ICAR-NBSS&LUP Sujala MWS Publ.89

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

## BALBATTI-3 (4D5A3O1c) MICROWATERSHED

**Jewargi Taluk, Gulbarga District, Karnataka**

Karnataka Watershed Development Project – II

## SUJALA – III

**World Bank funded Project**

The World Bank

ICAR – NATIONAL BUREAU OF SOIL SURVEY AND LAND USE PLANNING

WATERSHED DEVELOPMENT DEPARTMENT
GOVT. OF KARNATAKA, BANGALORE

## About ICAR - NBSS&LUP

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

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

**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 Balbatti-3 (4D5A3O1c) Microwatershed, Jewargi Taluk, Gulbarga District, Karnataka”, ICAR-NBSS&LUP Sujala MWS Publ.89, ICAR – NBSS & LUP, RC, Bangalore. p.79 & 29.

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# PREFACE

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

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

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

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

ICAR-NBSS&LUP, Regional Centre, Bangalore has taken up a project sponsored by the Karnataka Watershed Development Project-II, (Sujala-III), Government of Karnataka funded by the World Bank under Component -1 Land Resource Inventry. This study was taken up to demonstrate the utility of such a database in reviewing, monitoring and evaluating all the land based watershed development programs on a scientific footing. To meet the requirements of various land use planners at grassroots level, the present study on “Land Resource Inventory and Socio-Economic Status of Farm Households for Watershed Planning and Development of Balbatti-3 Microwatershed, Jewargi Taluk, Gulbarga District, Karnataka” for integrated development was taken up in collaboration with then State Agricutural Universities, IISC, KSRSAC, KSNDMC as Consortia partners. The project provides detailed land resource information at cadastral level (1:7920 scale) for all the plots and socio-economic status of farm households covering thirty per cent farmers randomely selected representing landed and landless class of farmers in the 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: 07.03.2018

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# PART-A

## LAND RESOURCE INVENTORY

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# *EXECUTIVE SUMMARY*

*The land resource inventory of Balbatti-3 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 437 ha in Balbatti-3 microwatershed in Jewargi taluk of Gulbarga district, Karnataka. The climate is semiarid and categorized as drought- prone with an average annual rainfall of 751 mm, of which about 538 mm is received during south–west monsoon, 138 mm during north-east and the remaining 75 mm during the rest of the year. 99 per cent area is covered by soils and 1 per cent is by Habitation and waterbody. The salient findings from the land resource inventory are summarized briefly below.*

- *The soils belong to 5 soil series and 10 soil phases (management units) and 3 Land Use Classes.*
- *The length of crop growing period is about 150 days starting from the $1^{st}$ week of June to $1^{st}$ 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.*
- *Entire area is suitable for agriculture.*
- *About 83 per cent of the soils are deep to very deep (100->150 cm) and 16 per cent are very shallow to shallow (<25-50 cm) soils.*
- *Entire area has clayey soils at the surface.*
- *About 99 per cent of the area has non-gravelly soils.*
- *About 83 per cent of the area has soils that are very high (>200mm/m) in available water capacity and about 16 per cent low (50-100 mm/m) and very low (<50 mm/m).*
- *About 99 per cent of the area has nearly level (0-1%) to very gently sloping (1-3%) lands.*

- *An area of about 73 per cent has soils that are slightly eroded (e1), 25 per cent moderately eroded (e2) and 0.05 per cent severely eroded (e3).*
- *An area of about 99 per cent has soils that strongly alkaline soils (pH 7.3-9.0).*
- *The Electrical Conductivity (EC) of the soils are dominantly <2* $dsm^{-1}$*indicating that the soils are non-saline.*
- *About 19 ha (4%) area is low (<0.5%) in organic carbon, medium (0.5-0.75%) in about maximum area of 276 ha (63%) and high (>0.75%) in 137 ha (31%) in organic carbon.*
- *Major area of 73 per cent has soils that are low (<23 kg/ha and 26 per cent medium (23-57 kg/ha) in available phosphorus.*
- *About 99 per cent high (>337 kg/ha) in available potassium.*
- *Available sulphur is low (<10 ppm) in about 1 per cent area, medium (10-20 ppm) in 34 per cent and 64 per cent high (>20 ppm).*
- *Available boron is low (<0.5 ppm) in about 30 per cent area and 69 per cent medium (0.5-1.0 ppm) .*
- *About 77 per cent area is sufficient (>4.5 ppm) in iron and 22 per cent deficient (<4.5 ppm) in available iron.*
- *Available manganese and copper are sufficient in all the soils.*
- *About 56 per cent area has soils that are deficient (<0.6 ppm) in available zinc and 43 per cent sufficient (>0.6 ppm).*
- *The land suitability for 19 major crops grown in the microwatershed were assessed and the areas that are highly suitable (S1) and moderately suitable (S2) are given below. It is however to be noted that a given soil may be suitable for various crops but what specific crop to be grown may be decided by the farmer looking to his capacity to invest on various inputs, marketing infrastructure, market price and finally the demand and supply position.*

