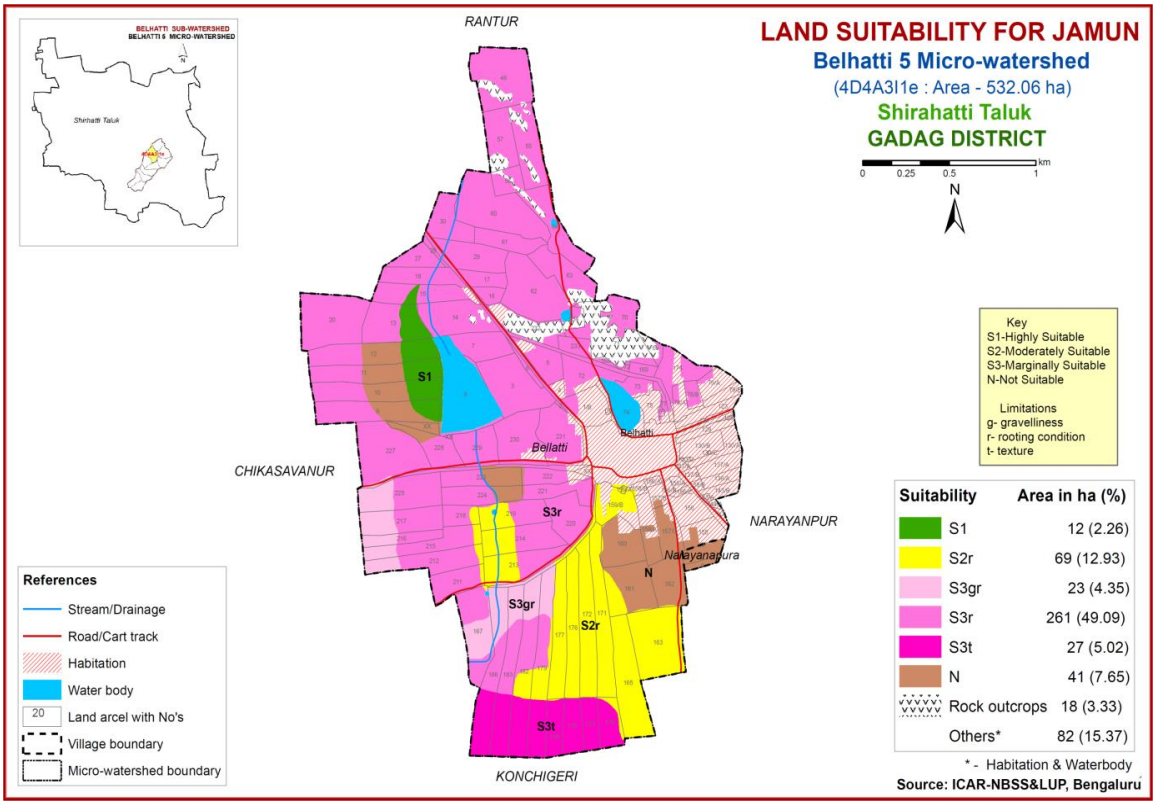


Fig. 7.15 Land Suitability map of Jamun

7.16 Land Suitability for Musambi (*Citrus limetta*)

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

Highly suitable (Class S1) lands occupy a very small area of about 12 ha (2%) for growing musambi and occur in the central part of the microwatershed. Moderately suitable (S2) lands occupy an area of about 69 ha (13%) and are distributed in the southeastern and central part of the microwatershed. They have minor limitation of

rooting depth. An area of about 114 ha (22%) is marginally suitable (Class S3) and are distributed in the southern, northern and southwestern part of the microwatershed with moderate limitations of gravelliness and rooting depth. Major area of about 237 ha (45%) is not suitable (Class N) and occur in major part of the microwatershed.

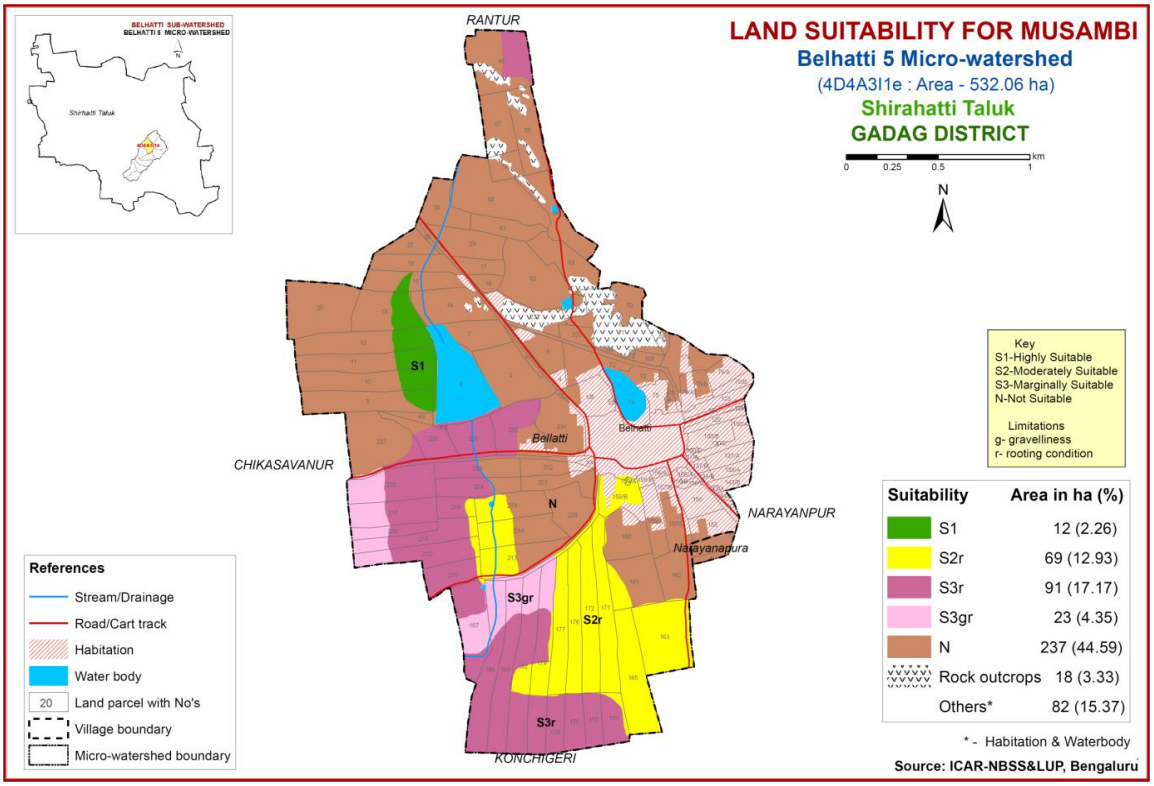


Fig. 7.16 Land Suitability map of Musambi

7.17 Land Suitability for Lime (*Citrus sp*)

Lime is one of the most important fruit crop grown in an area of 11752 ha in almost all the districts of the State. The crop requirements for growing lime (Table 7.15) were matched with the soil-site characteristics (Table 7.1) and a land suitability map for growing lime was generated. The area extent and their geographical distribution of different suitability subclasses in the microwatershed is given in Figure 7.17.

Highly suitable (Class S1) lands occupy a very small area of about 12 ha (2%) for growing lime and occur in the central part of the microwatershed. Moderately suitable (S2) lands occupy an area of about 69 ha (13%) and are distributed in the southeastern and central part of the microwatershed. They have minor limitation of rooting depth. An area of about 114 ha (22%) is marginally suitable (Class S3) and are distributed in the southern, northern and southwestern part of the microwatershed with moderate limitations of gravelliness and rooting depth. Major area of about 237 ha (45%) is not suitable (Class N) and occur in major part of the microwatershed.

Table 7.15 Crop suitability criteria for Lime

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

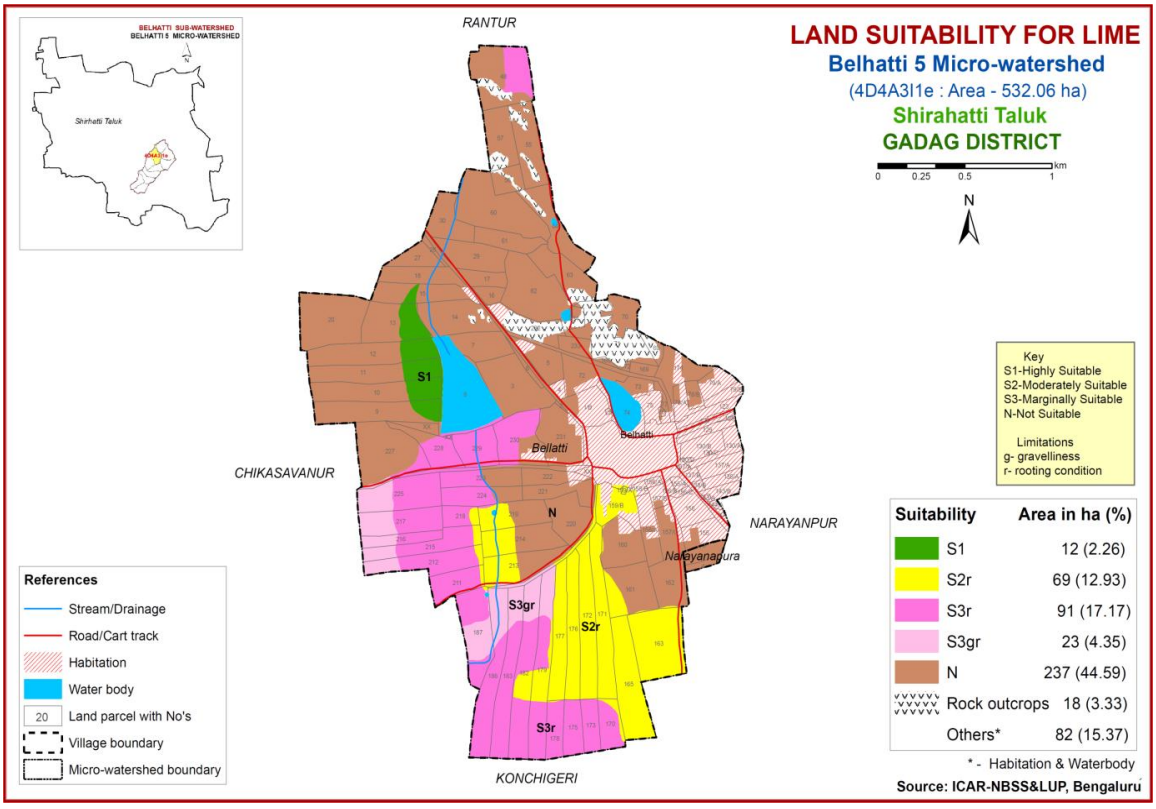


Fig. 7.17 Land Suitability map of Lime

7.18 Land Suitability for Cashew (*Anacardium occidentale)*

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

A very small area of about 12 ha (2%) is highly suitable for growing cashew and occur in the central part of the microwatershed. Moderately suitable (S2) lands occupy an area of about 156 ha (29%) and are distributed in the southeastern, southwestern, central and northern part of the microwatershed. They have minor limitations of gravelliness and rooting depth. Major area of about 187 ha (35%) is marginally suitable (Class S3) for growing cashew and are distributed in all parts of the microwatershed with moderate limitations of gravelliness and rooting depth. An area of about 77 ha (14%) is not suitable (Class N) for growing cashew and are distributed in the central, southeastern and southern part of the microwatershed.

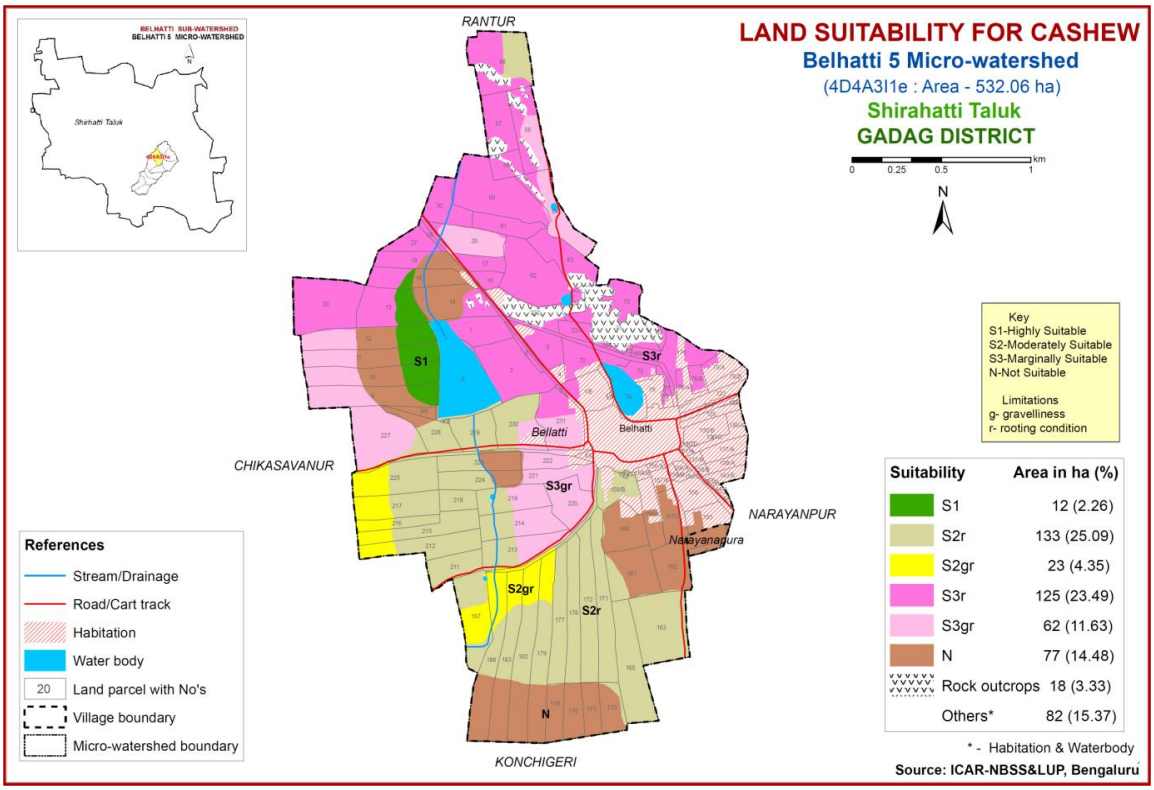


Fig. 7.18 Land Suitability map of Cashew

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

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

An area of 81 ha (15%) is highly suitable (Class S1) for growing custard apple and occur in the southeastern and central part of the microwatershed. Maximum area of about 272 ha (51%) is moderately suitable (Class S2) and occur in all parts of the microwatershed. They have minor limitations of rooting depth and gravelliness. An area of about 80 ha (15%) is marginally suitable (Class S3) for growing custard apple and are distributed in the northeastern, southeastern and central part of the microwatershed with moderate limitations of gravelliness and rooting depth.

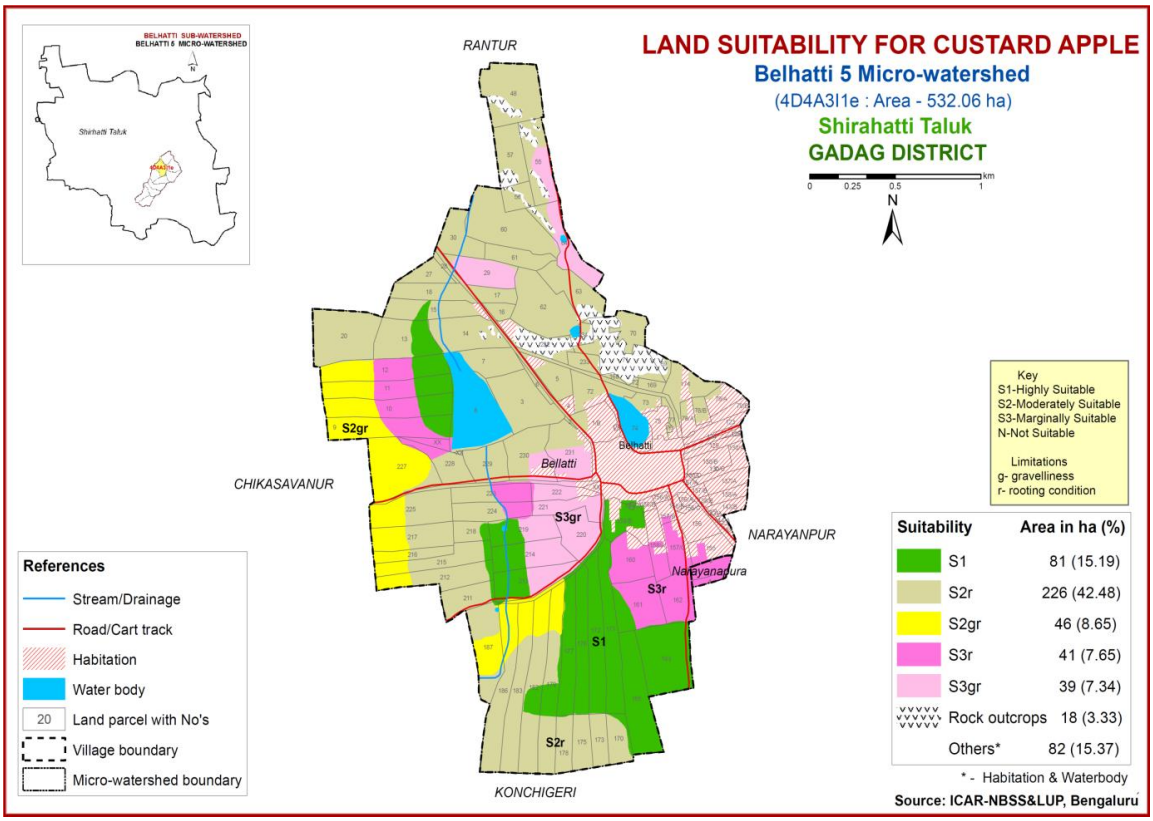


Fig. 7.19 Land Suitability map of Custard Apple

7.20 Land Suitability for Amla (*Phyllanthus emblica*)

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

Highly suitable (Class S1) lands occupy an area of about 81 ha (15%) and are distributed in the southeastern and central part of the microwatershed. Maximum area of about 272 ha (51%) is moderately suitable (Class S2) and occur in all parts of the microwatershed. They have minor limitations of rooting depth and gravelliness. An area of about 80 ha (15%) is marginally suitable (Class S3) for growing amla and are distributed in the northeastern, southeastern and central part of the microwatershed with moderate limitations of gravelliness and rooting depth.

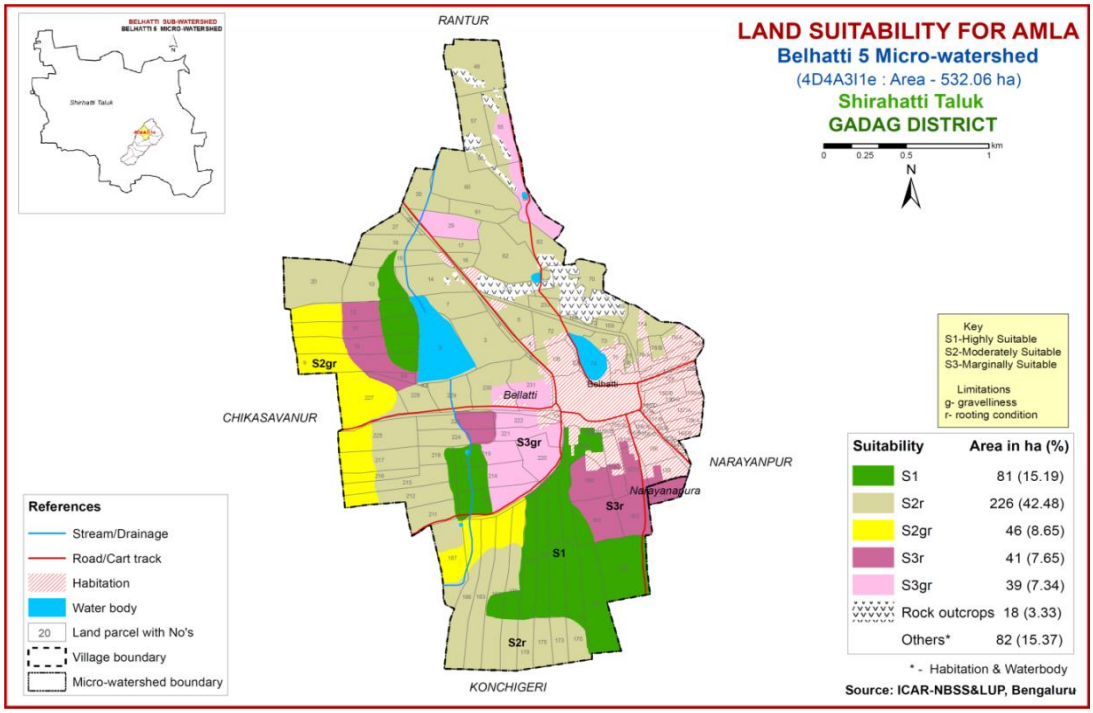


Fig. 7.20 Land Suitability map of Amla

7.21 Land Suitability for Tamarind (*Tamarindus indica*)

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

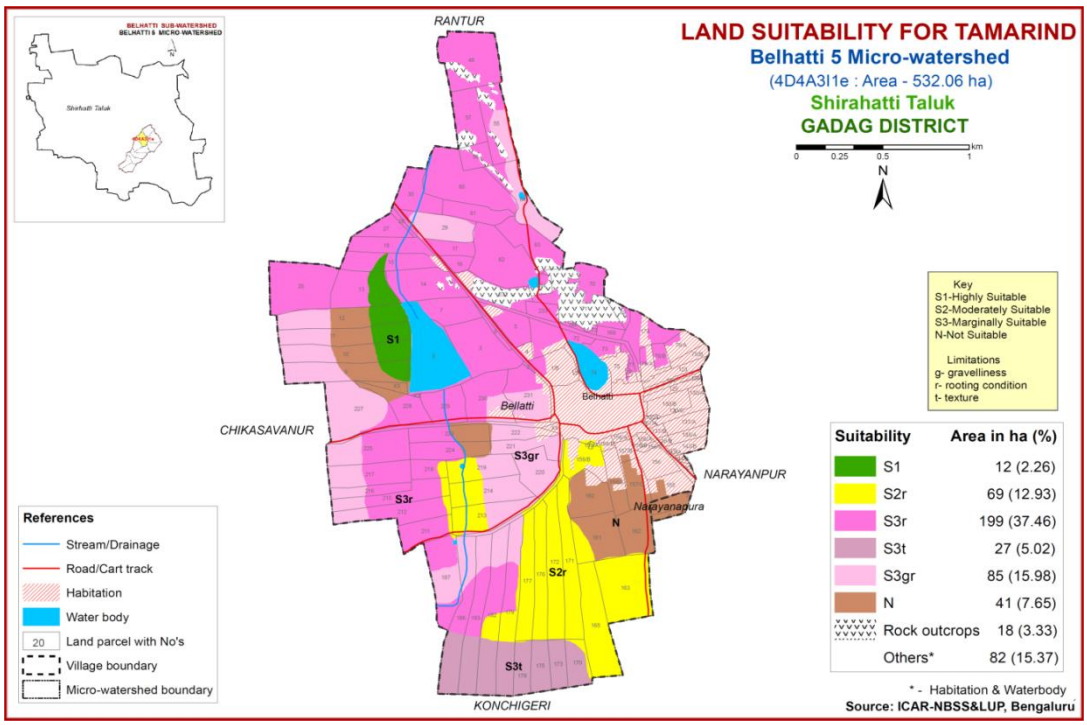


Fig. 7.21 Land Suitability map of Tamarind

A very small area of about 12 ha (2%) is highly suitable for growing tamarind and occur in the central part of the microwatershed. Moderately suitable (S2) lands occupy an area of about 69 ha (13%) and are distributed in the southeastern and central part of the microwatershed. They have minor limitation of rooting depth. Major area of about 311 ha (58%) is marginally suitable (Class S3) and is distributed in all parts of the microwatershed and have moderate limitations of gravelliness, rooting depth and texture. An area of about 41 ha (8%) is not suitable (Class N) for growing tamarind and are distributed in the southeastern and central part of the microwatershed.

7.22 Land Suitability for Marigold (*Tagetes erecta*)

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

An area of about 97 ha (18%) is highly suitable (Class S1) for growing marigold. They are distributed in the southeastern, central and northern part of the microwatershed. Major area of about 221 ha (41%) has soils that are moderately suitable (Class S2) with minor limitations of gravelliness, rooting depth, texture and wetness. They are distributed in all parts of the microwatershed. The marginally suitable (Class S3) lands cover an area of about 77 ha (14%) and occur in the western, southeastern and northeastern part of the microwatershed with moderate limitations of rooting depth and gravelliness. An area of about 39 ha (7%) is not suitable (Class N) for growing marigold and are distributed in the central and northwestern part of the microwatershed.

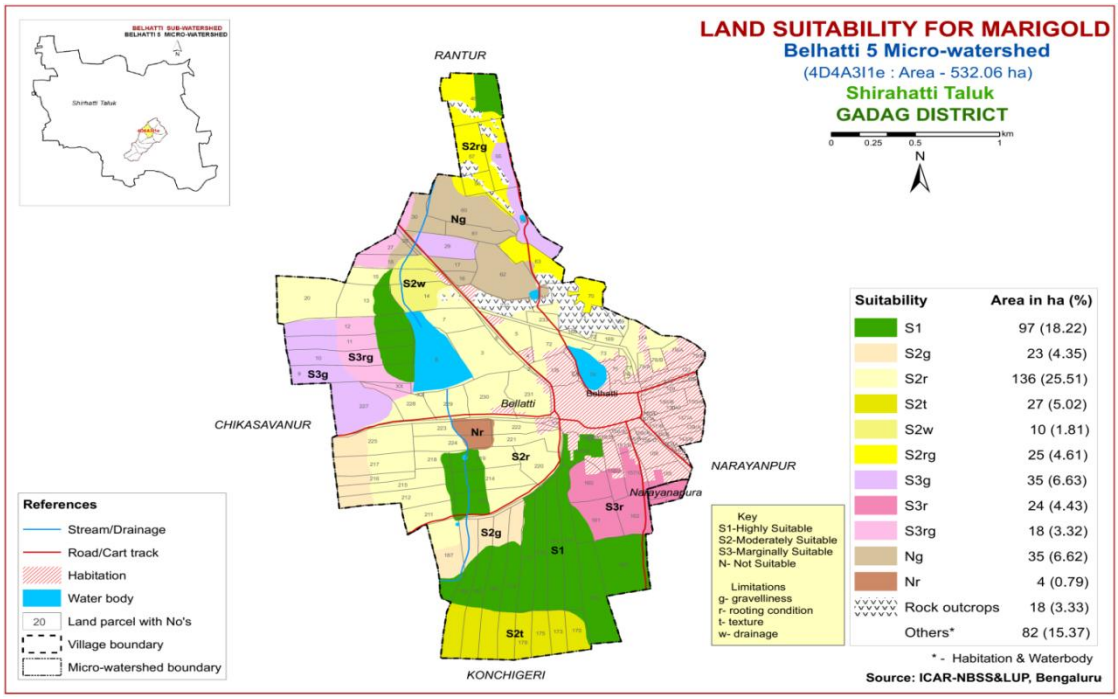


Fig. 7.22 Land Suitability map of Marigold

7.23 Land Suitability for Chrysanthemum (*Chrysanthemum indicum*)

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

An area of about 97 ha (18%) is highly suitable (Class S1) for growing chrysanthemum. They are distributed in the southeastern, central and northern part of the microwatershed. Major area of about 221 ha (41%) has soils that are moderately suitable (Class S2) with minor limitations of gravelliness, rooting depth, texture and wetness. They are distributed in all parts of the microwatershed. The marginally suitable (Class S3) lands cover an area of about 77 ha (14%) and occur in the western, southeastern and northeastern part of the microwatershed with moderate limitations of rooting depth and gravelliness. An area of about 39 ha (7%) is not suitable (Class N) for growing chrysanthemum and are distributed in the central and northwestern part of the microwatershed.

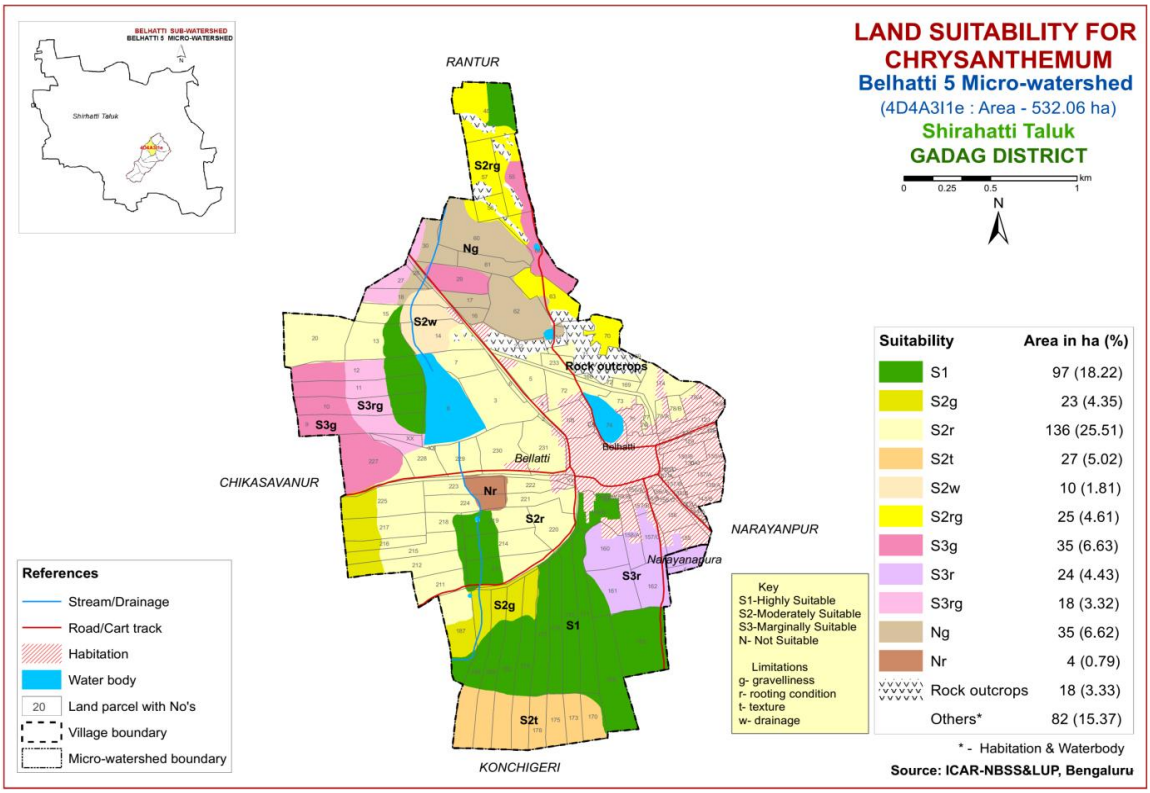


Fig. 7.23 Land Suitability map of Chrysanthemum

7.22 Land Use Classes (LUCs)

The 29 soil map units identified in Belhatti-5 Microwatershed have been grouped into 9 Land Use Classes (LUC's) for the purpose of preparing a Proposed Crop Plan. Land use classess 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 Use Classes map (Fig.7.24) has been prepared. These land use classes are expected to behave similarly for a given level of management.

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

LUCs	Soil map units	Soil and site characteristics
1	HLKcB2 HLKhB2	Very deep, dark brown to dark reddish brown clayey soils with slopes of 1-3% and moderate erosion
2	KMHcA1g1 KMHhB2,VDHcA1 VDHiA1	Deep , sandy loam to sandy clay loam soils with slopes of 0-3%, gravelly (15-35%) and slight to moderate erosion
3	CKMhB1g1 CKMhB2g1, GHThA1 GHThB2g1	Moderately shallow to moderately deep, dark red sandy clay loam soils with slopes of 0-3%, gravelly (15-35%) and slight to moderate erosion
4	HDHcA1g1	Moderately deep, sandy loam soils with slopes of 0-1%, gravelly (15-35%) and slight erosion
5	JLGmB2g1	Moderately deep, black cracking clay soils with slope of 1-3%, gravelly (15-35%) and moderate erosion
6	HNHhA1	Moderately deep , sandy clay loam soils with slope of 0-1%, slight erosion
7	KGHbB2g1, KGHbB2g2 KGHcB2g1, KGHcB2g3 KGHcC2g2, KGHiB1g1 KTPcB2g2, KTPhB1g1 KTPhB2g2, LKRbB2g2 LKRcB2g1, TDHhB1g1	Shallow to moderately shallow, dark brown loamy sand to sandy clay loam soils with slopes of 1-5%, gravelly to extremely gravelly (15-80%) and slight to severe erosion
8	HRVhB2g2 KGPcB2g1	Shallow, sandy loam to sandy clay loam soils with slopes of 1-3%, gravelly to very gravelly (15-60%) and moderate erosion
9	DVHiA1g1	Very shallow, sandy clay soils with slopes of 0-1% , gravelly (15-35%) and slight erosion

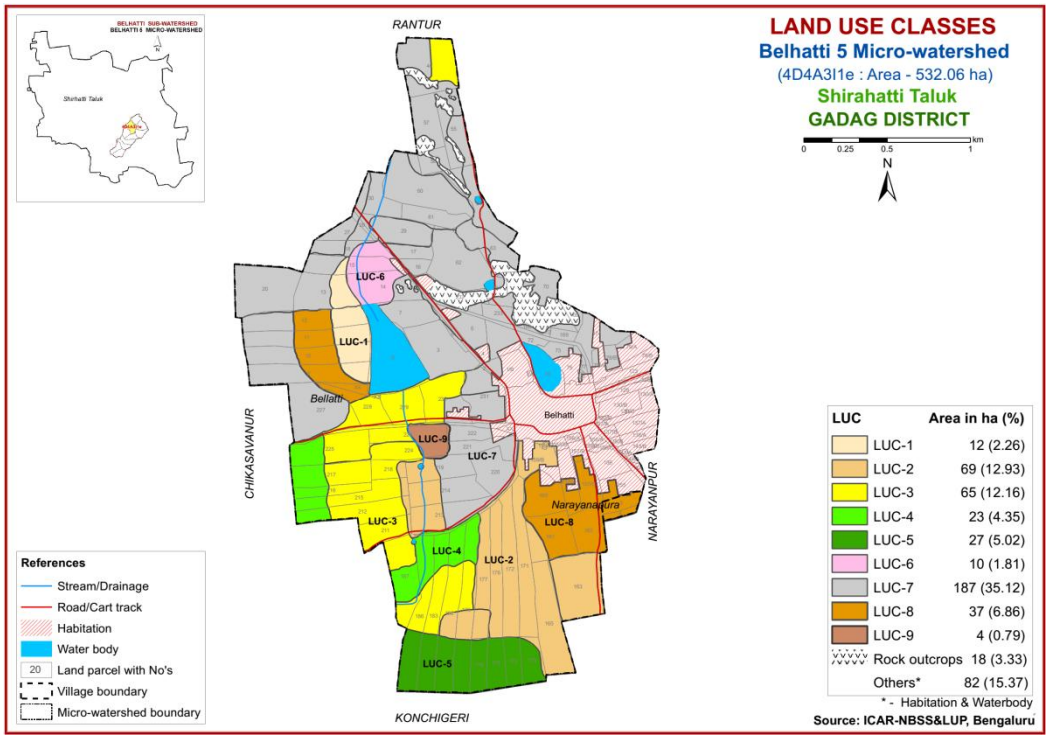


Fig. 7.24 Land Use Classes Map- Belhatti-5 Microwatershed

7.23 Proposed Crop Plan for Belhatti-5 Microwatershed

After assessing the land suitability for the 23 crops, the proposed crop plan has been prepared for the 9 identified LUCs by considering only the highly (Class S1) suitable and moderately (Class S2) suitable lands for each of the 23 crops. The resultant proposed crop plan is presented below in Table 7.16.

Table 7.16 Proposed Crop Plan for Belhatti-5 Microwatershed

LUC No	Mapping Units	Survey Number	Soil Characteristics	Field Crops/ Forestry	Suitable Horticulture Crops under Irrigation	Horticulture Crops with suitable Interventions	Suitable Interventions
LUC 1	7, 8 (>150 cm) Very deep	**Bellati:** 15,13,12,10, 11,9	Very deep, dark brown to dark reddish brown clayey soils with slopes of 1-3% and moderate erosion	Redgram (short duration). Bajra, Sorghum, Sesamum, Greengram, Blackgram, Horsegram, Redgram+Maize, Redgram+Groundnut, Redgram + Fodder jowar	**Perennial Component:** Mango, Tamarind, Aonla, Pomelo **Intercrops:** Groundnut, Hebbal Avare, Clusterbean, Coriander **Vegetables:** Tomato, Green Chillies, French Bean, Bhendi, Vegetable Cowpea, Cucurbits, Onion **Flower Crops:** Marigold, Gaillardia	Mango, Sapota, Guava, Lime, Banana, Papaya, Jamun **Mixed Orchards:** Mango+Guava+Drumstick+ Curry Leaf Sapota+Guava+Drumstick+ Curry leaf **Vegetables**: Tomoto, Capsicum, Green chillies, French Bean, Bhendi, Crucifers, Cucurbits **Flower Crops:** Tuberose, Aster, Chrysanthemum, Rose, Jasmine, Spider Lilly	Drip irrigation, Mulching, other suitable conservation practices (Crescent Bunding with Catch Pit etc)
LUC 2	19, 20, 27, 28 (100-150 cm) Deep	**Bellati:** 159/A,159/B, 163,165,171, 172,176,177, 213	Deep , sandy loam to sandy clay loam soils with slopes of 0-3%, gravelly (15-35%) and slight to moderate erosion	Ragi, Maize, Groundnut, Sorghum, Sunflower, Bajra, Sesamum, Castor	**Perennial Component:** Mango, Tamarind, Aonla, Pomelo **Intercrops:**	Mango,Sapota,Guava,Lime,Banana, Papaya, Jamun **Mixed Orchards:** Mango+Guava+Drumst	-do-

					Groundnut, Hebbal Avare, Clusterbean, Coriander **Vegetables:** Tomato, Green Chillies, French Bean,Bhendi, Vegetable Cowpea, Cucurbits **Flower Crops:** Marigold, Gaillardia	icks+Curryleaf Sapota+Guava+Drumsticks+Curryleaf **Vegetables**: Tomoto,Capsicum, Green Chillies, French Bean, Bhendi, Crucifers, Cucurbits **Flower Crops:** Tuberose,Aster, Chrysanthemum, Rose, Jasmine, Spider Lilly	
LUC 3	1,2, 4, 5 (75-100 cm) moderately shallow to moderately deep	**Bellati:** 48,211,212,215, 216,217,218,224, 225,228, 229,230	Moderately shallow to moderately deep, dark red sandy clay loam soils with slopes of 0-3%, gravelly (15-35%) and slight to moderate erosion	-do-	-do-	-do-	-do-
LUC 4	6(75-100 cm) moderately deep	**Bellati:**187	Moderately deep, sandy loam soils with slopes of 0-1%, gravelly (15-35%) and slight erosion	-do-	-do-	-do-	-do-
LUC 5	11 (75-100 cm) moderately deep	**Bellati:** 170,173,175,178, 179,182, 183,186	Moderately deep, black cracking clay soils with slope of 1-3%, gravelly (15-35%) and moderate erosion	Sorghum, Bajra, Sunflower, Cotton, Safflower, Coriander, Linseed **Multiple/Crop rotation:** Redgram+Maize, Redgram+Fodder jowar, Pulses-Sorghum	**Vegetables:** Chillies, Tomato, Bhendi, Onion, Cabbage, Drumstick **Perenial Components:** Tamarind, Custard	**Flower Crops:** Marigold, Gaillardia, Tuberose, Chrysanthemum **Perenial Components:** Tamarind, Custard Apple, Amla, Lime, Moosambi,	Drip irrigation, Mulching, other suitable conservation practices

					Apple, Amla, Lime, Moosambi, Pomegranate	Pomegranate **Vegetables:** Chillies, Bhendi, Crucifers	
LUC 6	9 (50-75 cm) moderately deep	**Bellati:** 14,15,18	Moderately deep , sandy clay loam soils with slope of 0-1%, slight erosion	Ragi, Maize, Bajra, Castor	**Vegetables:** Cluster Bean, Ridge Gouard, Ash Gouard	Custurd Apple, Bear, Fig, Aonla, Pomelo	-do-
LUC 7	12, 13, 14, 15, 16, 17, 21, 22, 23, 24, 25, 26 (50-75 cm) Shallow to moderately shallow	**Bellati:** 2,3,5,6,7,9,10,11, 12, 13,16,17,20,27,28,29, 30,55, 56,57,60,61,62, 63,64,70,72,73,76,77,78/B,168,169,174, 214,219,220,221, 222, 227,231,233	Shallow to moderately shallow, dark brown loamy sand to sandy clay loam soils with slopes of 1-5%, gravelly to extremely gravelly (15-80%) and slight to severe erosion	Ragi, Bajra, Horsegram, Groundnut	Bear, Custurd Apple **Vegetables:** Cluster Bean, Ridge Gouard, Ash Gouard	Fig, Aonla, Pomelo	Drip irrigation, Mulching, other suitable conservation practices
LUC 8	10, 18 (25-50 cm) shallow	**Bellati:** 157/C,160,161,162 **Narayanapura:** 3,4	Shallow, sandy loam to sandy clay loam soils with slopes of 1-3%, gravelly to very gravelly (15-60%) and moderate erosion	Groundnut, Horsegram, Greengram **Silviculture:** Simaruba, Acacia auriculiformis, Glyricidia, Subabul, Agave, Cassia sp.	**Vegetables:** Chillies, Tomato	-	-do-
LUC 9	3(<25 cm) very shallow	**Bellati:** 223	Very shallow, sandy clay soils with slopes of 0-1% , gravelly (15-35%) and slight erosion	Anjan Grass, Marvel Grass, Styloxanthes hamata	-	-	-do-

Chapter 8

SOIL HEALTH MANAGEMENT

8.1 Soil Health

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

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

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

The most important characterististics of a healthy soil are

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

Characteristics of Belhatti-5 Microwatershed

- The soil phases with sizeable area identified in the microwatershed belonged to the soil series of KGH (96 ha), KMH (54 ha), GHT (49 ha), LKR (35 ha), KTP (28 ha), TDH (27 ha), JLG (27 ha), KGP (24 ha), HDH (23 ha), CKM (16 ha), VDH (15 ha), HRV (13 ha), HLK (12 ha), HNH (10 ha) and DVH (4 ha).
- As per land capability classification, an area about 81 per cent in the microwatershed falls under arable land category (Class II, III and IV). The major limitations identified in the arable lands were soil, erosion and wetness.
- On the basis of soil reaction, maximum area of about 184 ha (34%) is moderately alkaline (pH 7.8-8.4), 38 ha (7%) under strongly alkaline (pH 8.4-9.0) and 114 ha

(21%) area is slightly alkaline (pH 7.3-7.8). An area of about 96 ha (18%) is under neutral (pH 6.5-7.3).

Soil Health Management

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

Alkaline soils

(Slightly alkaline to moderately alkaline soils)

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

Neutral soils

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

Acid soils

(Slightly acid to strongly acid soils)

1. Application of lime in the form of calcium carbonate or limestone ($CaCO_3$)
2. Use of rock phosphate (30-50 % of CaO, which helps in improving soil pH).
3. Application of basic fertilizers (Sodium nitrate, basic slag etc, reduces acidity in acid soils)
4. 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.

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

Soil Degradation

Soil erosion is one of the major factor affecting the soil health in the microwatershed. Out of total 532 ha area in the microwatershed, an area of 290 ha is

suffering from moderate erosion. These areas need immediate soil and water conservation and, other land development and land husbandry practices for restoring soil health.

Dissemination of information and communication of benefits

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

Inputs for Net Planning (Saturation Plan) and Interventions needed

Net planning in IWMP is focusing on preparation of

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

In this connection, how various outputs of Sujala-III are of use in addressing these objectives of Net Planning (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 Belhatti-5 Microwatershed.
- **Organic Carbon:** The OC content (an index of available Nitrogen) is medium (0.5-0.75%) in maximum area of about 203 ha (38%), low (<0.5%) in 170 ha (32%) and high (>0.5%) in 60 ha (11%). The areas that are low and medium in OC needs to be further improved by applying farmyard manure and rotating crops with cereals and legumes or mixed cropping.
- **Promoting green manuring:** Growing of green manuring crops costs Rs. 1250/ha (green manuring seeds) and about Rs. 2000/ha towards cultivation that totals to Rs. 3250/- per ha. On the other hand, application of organic manure @ 10 tons/ha costs Rs. 5000/ha. The practice needs to be continued for 2-3 years or more. Nitrogen fertilizer needs to be supplemented by 25% in addition to the recommended level in 373 ha area where OC is less than 0.5% and medium (0.5-0.75%) in OC. For example, for rainfed maize, recommended level is 50 kg N per ha and an additional 12 kg /ha needs to be applied for all the crops grown in these plots.
- **Available Phosphorus**: Available phosphorus is medium in an area of about 333 ha (63%), 94 ha (18%) low (<23 kg/ha) and a very small area of about 5 ha (1%) is high (>57 kg/ha) in the microwatershed.. Hence for all the crops, 25% additional P-needs to be applied.
- **Available Potassium:** Available potassium is medium (145-337 kg/ha) in maximum area of about 257 ha (48%) and 176 ha (33%) is high (>337 kg/ha) in the microwatershed. For all crops, additional 25 % potassium may be applied in the areas where available potassium is medium.
- **Available Sulphur:** Available sulphur is a very critical nutrient for oilseed crops. Available sulphur is medium (10-20 ppm) in maximum area of about 241 ha (45%) in the microwatershed. An area of about 170 ha (32%) is low in available sulphur. These areas need to be applied with magnesium sulphate or gypsum or Factamphos (p) fertitilizer (13% sulphur) for 2-3 years for the deficiency to be corrected. It is high (>20 ppm) in about 21 ha (4%).
- **Available Boron:** Available boron is medium in an area of 395 ha (74%) and low in 28 ha (5%) in the microwatershed. These areas need to be applied with sodium borate @ 10 kg/ha as soil application or 0.2% borax as foliar application to correct the boron deficiency. It is high in about 9 ha (2%).
- **Available iron:** It is deficient in an area of 144 ha (27%) in the microwatershed. To manage iron deficiency, iron sulphate @ 25kg /ha needs to be applied for 2-3 years. It is sufficient in maximum area of about 288 ha (54 %) in the microwatershed.

- **Available Zinc:** It is deficient (<0.6 ppm) in 427 ha (80%) area and sufficient (>0.6 ppm) in 6 ha (1%) in the microwatershed. Application of zinc sulphate @25kg/ha is to be followed in deficient areas.
- **Soil alkalinity:** The microwatershed has 336 ha (63%) area with soils that are slightly to strongly alkaline. These areas need application of gypsum and wherever calcium is in excess, iron pyrites and element sulphur can be recommended. Management practices like treating repeatedly with good quality water to drain out the excess salts and provision of subsurface drainage and growing of salt tolerant crops like Casuarina, Acasia, Neem, Ber etc, are recommended.

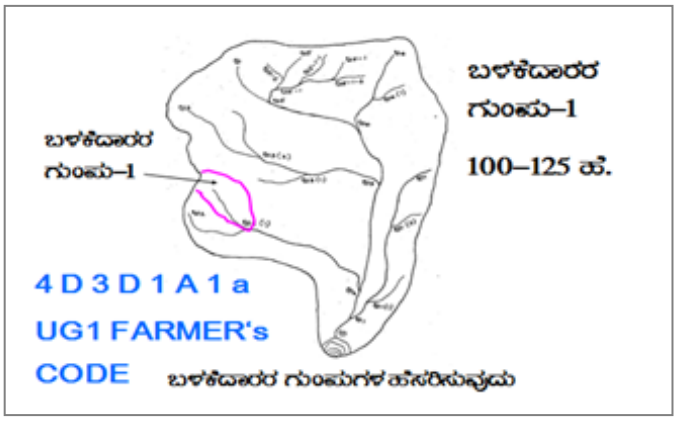
Land Suitability for various crops: Areas that are highly, moderately and marginally suitable for growing various crops are indicated. Along with the suitability, various constraints that are limiting the productivity are also indicated. For example, in case of cotton, gravel content, rooting depth and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

Chapter 9

SOIL AND WATER CONSERVATION TREATMENT PLAN

For preparing soil and water conservation treatment plan for Belhatti-5 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 is collected.