***Land suitability for various crops in the microwatershed***

| *Crop* | *Suitability Area in ha (%)* | | | *Crop* | *Suitability Area in ha (%)* | |
|---|---|---|---|---|---|---|
| | *Highly suitable(S1)* | *Moderately suitable(S2)* | | | *Highly suitable(S1)* | *Moderately suitable(S2)* |
| *Sorghum* | *363 (83)* | *-* | | *Guava* | *-* | *363 (83)* |
| *Maize* | *-* | *-* | | *Jackfruit* | *-* | *-* |
| *Red gram* | *-* | *-* | | *Jamun* | *-* | *363 (83)* |
| *Soybean* | *363 (83)* | *-* | | *Musambi* | *363 (83)* | *-* |
| *Bengalgram* | *363 (83)* | *68 (16)* | | *Lime* | *363 (83)* | *-* |
| *Sunflower* | *363 (83)* | *-* | | *Cashew* | *-* | *-* |
| *Cotton* | *363 (83)* | *-* | | *Custard apple* | *363 (83)* | *-* |
| *Sugarcane* | *-* | *-* | | *Amla* | *363 (83)* | *-* |
| *Mango* | *-* | *-* | | *Tamarind* | *-* | *363 (83)* |
| *Sapota* | *-* | *363 (83)* | | | | |

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

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

*Chapter 1*

# INTRODUCTION

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

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

In this critical juncture, the challenge before us is not only to increase the productivity per unit area which is steadily declining and showing a fatigue syndrome, but also to prevent or at least reduce the severity of degradation. If the situation is not reversed at the earliest, then the sustainability of the already fragile crop production system and the overall ecosystem will be badly affected in the state. The continued neglect and unscientific use of the resources for a long time has led to the situation observed at present in the state. It is a known fact and established beyond doubt by many studies in the past that the cause for all kinds of degradation is the neglect and irrational use of the land resources. Hence, there is urgent need to generate a detailed site-specific farm level database on various land resources for all the villages/watersheds in a time bound manner that would help to protect the valuable soil and land resources and also to stabilize the farm production.

Therefore, the land resource inventory required for farm level planning is the one which investigates not only the surface but also consider the other parameters which are critical for productivity *viz.*, soil, climate, water, minerals and rocks, topography, geology, hydrology, vegetation, crops, land use pattern, animal population, socio-economic conditions, infrastructure, marketing facilities and various schemes and developmental works of the government etc. From the data collected at farm level, the specific problems and potentials of the area can be identified and highlighted, conservation measures required for the area can be planned on a scientific footing, suitability of the area for various uses can be worked out and finally viable and sustainable land use options suitable for each and every land holding can be prescribed.

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

The land resource inventory aims to provide site specific database for Balbatti-3 microwatershed in Jewargi Taluk, Kalaburagi District, Karnataka State for the Karnataka Watershed Development Department. The database was generated by using cadastral map of the village as a base along with high resolution IRS LISS IV and Cartosat-1 merged satellite imagery. Later, an attempt will be made to uplink this LRI data generated at 1:7920 scale under Sujala-III Project to the proposed Landscape Ecological Units (LEUs) map.

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

*Chapter 2*

# GEOGRAPHICAL SETTING

## 2.1 Location and Extent

The Balbatti-3 microwatershed (Dummadri subwatershed) is located in the northern part of Karnataka in Jewargi Taluk, Kalaburagi District, Karnataka State (Fig.2.1). It comprises parts of Balabatti, Hangala, Shivapura, Sumbada and Vadagera villages. It lies between $16^0 46'$ – $16^0 48'$ North latitudes and $76^0 34'$ – $76^0 36'$ East longitudes and covers an area of 437 ha. It is about 80 km south of Kalaburagi town and is surrounded by Hangala and Shivapura villages on the north, Balbatti village on the south, Vadegara and Sumbda villageson the west.

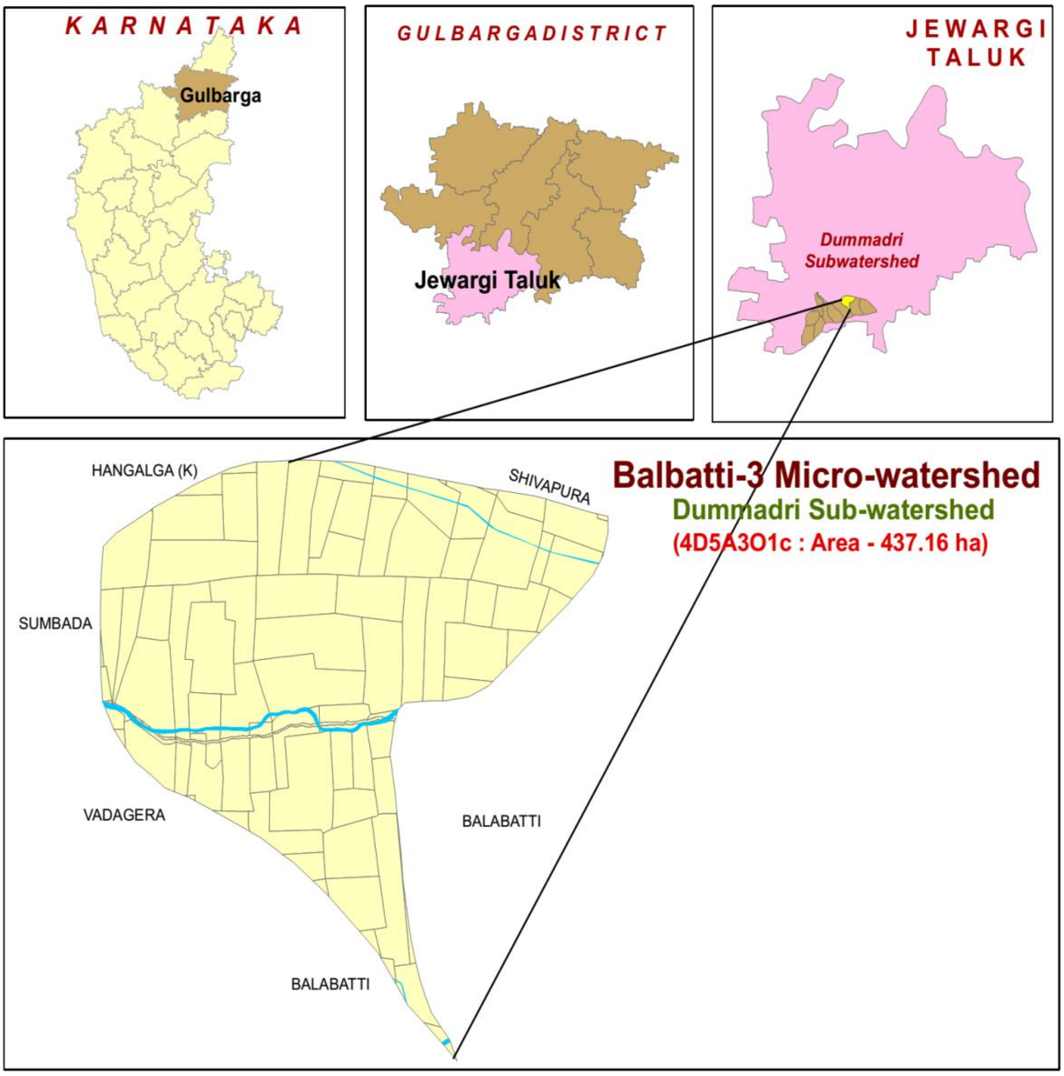



Fig.2.1 Location map of Balbatti-3 Microwatershed

## 2.2 Geology

Major rock formation observed in the microwatershed is Basalt or Deccan trap (Fig.2.2a) and Shales (Fig.2.2b). The Deccan Traps cover the whole of Bidar, parts of Kalaburgi, Bijapur and Belgaum districts. In all, eight lava flows have been identified in

Karnataka horizontally overlying the older formations. The thickness of the individual flows averages about five meters. It is relatively uniform in petrographic character. The most common type is augite basalt. Dominant colour is grayish green and texture ranges from cryptocrystalline to glassy. The rock is often vesicular and scoriaceous filled up with secondary minerals like coloured agate, quartz, calcite and a large variety of zeolites. The Deccan Traps form an excellent building material and also used as road-metal and railway ballast.

Shales are gray in color, composed of clay to fine silt-size quartz, sericite, opaques and, in some cases, chlorite. Alternate silt-rich and sericite-rich laminations are common within the Manoli Argillite. The silt-rich laminations contain angular to very well rounded quartz grains (polymodal source) with some sub-rounded to subangular clasts of feldspar (predominantly microcline). Shales are gray in color fissile and friable but become compact and slabby towards the top and grade into calcareous shales.

Fig. 2.2a Basalt rock formation

Fig. 2.2 b Shale rock formation

**2.3 Physiography**

Physiographically, the area has been identified as Basalt and Shales landscapes based on geology. Based on slope and its relief features, the area has been further subdivided into four landforms, viz; mounds/ridges, summits, side slopes and very gently sloping uplands. The elevation ranges from 431 to 481 m. The mounds and ridges are mostly covered by rock outcrops.

## 2.4 Drainage

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

## 2.5 Climate

The district falls under semiarid tract and is categorized as drought-prone with average annual rainfall of 751 mm (Table 2.1). Of the total rainfall, a maximum of 538 mm is received during south–west monsoon period from June to September, north-east monsoon from October to early December contributes about 138 mm and the remaining 75 mm is received during the rest of the year. The winter season is from December to February. During April and May, the temperatures reach up to 42°C and in December and January, the temperatures will go down to 16°C. Rainfall distribution is shown in Figure 2.4. The average Potential Evapo-Transpiration (PET) is 159 mm and varies from a low of 115 mm in December to 232 mm in the month of May. The PET is always higher than precipitation in all the months except in September month. Generally, the Length of crop Growing Period (LGP) is 150 days and starts from 1$^{st}$ week of June to 1$^{st}$ week of October.