Steps for Survey and Preparation of Treatment Plan

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

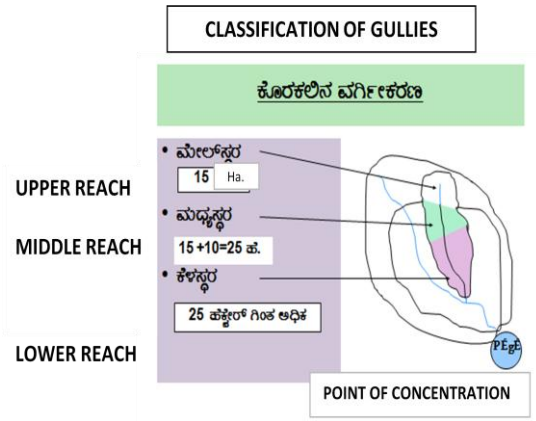
- Naming of user groups and farmers
- Identification of arable and non arable lands
- Identification of drainage lines and gullies
- Identification of non treatable areas
- Identification of priority areas in the arable lands
- Treatment plan for arable lands
- Location of water harvesting and recharge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

9.1 Treatment Plan

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

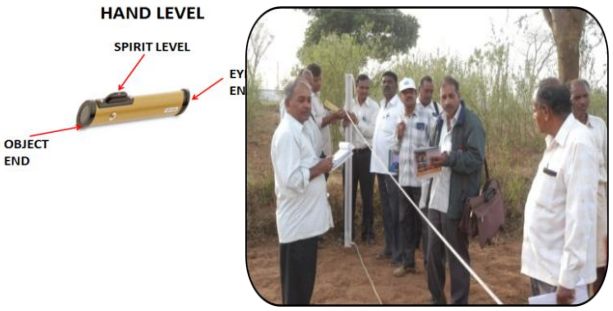
9.1.1 Arable Land Treatment

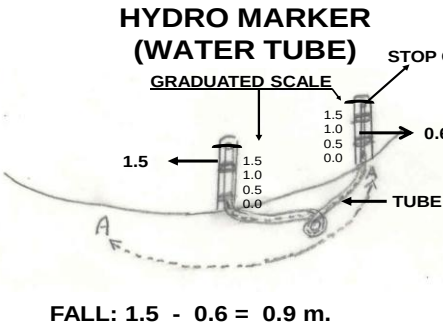
A. BUNDING

<table>
<tr><th colspan="2">Steps for Survey and Preparation of Treatment Plan</th><th>USER GROUP-1</th></tr>
<tr><td colspan="2">• 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</td><td rowspan="5"> 
</td></tr>
<tr><td>Small gullies</td><td>(up to 5 ha catchment)</td></tr>
<tr><td>Medium gullies</td><td>(5-15 ha catchment)</td></tr>
<tr><td>Ravines</td><td>(15-25 ha catchment) and</td></tr>
<tr><td>Halla/Nala</td><td>(more than 25ha catchment)</td></tr>
</table>

Measurement of Land Slope

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





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

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

Note: i) The above intervals are maximum.

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

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

Section of the Bund

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

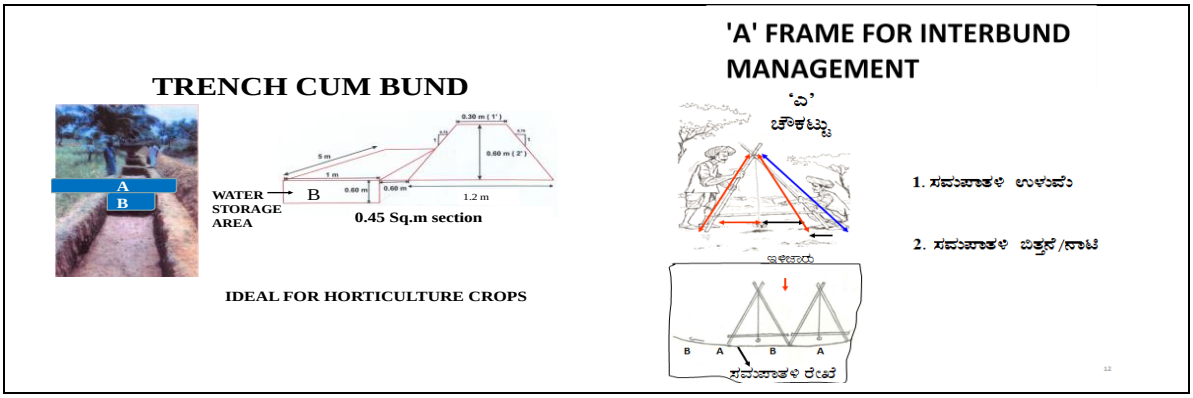
Recommended Bund Section

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

Formation of Trench cum Bund

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

Details of Borrow Pit dimensions are given below



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

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

B. Waterways

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

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

c) The design details are given in the Manual.

C. Farm Ponds

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

D. Diversion channel

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

9.1.2 Non-Arable Land Treatment

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

9.1.3 Treatment of Natural Water Course/ Drainage Lines

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

b) The drainage line will be demarcated into Upper Reach, Middle Reach and Lower Reach.
c) Considering the Catchment, Nala bed and bank conditions, suitable structures are decided.
d) Number of storage structures (Check dam/ Nala bund/ Percolation tank) will be decided considering the commitments and available runoff 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. Maximum area of about 347 ha (65%) requires trench cum bunding and about 85 ha (16%) area needs graded bunds or strengthening of existing bunds. 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.

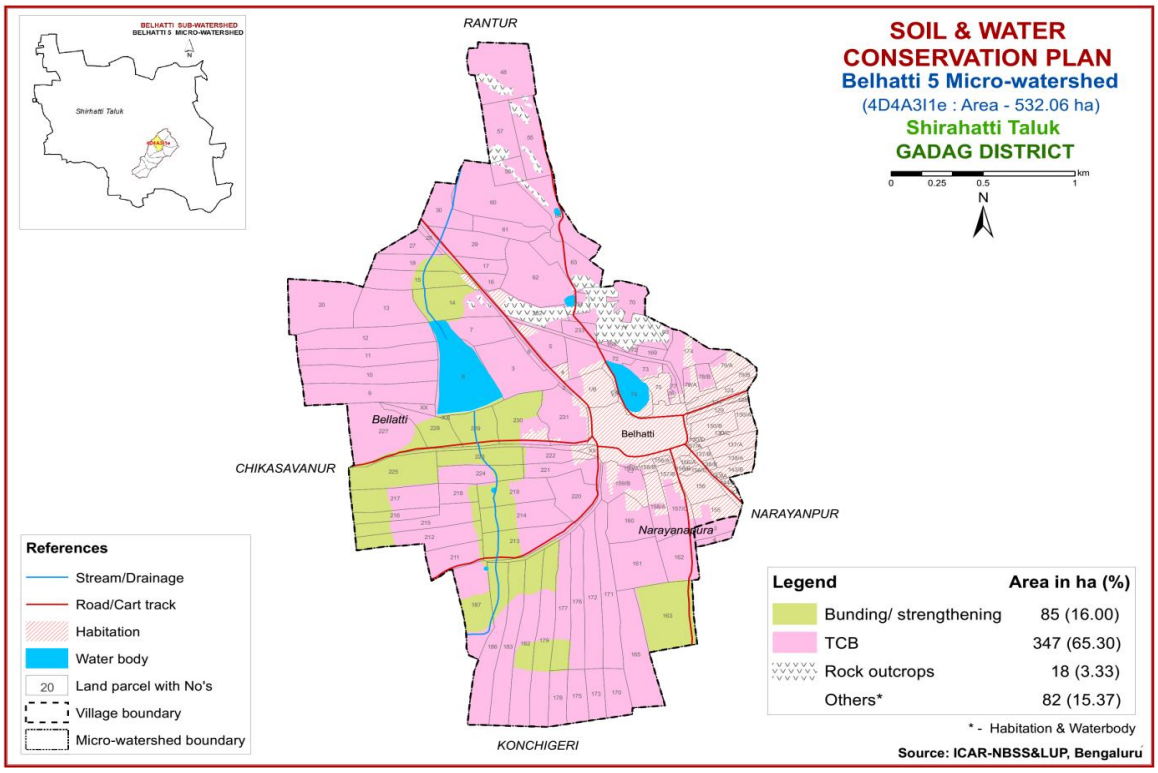


Fig. 9.1 Soil and Water Conservation Plan map of Belhatti-5 Microwatershed

9.3 Greening of Microwatershed

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

It is recommended to open 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 Neral (*Sizyzium cumini*) and Bamboo. Dry areas are to be planted with species like Honge, Bevu, Seetaphal *etc*.

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

References

1. FAO (1976) Framework for Land Evaluation, Food and Agriculture Organization, Rome.72 pp.
2. FAO (1983) Guidelines for Land Evaluation for Rainfed Agriculture, FAO, Rome, 237 pp.
3. IARI (1971) Soil Survey Manual, All India Soil and Land Use Survey Organization, IARI, New Delhi, 121 pp.
4. Katyal, J.C. and Rattan, R.K. (2003) Secondary and Micronutrients; Reaserch Gap and future needs. Fert. News 48 (4); 9-20.
5. Naidu, L.G.K., Ramamurthy, V., Challa, O., Hegde, R. and Krishnan, P. (2006) Manual Soil Site Suitability Criteria for Major Crops, NBSS Publ. No. 129, NBSS &LUP, Nagpur, 118 pp.
6. Natarajan, A. and Dipak Sarkar (2010) Field Guide for Soil Survey, National Bureau of Soil Survey and Land Use Planning (ICAR), Nagpur, India.
7. Natarajan, A., Rajendra Hegde, Raj, J.N. and Shivananda Murthy, H.G. (2015) Implementation Manual for Sujala-III Project, Watershed Development Department, Bengaluru, Karnataka.
8. Sarma, V.A.K., Krishnan, P. and Budihal, S.L. (1987) Laboratory Manual, Tech. Bull. 23, NBSS &LUP, Nagpur.
9. Sehgal, J.L. (1990) Soil Resource Mapping of Different States of India; Why and How?, National Bureau of Soil Survey and Land Use Planning, Nagpur, 49 pp.
10. Shivaprasad, C.R., R.S. Reddy, J. Sehgal and M. Velayuthum (1998) Soils of Karntaka for Optimising Land Use, NBSS Publ. No. 47b, NBSS & LUP, Nagpur, India.
11. Soil Survey Staff (2006) Keys to Soil Taxonomy, Tenth edition, U.S. Department of Agriculture/ NRCS, Washington DC, U.S.A.
12. Soil Survey Staff (2012) Soil Survey Manual, Handbook No. 18, USDA, Washington DC, USA.

Appendix I

Belhatti 5 Microwatershed

Soil Phase Information

Village	Survey No.	Area (ha)	Soil Phase	LUC	Soil Depth	Surface Soil Texture	Soil Gravelliness	Available Water Capacity	Slope	Soil Erosion	Current Land Use	WELLS	Land Capability	Conservation Plan
Bellatti	1/A	0.08	Habitation	Others	Others	Others	Others	Others	Others	Others	Others	Not Available	Others	Others
Bellatti	1/B	4.12	Habitation	Others	Others	Others	Others	Others	Others	Others	Scrubland+Cotton (Sl+Ct)	Not Available	Others	Others
Bellatti	2	0.1	KGHiB1g1	LUC-7	Moderately shallow (50-75 cm)	Sandy clay	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Slight	Road	Not Available	IIs	TCB
Bellatti	3	8.93	KGHbB2g1	LUC-7	Moderately shallow (50-75 cm)	Loamy sand	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Cotton+Sugarcane+Maize (Ct+Sc+Mz)	Not Available	IIes	TCB
Bellatti	4	0.68	Habitation	Others	Others	Others	Others	Others	Others	Others	NA	Not Available	Others	Others
Bellatti	5	3.73	KGHiB1g1	LUC-7	Moderately shallow (50-75 cm)	Sandy clay	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Slight	NA	Not Available	IIs	TCB
Bellatti	6	0.62	KGHbB2g1	LUC-7	Moderately shallow (50-75 cm)	Loamy sand	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Road	Not Available	IIes	TCB
Bellatti	7	5.6	KGHbB2g1	LUC-7	Moderately shallow (50-75 cm)	Loamy sand	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Fallowland (Fl)	2 Borewell	IIes	TCB
Bellatti	8	11.73	Water body	Others	Others	Others	Others	Others	Others	Others	Others	Tank	Others	Others
Bellatti	9	8.51	LKRbB2g2	LUC-7	Moderately shallow (50-75 cm)	Loamy sand	Very gravelly (35-60%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Maize+Fallowland (Mz+Fl)	Not Available	IIIes	TCB
Bellatti	10	8.08	LKRbB2g2	LUC-7	Moderately shallow (50-75 cm)	Loamy sand	Very gravelly (35-60%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Groundnut+Maize+Cotton (Gn+Mz+Ct)	Openwell, Borewell	IIIes	TCB
Bellatti	11	7.56	LKRbB2g2	LUC-7	Moderately shallow (50-75 cm)	Loamy sand	Very gravelly (35-60%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Mulberry+Groundnut+Cotton (Mu+Gn+Ct)	Openwell, Borewell	IIIes	TCB
Bellatti	12	8.56	LKRbB2g2	LUC-7	Moderately shallow (50-75 cm)	Loamy sand	Very gravelly (35-60%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Horsegram+Onion+Groundnut (Hg+On+Gn)	Borewell	IIIes	TCB
Bellatti	13	7.17	KGHcB2g1	LUC-7	Moderately shallow (50-75 cm)	Sandy loam	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Maize+Groundnut+Onion (Mz+Gn+On)	Not Available	IIes	TCB
Bellatti	14	7.1	HNHhA1	LUC-6	Moderately shallow (50-75 cm)	Sandy clay loam	Non gravelly (<15%)	Low (51-100 mm/m)	Nearly level (0-1%)	Slight	Fallowland+Cotton (Fl+Ct)	Not Available	IIIw	Bunding/ strengthening of existing bunds
Bellatti	15	5.74	HNHhA1	LUC-6	Moderately shallow (50-75 cm)	Sandy clay loam	Non gravelly (<15%)	Low (51-100 mm/m)	Nearly level (0-1%)	Slight	Fallowland (Fl)	Not Available	IIIw	Bunding/ strengthening of existing bunds

Village	Survey No.	Area (ha)	Soil Phase	LUC	Soil Depth	Surface Soil Texture	Soil Gravelliness	Available Water Capacity	Slope	Soil Erosion	Current Land Use	WELLS	Land Capability	Conservation Plan
Bellatti	16	1.31	KGHcC2g2	LUC-7	Moderately shallow (50-75 cm)	Sandy loam	Very gravelly (35-60%)	Low (51-100 mm/m)	Gently sloping (3-5%)	Moderate	Fallowland (Fl)	Not Available	IIes	TCB
Bellatti	17	2.14	KGHcC2g2	LUC-7	Moderately shallow (50-75 cm)	Sandy loam	Very gravelly (35-60%)	Low (51-100 mm/m)	Gently sloping (3-5%)	Moderate	Groundnut+Cotton+Onion (Gn+Ct+On)	Not Available	IIes	TCB
Bellatti	18	4.23	HNHhA1	LUC-6	Moderately shallow (50-75 cm)	Sandy clay loam	Non gravelly (<15%)	Low (51-100 mm/m)	Nearly level (0-1%)	Slight	Maize+Fallowland (Mz+Fl)	Openwell	IIIw	Bunding/ strengthening of existing bunds
Bellatti	20	10.45	KGHcB2g1	LUC-7	Moderately shallow (50-75 cm)	Sandy loam	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Maize+Cotton (Mz+Ct)	Not Available	IIes	TCB
Bellatti	27	2.63	KTPcB2g2	LUC-7	Moderately shallow (50-75 cm)	Sandy loam	Very gravelly (35-60%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Maize (Mz)	Not Available	IIes	TCB
Bellatti	28	0.47	KGHcB2g3	LUC-7	Moderately shallow (50-75 cm)	Sandy loam	Extremely gravelly (60-80%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	NA	Not Available	IIIes	TCB
Bellatti	29	5.48	LKRcB2g1	LUC-7	Moderately shallow (50-75 cm)	Sandy loam	Gravelly (15-35%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Sugarcane+Cotton+Mulberry (Sc+Ct+Mu)	Openwell	IIIes	TCB
Bellatti	30	4.67	KGHcB2g3	LUC-7	Moderately shallow (50-75 cm)	Sandy loam	Extremely gravelly (60-80%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Maize+Groundnut (Mz+Gn)	Not Available	IIIes	TCB
Bellatti	48	10.62	CKMhB1g1	LUC-3	Moderately deep (75-100 cm)	Sandy clay loam	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Slight	Groundnut (Gn)	Borewell	IIs	TCB
Bellatti	55	6.72	KTPhB2g2	LUC-7	Moderately shallow (50-75 cm)	Sandy clay loam	Very gravelly (35-60%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Maize+Horsegram (Mz+Hg)	Not Available	IIes	TCB
Bellatti	56	2.44	KTPhB2g2	LUC-7	Moderately shallow (50-75 cm)	Sandy clay loam	Very gravelly (35-60%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Fallowland (Fl)	Not Available	IIes	TCB
Bellatti	57	5.38	KTPhB2g2	LUC-7	Moderately shallow (50-75 cm)	Sandy clay loam	Very gravelly (35-60%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Maize+Sugarcane+Horsegram (Mz+Sc+Gn)	Not Available	IIes	TCB
Bellatti	60	11.81	KGHcB2g3	LUC-7	Moderately shallow (50-75 cm)	Sandy loam	Extremely gravelly (60-80%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Maize+Fallowland+Groundnut (Mz+Fl+Gn)	Not Available	IIIes	TCB
Bellatti	61	3.52	KGHcB2g3	LUC-7	Moderately shallow (50-75 cm)	Sandy loam	Extremely gravelly (60-80%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Maize (Mz)	Not Available	IIIes	TCB
Bellatti	62	10	KGHcC2g2	LUC-7	Moderately shallow (50-75 cm)	Sandy loam	Very gravelly (35-60%)	Low (51-100 mm/m)	Gently sloping (3-5%)	Moderate	Maize+Redgram+Cotton (Mz+Rg+Ct)	Not Available	IIes	TCB
Bellatti	63	5.95	KTPhB2g2	LUC-7	Moderately shallow (50-75 cm)	Sandy clay loam	Very gravelly (35-60%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram+Groundnut+Maize (Rg+Gn+Mz)	Openwell	IIes	TCB

Village	Survey No.	Area (ha)	Soil Phase	LUC	Soil Depth	Surface Soil Texture	Soil Gravelliness	Available Water Capacity	Slope	Soil Erosion	Current Land Use	WELLS	Land Capability	Conservation Plan
Bellatti	64	6.26	LKRcB2g1	LUC-7	Moderately shallow (50-75 cm)	Sandy loam	Gravelly (15-35%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Sorghum+Horsegram+Groundnut (Sg+Hg+Gn)	Tank	IIIes	TCB
Bellatti	69	1.11	Rockout crop	Rock outcrops	Rockout crop	Rockout crop	Rockout crop	Rock outcrops	Rockout crop	Rockout crop	Fallowland (Fl)	Not Available	VIII	Rock outcrops
Bellatti	70	3.15	KTPhB2g2	LUC-7	Moderately shallow (50-75 cm)	Sandy clay loam	Very gravelly (35-60%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Fallowland (Fl)	Not Available	IIes	TCB
Bellatti	71	8.84	Rockout crop	Rock outcrops	Rockout crop	Rockout crop	Rockout crop	Rock outcrops	Rockout crop	Rockout crop	Rockout crop	Not Available	VIII	Rock outcrops
Bellatti	72	4.61	KGHiB1g1	LUC-7	Moderately shallow (50-75 cm)	Sandy clay	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Slight	Groundnut+Horsegram (Gn+Hg)	Not Available	IIs	TCB
Bellatti	73	1.75	KGHiB1g1	LUC-7	Moderately shallow (50-75 cm)	Sandy clay	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Slight	Others	Not Available	IIs	TCB
Bellatti	74	4.56	Water body	Others	Others	Others	Others	Others	Others	Others	Others	Not Available	Others	Others
Bellatti	75	1.9	Habitation	Others	Others	Others	Others	Others	Others	Others	Others	Not Available	Others	Others
Bellatti	76	0.17	KGHiB1g1	LUC-7	Moderately shallow (50-75 cm)	Sandy clay	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Slight	Others	Not Available	IIs	TCB
Bellatti	77	0.74	KGHiB1g1	LUC-7	Moderately shallow (50-75 cm)	Sandy clay	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Slight	Road	Not Available	IIs	TCB
Bellatti	78/A	1.72	Habitation	Others	Others	Others	Others	Others	Others	Others	Others	Not Available	Others	Others
Bellatti	78/B	1.24	KTPhB1g1	LUC-7	Moderately shallow (50-75 cm)	Sandy clay loam	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Slight	Others	Not Available	IIs	TCB
Bellatti	79/A	2.32	Habitation	Others	Others	Others	Others	Others	Others	Others	Others	Not Available	Others	Others
Bellatti	79/B	1.32	Habitation	Others	Others	Others	Others	Others	Others	Others	NA	Not Available	Others	Others
Bellatti	123	1.91	Habitation	Others	Others	Others	Others	Others	Others	Others	NA	Not Available	Others	Others
Bellatti	124	0.76	Habitation	Others	Others	Others	Others	Others	Others	Others	NA	Not Available	Others	Others
Bellatti	125	0.1	Habitation	Others	Others	Others	Others	Others	Others	Others	Road	Not Available	Others	Others
Bellatti	129	1.44	Habitation	Others	Others	Others	Others	Others	Others	Others	NA	Not Available	Others	Others
Bellatti	130/A	2.17	Habitation	Others	Others	Others	Others	Others	Others	Others	NA	Not Available	Others	Others
Bellatti	130/B	2.75	Habitation	Others	Others	Others	Others	Others	Others	Others	NA	Not Available	Others	Others

Village	Survey No.	Area (ha)	Soil Phase	LUC	Soil Depth	Surface Soil Texture	Soil Gravelliness	Available Water Capacity	Slope	Soil Erosion	Current Land Use	WELLS	Land Capability	Conservation Plan
Bellatti	130/C	0.03	Habitation	Others	Others	Others	Others	Others	Others	Others	NA	Not Available	Others	Others
Bellatti	130/D	0.11	Habitation	Others	Others	Others	Others	Others	Others	Others	NA	Not Available	Others	Others
Bellatti	137/A	2.54	Habitation	Others	Others	Others	Others	Others	Others	Others	NA	Not Available	Others	Others
Bellatti	137/B	0.57	Habitation	Others	Others	Others	Others	Others	Others	Others	NA	Not Available	Others	Others
Bellatti	138/A	1.39	Habitation	Others	Others	Others	Others	Others	Others	Others	NA	Not Available	Others	Others
Bellatti	138/B	0.32	Habitation	Others	Others	Others	Others	Others	Others	Others	NA	Not Available	Others	Others
Bellatti	143/A	0.13	Habitation	Others	Others	Others	Others	Others	Others	Others	NA	Not Available	Others	Others
Bellatti	143/B	1.39	Habitation	Others	Others	Others	Others	Others	Others	Others	NA	Not Available	Others	Others
Bellatti	144/A	0.23	Habitation	Others	Others	Others	Others	Others	Others	Others	NA	Not Available	Others	Others
Bellatti	155	3.05	Habitation	Others	Others	Others	Others	Others	Others	Others	Fallowland (Fl)	Not Available	Others	Others
Bellatti	156/A	0.93	Habitation	Others	Others	Others	Others	Others	Others	Others	NA	Not Available	Others	Others
Bellatti	156/B	0.4	Habitation	Others	Others	Others	Others	Others	Others	Others	NA	Not Available	Others	Others
Bellatti	156/C	0.36	Habitation	Others	Others	Others	Others	Others	Others	Others	NA	Not Available	Others	Others
Bellatti	156	3.12	Habitation	Others	Others	Others	Others	Others	Others	Others	Others	Not Available	Others	Others
Bellatti	157/B	1.17	Habitation	Others	Others	Others	Others	Others	Others	Others	Others	Not Available	Others	Others
Bellatti	157/C	3.49	KGPcB2g1	LUC-8	Shallow (25-50 cm)	Sandy loam	Gravelly (15-35%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Cotton+Maize (Ct+Mz)	Not Available	IIIes	TCB
Bellatti	158/A	3.58	Habitation	Others	Others	Others	Others	Others	Others	Others	Fallowland+Mulberry (Fl+Mu)	Not Available	Others	Others
Bellatti	158/B	0.58	Habitation	Others	Others	Others	Others	Others	Others	Others	NA	Not Available	Others	Others
Bellatti	159/A	0.1	KMHhB2	LUC-2	Deep (100-150 cm)	Sandy clay loam	Non gravelly (<15%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Moderate	NA	Not Available	IIes	TCB
Bellatti	159/B	4.6	KMHhB2	LUC-2	Deep (100-150 cm)	Sandy clay loam	Non gravelly (<15%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Moderate	Fallowland (Fl)	Not Available	IIes	TCB
Bellatti	160	5.73	KGPcB2g1	LUC-8	Shallow (25-50 cm)	Sandy loam	Gravelly (15-35%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Fallowland (Fl)	Not Available	IIIes	TCB

Village	Survey No.	Area (ha)	Soil Phase	LUC	Soil Depth	Surface Soil Texture	Soil Gravelliness	Available Water Capacity	Slope	Soil Erosion	Current Land Use	WELLS	Land Capability	Conservation Plan
Bellatti	161	7.33	KGPcB2g1	LUC-8	Shallow (25-50 cm)	Sandy loam	Gravelly (15-35%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Horsegram+Cotton (Hg+Ct)	Not Available	IIIes	TCB
Bellatti	162	5.11	KGPcB2g1	LUC-8	Shallow (25-50 cm)	Sandy loam	Gravelly (15-35%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Maize+Redgram (Mz+Rg)	Not Available	IIIes	TCB
Bellatti	163	10.82	KMHcA1g1	LUC-2	Deep (100-150 cm)	Sandy loam	Gravelly (15-35%)	Medium (101-150 mm/m)	Nearly level (0-1%)	Slight	Cotton+Sugarcane+Maize (Ct+Sc+Mz)	Openwell	IIs	Bunding/ strengthening of existing bunds
Bellatti	165	9.62	KMHhB2	LUC-2	Deep (100-150 cm)	Sandy clay loam	Non gravelly (<15%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Moderate	Maize (Mz)	Not Available	IIes	TCB
Bellatti	168	0.32	KGHiB1g1	LUC-7	Moderately shallow (50-75 cm)	Sandy clay	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Slight	Road	Not Available	IIs	TCB
Bellatti	169	0.94	KGHiB1g1	LUC-7	Moderately shallow (50-75 cm)	Sandy clay	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Slight	Fallowland (Fl)	Not Available	IIs	TCB
Bellatti	170	3.59	JLGmB2g1	LUC-5	Moderately deep (75-100 cm)	Clay	Gravelly (15-35%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Moderate	Cotton+Maize (Ct+Mz)	Not Available	IIIs	TCB
Bellatti	171	7.88	KMHhB2	LUC-2	Deep (100-150 cm)	Sandy clay loam	Non gravelly (<15%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Moderate	Cotton+Horsgram (Ct+Hg)	Not Available	IIes	TCB
Bellatti	172	7.81	KMHhB2	LUC-2	Deep (100-150 cm)	Sandy clay loam	Non gravelly (<15%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Moderate	Maize+Redgram+Horsegram (Mz+Rg+Hg)	Not Available	IIes	TCB
Bellatti	173	2.82	JLGmB2g1	LUC-5	Moderately deep (75-100 cm)	Clay	Gravelly (15-35%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Moderate	Maize+Cotton+Chilly (Mz+Ct+Ch)	Not Available	IIIs	TCB
Bellatti	174	4.46	KGHiB1g1	LUC-7	Moderately shallow (50-75 cm)	Sandy clay	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Slight	Fallowland (Fl)	Not Available	IIs	TCB
Bellatti	175	3.34	JLGmB2g1	LUC-5	Moderately deep (75-100 cm)	Clay	Gravelly (15-35%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Moderate	Cotton+Sorghum (Ct+Sg)	Not Available	IIIs	TCB
Bellatti	176	6.06	KMHhB2	LUC-2	Deep (100-150 cm)	Sandy clay loam	Non gravelly (<15%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Moderate	Maize+Cotton+Sugarcane (Mz+Ct+Sc)	Not Available	IIes	TCB
Bellatti	177	6.24	KMHhB2	LUC-2	Deep (100-150 cm)	Sandy clay loam	Non gravelly (<15%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Moderate	Pomagranate+Maize+Cotton (Pg+Mz+Ct)	Not Available	IIes	TCB
Bellatti	178	3.12	JLGmB2g1	LUC-5	Moderately deep (75-100 cm)	Clay	Gravelly (15-35%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Moderate	Sorghum+Sugarcane (Sg+Sc)	Not Available	IIIs	TCB
Bellatti	179	9.6	JLGmB2g1	LUC-5	Moderately deep (75-100 cm)	Clay	Gravelly (15-35%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Moderate	Cotton+Sugarcane+Onion (Ct+Sc+On)	Not Available	IIIs	TCB

Village	Survey No.	Area (ha)	Soil Phase	LUC	Soil Depth	Surface Soil Texture	Soil Gravelliness	Available Water Capacity	Slope	Soil Erosion	Current Land Use	WELLS	Land Capability	Conservation Plan
Bellatti	182	9.98	JLGmB2g1	LUC-5	Moderately deep (75-100 cm)	Clay	Gravelly (15-35%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Moderate	Sorghum+Sugarcane+Maize (Sg+Sc+Mz)	3 Borewell	IIIs	TCB
Bellatti	183	8.52	JLGmB2g1	LUC-5	Moderately deep (75-100 cm)	Clay	Gravelly (15-35%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Moderate	Mulberry+Maize+Brinjal (Mu+Mz+Br)	2 Borewell, 2 Openwell	IIIs	TCB
Bellatti	186	9.36	JLGmB2g1	LUC-5	Moderately deep (75-100 cm)	Clay	Gravelly (15-35%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Moderate	Maize+Mulberry+Brinjal (Mz+Mu+Br)	4 Borewell, 2 Openwell	IIIs	TCB
Bellatti	187	8.09	HDHcA1g1	LUC-4	Moderately deep (75-100 cm)	Sandy loam	Gravelly (15-35%)	Very Low (<50 mm/m)	Nearly level (0-1%)	Slight	Maize+Horsegram+Cotton (Mz+Hg+Ct)	Borewell	IIIs	Bunding/ strengthening of existing bunds
Bellatti	211	4.23	GHThB2g1	LUC-3	Moderately deep (75-100 cm)	Sandy clay loam	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Maize+Horsegram (Mz+Hg)	Not Available	IIes	TCB
Bellatti	212	6.67	GHThB2g1	LUC-3	Moderately deep (75-100 cm)	Sandy clay loam	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Onion+Cotton+Chilly (On+Ct+Ch)	Borewell	IIes	TCB
Bellatti	213	6.51	VDHcA1	LUC-2	Deep (100-150 cm)	Sandy loam	Non gravelly (<15%)	Medium (101-150 mm/m)	Nearly level (0-1%)	Slight	Sugarcane+Cotton+Brinjal (Sc+Ct+Br)	2 Borewell	IIs	Bunding/ strengthening of existing bunds
Bellatti	214	6.38	TDHhB1g1	LUC-7	Moderately shallow (50-75 cm)	Sandy clay loam	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Slight	Cotton+Horsgram+Onion (Ct+Hg+On)	3 Borewell	IIs	TCB
Bellatti	215	5.81	GHThB2g1	LUC-3	Moderately deep (75-100 cm)	Sandy clay loam	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Sorghum+Sugarcane (Sg+Sc)	Openwell, 2 Borewell	IIes	TCB
Bellatti	216	2.73	GHThB2g1	LUC-3	Moderately deep (75-100 cm)	Sandy clay loam	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Maize (Mz)	Borewell	IIes	TCB
Bellatti	217	6.29	GHThB2g1	LUC-3	Moderately deep (75-100 cm)	Sandy clay loam	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Groundnut+Maize (Gn+Mz)	Not Available	IIes	TCB
Bellatti	218	2.35	GHThB2g1	LUC-3	Moderately deep (75-100 cm)	Sandy clay loam	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Maize (Mz)	Not Available	IIes	TCB
Bellatti	219	5.51	TDHhB1g1	LUC-7	Moderately shallow (50-75 cm)	Sandy clay loam	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Slight	Maize+Sugarcane+Groundnut (Mz+Sc+Gn)	Not Available	IIs	TCB
Bellatti	220	5.27	TDHhB1g1	LUC-7	Moderately shallow (50-75 cm)	Sandy clay loam	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Slight	Onion+Maize (On+Mz)	Openwell	IIs	TCB
Bellatti	221	3.76	TDHhB1g1	LUC-7	Moderately shallow (50-75 cm)	Sandy clay loam	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Slight	Fallowland+Maize (Fl+Mz)	Not Available	IIs	TCB

Village	Survey No.	Area (ha)	Soil Phase	LUC	Soil Depth	Surface Soil Texture	Soil Gravelliness	Available Water Capacity	Slope	Soil Erosion	Current Land Use	WELLS	Land Capability	Conservation Plan
Bellatti	222	2.72	TDHhB1g1	LUC-7	Moderately shallow (50-75 cm)	Sandy clay loam	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Slight	Coconut+Chilly (CN+Ch)	Not Available	IIs	TCB
Bellatti	223	4.42	DVHiA1g1	LUC-9	Very shallow (<25 cm)	Sandy clay	Gravelly (15-35%)	Very Low (<50 mm/m)	Nearly level (0-1%)	Slight	Maize+Brinjal (Mz+Br)	Openwell, Borewell	IVs	Bunding/ strengthening of existing bunds
Bellatti	224	4.56	GHThB2g1	LUC-3	Moderately deep (75-100 cm)	Sandy clay loam	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Maize+Cotton (Mz+Ct)	Not Available	IIes	TCB
Bellatti	225	7.94	GHThA1	LUC-3	Moderately deep (75-100 cm)	Sandy clay loam	Non gravelly (<15%)	Low (51-100 mm/m)	Nearly level (0-1%)	Slight	Horsegram+Maize (Hg+Mz)	Not Available	IIs	Bunding/ strengthening of existing bunds
Bellatti	227	10.61	LKRbB2g2	LUC-7	Moderately shallow (50-75 cm)	Loamy sand	Very gravelly (35-60%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Maize+Cotton (Mz+Ct)	Not Available	IIIes	TCB
Bellatti	228	4.25	GHThA1	LUC-3	Moderately deep (75-100 cm)	Sandy clay loam	Non gravelly (<15%)	Low (51-100 mm/m)	Nearly level (0-1%)	Slight	Maize+Redgram (Mz+Rg)	Not Available	IIs	Bunding/ strengthening of existing bunds
Bellatti	229	4.66	GHThA1	LUC-3	Moderately deep (75-100 cm)	Sandy clay loam	Non gravelly (<15%)	Low (51-100 mm/m)	Nearly level (0-1%)	Slight	Scrubland+Maize (Sl+Mz)	Not Available	IIs	Bunding/ strengthening of existing bunds
Bellatti	230	7.3	GHThA1	LUC-3	Moderately deep (75-100 cm)	Sandy clay loam	Non gravelly (<15%)	Low (51-100 mm/m)	Nearly level (0-1%)	Slight	Maize+Cotton (Mz+Ct)	Not Available	IIs	Bunding/ strengthening of existing bunds
Bellatti	231	7.08	TDHhB1g1	LUC-7	Moderately shallow (50-75 cm)	Sandy clay loam	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Slight	Onion+Cotton+Groundnut (On+Ct+Gn)	Not Available	IIs	TCB
Bellatti	232	4.82	Rockout crop	Rock outcrops	Rockout crop	Rockout crop	Rockout crop	Rock outcrops	Rockout crop	Rockout crop	Rockout crop	Not Available	VIII	Rock outcrops
Bellatti	233	1.74	KGHiB1g1	LUC-7	Moderately shallow (50-75 cm)	Sandy clay	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Slight	Maize (Mz)	Not Available	IIs	TCB
Bellatti	234	1.37	Rockout crop	Rock outcrops	Rockout crop	Rockout crop	Rockout crop	Rock outcrops	Rockout crop	Rockout crop	Others	Hand Pump,Tank	VIII	Rock outcrops
Narayanapura	3	1.92	KGPcB2g1	LUU-8	Shallow (25-50 cm)	Sandy loam	Gravelly (15-35%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Cotton+Redgram (Ct+Rg)	Not Available	IIIes	TCB
Narayanapura	4	0.78	KGPcB2g1	LUU-8	Shallow (25-50 cm)	Sandy loam	Gravelly (15-35%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Cotton (Ct)	Not Available	IIIes	TCB

Appendix II

Belhatti 5 Microwatershed

Soil Fertility Information

Village	Survey Number	Soil Reaction	Salinity	Organic Carbon	Available Phosphorus	Available Potassium	Available Sulphur	Available Boron	Available Iron	Available Manganese	Available Copper	Available Zinc
Bellatti	1/A	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Bellatti	1/B	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Bellatti	2	Slightly alkaline (pH 7.3-7.8)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	High (>57 kg/ha)	High (>337 kg/ha)	Medium (10-20 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	3	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	Low (<0.5 %)	Medium (23-57 kg/ha)	High (>337 kg/ha)	Medium (10-20 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	4	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Bellatti	5	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	Low (<0.5 %)	Medium (23-57 kg/ha)	High (>337 kg/ha)	Low (<10 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	6	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	Low (<0.5 %)	Medium (23-57 kg/ha)	High (>337 kg/ha)	Low (<10 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	7	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	Low (<0.5 %)	Medium (23-57 kg/ha)	Medium (145-337 kg/ha)	Low (<10 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	8	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Bellatti	9	Neutral (pH 6.5-7.3)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Medium (23-57 kg/ha)	Medium (145-337 kg/ha)	Medium (10-20 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	10	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Medium (23-57 kg/ha)	Medium (145-337 kg/ha)	Medium (10-20 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	11	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Medium (23-57 kg/ha)	Medium (145-337 kg/ha)	Medium (10-20 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	12	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Medium (23-57 kg/ha)	Medium (145-337 kg/ha)	Medium (10-20 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	13	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Low (<10 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	14	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	Low (<0.5 %)	Medium (23-57 kg/ha)	Medium (145-337 kg/ha)	Low (<10 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	15	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	Low (<0.5 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Low (<10 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	16	Strongly alkaline (pH 8.4-9.0)	Non Saline (<2 dsm)	Low (<0.5 %)	Medium (23-57 kg/ha)	Medium (145-337 kg/ha)	Low (<10 ppm)	Medium (0.5-1.0 ppm)	Deficient (<4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	17	Strongly alkaline (pH 8.4-9.0)	Non Saline (<2 dsm)	Low (<0.5 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Low (<10 ppm)	Medium (0.5-1.0 ppm)	Deficient (<4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	18	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	Low (<0.5 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Low (<10 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	20	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	Low (<0.5 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Low (<10 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	27	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	Low (<0.5 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Low (<10 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	28	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	Low (<0.5 %)	Medium (23-57 kg/ha)	Medium (145-337 kg/ha)	Low (<10 ppm)	Medium (0.5-1.0 ppm)	Deficient (<4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	29	Slightly alkaline (pH 7.3-7.8)	Non Saline (<2 dsm)	Low (<0.5 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Low (<10 ppm)	Medium (0.5-1.0 ppm)	Deficient (<4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	30	Neutral (pH 6.5-7.3)	Non Saline (<2 dsm)	Low (<0.5 %)	Medium (23-57 kg/ha)	Medium (145-337 kg/ha)	Low (<10 ppm)	Medium (0.5-1.0 ppm)	Deficient (<4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)

Village	Survey Number	Soil Reaction	Salinity	Organic Carbon	Available Phosphorus	Available Potassium	Available Sulphur	Available Boron	Available Iron	Available Manganese	Available Copper	Available Zinc
Bellatti	48	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	Low (<0.5 %)	Low (<23 kg/ha)	Medium (145-337 kg/ha)	Medium (10-20 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	55	Neutral (pH 6.5-7.3)	Non Saline (<2 dsm)	Low (<0.5 %)	Medium (23-57 kg/ha)	Medium (145-337 kg/ha)	Low (<10 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	56	Neutral (pH 6.5-7.3)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Medium (23-57 kg/ha)	Medium (145-337 kg/ha)	Low (<10 ppm)	Medium (0.5-1.0 ppm)	Deficient (<4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	57	Neutral (pH 6.5-7.3)	Non Saline (<2 dsm)	Low (<0.5 %)	Medium (23-57 kg/ha)	Medium (145-337 kg/ha)	Low (<10 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	60	Neutral (pH 6.5-7.3)	Non Saline (<2 dsm)	Low (<0.5 %)	Medium (23-57 kg/ha)	Medium (145-337 kg/ha)	Low (<10 ppm)	Medium (0.5-1.0 ppm)	Deficient (<4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	61	Neutral (pH 6.5-7.3)	Non Saline (<2 dsm)	Low (<0.5 %)	Medium (23-57 kg/ha)	Medium (145-337 kg/ha)	Low (<10 ppm)	Low (<0.5 ppm)	Deficient (<4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	62	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	Low (<0.5 %)	Medium (23-57 kg/ha)	Medium (145-337 kg/ha)	Low (<10 ppm)	Medium (0.5-1.0 ppm)	Deficient (<4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	63	Slightly alkaline (pH 7.3-7.8)	Non Saline (<2 dsm)	Low (<0.5 %)	Medium (23-57 kg/ha)	Medium (145-337 kg/ha)	Low (<10 ppm)	Medium (0.5-1.0 ppm)	Deficient (<4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	64	Neutral (pH 6.5-7.3)	Non Saline (<2 dsm)	Low (<0.5 %)	Medium (23-57 kg/ha)	Medium (145-337 kg/ha)	Low (<10 ppm)	Medium (0.5-1.0 ppm)	Deficient (<4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	69	Rock outcrops	Rockout crops	Rock outcrops	Rock outcrops	Rock outcrops	Rock outcrops	Rock outcrops	Rock outcrops	Rock outcrops	Rock outcrops	Rock outcrops
Bellatti	70	Slightly alkaline (pH 7.3-7.8)	Non Saline (<2 dsm)	Low (<0.5 %)	Medium (23-57 kg/ha)	High (>337 kg/ha)	Medium (10-20 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	71	Rock outcrops	Rockout crops	Rock outcrops	Rock outcrops	Rock outcrops	Rock outcrops	Rock outcrops	Rock outcrops	Rock outcrops	Rock outcrops	Rock outcrops
Bellatti	72	Slightly alkaline (pH 7.3-7.8)	Non Saline (<2 dsm)	Low (<0.5 %)	High (>57 kg/ha)	High (>337 kg/ha)	Medium (10-20 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	73	Neutral (pH 6.5-7.3)	Non Saline (<2 dsm)	Low (<0.5 %)	Medium (23-57 kg/ha)	High (>337 kg/ha)	Medium (10-20 ppm)	Low (<0.5 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	74	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Bellatti	75	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Bellatti	76	Neutral (pH 6.5-7.3)	Non Saline (<2 dsm)	Low (<0.5 %)	Medium (23-57 kg/ha)	Medium (145-337 kg/ha)	Medium (10-20 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	77	Neutral (pH 6.5-7.3)	Non Saline (<2 dsm)	Low (<0.5 %)	Medium (23-57 kg/ha)	Medium (145-337 kg/ha)	Medium (10-20 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	78/A	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Bellatti	78/B	Neutral (pH 6.5-7.3)	Non Saline (<2 dsm)	Low (<0.5 %)	Medium (23-57 kg/ha)	Medium (145-337 kg/ha)	Low (<10 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	79/A	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Bellatti	79/B	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Bellatti	123	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Bellatti	124	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Bellatti	125	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Bellatti	129	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Bellatti	130/A	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Bellatti	130/B	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Bellatti	130/C	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Bellatti	130/D	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Bellatti	137/A	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Bellatti	137/B	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others

Village	Survey Number	Soil Reaction	Salinity	Organic Carbon	Available Phosphorus	Available Potassium	Available Sulphur	Available Boron	Available Iron	Available Manganese	Available Copper	Available Zinc
Bellatti	138/A	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Bellatti	138/B	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Bellatti	143/A	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Bellatti	143/B	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Bellatti	144/A	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Bellatti	155	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Bellatti	156/A	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Bellatti	156/B	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Bellatti	156/C	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Bellatti	156	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Bellatti	157/B	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Bellatti	157/C	Slightly alkaline (pH 7.3-7.8)	Non Saline (<2 dsm)	Low (<0.5 %)	Medium (23-57 kg/ha)	Medium (145-337 kg/ha)	Low (<10 ppm)	Low (<0.5 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	158/A	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Bellatti	158/B	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Bellatti	159/A	Neutral (pH 6.5-7.3)	Non Saline (<2 dsm)	Low (<0.5 %)	Medium (23-57 kg/ha)	Medium (145-337 kg/ha)	Low (<10 ppm)	Low (<0.5 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	159/B	Neutral (pH 6.5-7.3)	Non Saline (<2 dsm)	Low (<0.5 %)	Medium (23-57 kg/ha)	Medium (145-337 kg/ha)	Others	Low (<0.5 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	160	Neutral (pH 6.5-7.3)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Medium (23-57 kg/ha)	Medium (145-337 kg/ha)	Low (<10 ppm)	Low (<0.5 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	161	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)	Deficient (<0.6 ppm)
Bellatti	162	Slightly alkaline (pH 7.3-7.8)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Medium (23-57 kg/ha)	Medium (145-337 kg/ha)	Low (<10 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	163	Slightly alkaline (pH 7.3-7.8)	Non Saline (<2 dsm)	High (>0.75 %)	Medium (23-57 kg/ha)	Medium (145-337 kg/ha)	Medium (10-20 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	165	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Medium (23-57 kg/ha)	Medium (145-337 kg/ha)	Medium (10-20 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	168	Neutral (pH 6.5-7.3)	Non Saline (<2 dsm)	Low (<0.5 %)	Medium (23-57 kg/ha)	High (>337 kg/ha)	Medium (10-20 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	169	Neutral (pH 6.5-7.3)	Non Saline (<2 dsm)	Low (<0.5 %)	Medium (23-57 kg/ha)	High (>337 kg/ha)	Medium (10-20 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	170	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Medium (23-57 kg/ha)	Medium (145-337 kg/ha)	Low (<10 ppm)	Medium (0.5-1.0 ppm)	Deficient (<4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	171	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)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	172	Slightly alkaline (pH 7.3-7.8)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Medium (23-57 kg/ha)	Medium (145-337 kg/ha)	Low (<10 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	173	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Low (<23 kg/ha)	High (>337 kg/ha)	Low (<10 ppm)	Medium (0.5-1.0 ppm)	Deficient (<4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	174	Neutral (pH 6.5-7.3)	Non Saline (<2 dsm)	Low (<0.5 %)	Medium (23-57 kg/ha)	High (>337 kg/ha)	Medium (10-20 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	175	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Low (<23 kg/ha)	High (>337 kg/ha)	Low (<10 ppm)	Medium (0.5-1.0 ppm)	Deficient (<4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	176	Slightly alkaline (pH 7.3-7.8)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Medium (23-57 kg/ha)	Medium (145-337 kg/ha)	Medium (10-20 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	177	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	High (>0.75 %)	Medium (23-57 kg/ha)	High (>337 kg/ha)	Medium (10-20 ppm)	Medium (0.5-1.0 ppm)	Deficient (<4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)

Village	Survey Number	Soil Reaction	Salinity	Organic Carbon	Available Phosphorus	Available Potassium	Available Sulphur	Available Boron	Available Iron	Available Manganese	Available Copper	Available Zinc
Bellatti	178	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Low (<23 kg/ha)	High (>337 kg/ha)	Low (<10 ppm)	Medium (0.5-1.0 ppm)	Deficient (<4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	179	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Medium (23-57 kg/ha)	High (>337 kg/ha)	Medium (10-20 ppm)	Medium (0.5-1.0 ppm)	Deficient (<4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	182	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Low (<23 kg/ha)	High (>337 kg/ha)	Medium (10-20 ppm)	Medium (0.5-1.0 ppm)	Deficient (<4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	183	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Low (<23 kg/ha)	High (>337 kg/ha)	Medium (10-20 ppm)	Medium (0.5-1.0 ppm)	Deficient (<4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	186	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Medium (23-57 kg/ha)	High (>337 kg/ha)	Medium (10-20 ppm)	Medium (0.5-1.0 ppm)	Deficient (<4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	187	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	High (>0.75 %)	Medium (23-57 kg/ha)	High (>337 kg/ha)	Medium (10-20 ppm)	Medium (0.5-1.0 ppm)	Deficient (<4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	211	Strongly alkaline (pH 8.4-9.0)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Medium (23-57 kg/ha)	High (>337 kg/ha)	Medium (10-20 ppm)	Medium (0.5-1.0 ppm)	Deficient (<4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	212	Strongly alkaline (pH 8.4-9.0)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Medium (23-57 kg/ha)	High (>337 kg/ha)	Medium (10-20 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	213	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Medium (23-57 kg/ha)	High (>337 kg/ha)	Medium (10-20 ppm)	Medium (0.5-1.0 ppm)	Deficient (<4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	214	Slightly alkaline (pH 7.3-7.8)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Medium (23-57 kg/ha)	High (>337 kg/ha)	Medium (10-20 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	215	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Medium (23-57 kg/ha)	High (>337 kg/ha)	Medium (10-20 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	216	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Low (<23 kg/ha)	High (>337 kg/ha)	Medium (10-20 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	217	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	Low (<0.5 %)	Medium (23-57 kg/ha)	Medium (145-337 kg/ha)	Medium (10-20 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	218	Slightly alkaline (pH 7.3-7.8)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Medium (23-57 kg/ha)	High (>337 kg/ha)	Medium (10-20 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	219	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Medium (23-57 kg/ha)	High (>337 kg/ha)	Medium (10-20 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	220	Neutral (pH 6.5-7.3)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Medium (23-57 kg/ha)	Medium (145-337 kg/ha)	Medium (10-20 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	221	Neutral (pH 6.5-7.3)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Medium (23-57 kg/ha)	High (>337 kg/ha)	High (>20 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	222	Slightly alkaline (pH 7.3-7.8)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Medium (23-57 kg/ha)	High (>337 kg/ha)	High (>20 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	223	Moderately alkaline (pH 7.8-8.4)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Medium (23-57 kg/ha)	High (>337 kg/ha)	High (>20 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	224	Slightly alkaline (pH 7.3-7.8)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Medium (23-57 kg/ha)	High (>337 kg/ha)	Medium (10-20 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	225	Slightly alkaline (pH 7.3-7.8)	Non Saline (<2 dsm)	Low (<0.5 %)	Medium (23-57 kg/ha)	Medium (145-337 kg/ha)	Medium (10-20 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	227	Neutral (pH 6.5-7.3)	Non Saline (<2 dsm)	Low (<0.5 %)	Medium (23-57 kg/ha)	Medium (145-337 kg/ha)	Medium (10-20 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	228	Slightly alkaline (pH 7.3-7.8)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Medium (23-57 kg/ha)	High (>337 kg/ha)	Medium (10-20 ppm)	High (>1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	229	Strongly alkaline (pH 8.4-9.0)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Medium (23-57 kg/ha)	High (>337 kg/ha)	High (>20 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)