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

| Sl. no. | Months | Rainfall | PET | 1/2 PET |
|---|---|---|---|---|
| 1 | JAN | 3.40 | 126.80 | 63.40 |
| 2 | FEB | 2.00 | 143.90 | 71.95 |
| 3 | MAR | 12.70 | 189.90 | 94.95 |
| 4 | APR | 21.90 | 209.80 | 104.90 |
| 5 | MAY | 34.60 | 232.20 | 116.10 |
| 6 | JUN | 109.20 | 186.40 | 93.20 |
| 7 | JUL | 128.20 | 152.80 | 76.40 |
| 8 | AUG | 141.30 | 147.60 | 73.80 |
| 9 | SEP | 159.00 | 131.70 | 65.85 |
| 10 | OCT | 104.90 | 145.50 | 72.75 |
| 11 | NOV | 28.60 | 129.80 | 64.90 |
| 12 | DEC | 4.90 | 114.80 | 57.40 |
| **Total** | | **750.70** | **159.27** | |

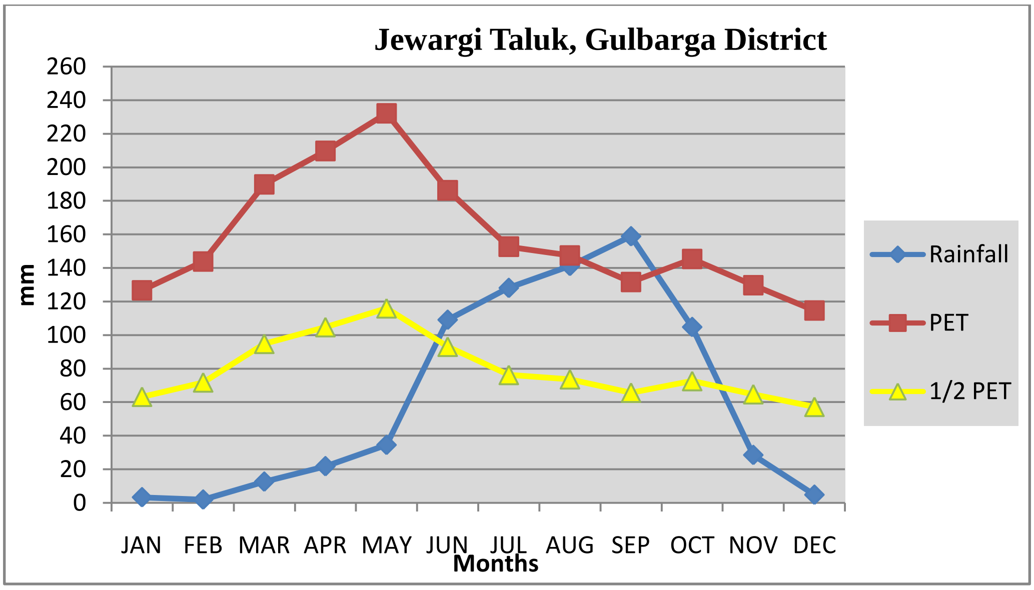



Fig 2.3 Rainfall distribution in Jewargi Taluk, Kalaburagi District

### 2.6 Natural Vegetation

The natural vegetation is sparse comprising few tree species, shrubs and herbs. The mounds, ridges and boulders occupy very sizeable area which are under thin to moderately thick forest vegetation. Still, there are some remnants of the past forest cover which can be seen in patches in some ridges and hillocks in the microwatershed (Fig. 2.4).

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

Fig. 2.4 Natural vegetation of Balbatti-3 Microwatershed

## 2.7 Land Utilization

About 84 per cent area (Table 2.2) in Jewargi taluk is cultivated at present. An area of about 4 per cent is permanently under pasture, one per cent each under non agricultural land and currently barren. Forests occupy an area of about less than one per cent and the tree cover is in a very poor state. Most of the mounds, ridges and bouldery areas have very poor vegetative cover. Major crops grown in the area are sorghum, maize, wheat, cotton, sunflower, sugarcane, safflower, groundnut, red gram, mango, custard apple, cashew and sapota. While carrying out land resource inventory, the land use/land cover particulars are collected from all the survey numbers and a current land use map of the microwatershed is generated. The current land use map generated shows the arable and non-arable lands, other land uses and different types of crops grown in the area. The current land use map of Balbatti-3 microwatershed is presented in Figure 2.5. The different crops and cropping systems adopted in the microwatershed is presented in Figure 2.6. There are no wells and conservations structures in the Balabatti-3 microwatershed.