Village	Survey Number	Soil Reaction	Salinity	Organic Carbon	Available Phosphorus	Available Potassium	Available Sulphur	Available Boron	Available Iron	Available Manganese	Available Copper	Available Zinc
Bellatti	230	Slightly alkaline (pH 7.3-7.8)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Medium (23-57 kg/ha)	High (>337 kg/ha)	High (>20 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	231	Slightly alkaline (pH 7.3-7.8)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Medium (23-57 kg/ha)	High (>337 kg/ha)	Medium (10-20 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	232	Rock outcrops	Rockout crops	Rock outcrops	Rock outcrops	Rock outcrops	Rock outcrops	Rock outcrops	Rock outcrops	Rock outcrops	Rock outcrops	Rock outcrops
Bellatti	233	Slightly alkaline (pH 7.3-7.8)	Non Saline (<2 dsm)	Low (<0.5 %)	Medium (23-57 kg/ha)	High (>337 kg/ha)	Medium (10-20 ppm)	Medium (0.5-1.0 ppm)	Deficient (<4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Bellatti	234	Rock outcrops	Rockout crops	Rock outcrops	Rock outcrops	Rock outcrops	Rock outcrops	Rock outcrops	Rock outcrops	Rock outcrops	Rock outcrops	Rock outcrops
Narayan apura	3	Slightly alkaline (pH 7.3-7.8)	Non Saline (<2 dsm)	Low (<0.5 %)	Medium (23-57 kg/ha)	Medium (145-337 kg/ha)	Low (<10 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)
Narayan apura	4	Slightly alkaline (pH 7.3-7.8)	Non Saline (<2 dsm)	Medium (0.5-0.75 %)	Medium (23-57 kg/ha)	Medium (145-337 kg/ha)	Low (<10 ppm)	Medium (0.5-1.0 ppm)	Sufficient (>4.5 ppm)	Sufficient (>1.0 ppm)	Sufficient (>0.2 ppm)	Deficient (<0.6 ppm)

Appendix III

Belhatti 5 Microwatershed

Soil Suitability Information

Village	Survey No.	Sorgham	Maize	Sunflower	Cotton	Mango	Sapota	Guava	Jackfruit	Musambi	Lime	Cashew	Custard-apple	Amla	Tamarind	Jamun	Sugarcane	Groundnut	Onion	Chilly	Tomato	Marigold	Chrysanthemum	Pomegranate	Citrus	Bhendi
Bellatti	1/A	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Bellatti	1/B	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Bellatti	2	S2rg	S2rg	S3r	S2r	N	S3r	S3r	N	N	N	S3r	S2r	S2r	S3r	S3r	S3r	S2r	S2rg	S2rg	S2r	S2r	S2r	S3r	S3r	S2r
Bellatti	3	S2rg	S2rg	S3r	S2r	N	S3r	S3r	N	N	N	S3r	S2r	S2r	S3r	S3r	S3r	S2r	S2rg	S2rg	S2r	S2r	S2r	S3r	S3r	S2r
Bellatti	4	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Bellatti	5	S2rg	S2rg	S3r	S2r	N	S3r	S3r	N	N	N	S3r	S2r	S2r	S3r	S3r	S3r	S2r	S2rg	S2rg	S2r	S2r	S2r	S3r	S3r	S2r
Bellatti	6	S2rg	S2rg	S3r	S2r	N	S3r	S3r	N	N	N	S3r	S2r	S2r	S3r	S3r	S3r	S2r	S2rg	S2rg	S2r	S2r	S2r	S3r	S3r	S2r
Bellatti	7	S2rg	S2rg	S3r	S2r	N	S3r	S3r	N	N	N	S3r	S2r	S2r	S3r	S3r	S3r	S2r	S2rg	S2rg	S2r	S2r	S2r	S3r	S3r	S2r
Bellatti	8	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Bellatti	9	Ng	Ng	S3rg	Ng	N	S3rg	S3rg	N	N	N	S3gr	S2gr	S2gr	S3gr	S3r	Ng	S3g	Ng	S3g	Ng	S3g	S3g	S3rg	S3rg	S3rg
Bellatti	10	Ng	Ng	S3rg	Ng	N	S3rg	S3rg	N	N	N	S3gr	S2gr	S2gr	S3gr	S3r	Ng	S3g	Ng	S3g	Ng	S3g	S3g	S3rg	S3rg	S3rg
Bellatti	11	Ng	Ng	S3rg	Ng	N	S3rg	S3rg	N	N	N	S3gr	S2gr	S2gr	S3gr	S3r	Ng	S3g	Ng	S3g	Ng	S3g	S3g	S3rg	S3rg	S3rg
Bellatti	12	Ng	Ng	S3rg	Ng	N	S3rg	S3rg	N	N	N	S3gr	S2gr	S2gr	S3gr	S3r	Ng	S3g	Ng	S3g	Ng	S3g	S3g	S3rg	S3rg	S3rg
Bellatti	13	S2rg	S2rg	S3r	S2r	N	S3r	S3r	N	N	N	S3r	S2r	S2r	S3r	S3r	S3r	S2r	S2rg	S2rg	S2r	S2r	S2r	S3r	S3r	S2r
Bellatti	14	S1	S1	S2w	S2r	N	S3w	S3w	N	N	N	N	S2r	S2r	S3r	S3r	S3r	S2r	S2r	S2w	S2r	S2w	S2w	S3w	S2w	S2w
Bellatti	15	S1	S1	S2w	S2r	N	S3w	S3w	N	N	N	N	S2r	S2r	S3r	S3r	S3r	S2r	S2r	S2w	S2r	S2w	S2w	S3w	S2w	S2w
Bellatti	16	Ng	Ng	Ng	Ng	N	Ng	Ng	N	N	N	S3r	S2r	S2r	S3r	S3r	Ng	S3g	Ng	Ng	Ng	Ng	Ng	Ng	Ng	S2rg
Bellatti	17	Ng	Ng	Ng	Ng	N	Ng	Ng	N	N	N	S3r	S2r	S2r	S3r	S3r	Ng	S3g	Ng	Ng	Ng	Ng	Ng	Ng	Ng	S2rg
Bellatti	18	S1	S1	S2w	S2r	N	S3w	S3w	N	N	N	N	S2r	S2r	S3r	S3r	S3r	S2r	S2r	S2w	S2r	S2w	S2w	S3w	S2w	S2w
Bellatti	20	S2rg	S2rg	S3r	S2r	N	S3r	S3r	N	N	N	S3r	S2r	S2r	S3r	S3r	S3r	S2r	S2rg	S2rg	S2r	S2r	S2r	S3r	S3r	S2r
Bellatti	27	S3g	S3rg	S3rg	S3g	N	S3rg	S3rg	N	N	N	S3r	S2r	S2r	S3r	S3r	S3rg	S2rg	S3rg	S3g	S2rg	S3rg	S3rg	S3rg	S3rg	S2rg
Bellatti	28	Ng	Ng	Ng	Ng	N	Ng	Ng	N	N	N	S3r	S2r	S2r	S3r	S3r	Ng	S3g	Ng	Ng	Ng	Ng	Ng	Ng	Ng	S3rg
Bellatti	29	S3g	S3g	S3rg	S3g	N	S3rg	S3rg	N	N	N	S3gr	S3gr	S3gr	S3gr	S3r	S3rg	S2g	S3g	S3g	S3g	S3g	S3g	S3rg	S3rg	S3rg
Bellatti	30	Ng	Ng	Ng	Ng	N	Ng	Ng	N	N	N	S3r	S2r	S2r	S3r	S3r	Ng	S3g	Ng	Ng	Ng	Ng	Ng	Ng	Ng	S3rg
Bellatti	48	S1	S1	S2r	S2r	S3r	S2r	S2rt	S3r	S3r	S3r	S2r	S2r	S2r	S3r	S3r	S2r	S1	S1	S1	S1	S1	S1	S2r	S2r	S1

Village	Survey No.	Sorgham	Maize	Sunflower	Cotton	Mango	Sapota	Guava	Jackfruit	Musambi	Lime	Cashew	Custard-apple	Amla	Tamarind	Jamun	Sugarcane	Groundnut	Onion	Chilly	Tomato	Marigold	Chrysanthemum	Pomegranate	Citrus	Bhendi
Bellatti	55	S3g	S3g	S3rg	S3g	N	S3rg	S3rg	N	N	N	S3r	S2r	S2r	S3r	S3r	S3gr	S2rg	S3g	S3g	S2rg	S2rg	S2rg	S3rg	S3rg	S2rg
Bellatti	56	S3g	S3g	S3rg	S3g	N	S3rg	S3rg	N	N	N	S3r	S2r	S2r	S3r	S3r	S3gr	S2rg	S3g	S3g	S2rg	S2rg	S2rg	S3rg	S3rg	S2rg
Bellatti	57	S3g	S3g	S3rg	S3g	N	S3rg	S3rg	N	N	N	S3r	S2r	S2r	S3r	S3r	S3gr	S2rg	S3g	S3g	S2rg	S2rg	S2rg	S3rg	S3rg	S2rg
Bellatti	60	Ng	Ng	Ng	Ng	N	Ng	Ng	N	N	N	S3r	S2r	S2r	S3r	S3r	Ng	S3g	Ng	Ng	Ng	Ng	Ng	Ng	Ng	S3rg
Bellatti	61	Ng	Ng	Ng	Ng	N	Ng	Ng	N	N	N	S3r	S2r	S2r	S3r	S3r	Ng	S3g	Ng	Ng	Ng	Ng	Ng	Ng	Ng	S3rg
Bellatti	62	Ng	Ng	Ng	Ng	N	Ng	Ng	N	N	N	S3r	S2r	S2r	S3r	S3r	Ng	S3g	Ng	Ng	Ng	Ng	Ng	Ng	Ng	S2rg
Bellatti	63	S3g	S3g	S3rg	S3g	N	S3rg	S3rg	N	N	N	S3r	S2r	S2r	S3r	S3r	S3gr	S2rg	S3g	S3g	S2rg	S2rg	S2rg	S3rg	S3rg	S2rg
Bellatti	64	S3g	S3g	S3rg	S3g	N	S3rg	S3rg	N	N	N	S3gr	S3gr	S3gr	S3gr	S3r	S3rg	S2g	S3g	S3g	S3g	S3g	S3g	S3rg	S3rg	S3rg
Bellatti	69	Rock outcrops	Rock outcrops	Rock outcrops	Rock outcrops	Rock out crop	Rock outcrops	Rock outcrops	Rock out crop	Rock out crop	Rock out crop	Rock out crop	Rock out crop	Rock out crop	Rock out crop	Rock out crop	Rock outcrops	Rock outcrops	Rock outcrops	Rock outcrops	Rock outcrops	Rock outcrops	Rock outcrops	Rock outcrops	Rock outcrops	Rock out crop
Bellatti	70	S3g	S3g	S3rg	S3g	N	S3rg	S3rg	N	N	N	S3r	S2r	S2r	S3r	S3r	S3gr	S2rg	S3g	S3g	S2rg	S2rg	S2rg	S3rg	S3rg	S2rg
Bellatti	71	Rock outcrops	Rock outcrops	Rock outcrops	Rock outcrops	Rock out crop	Rock outcrops	Rock outcrops	Rock out crop	Rock out crop	Rock out crop	Rock out crop	Rock out crop	Rock out crop	Rock out crop	Rock out crop	Rock outcrops	Rock outcrops	Rock outcrops	Rock outcrops	Rock outcrops	Rock outcrops	Rock outcrops	Rock outcrops	Rock outcrops	Rock out crop
Bellatti	72	S2rg	S2rg	S3r	S2r	N	S3r	S3r	N	N	N	S3r	S2r	S2r	S3r	S3r	S3r	S2r	S2rg	S2rg	S2r	S2r	S2r	S3r	S3r	S2r
Bellatti	73	S2rg	S2rg	S3r	S2r	N	S3r	S3r	N	N	N	S3r	S2r	S2r	S3r	S3r	S3r	S2r	S2rg	S2rg	S2r	S2r	S2r	S3r	S3r	S2r
Bellatti	74	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Bellatti	75	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Bellatti	76	S2rg	S2rg	S3r	S2r	N	S3r	S3r	N	N	N	S3r	S2r	S2r	S3r	S3r	S3r	S2r	S2rg	S2rg	S2r	S2r	S2r	S3r	S3r	S2r
Bellatti	77	S2rg	S2rg	S3r	S2r	N	S3r	S3r	N	N	N	S3r	S2r	S2r	S3r	S3r	S3r	S2r	S2rg	S2rg	S2r	S2r	S2r	S3r	S3r	S2r
Bellatti	78/A	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Bellatti	78/B	S2rg	S2rg	S3r	S2r	N	S3r	S3r	N	N	N	S3r	S2r	S2r	S3r	S3r	S2r	S2r	S2r	S2rg	S2r	S2r	S2r	S3r	S3r	S2rg
Bellatti	79/A	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Bellatti	79/B	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Bellatti	123	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others

Village	Survey No.	Sorgham	Maize	Sunflower	Cotton	Mango	Sapota	Guava	Jackfruit	Musambi	Lime	Cashew	Custard-apple	Amla	Tamarind	Jamun	Sugarcane	Groundnut	Onion	Chilly	Tomato	Marigold	Chrysanthemum	Pomegranate	Citrus	Bhendi
Bellatti	124	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Bellatti	125	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Bellatti	129	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Bellatti	130/A	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Bellatti	130/B	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Bellatti	130/C	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Bellatti	130/D	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Bellatti	137/A	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Bellatti	137/B	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Bellatti	138/A	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Bellatti	138/B	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Bellatti	143/A	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Bellatti	143/B	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Bellatti	144/A	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Bellatti	155	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Bellatti	156/A	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Bellatti	156/B	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Bellatti	156/C	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Bellatti	156	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Bellatti	157/B	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Bellatti	157/C	S3r	S3r	Nr	S3r	N	Nr	Nr	N	N	N	N	S3r	S3r	N	N	Nr	S3r	S3r	S3r	S3r	S3r	S3r	Nr	Nr	S3r
Bellatti	158/A	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others
Bellatti	158/B	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others	Others

Village	Survey No.	Sorgham	Maize	Sunflower	Cotton	Mango	Sapota	Guava	Jackfruit	Musambi	Lime	Cashew	Custard-apple	Amla	Tamarind	Jamun	Sugarcane	Groundnut	Onion	Chilly	Tomato	Marigold	Chrysanthemum	Pomegranate	Citrus	Bhendi
Bellatti	159/A	S1	S1	S1	S1	S2r	S2g	S1	S2r	S2r	S2r	S2r	S1	S1	S2r	S2r	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1
Bellatti	159/B	S1	S1	S1	S1	S2r	S2g	S1	S2r	S2r	S2r	S2r	S1	S1	S2r	S2r	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1
Bellatti	160	S3r	S3r	Nr	S3r	N	Nr	Nr	N	N	N	N	S3r	S3r	N	N	Nr	S3r	S3r	S3r	S3r	S3r	S3r	Nr	Nr	S3r
Bellatti	161	S3r	S3r	Nr	S3r	N	Nr	Nr	N	N	N	N	S3r	S3r	N	N	Nr	S3r	S3r	S3r	S3r	S3r	S3r	Nr	Nr	S3r
Bellatti	162	S3r	S3r	Nr	S3r	N	Nr	Nr	N	N	N	N	S3r	S3r	N	N	Nr	S3r	S3r	S3r	S3r	S3r	S3r	Nr	Nr	S3r
Bellatti	163	S1	S1	S1	S1	S2r	S2g	S1	S2r	S2r	S2r	S2r	S1	S1	S2r	S2r	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1
Bellatti	165	S1	S1	S1	S1	S2r	S2g	S1	S2r	S2r	S2r	S2r	S1	S1	S2r	S2r	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1
Bellatti	168	S2rg	S2rg	S3r	S2r	N	S3r	S3r	N	N	N	S3r	S2r	S2r	S3r	S3r	S3r	S2r	S2rg	S2rg	S2r	S2r	S2r	S3r	S3r	S2r
Bellatti	169	S2rg	S2rg	S3r	S2r	N	S3r	S3r	N	N	N	S3r	S2r	S2r	S3r	S3r	S3r	S2r	S2rg	S2rg	S2r	S2r	S2r	S3r	S3r	S2r
Bellatti	170	S1	S3t	S2r	S2r	N	S3t	S3t	N	S3r	S3r	N	S2r	S2r	S3t	S3t	S3t	S3t	S3t	S2g	S2rt	S2t	S2t	S2t	S2r	S2tw
Bellatti	171	S1	S1	S1	S1	S2r	S2g	S1	S2r	S2r	S2r	S2r	S1	S1	S2r	S2r	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1
Bellatti	172	S1	S1	S1	S1	S2r	S2g	S1	S2r	S2r	S2r	S2r	S1	S1	S2r	S2r	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1
Bellatti	173	S1	S3t	S2r	S2r	N	S3t	S3t	N	S3r	S3r	N	S2r	S2r	S3t	S3t	S3t	S3t	S3t	S2g	S2rt	S2t	S2t	S2t	S2r	S2tw
Bellatti	174	S2rg	S2rg	S3r	S2r	N	S3r	S3r	N	N	N	S3r	S2r	S2r	S3r	S3r	S3r	S2r	S2rg	S2rg	S2r	S2r	S2r	S3r	S3r	S2r
Bellatti	175	S1	S3t	S2r	S2r	N	S3t	S3t	N	S3r	S3r	N	S2r	S2r	S3t	S3t	S3t	S3t	S3t	S2g	S2rt	S2t	S2t	S2t	S2r	S2tw
Bellatti	176	S1	S1	S1	S1	S2r	S2g	S1	S2r	S2r	S2r	S2r	S1	S1	S2r	S2r	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1
Bellatti	177	S1	S1	S1	S1	S2r	S2g	S1	S2r	S2r	S2r	S2r	S1	S1	S2r	S2r	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1
Bellatti	178	S1	S3t	S2r	S2r	N	S3t	S3t	N	S3r	S3r	N	S2r	S2r	S3t	S3t	S3t	S3t	S3t	S2g	S2rt	S2t	S2t	S2t	S2r	S2tw
Bellatti	179	S1	S3t	S2r	S2r	N	S3t	S3t	N	S3r	S3r	N	S2r	S2r	S3t	S3t	S3t	S3t	S3t	S2g	S2rt	S2t	S2t	S2t	S2r	S2tw
Bellatti	182	S1	S3t	S2r	S2r	N	S3t	S3t	N	S3r	S3r	N	S2r	S2r	S3t	S3t	S3t	S3t	S3t	S2g	S2rt	S2t	S2t	S2t	S2r	S2tw
Bellatti	183	S1	S3t	S2r	S2r	N	S3t	S3t	N	S3r	S3r	N	S2r	S2r	S3t	S3t	S3t	S3t	S3t	S2g	S2rt	S2t	S2t	S2t	S2r	S2tw
Bellatti	186	S1	S3t	S2r	S2r	N	S3t	S3t	N	S3r	S3r	N	S2r	S2r	S3t	S3t	S3t	S3t	S3t	S2g	S2rt	S2t	S2t	S2t	S2r	S2tw
Bellatti	187	S3g	S3g	S3g	S3g	S3gr	S3g	S3g	S3gr	S3gr	S3gr	S2gr	S2gr	S2gr	S3gr	S3gr	S3g	S2g	S3g	S3g	S3g	S2g	S2g	S3g	S3g	S2g
Bellatti	211	S2g	S2g	S2rg	S2r	S3r	S2r	S2rg	S3r	S3r	S3r	S2r	S2r	S2r	S3r	S3r	S2rg	S1	S2g	S2g	S2g	S2r	S2r	S2rg	S2rg	S1
Bellatti	212	S2g	S2g	S2rg	S2r	S3r	S2r	S2rg	S3r	S3r	S3r	S2r	S2r	S2r	S3r	S3r	S2rg	S1	S2g	S2g	S2g	S2r	S2r	S2rg	S2rg	S1
Bellatti	213	S1	S1	S1	S1	S2r	S1	S2t	S2r	S2r	S2r	S2r	S1	S1	S2r	S2r	S1	S2t	S2t	S1	S1	S1	S1	S1	S1	S1
Bellatti	214	S2rg	S2rg	S2rg	S2rg	N	S3r	S3r	N	N	N	S3gr	S3gr	S3gr	S3gr	S3r	S3r	S2r	S2rg	S2rg	S2r	S2r	S2r	S3r	S3r	S2r
Bellatti	215	S2g	S2g	S2rg	S2r	S3r	S2r	S2rg	S3r	S3r	S3r	S2r	S2r	S2r	S3r	S3r	S2rg	S1	S2g	S2g	S2g	S2r	S2r	S2rg	S2rg	S1

Village	Survey No.	Sorgham	Maize	Sunflower	Cotton	Mango	Sapota	Guava	Jackfruit	Musambi	Lime	Cashew	Custard-apple	Amla	Tamarind	Jamun	Sugarcane	Groundnut	Onion	Chilly	Tomato	Marigold	Chrysanthemum	Pomegranate	Citrus	Bhendi
Bellatti	216	S2g	S2g	S2rg	S2r	S3r	S2r	S2rg	S3r	S3r	S3r	S2r	S2r	S2r	S3r	S3r	S2rg	S1	S2g	S2g	S2g	S2r	S2r	S2rg	S2rg	S1
Bellatti	217	S2g	S2g	S2rg	S2r	S3r	S2r	S2rg	S3r	S3r	S3r	S2r	S2r	S2r	S3r	S3r	S2rg	S1	S2g	S2g	S2g	S2r	S2r	S2rg	S2rg	S1
Bellatti	218	S2g	S2g	S2rg	S2r	S3r	S2r	S2rg	S3r	S3r	S3r	S2r	S2r	S2r	S3r	S3r	S2rg	S1	S2g	S2g	S2g	S2r	S2r	S2rg	S2rg	S1
Bellatti	219	S2rg	S2rg	S2rg	S2rg	N	S3r	S3r	N	N	N	S3gr	S3gr	S3gr	S3gr	S3r	S3r	S2r	S2rg	S2rg	S2r	S2r	S2r	S3r	S3r	S2r
Bellatti	220	S2rg	S2rg	S2rg	S2rg	N	S3r	S3r	N	N	N	S3gr	S3gr	S3gr	S3gr	S3r	S3r	S2r	S2rg	S2rg	S2r	S2r	S2r	S3r	S3r	S2r
Bellatti	221	S2rg	S2rg	S2rg	S2rg	N	S3r	S3r	N	N	N	S3gr	S3gr	S3gr	S3gr	S3r	S3r	S2r	S2rg	S2rg	S2r	S2r	S2r	S3r	S3r	S2r
Bellatti	222	S2rg	S2rg	S2rg	S2rg	N	S3r	S3r	N	N	N	S3gr	S3gr	S3gr	S3gr	S3r	S3r	S2r	S2rg	S2rg	S2r	S2r	S2r	S3r	S3r	S2r
Bellatti	223	Nr	Nr	Nr	Nr	N	Nr	Nr	N	N	N	N	S3r	S3r	N	N	Nr	Nr	Nr	Nr	Nr	Nr	Nr	Nr	Nr	Nr
Bellatti	224	S2g	S2g	S2rg	S2r	S3r	S2r	S2rg	S3r	S3r	S3r	S2r	S2r	S2r	S3r	S3r	S2rg	S1	S2g	S2g	S2g	S2r	S2r	S2rg	S2rg	S1
Bellatti	225	S2g	S2g	S2rg	S2r	S3r	S2r	S2rg	S3r	S3r	S3r	S2r	S2r	S2r	S3r	S3r	S2rg	S1	S2g	S2g	S2g	S2r	S2r	S2rg	S2rg	S1
Bellatti	227	Ng	Ng	S3rg	Ng	N	S3rg	S3rg	N	N	N	S3gr	S2gr	S2gr	S3gr	S3r	Ng	S3g	Ng	S3g	Ng	S3g	S3g	S3rg	S3rg	S3rg
Bellatti	228	S2g	S2g	S2rg	S2r	S3r	S2r	S2rg	S3r	S3r	S3r	S2r	S2r	S2r	S3r	S3r	S2rg	S1	S2g	S2g	S2g	S2r	S2r	S2rg	S2rg	S1
Bellatti	229	S2g	S2g	S2rg	S2r	S3r	S2r	S2rg	S3r	S3r	S3r	S2r	S2r	S2r	S3r	S3r	S2rg	S1	S2g	S2g	S2g	S2r	S2r	S2rg	S2rg	S1
Bellatti	230	S2g	S2g	S2rg	S2r	S3r	S2r	S2rg	S3r	S3r	S3r	S2r	S2r	S2r	S3r	S3r	S2rg	S1	S2g	S2g	S2g	S2r	S2r	S2rg	S2rg	S1
Bellatti	231	S2rg	S2rg	S2rg	S2rg	N	S3r	S3r	N	N	N	S3gr	S3gr	S3gr	S3gr	S3r	S3r	S2r	S2rg	S2rg	S2r	S2r	S2r	S3r	S3r	S2r
Bellatti	232	Rock outcrops	Rock outcrops	Rock outcrops	Rock outcrops	Rock out crop	Rock outcrops	Rock outcrops	Rock out crop	Rock out crop	Rock out crop	Rock out crop	Rock out crop	Rock out crop	Rock out crop	Rock out crop	Rock outcrops	Rock outcrops	Rock outcrops	Rock outcrops	Rock outcrops	Rock outcrops	Rock outcrops	Rock outcrops	Rock outcrops	Rock out crop
Bellatti	233	S2rg	S2rg	S3r	S2r	N	S3r	S3r	N	N	N	S3r	S2r	S2r	S3r	S3r	S3r	S2r	S2rg	S2rg	S2r	S2r	S2r	S3r	S3r	S2r
Bellatti	234	Rock outcrops	Rock outcrops	Rock outcrops	Rock outcrops	Rock out crop	Rock outcrops	Rock outcrops	Rock out crop	Rock out crop	Rock out crop	Rock out crop	Rock out crop	Rock out crop	Rock out crop	Rock out crop	Rock outcrops	Rock outcrops	Rock outcrops	Rock outcrops	Rock outcrops	Rock outcrops	Rock outcrops	Rock outcrops	Rock outcrops	Rock out crop
Narayanapura	3	S3r	S3r	Nr	S3r	N	Nr	Nr	N	N	N	N	S3r	S3r	N	N	Nr	S3r	S3r	S3r	S3r	S3r	S3r	Nr	Nr	S3r
Narayanapura	4	S3r	S3r	Nr	S3r	N	Nr	Nr	N	N	N	N	S3r	S3r	N	N	Nr	S3r	S3r	S3r	S3r	S3r	S3r	Nr	Nr	S3r