**Table 2.2 Land Utilization in Jewargi Taluk**

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

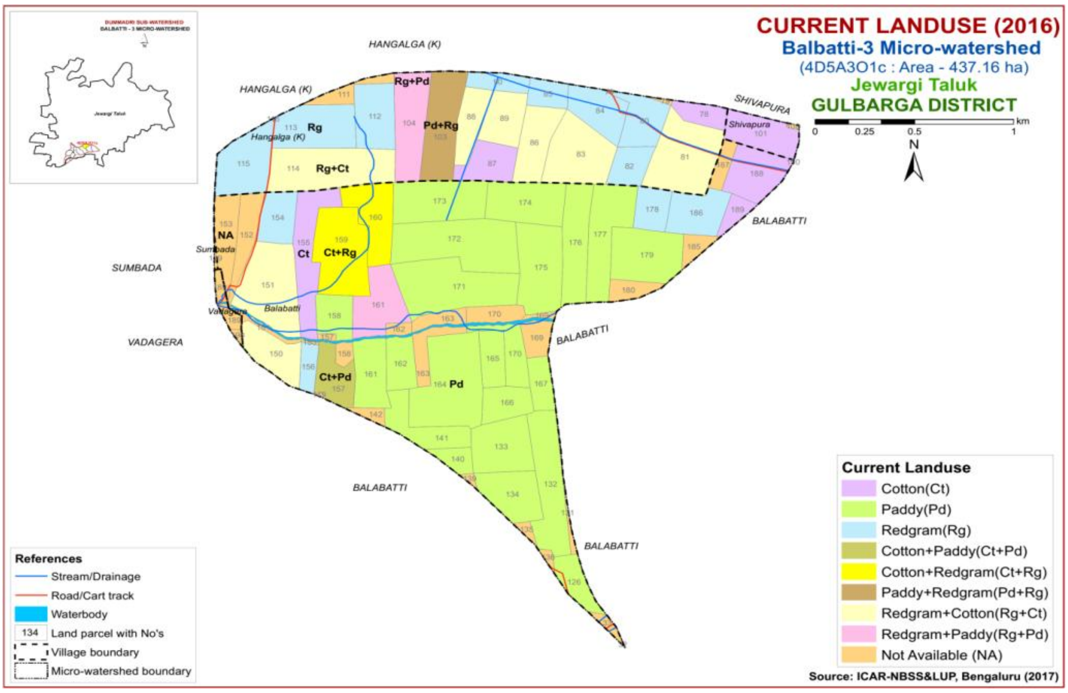



Fig.2.5 Current Land Use – Balbatti-3 Microwatershed

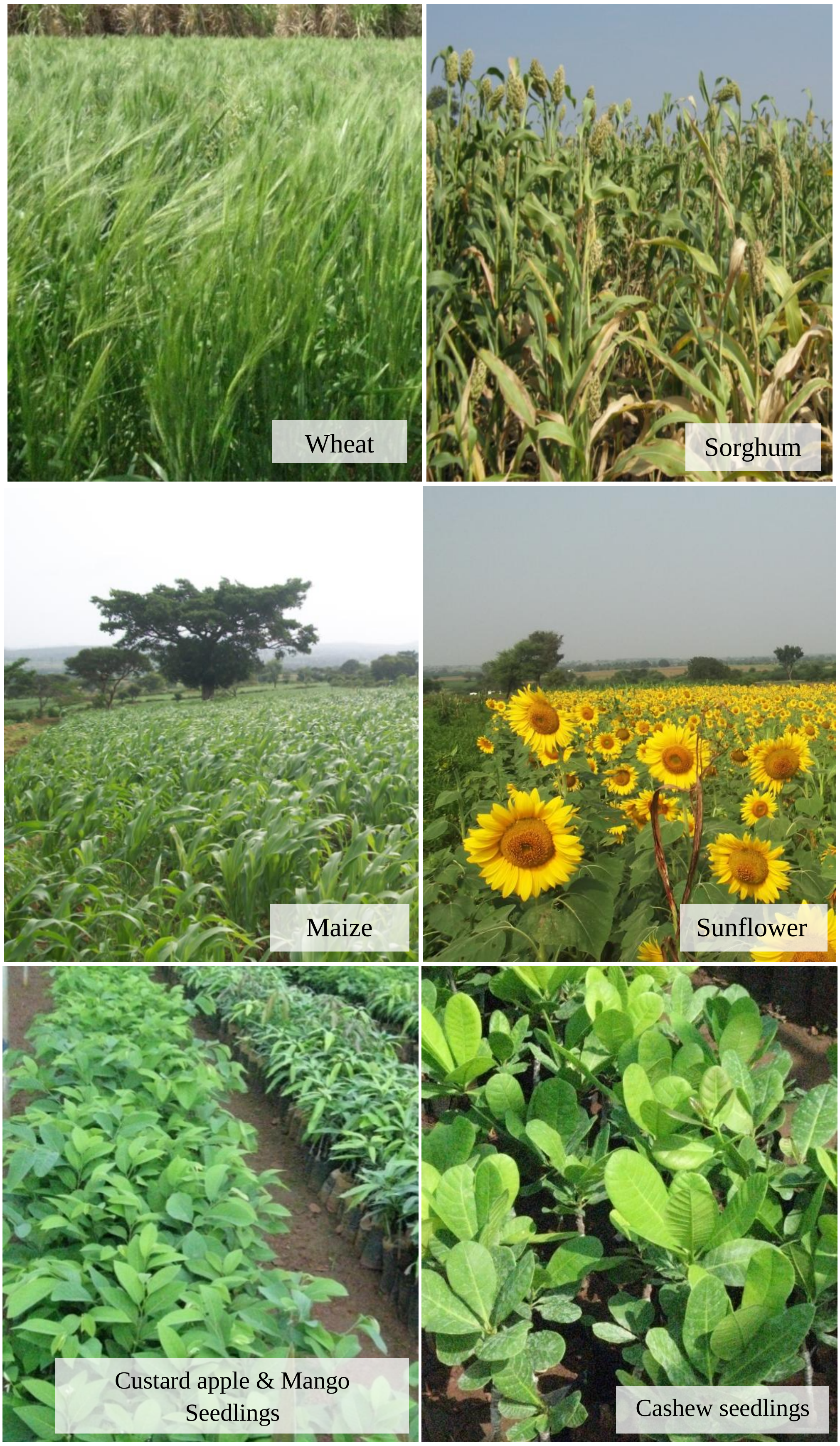



Fig.2.6 Different crops and cropping systems in Balabtti-3 Microwatershed

*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 Balbatti-3 microwatershed by the detailed study of all the soil characteristics (depth, texture, colour, structure, consistence, coarse fragments, porosity, soil reaction, soil horizons etc.), and site characteristics (slope of the land, erosion, drainage, occurrence of rock fragments etc.) and followed by grouping of similar areas based on soil-site characteristics into homogeneous (management units) units, and showing their area extent and geographic distribution on the microwatershed cadastral map. The detailed survey at 1:7920 scale was carried out in an area of 437 ha. The methodology followed for carrying out land resource inventory was as per the guidelines given in Soil Survey Manual (IARI, 1971; Soil Survey Staff, 2006; Natarajan *et al.,* 2015) which is briefly described below.

## 3.1 Base Maps

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

## 3.2 Image Interpretation for Physiography

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

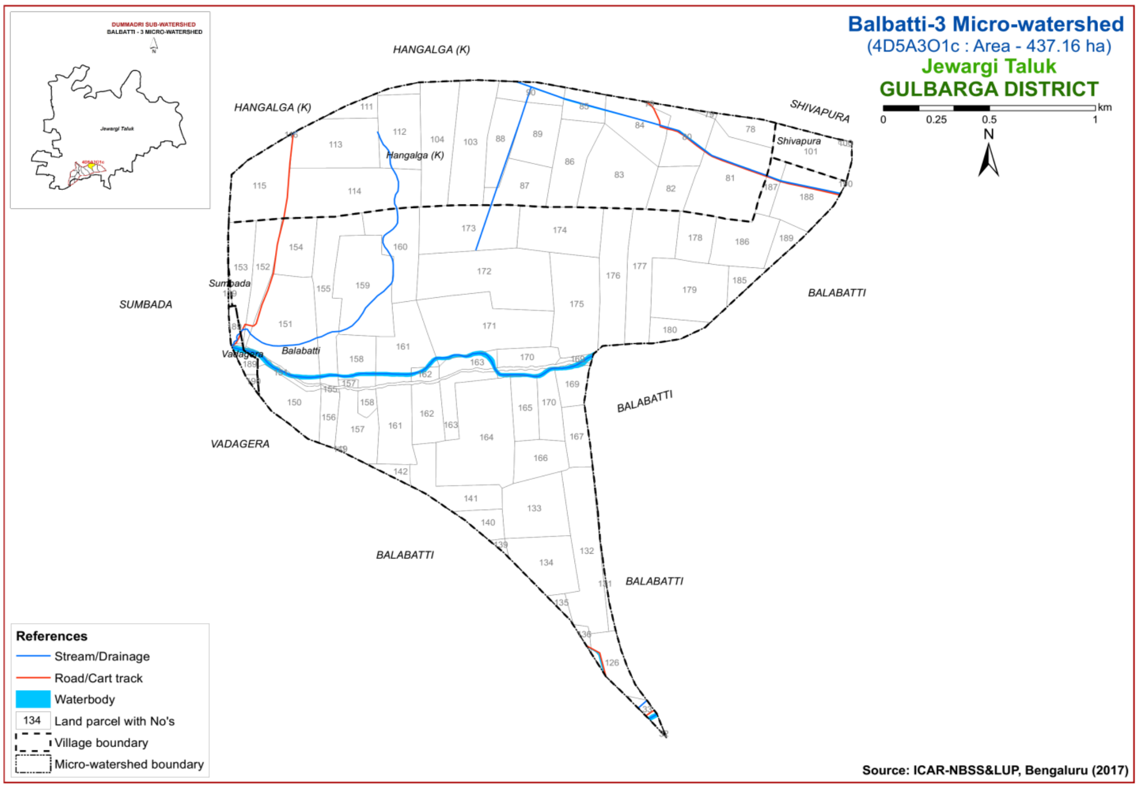



Fig 3.1 Scanned and Digitized Cadastral map of Balbatti-3 Microwatershed