PART-B

SOCIO-ECONOMIC STATUS OF FARM HOUSEHOLDS

CONTENTS

LIST OF TABLES

LIST OF FIGURES

Chapter 1

EXECUTIVE SUMMARY

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

Methodology: *Belhatti-5 Microwatershed (Belhatti sub-watershed, Shirahatti taluk, Gadag district) is located in between $15^0 3'$ – $15^0 6'$ North latitudes and $75^0 37'$ – $75^0 39'$ East longitudes, covering an area of about 532 ha, bounded by Narayanpur, Chiksavanur, Rantur, Konchigeri villages with length of growing period (LGP) 150-180 days. We used soil resource map as basis for sampling farm households to test the hypothesis that soil quality influence crop selection, and conservation investment of farm households. The level of technology adoption and productivity gaps and livelihood patterns were analyses. The cost of soil degradation and ecosystem services were quantified.*

Results: *The socio-economic outputs for the Belhatti-5 Microwatershed (Belhatti sub-watershed) in Shirahatti taluk and Gadag district are presented here.*

Social Indicators;

- *Male and female ratio is 54 to 46 per cent to the total sample population.*
- *Younger age 18 to 50 years group of population is around 52 per cent to the total population.*
- *Literacy population is around 86 per cent.*
- *Social groups belong to other backward caste (OBC) were among all sample households.*
- *Fire wood is the source of energy for a cooking among 80 per cent.*
- *About 30 per cent of households have a yashaswini health card.*
- *Majority of farm households (70%) are having MGNREGA card for rural employments.*
- *Dependence on ration cards for food grains through public distribution system is around 70.0 per cent.*
- *Swach bharath program providing closed toilet facilities around 50 per cent of sample households.*
- *Institutional participation is only 2.0 per cent of sample households.*
- *Women participation in local organisation was among all sample households were found.*

Economic Indicators;

- *The average land holding is 1.3 ha indicates that majority of farm households are belong to small and medium farmers. The dry land account for 80.6 per cent and irrigated land 19.4 per cent of total cultivated land area among the sample farmers.*
- *Agriculture is the main occupation among 50 per cent and agriculture is the main and agriculture labour is subsidiary occupation for 46 per cent of sample households.*
- *The average value of domestic assets is around Rs. 14215 per household. Mobile and television are popular media mass communication.*
- *The average value of farm assets is around Rs. 81533 per household, about 50 per cent of sample farmers having plough and bullock cart.*
- *The average value of livestock is around Rs. 42083 per household; about 64.3 per cent of household are having livestock.*
- *The average per capita food consumption is around 769.5 grams (1706.3 kilo calories) against national institute of nutrition (NIN) recommendation at 827 gram. Around 80 per cent of sample households are consuming less than the NIN recommendation.*
- *The annual average income is around Rs.24714 per household. About 90 per cent of farm households are below poverty line.*
- *The per capita monthly average expenditure is around Rs.1048.*

Environmental Indicators-Ecosystem Services;

- *The value of ecosystem service helps to support investment to decision on soil and water conservation and in promoting sustainable land use.*
- *The onsite cost of different soil nutrients lost due to soil erosion is around Rs.847 per ha/year. The total cost of annual soil nutrients is around Rs. 365940 per year for the total area of 532.06 ha.*
- *The average value of ecosystem service for food grain production is around Rs. 8551/ ha/year. Per hectare food grain production services is maximum in onion (Rs. 23224) followed by horse gram (Rs. 6654), maize (Rs. 3454) and green gram (Rs. 874).*
- *The average value of ecosystem service for fodder production is around Rs. 2762 ha/year. Per hectare fodder production services is maximum in horse gram (Rs. 4867) followed by maize (Rs. 2808) and green gram (Rs. 612).*
- *The data on water requirement for producing one quintal of grain is considered for estimating the total value of water required for crop production. The per hectare value of water used and value of water maize (Rs. 37890), horse gram (Rs. 29284), green gram (Rs. 26405) and onion (Rs. 13437).*

Economic Land Evaluation;

- *The major cropping pattern is maize (83.1 %) followed by green gram (9.8 %), horse gram (4.0 %) and onion (3.0 %).*
- *In Belhatti-5 Microwatershed, major soil is Kagalipura (KGP) series is having shallow soil depth covered around 4.4 % of area. On this soil farmers are presently growing horse gram. Kutegoudanahundi (KGH) soil series also having moderately shallow soil depth cover 18.1 % of area; the crops are horse gram (7.0 %) and maize (93.0 %). Tammadahalli (TDH) soil series having moderately shallow soil depth cover around 5.0 per cent of areas, crops is maize (87.3%) and onion (12.7 %). Kethanapura (KTP) soil series having moderately shallow soil depth cover around 5.34 per cent of area, crops are green gram. Chikkamegheri (CKM) soil series are having moderately deep soil depth cover around 3.0 per cent of area; the major crops grown are maize. Gollarahatti (GHT) soil series are having moderately deep soil depth covers around 9.13 per cent of area, the major crop grown is maize. Jelligere (JLG) soil series having moderately deep soil depth cover 5.0 per cent of areas; crops are maize.*
- *The total cost of cultivation and benefit cost ratio (BCR) in study area for maize ranges between Rs.132251 in CKM soil (with BCR of 0.96) and Rs.10239 in KGH soil (with BCR of 2.09).*
- *In horse gram the cost of cultivation range between Rs 58540 in KGP soil (with of 1.06) and Rs.37563 in KGH soil (with BCR of 1.51).*
- *In onion cost of cultivation in TDH soil is Rs. 50876/ha (with BCR of 1.46) and green gram cost of cultivation in KTP soil is Rs. 16332/ha (with BCR of 1.09).*
- *The land management practices reported by the farmers are crop rotation, tillage practices, fertilizer application and use of farm yard manure (FYM). Due to higher wages farmer are following labour saving strategies is not prating soil and water conservation measures. Less ownership of livestock limiting application of FYM.*
- *It was observed soil quality influences on the type and intensity of land use. More fertilizer applications are deeper soil to maximize returns.*

Suggestions;

- *Involving farmers is watershed planning helps in strengthing institutional participation.*
- *The per capita food consumption and monthly income is very low. Diversifying income generation activities from crop and livestock production in order to reduce risk related to drought and market prices.*
- *Majority of farmers reported that they are not getting timely support/extension services from the concerned development departments.*

- *By strengthing agricultural extension for providing timely advice improved technology there is scope to increase in net income of farm households.*
- *By adopting recommended package of practices by following the soil test fertiliser recommendation, there is scope to increase yield in onion (79.8 %), maize (4.7 to 79.2 %), green gram (55.2 %) and horse gram (6.3 %).*

- ***Chapter 2***

INTRODUCTION

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

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

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

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

Objectives of the study

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

Chapter 3

METHODOLOGY

Study area

Belhatti-5 Microwatershed is located in Northern Transition Zone of Karnataka (Figure 1). Extends over all area of 1.13 M ha of which 0.86 M ha is under cultivation. Nearly 0.052 M ha in the zone enjoys irrigation facilities. Elevation ranges between 450-900 m MSL with most parts situated between 800 and 900 m. Shallow to black soils and red loams are distributed in equal proportion. The average annual rainfall ranges from 620 to 1300 mm of which more than 60 per cent is received during the southwest monsoon (*kharif*). Sorghum, rice, groundnut, maize, chilli, pulses, sugarcane, tobacco and cotton are the major crops grown. It's represented Agro Ecological Sub Region (AESR) 6.4 having LGP 150-180 days.

Belhatti-5 Microwatershed (Belhatti sub-watershed, Shirahatti taluk, Gadag district) is located in between $15^0$3' – $15^0$6' North latitudes and $75^0$37' – $75^0$39' East longitudes, covering an area of about 532 ha, bounded by Narayanpur, Chiksavanur, Rantur, Konchigeri villages.

Sampling Procedure:

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

Sources of data and analysis:

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

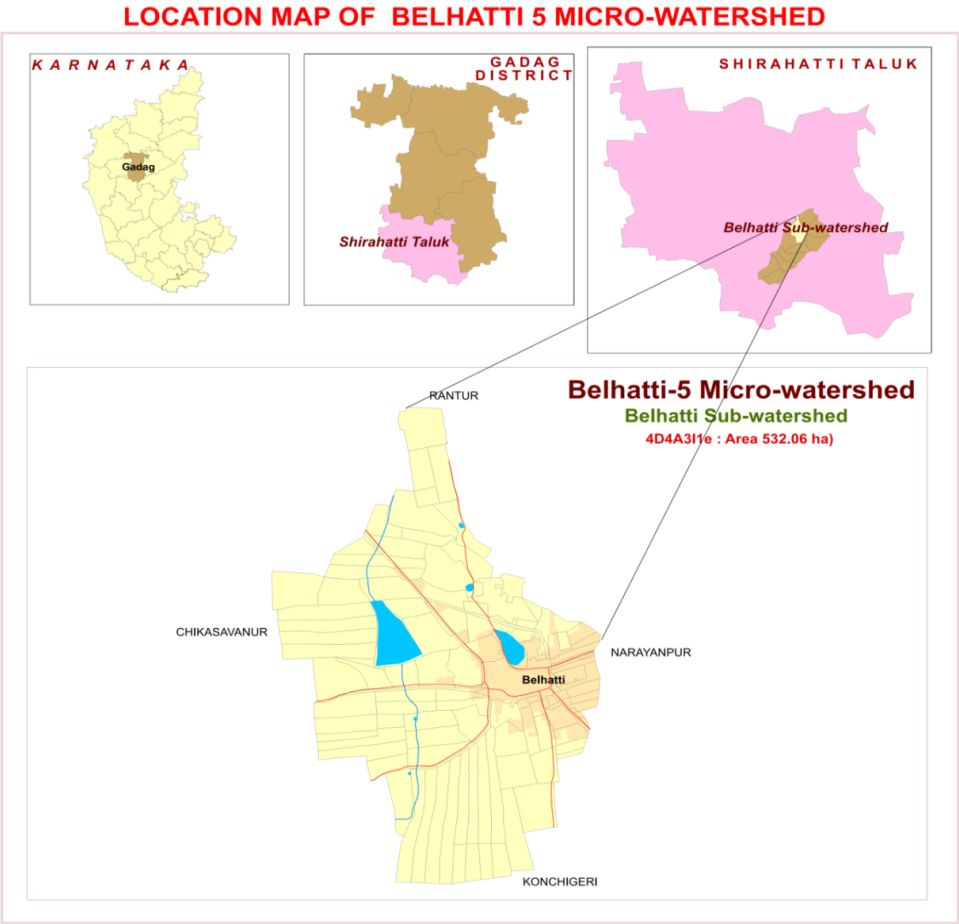
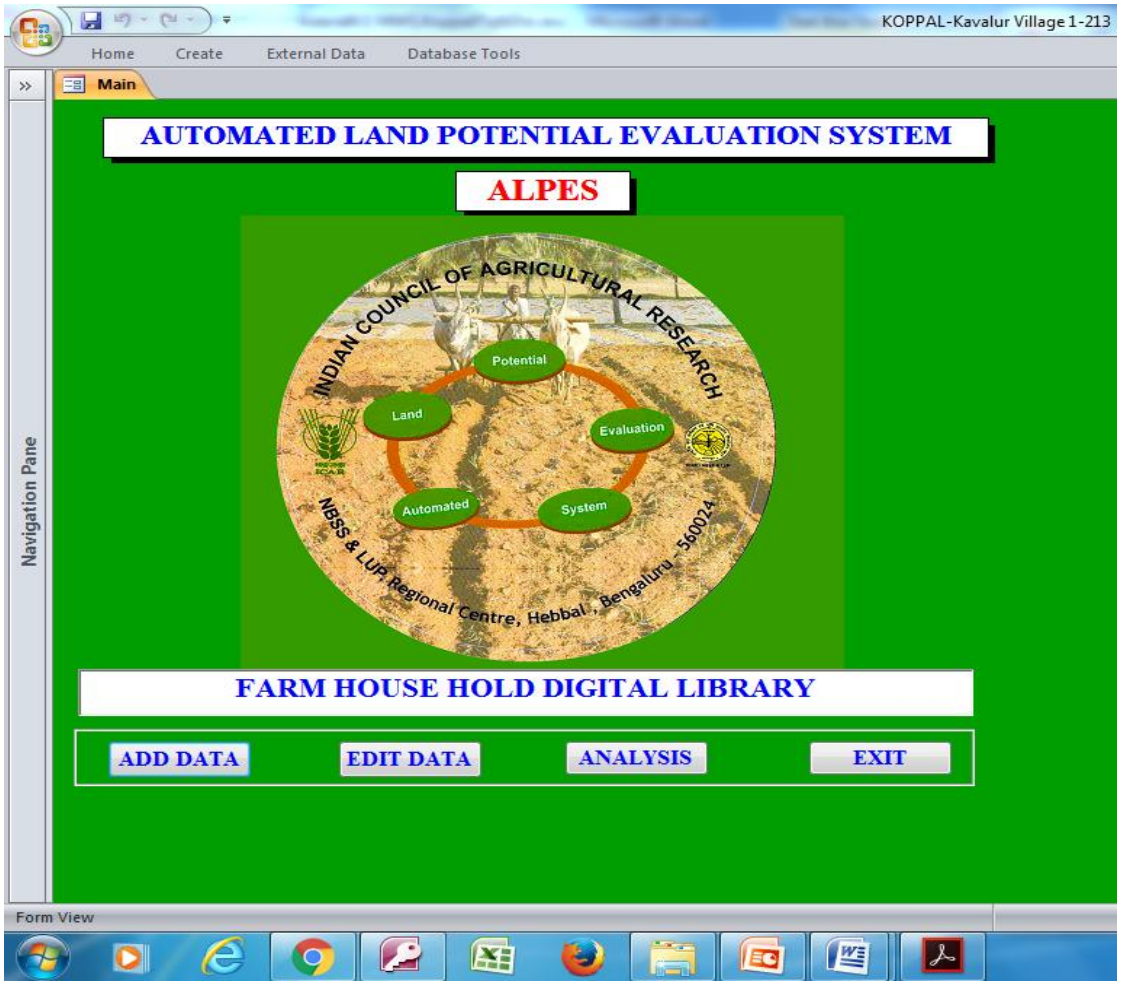


Figure 1: Location of study area

Steps followed in socio-economic assessment

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



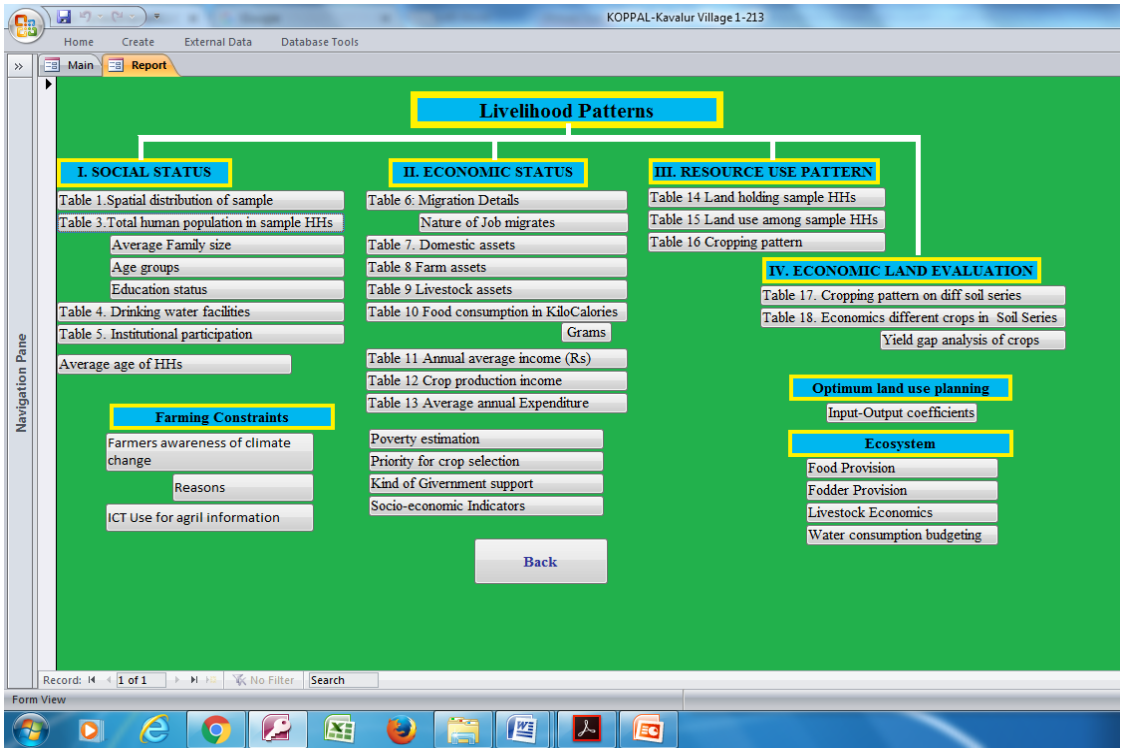


Figure 2: ALPES FRAMEWORK

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

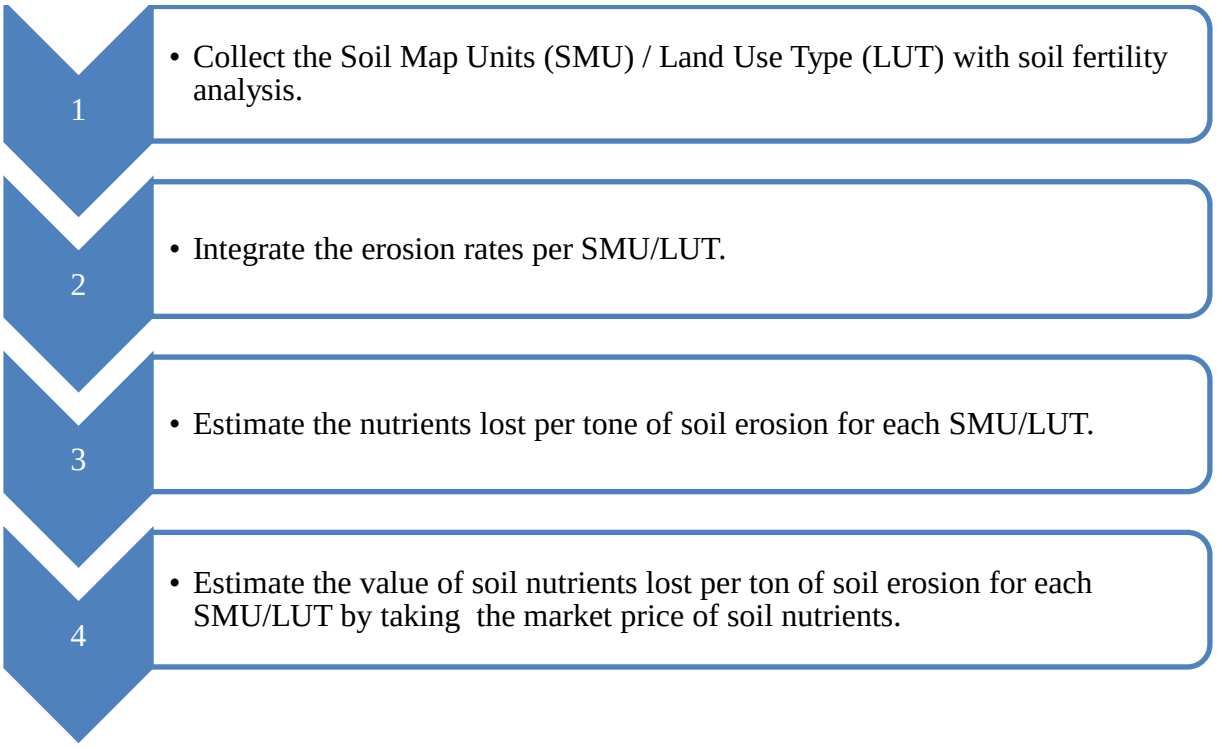
Operational Cost = cost of seeds, fertilizers, pesticides. Cost of human and bullock labour, cost of machinery, cost of irrigation water + interest on working capital.
Gross returns = Yield (Quintals/hectare)*Price (Rs/Quintal)
Net returns = Gross returns-Operational cost.
Benefit Cost Ratio = Net returns/Total cost.

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

Economic Valuation of Soil ecosystem services:

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

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



Chapter 4

RESULTS AND DISCUSSIONS

The demographic information shows that the household population dynamics encompasses the socioeconomic status of the farmer. For a rural family, the household size should be optimal to earn a comfortable livelihood through farm and non-farm wage earning. The total number of population in watershed area was 50, out of which 54 per cent were males and 46 per cent females. Average family size of the households is 5.0. Age is an important factor, which affects the potential employment and mobility status of respondents. The data on age wise distribution of farmers in the sample households indicated that majority of the farmers are coming under the age group of 30 to 50 years (30 %) followed by 0 to18year (24 %), more than 50 years (24 %) and 18 to 30 years (22 %). Hence, in the study area in general, the respondents were of young and middle age, indicating thereby that the households had almost settled with whatever livelihood options they were practicing and sample respondents were young by age who could venture into various options of livelihood sources. Data on literacy indicated that 86 per cent of respondents were literate and 14 per cent illiterate (Table 1).

Table 1: Human population among sample households in Belhatti-5 Micro watershed

Particulars	**Units**	**Value**
Total human population in sample HHs	Number	50
Male	% to total Population	54.0
Female	% to total Population	46.0
Average family size	Number	5.0
Age group		
0 to 18 years	% to total Population	24.0
18 to 30 years	% to total Population	22.0
30 to 50 years	% to total Population	30.0
>50 years	% to total Population	24.0
Average age	Age in years	35.1
Education Status		
Illiterates	% to total Population	14.0
Literates	% to total Population	86.0
Primary School (<5 class)	% to total Population	22.0
Middle School (6- 8 class)	% to total Population	14.0
High School (9- 10 class)	% to total Population	38.0
Others	% to total Population	12.0

The ethnic groups all among the sample farm households to be belonging to other backward castes (OBC) (Table 2 and Figure 3). Majority of the sample households are using fire wood was 80 per cent fallow by LPG gas (20 %) as source of fuel for cooking.

All the sample farmers are having electricity connection. About 30 per cent are sample households having health cards. Majority (70 %) are having MGNREGA job cards for employment generation. About 70.0 per cent of farm households are having ration cards for taking food grains from public distribution system. About 50 per cent of farm households are having toilet facilities.

Table 2: Basic needs of sample households in Belhatti-5 Micro watershed

Particulars	Units	Value
Social groups		
OBC	% of Households	100.0
Types of fuel use for cooking		
Fire wood	% of Households	80.0
Gas	% of Households	20.0
Energy supply for home		
Electricity	% of Households	100.0
Number of households having Health card		
Yes	% of Households	30.0
No	% of Households	70.0
MGNREGA Card		
Yes	% of Households	70.0
No	% of Households	30.0
Ration Card		
Yes	% of Households	70.0
No	% of Households	30.0
Households with toilet		
Yes	% of Households	50.0
No	% of Households	50.0
Drinking water facilities		
Tube Well	% of Households	100

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

Only 2.0 per cent of the farmers are participating in community based organisations (Table 3). Among them majority is marketing co-operative societies.