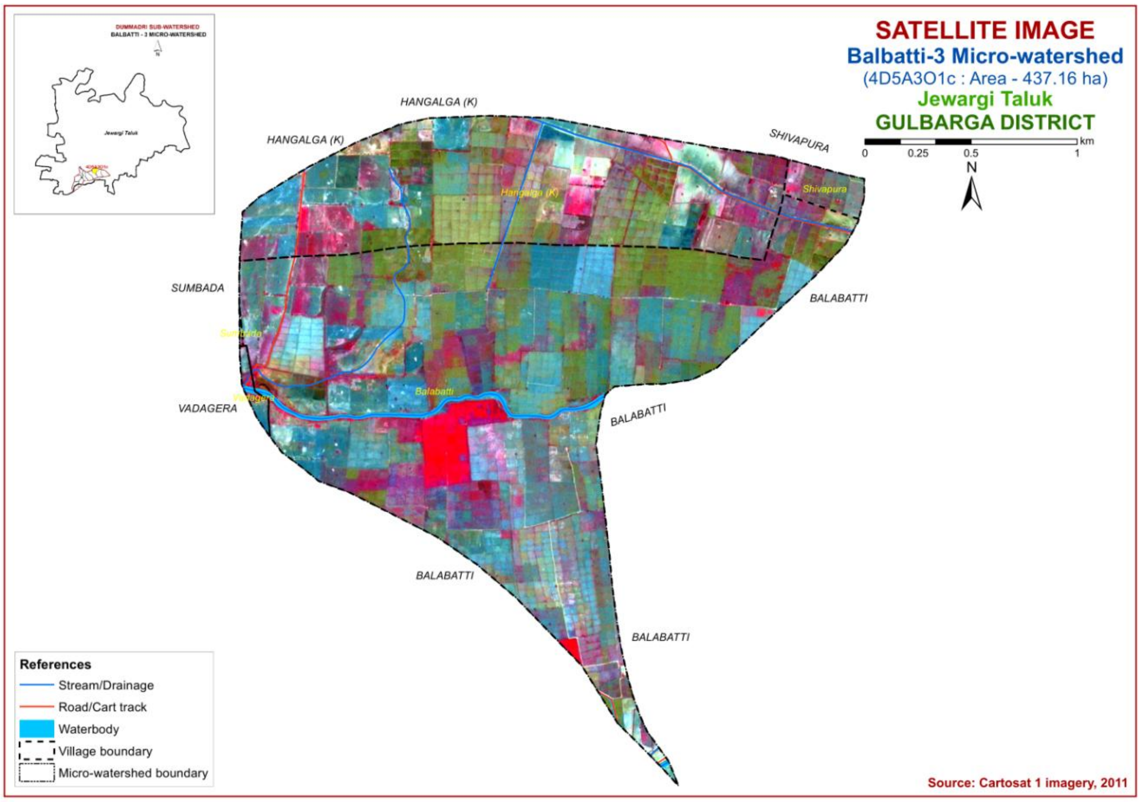



Fig.3.2 Satellite Image of Balbatti-3 Microwatershed

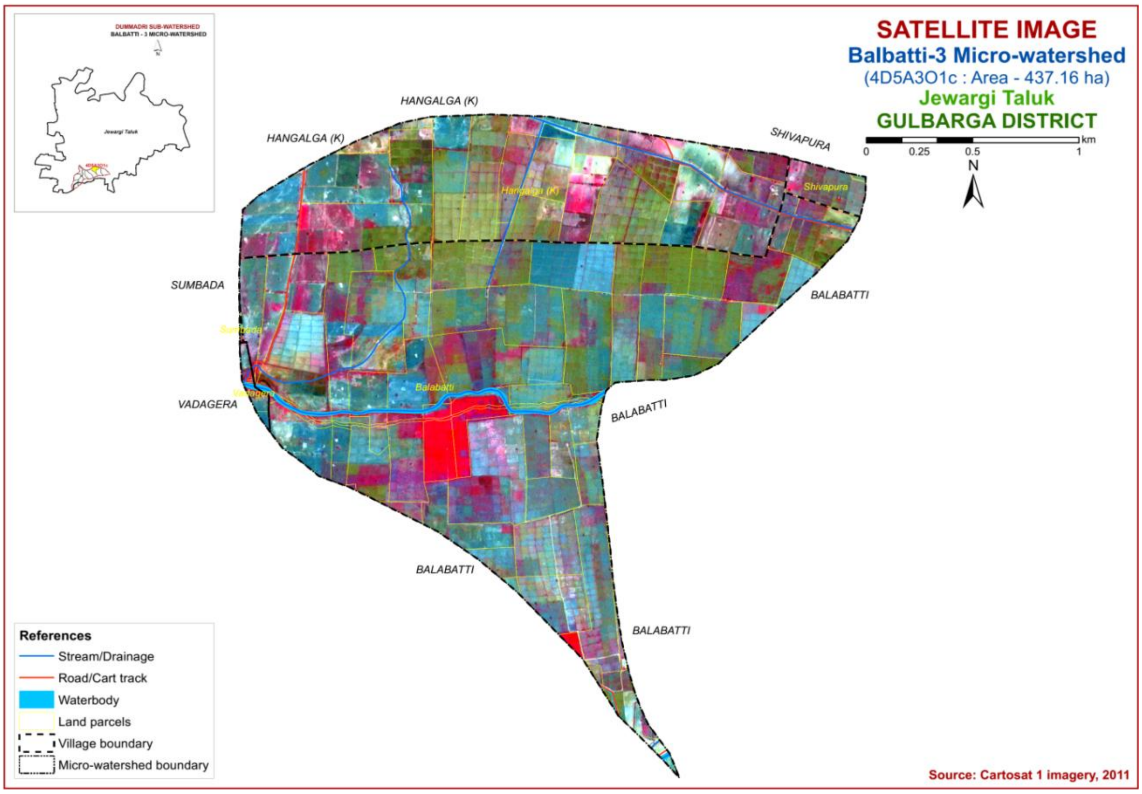



Fig.3.3 Cadastral map overlaid on IRS PAN+LISS IV merged imagery of Balbatti-3 Microwatershed