Table 3: Institutional participation among the sample population in Belhatti-5 Microwatershed

Particulars	Units	Value
No. Of people participating	% to total	2.00
Co-operative Societies - Marketing	% to total	2.00
No. Of people not participating	% to total	98.00

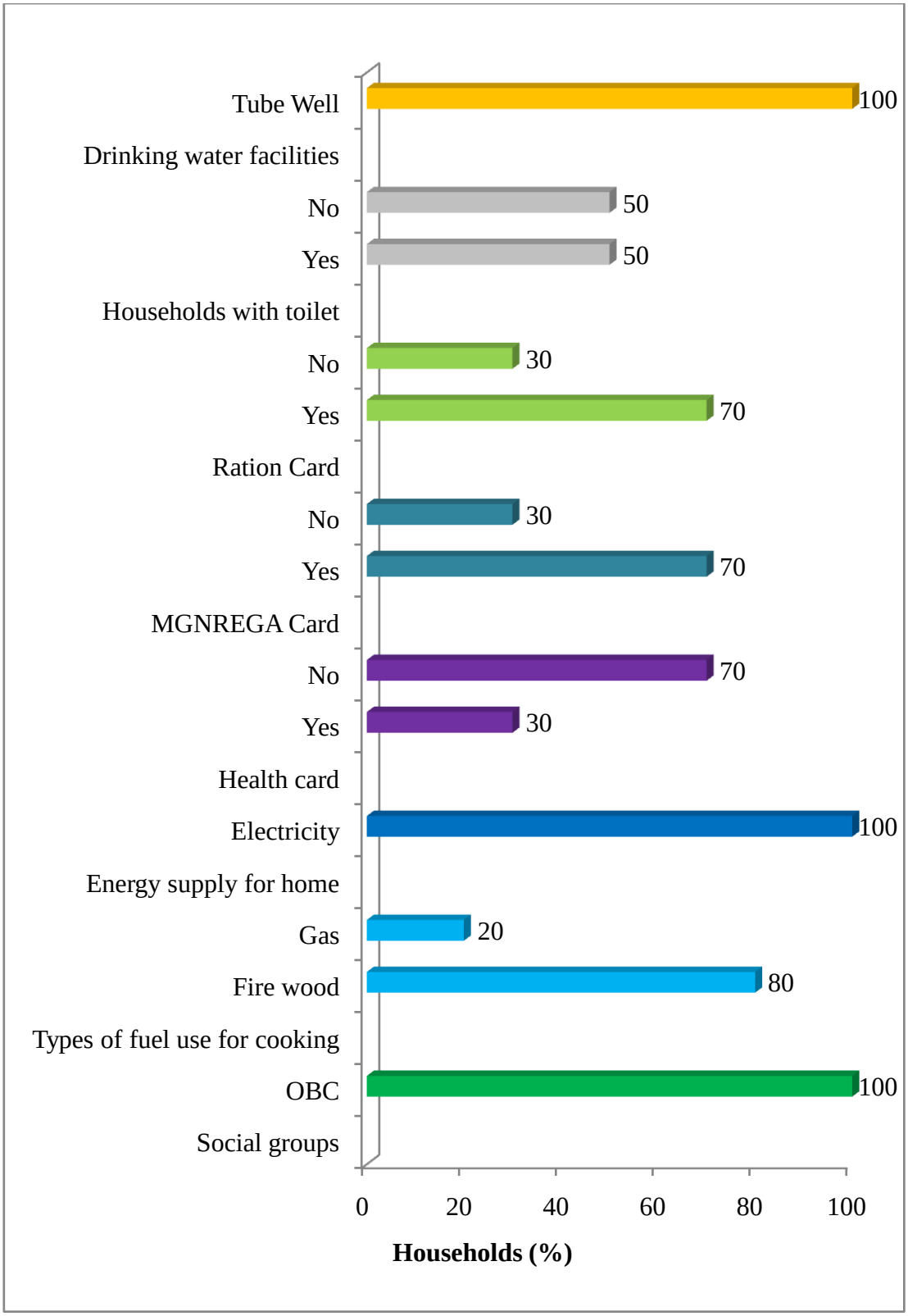


Figure 3: Basic needs of sample households in Belhatti-5 Microwatershed

The occupational pattern (Table 4) among sample households shows that agriculture is the main occupation around 50.0 per cent of farmers followed by subsidiary occupations like agricultural labour (46%) and private service (4%).

Table 4: Occupational pattern in sample population in Belhatti-5 Microwatershed

Occupation		% to total
Main	**Subsidiary**	
Agriculture	Agriculture	50.0
	Agriculture labour	46.0
	Private service	4.0
Family labour availability		**Man days/month**
Male		42.5
Female		30.0
Average		72.5

The important assets especially with reference to domestic assets were analyzed and are given in Table 5 and Figure 4. The important domestic assets possessed by all categories of farmers are mobile phones (90 %) followed by television (90 %), mixer/grinder (60 %) and motorcycle (40 %). The average value of domestic assets is around Rs.14215 per households.

Table 5: Domestic assets among the sample households in Belhatti-5 Microwatershed

Particulars	% of households	Average value in Rs
Mixer/grinder	60.0	3417
Mobile Phone	90.0	4167
Motorcycle	40.0	42500
Television	90.0	6778
Average Value	14215	

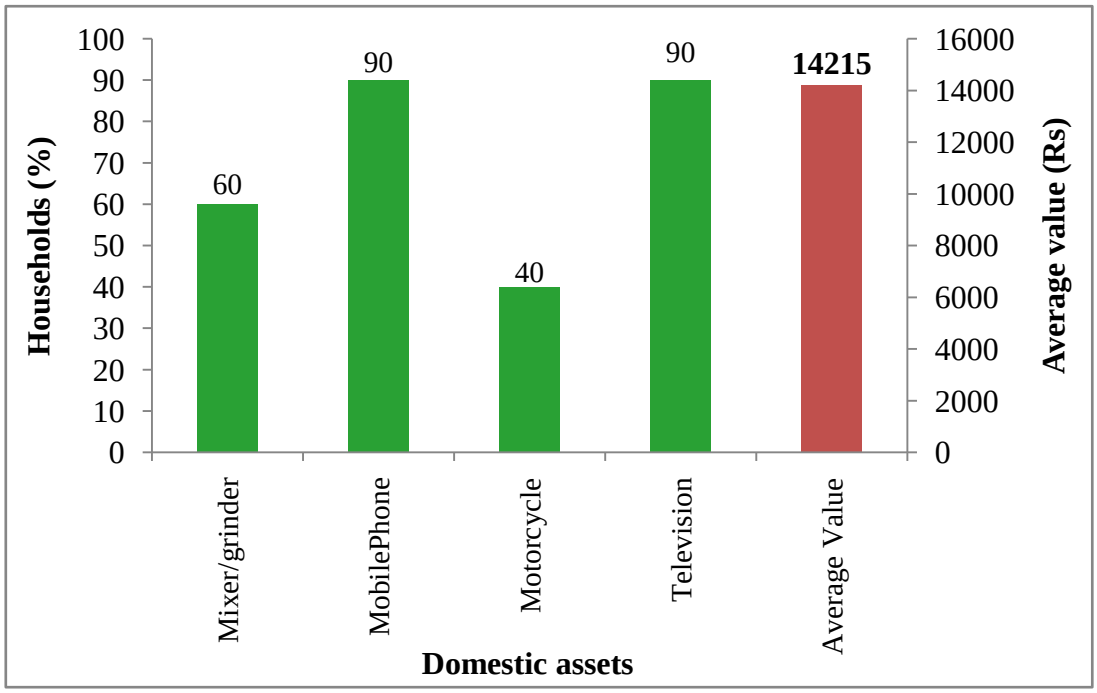


Figure 4: Domestic assets among the sample households in Belhatti-5 Microwatershed

The most popularly owned farm equipments were sickles, plough, cattle shed; pump sets, bullock cart, and sprayer. Plough and sickle were commonly present in all the sampled farmers; these were primary implements in agriculture. The per cent of households owned bullock cart (50%), plough (50%), power tiller (10%), seed cum fertilizer drill (40%), sprayer (10%), tractor (10%) and weeder (20.0%) was found highest among the sample farmers. The average value of farm assets is around Rs 24910 per households (Table 6 and Figure 4).

Table 6: Farm assets among samples households in Belhatti-5 Microwatershed

Particulars	% of households	Average value in Rs
Bullock cart	50.0	20000
Plough	50.0	2436
Power tiller	10.0	25000
Seed Cum fertiliser drill	40.0	18500
Sprayer	10.0	4500
Tractor	10.0	500000
Weeder	20.0	300
Average Value	81533	

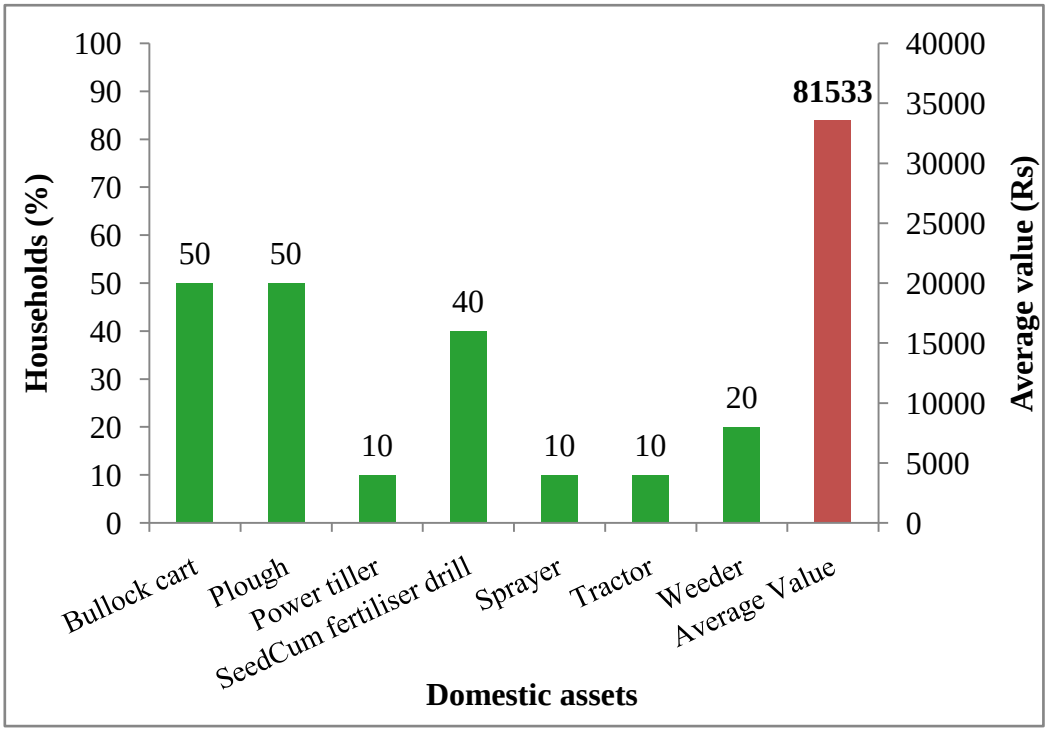


Figure 5: Farm assets among samples households in Belhatti-5 Microwatershed

Livestock is an integral component of the conventional farming systems (Table 7 and Figure 6). The highest livestock population is bullocks (44.4%), local milching cow (33.3%), and mulching buffalos (22.2%). The average livestock value was Rs 14380 per livestock.

Table 7: Livestock assets among sample households in Belhatti-5 micro-watershed

Particulars	% of livestock population	Average value in Rs
Local Milching Cow	33.3	20000
Mulching Buffalos	22.2	25000
Bullocks	44.4	81250
Average value	42083	

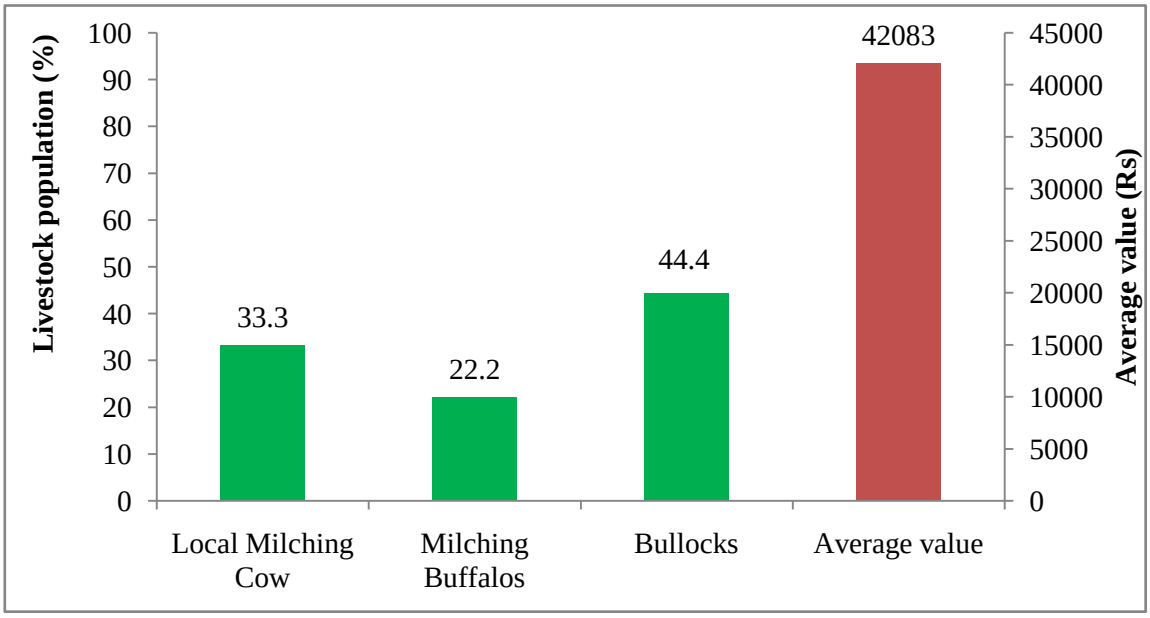


Figure 6: Livestock assets among sample households in Belhatti-5 micro-watershed

Average milk produced in sample households is 564 litters/ annum. Among the farm households, maize greengram and sorghum are the main crops for domestic food and fodder for animals. About 2210 kg /ha of average fodder is available per season for the livestock feeding (Table 8).

Table 8: Milk produced and fodder availability of sample households in Belhatti-5 Microwatershed

Particulars	
Name of the Livestock	**Ltr./Lactation/animal**
Local Milching Cow	440
Milching Buffalos	750
Average Milk Produced	564
Fodder produces	**Fodder yield (kg/ha.)**
Maize	3283
Greengram	774
Horsegram	6157
Average fodder availability	3404
Livestock having households (%)	64.3
Livestock population (Numbers)	14

A woman participation in Table 9 About 100 per cent of women earning for her family requirement, 100 per cent women taking decision in her family and agriculture related activities.

Table 9: Women empowerment of sample households in Belhatti-5 Micro watershed

% to Grand Total

Particulars	**Yes**	**No**
Women participation in local organization activities	0.0	100
Women elected as panchayat member	0.0	100
Women earning for her family requirement	100	0.0
Women taking decision in her family and agriculture related activities	100	0.0

The food intake in terms of kilo calorie (kcal) per person per day was calculated and presented in the Table 10 and Figure 7. More quantity of cereals is consumed by sample farmers which accounted for 1128.6 kcal per person. The other important food items consumed was pulses 217.6 kcal followed by cooking oil 181.7 kcal, milk 113.8 kcal, vegetables 35.5 kcal, egg 0.5 kcal and meat 4.2 kcal. In the sampled households, farmers were consuming less (1706.3 kcal) than NIN- recommended food requirement (2250 kcal).

Table 10: Per capita daily consumption of food among the sample households in Belhatti-5 Micro watershed

Particulars	**NIN recommendation (gram/ per day/ person)**	**Present level of consumption (gram/ per day/ person)**	**Kilo Calories /day/person**
Cereals	396	331.9	1128.6
Pulses	43	63.4	217.6
Milk	200	175.1	113.8
Vegetables	143	147.7	35.5
Cooking Oil	31	31.9	181.7
Egg	0.5	16.7	25.0
Meat	14.2	2.8	4.2
Total	**827.7**	**769.5**	**1706.3**
Threshold of NIN recommendation		827 gram*	2250 Kcal*
% Below NIN		80.0	70.0
% Above NIN		20.0	30.0

Note: * day/person

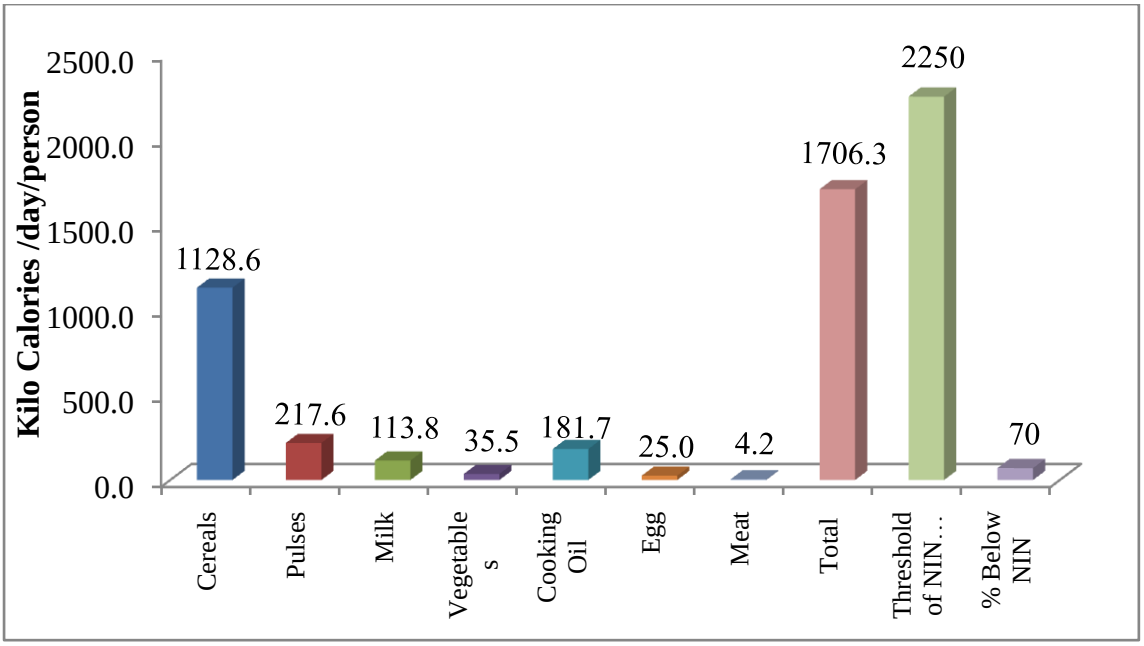


Figure 7: Per capita daily consumption of food among the sample farmers in Belhatti-5 Microwatershed

Annual income of the sample HHs: The total annual household income is around Rs 24714. Major source of income crop production income to the farmers in the study area is from (Rs. 13494) followed by livestock income (Rs. 11220). The average monthly per capita income is Rs 412, which is less than the threshold monthly income of Rs 975 for considering below poverty line. Due to the fact that erratic rainfall and shortage of water, farmers are diverting from crop production activities to enable the household for a comfortable livelihood. The incomes from the other aforesaid sources are very meagre (Table 11).

Table11: Annual average income of HHs from various sources in Belhatti-5 Microwatershed.

Particulars	Income *
Nonfarm income	0(0)
Livestock income (Rs)	11220 (40)
Crop Production (Rs)	13494 (100)
Total Annual Income (Rs)	***24714***
Average monthly per capita income (Rs)	412
Threshold for Poverty level (Rs 975 per month/person)	
% of households below poverty line	90.0
% of households above poverty line	10.0

* Figure in the parenthesis indicates % of Households

The average annual expenditure of farm households indicated that farmers in the study area spend highest on food (Rs.44040) followed by education, clothing, social function and health. Now a day's education is most important among all of us. In today's

competitive world, education is a necessity for man after food, clothing, and shelter. It is the only fundamental way by which a desired change in the society can happen. The average per capita monthly expenditure is around Rs 1048 and about 90.0 per cent of farm households are below poverty line (Table 12and Figure 8).

Table 12: Average annual expenditure of sample HHs in Belhatti-5 Microwatershed

Particulars	Value in Rupees	Per cent
Food	44040	70.0
Education	3880	6.2
Clothing	5480	8.7
Social functions	4400	7.0
Health	5080	8.1
Total Expenditure (Rs/year)	62880	100.0
Monthly per capita expenditure (Rs)	1048	

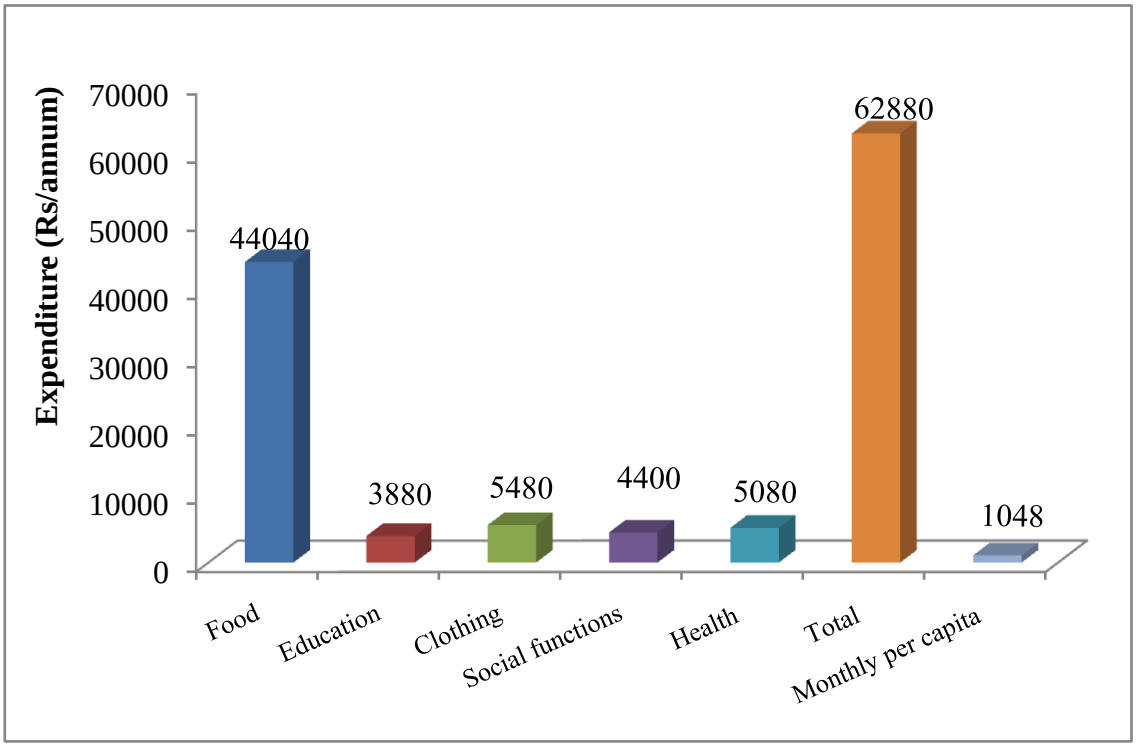


Figure 8: Average annual expenditure of sample HHs in Belhatti-5 Microwatershed

Land holding: Total area cultivated by them is 13.3 ha. The average land holding of sample HHs is 1.3 ha. Large number of sample HHs (90 %) belong to small size group with an average holding size of 0.8 ha followed by large farmers (10 %) with an average holding size of 5.8 ha (Table 13).

Table 13: Distribution of land holding among the sample households in Belhatti-5 micro-watershed

Particulars	Units	Values
Small farmers		
Total land	ha	7.6
Sample size	Per cent	90.0
Average land holding	ha	0.8
Large farmers		
Total land	ha	5.8
Sample size	Per cent	10.0
Average land holding	ha	5.8
Total sample households		
Total land	ha	13.3
Sample size	Per cent	100.0
Average land holding	ha	1.3

Land use: The average land holding in the Belhatti-5 Microwatershed is 1.3 ha (Table 14). Of which 2.6 ha is dry land and 10.7 ha is irrigated land. The total land holding per household is worked out to be 13.3 ha.

Table: 14 land holding among sample households in Belhatti-5 Microwatershed

Particulars	Per cent	Area in ha
Irrigated land	19.4	2.6
Rainfed Land	80.6	10.7
Fallow Land	0.0	0.0
Total land holding	100.0	13.3
Average land holding	1.3	

In the Microwatershed, the prevalent present land uses under perennial plants are banni trees (46.2%) followed by neem trees (23.1%), tarmind (15.4%) and mango (15.4%) (Table15).

Table 15: Number of trees/plants covered in sample farm households in Belhatti-5 Microwatershed.

Particulars	Number of Plants/trees	Per cent
Banni tree(shami)	6	46.2
Mango	2	15.4
Neem trees	3	23.1
Tamarind	2	15.4
Grand Total	13	100.0

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

The present dominant crops grown in dry lands and irrigated land in the study area were by maize (66.3%) followed by green gram (9.8%), onion (3.0 %) and horsegram (0.8%) which are taken during Kharif and maize (16.84%) and horse gram (3.3%) during Rabi season respectively (Table 16 and Figure 9).

Table 16: Present cropping pattern and cropping intensity in Belhatti-5 Microwatershed % to Grand Total

Crops	**Kharif**	**Rabi**	**Grand Total**
Maize	66.3	16.84	83.1
Greengram	9.8	0.0	9.8
Horsegram	0.8	3.3	4.0
Onion	3.0	0.0	3.0
Grand Total	***79.9***	***20.1***	***100.0***
Cropping intensity (%)	125.2		

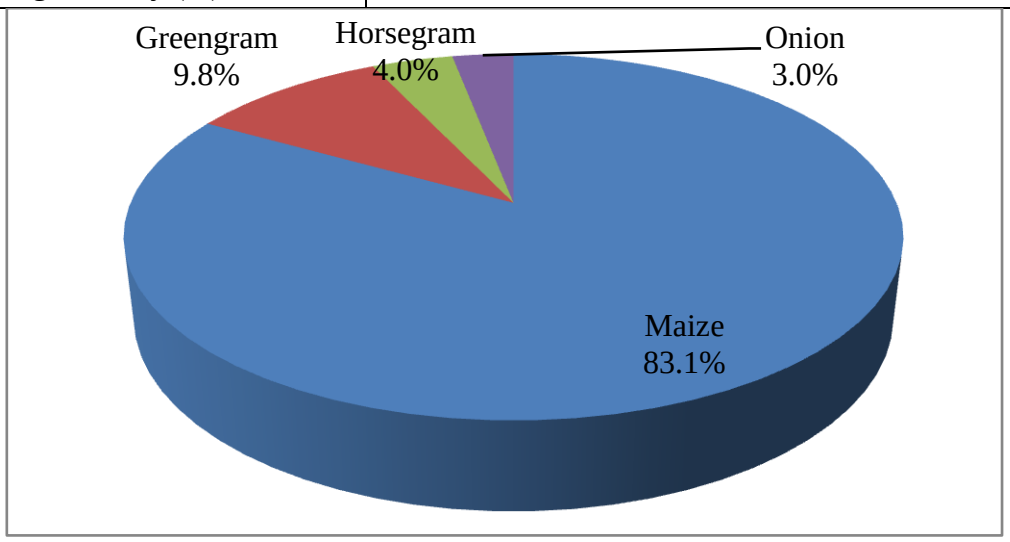


Figure 9: Present cropping pattern in Belhatti-5 Microwatershed

Economic land evaluation

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

In Belhatti-5 Microwatershed, 15 soil series are identified and mapped (Table 17). The distribution of major soil series Kutegoudanahundi(KGH) are covering an area around 96.5 ha (18.1 %) followed by Kumachahalli (KMH) 53.8 ha (10.1%), Gollarahatti (GHT) 48.6 ha (9.1%), Lakkur (LKR) 35.3 ha (6.6 %), Kethanapura (KTP) 28.5 ha (5.3 %), Jelligeri-JLG 26.7 ha (5.0), Tammadahalli (TDH) 26.6 ha (5.0 %), Kagalipura (KGP) 23.6 ha (4.4%), Hooradahalli (HDH) 23.1 ha (4.3 %), Chikkamegheri(CKM) 16.1 ha (3.0 %), Vaddarahalli (VDH) 15.0 ha (2.8 %), Harve (HRV) 12.9 ha (2.4 %), Hallikere (HLK)

12.0 ha (2.3 %), Honnenahalli (HNH) 9.6 ha (1.2 %), Devihal (DVH) 4.2 ha (0.8%), Rock out crops 17.7 ha (3.3 %) and habitation is 81.8 ha (15.4 %).

Table 17: Distribution of soil series in Belhatti-5 Microwatershed

Soil No	Soil Series	Mapping Unit Description	Area in ha (%)
1	CKM	Chikkamegheri soils are moderately deep (75-100 cm), well drained, have dark brown to dark reddish brown sandy clay soils occurring on very gently sloping uplands under cultivation	16.1 (3.0)
2	DVH	Devihal soils are very shallow (< 25 cm), well drained, have dark reddish brown to yellowish red clay loam soils occurring on very gently sloping uplands under cultivation.	4.2 (0.8)
3	GHT	Gollarahatti soils are moderately deep (75-100 cm), well drained, have dark reddish brown to dark red sandy clay loam to clay soils occurring on very gently to gently sloping uplands under cultivation	48.6 (9.1)
4	HDH	Hooradhahalli soils are moderately deep (75-100 cm), well drained, have red to dark red and reddish brown gravelly sandy clay loam to clay soils occurring on very gently to gently sloping uplands under cultivation	23.1 (4.3)
5	HLK	Hallikere soils are very deep (>150 cm), well drained, have dark brown to dark reddish brown clayey soils occurring on nearly level to very gently sloping uplands under cultivation	12.0 (2.3)
6	HNH	Honnenahalli soils are moderately deep (50-75 cm), well drained, have brown to dark brown clay soils occurring on nearly level to very gently sloping lowlands under cultivation	9.6 (1.2)
7	HRV	Harve soils are shallow (25-50 cm), well drained, have reddish brown to dark red sandy clay loam soils occurring on very gently to moderately sloping uplands under cultivation	12.9 (2.4)
8	JLG	Jelligeri soils are moderately deep (75-100 cm), moderately well drained, very dark brown to dark brown and black cracking clay soils occurring on very gently sloping uplands under cultivation	26.7 (5.0)
9	KGH	Kutegoudanahundi soils are moderately shallow (50-75 cm), well drained, have brown to dark brown loamy sand to sandy loam soils occurring on very gently to gently sloping uplands under cultivation	96.5 (18.1)
10	KGP	Kaggalipura soils are shallow (25-50 cm), well drained, have brown to dark reddish brown sandy clay loam to sandy clay soils occurring on very gently sloping uplands under cultivation	23.6 (4.43)
11	KMH	Kumchahalli soils are deep (100-150 cm), well drained, have dark reddish brown to dark red sandy clay loam to sandy clay soils occurring on nearly level to very gently sloping uplands under cultivation	53.8 (10.1)
12	KTP	Kethanapura soils are moderately shallow (50-75 cm), well drained, have dark reddish brown gravelly sandy loam soils occurring on	28.5 (5.3)

		very gently to gently sloping uplands under cultivation	
13	LKR	Lakkur soils are moderately shallow (50-75 cm), well drained, have reddish brown to dark red gravelly sandy clay loam to sandy clay red soils occurring on nearly level to gently and moderately sloping uplands under cultivation	35.3 (6.6)
14	TDH	Tammadahalli soils are moderately shallow (50–75 cm), well drained, have brown to very dark brown and dark reddish brown sandy loam to clay loam soils occurring on nearly level to gently sloping uplands under cultivation	26.6 (5.0)
15	VDH	Vaddarahalli soils are deep (100 - 150 cm), well drained, have dark reddish brown to dark brown clayey soils occurring on nearly level to very gently sloping uplands under cultivation	15.0 (2.8)
16	Rocky outcrops		17.7 (3.3)
17	Habitation		81.8 (15.4)

Present cropping pattern on different soil series are given in Table 18. Horse gram on Kagalipura soils is grown. Horse gram and maize are grown on Kutegoudanahundi soils. Maize and onion are Tammadahalli soils are grown. Green gram is Kethanapura soils are grown. Maize is Chikkamegheri soil is grown. Maize is Gollarahatti soils are grown. Maize is Jelligere soils are grown.

Table 18: Cropping pattern on major soil series in Belhatti-5 Microwatershed

(Area in per cent)

Soil Series	Soil Depth	Crops	Dry		Irrigated	Grand Total
			Kharif	Rabi	Kharif	
KGP	Shallow (25-50 cm)	Horse gram	100	0.0	0.0	100
KTP	Moderately shallow (50-75 cm)	Greengram	100	0.0	0.0	100
TDH	Moderately shallow (50-75 cm)	Maize	59.5	0.0	27.8	87.3
		Onion	0.0	0.0	12.7	12.7
KGH	Moderately shallow (50-75 cm)	Horse gram	0.0	7.0	0.0	7.0
		Maize	93.0	0.0	0.0	93.0
CKM	Moderately deep (75-100 cm)	Maize	100	0.0	0.0	100
GHT	Moderately deep (75-100 cm)	Maize	0.0	0.0	100	100
JLG	Moderately deep (75-100 cm)	Maize	100	0.0	0.0	100

Land is used for agricultural use for growing cereals, pulse, oilseeds and commercial crops. The soil/ land potential are measures in terms of physical yield and net

income. The alternative land use options for each micro-watershed are given below (Table 19).

Table 19: Alternative land use options for different size group of farmers (Benefit Cost Ratio) in Belhatti-5 Micro watershed.

Soil Series	Small farmers	Large farmers
KGH	Horsegram (1.51).	Maize (2.09)
CKM	Maize (0.96)).	
GHT	Maize (1.52).	
JLG	Maize (1.21).	
KGP	Horse gram (1.06).	
KTP	Green gram (1.09).	
TDH	Maize (1.43),	Onion (2.09)

The productivity of different crops grown in Belhatti-5 micro-watershed under potential yield of the crops is given in Table 20.

The data on cost of cultivation and benefit cost ratio (BCR) of different crops is given in Table 20. The total cost of cultivation in study area for maize ranges between Rs.132251/ha in CKM soil (with BCR of 0.96) and Rs.10239/ha in KGH soil (with BCR of 2.09), horse gram range between Rs 58540/ha in KGP soil (with of 1.06) and Rs.37563/ha in KGH soil (with BCR of 1.51), onion cost of cultivation is RS. 50876/ha in TDH soil (BCR of 1.46) and green gram cost of cultivation in KTP soil Rs. 16332/ha (BCR of 1.09).

The data on FYM, Nitrogen, Phosphorus and Potash application by the farmers to different crops and recommended FYM for different crops is given in Table 20. There is a huge gap between FYM application by farmers and recommended FYM in all the crops across the soils. There is a larger yield gap in crops grown across different soil series. Adequate knowledge about recommended package of practices is the pre-requisite for their use in cultivation of crops. It is a fact that, recommended practices are major contributing factors to yield. Inadequate knowledge about recommended practices leads to their improper adoption. Strengthening of extension services by concerned agency is required to increase adoption of recommended cultivation practices and ultimately reducing the gap. By adopting soil-test fertiliser recommendation, there is scope to increase yield and income to a maximum of Rs 271297 in onion and a minimum of Rs 1294 in horse gram cultivation.

Table 20: Economic land evaluation and bridging yield gap for different crops in Belhatti-5 Microwatershed

Particulars	KGP (25-50 cm)	KGH (50-75 cm)		TDH (50-75 cm)		KTP (50-75 cm)	CKM (75-100 cm)	GHT (75-100 cm)	JLG (75-100 cm)
	Horse gram	Horse gram	Maize	Maize	Onion	Greengram	Maize	Maize	Maize
Total cost (Rs/ha)	58540	37563	10239	23560	50876	16332	132251	25762	28351
Gross Return (Rs/ha)	62244	56719	21418	32381	74100	17818	126464	39243	34216
Net returns (Rs/ha)	3704	19155	11179	8821	23224	1486	-5787	13481	5865
BCR	1.06	1.51	2.09	1.43	1.46	1.09	0.96	1.52	1.21
Farmers Practices (FP)									
FYM (t/ha)	0.0	4.6	0.9	2.5	5.0	2.3	20.0	2.3	2.2
Nitrogen (kg/ha)	22.5	94.9	41.6	119.3	137.6	65.0	410.0	101.6	79.0
Phosphorus (kg/ha)	57.5	106.5	24.1	88.7	104.9	51.1	460.0	91.5	74.7
Potash (kg/ha)	75.0	0.0	26.2	19.1	38.3	15.5	0.0	19.9	0.0
Grain (Qtl/ha)	10.0	9.3	17.5	22.6	50.0	3.9	80.0	27.3	21.6
Price of Yield (Rs/Qtl)	5500	6000	1200	1300	1500	4500	1500	1400	1500
Soil test based fertilizer Recommendation (STBR)									
FYM (t/ha)	0.0	0.0	8.6	8.6	29.6	7.4	8.6	8.6	8.6
Nitrogen (kg/ha)	18.5	30.9	154.4	123.5	123.5	23.2	154.4	123.5	123.5
Phosphorus (kg/ha)	37.1	37.1	61.8	61.8	74.1	37.1	77.2	61.8	77.2
Potash (kg/ha)	24.7	18.5	32.1	24.1	92.6	37.1	32.1	24.1	24.1
Grain (Qtl/ha)	9.9	9.9	84.0	84.0	247.0	8.6	84.0	84.0	84.0
% of Adoption/yield gap (STBR-FP) / (STBR)									
FYM (%)	0	0	89.9	70.7	83.1	68.7	-131.3	73.0	75.0
Nitrogen (%)	-21.5	-207.4	73.0	3.4	-11.4	-180.8	-165.6	17.7	36.0
Phosphorus (%)	-55.2	-187.4	60.9	-43.7	-41.5	-37.9	-496.0	-48.2	3.3
Potash (%)	-203.6	100.0	18.3	20.5	58.7	58.2	100.0	17.5	0.0
Grain (%)	-1.2	6.3	79.2	73.1	79.8	55.2	4.7	67.5	74.2
Value of yield and Fertilizer (Rs)									
Additional Cost (Rs/ha)	-1954	-8083	10897	5072	24203	4400	-30624	5346	7607
Additional Benefits (Rs/ha)	-660	3724	79797	79813	295500	21488	5970	79410	93502
Net change Income (Rs/ha)	1294	11807	68900	74741	271297	17088	36594	74064	85896

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

The onsite cost of different soil nutrients lost due to soil erosion is given in Table 21 and Figure 10. The total value of soil nutrient loss is around Rs 847.1 per ha/year. The total cost of annual soil nutrients is around Rs 365940 per year for the total area of 532.06 ha.

Table 21: Estimation of onsite cost of soil erosion in Belhatti-5 Microwatershed

Particulars	Quantity(kg)		Value (Rs)	
	Per ha	Total	Per ha	Per ha
Organic matter	119.67	51698	753.93	325697
Phosphorous	0.15	64	6.48	2800
Potash	1.73	747	34.58	14939
Iron	0.06	25	2.77	1198
Manganese	0.14	61	38.78	16754
Cupper	0.01	4	5.42	2342
Zinc	0.00	1	0.13	55
Sulpher	0.12	50	4.67	2018
Boron	0.01	3	0.31	135
Total	119.94	52654	847.1	365940

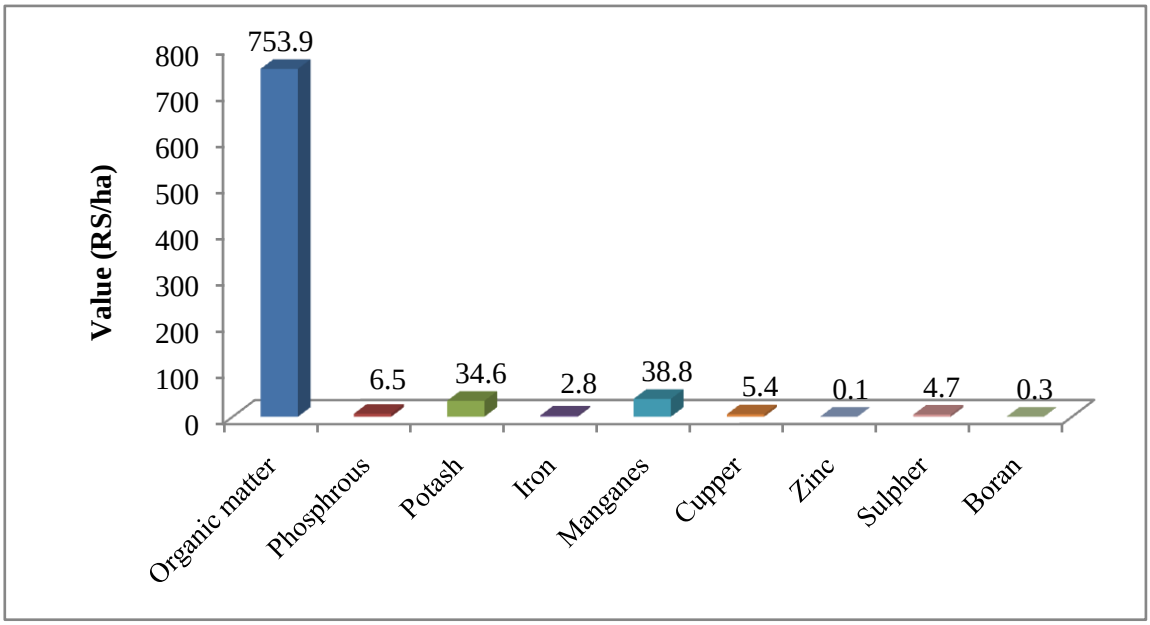


Figure 10: Estimation of onsite cost of soil erosion in Belhatti-5 micro-watershed

The average value of ecosystem service for food grain production is around Rs 8551 ha/year (Table 22 and Figure 11). Per hectare food grain production services is maximum in onion (Rs. 23224) followed by horse gram (Rs. 6654), maize (Rs. 3454) and green gram (Rs. 874).

Table 22: Ecosystem services of food grains production in Belhatti-5 Microwatershed

Production items	Crops	Area in ha	Yield (Qtl/ha)	Price (Rs/Qtl)	Gross Returns (Rs/ha)	Cost of Cultivation (Rs/ha)	Net Returns (Rs/ha)
Cereals	Maize	10.9	31	1343	41637	38183	3454
Pulses	Greengram	1.3	4	4500	17206	16332	874
	Horsegram	0.5	10	5750	54706	48052	6654
Vegetables	Onion	0.4	49	1500	74100	50876	23224
Average Value		13.1	23.5	3273	46912	38360	8551

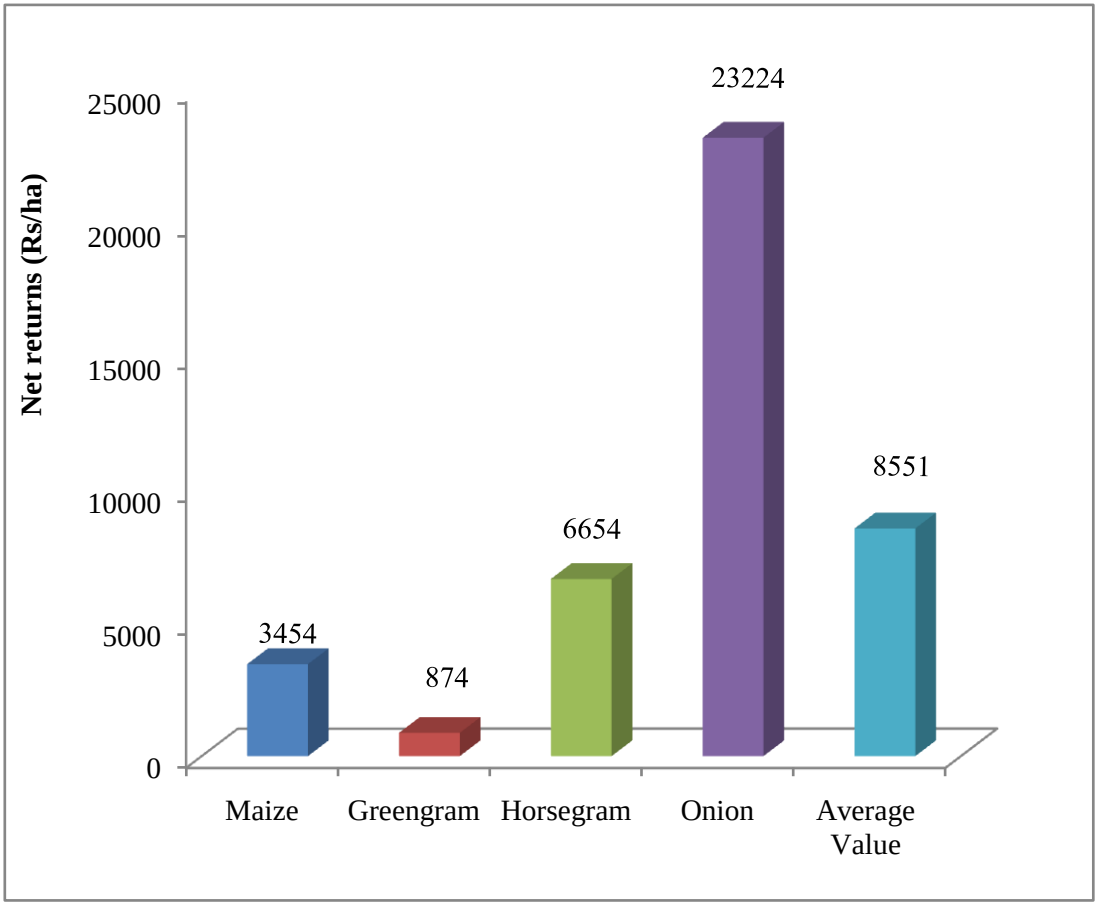


Figure 11: Ecosystem services of food grains production in Belhatti-5 Microwatershed

The average value of ecosystem service for fodder production is around Rs 2762 ha/year (Table 23). Per hectare fodder production services is maximum in horse gram (Rs 4867) followed by maize (Rs 2808) and green gram (Rs.612).

Table 23: Ecosystem services of fodder production in Belhatti-5 Microwatershed

Production items	Crops	Area in ha	Yield (Qtl/ha)	Price (Rs/Qtl)	Net Returns (Rs/ha)
Cereals	Maize	10.9	3.2	886	2808
Pulses	Greengram	1.3	0.8	800	612
	Horse gram	0.5	6.1	800	4867
Average		12.7	3.4	829	2762

The water demand for production of different crops was worked out in arriving at the ecosystem services of water support to crop growth. The data on water requirement for producing one quintal of grain is considered for estimating the total value of water required for crop production. The per hectare value of water used and value of water was maximum (Table 24 and Figure 12) in maize (Rs. 37890), horse gram (Rs. 29284), green gram (Rs.26405) and onion (Rs 13437).

Table 24: Ecosystem services of water supply in Belhatti-5 Microwatershed

Crops	Yield (Qtl/ha)	Virtual water (cubic meter) per ha	Value of Water (Rs/ha)	Water consumption (Cubic meters/Qtl)
Greengram	4	2641	26405	691
Horsegram	10	2928	29284	308
Maize	31	3789	37890	122
Onion	49	1344	13437	27
Average Value	23.5	2675.5	26754	287

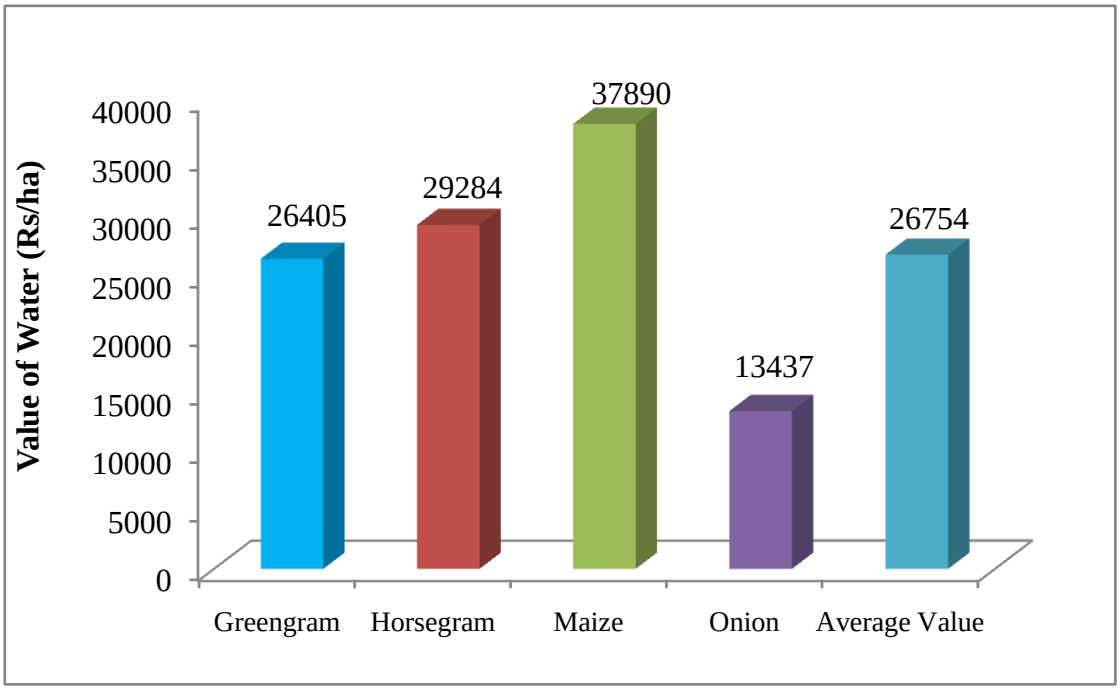


Figure 12: Ecosystem services of water supply in Belhatti-5 Micro watershed

The main farming constraints in Belhatti-5 Microwatershed to be found are less rainfall, lack of good quality seeds, lack of storage, damage of crops by wild animals and non availability of plant protection chemicals. Majority of farmers depend up on money lender of the sources of loan for purpose of crop production. Farmers to sell the agriculture produce through village market and the farmers getting the agriculture related information on newspaper and television. Farmers reported that they are not getting timely support/extension services from the concerned development department (Table 25).

Table 25: Farming constraints related land resources of sample households in Belhatti-5 Micro watershed

Sl. No	Particulars	Per cent
1	Less Rainfall	90
2	High Crop Pests & Diseases	20
3	Lack of transportation	10
4	Lack of storage	10
5	Damage of crops by Wild Animals	80
6	Non availability of Plant Protection Chemicals	100
7	**Source of loan**	
	Money Leander	90
	Village merchants	10
8	**Market for selling**	
	Village market	100
9	**Sources of Agri-Technology information**	
	Newspaper	100

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