### 3.3 Field Investigation

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

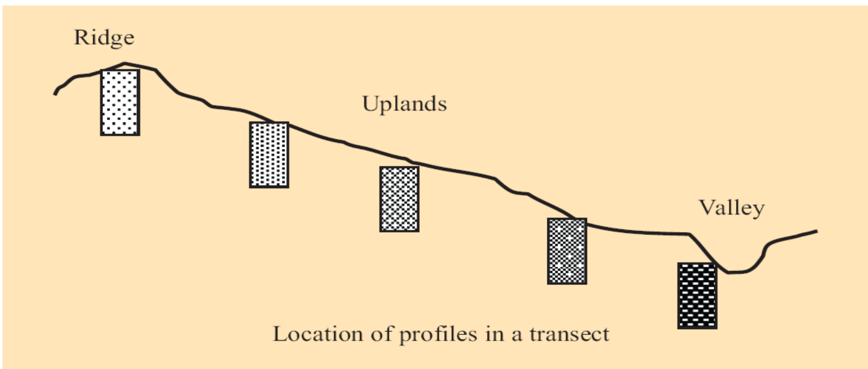



Fig: 3.4. Location of profiles in a transect

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

Based on the soil characteristics, the soils were grouped into different soil series. Soil series is the most homogeneous unit having similar horizons and properties and behaves similarly for a given level of management. Soil depth, texture, colour, kind of horizon and horizon sequence, amount and nature of gravel present, calcareousness, nature of substratum etc, were used as the major differentiating characteristics for identifying soil series occurring in the area. The differentiating characteristics used for identifying the soil series are given in Table 3.1. Based on the above characteristics, 5 soil series were identified in the Balbatti-3 microwatershed.

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

| Sl. No | Soil Series | Depth (cm) | Colour (moist) | Texture | Gravel (%) | Horizon sequence | Calcareo-usness |
|---|---|---|---|---|---|---|---|
| **Soils of Basalat Landscape** | | | | | | | |
| 1 | Margutti (MGT) | <25 | 10YR3/3,4/3,5/4 7.5YR4/3 | c | 15-35 | Ap-R/cr | - |
| 2 | Novinihala (NHA) | 25-50 | 10YR3/2,3/1,4/2 7.5YR3/4 | cl | 15-35 | Ap-Bw-cr/R | - |
| **Soils of Shale Landscape** | | | | | | | |
| 3. | Sumbda (SBD) | 25-50 | 10YR3/2,3/3 5/3,4/6 | c | <15 | Ap-ck | |
| 4. | Balbatti (BBT) | 100-150 | 10YR3/2, 3/3 4/4,3/1,2/2,2/1 | c | <15 | Ap-Bw | e-es |
| 5. | Yedrami (YDM) | >150 | 10YR3/2,3/3,3/1 4/4,4/6,4/3, 2/2, 2/1 | c | <15 | Ap-BW | e-es |

## 3.4 Soil mapping

The area under each soil series was further separated into soil phases and their boundaries delineated on the cadastral map based on the variations observed in the texture of the surface soil, slope, erosion, presence of gravel, stoniness etc. A soil phase is a subdivision of soil series based mostly on surface features that affect its use and management. The 10 soil mapping units identified and mapped are shown on the map (Fig.3.5) in the form of symbols. During the survey about 12 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 10 mapping units representing 5 soil series occurring in the microwatershed. The soil map unit (soil legend) description is presented in Table 3.2.The soil phase map (management units) shows the distribution of 10 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 10 soil phases identified and mapped in the microwatershed were regrouped into 3 Land Use Classes (LUCs) 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 choosen for identification and delineation of LUCs. For Balbatti-3 microwatershed, five soil and site characteristics, namely soil depth, soil texture, slope, erosion and gravel content have been considered for defining LUCs. The land management units are expected to behave similarly for a given level of management.

### 3.5 Laboratory Characterization

Soil samples were collected from representative master profiles for laboratory characterization by following the methods outlined in the Laboratory Manual (Sarma *et al*, 1987). 29 surface soil samples out of 69 samples marked for collection were collected from farmers fields for fertility status in the year 2016 (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 for the microwatershed.

**Table 3.2 Soil Map Unit Description of Balbatti-3 Microwatershed**

| Soil map unit no. | Soil series | Soil phase | Mapping Unit Description | Area in ha (%) |
|---|---|---|---|---|
| **Soils of Basalt Landscape** | | | | |
| | MGT | Marguti soils are very shallow (<25 cm), well drained. have very dark grayish brown to dark brown, clayey soils occuring on very gently sloping to moderately sloping uplands | | **0.21 (0.05)** |
| 1 | | MGTmD3g2 | Clay surface, 5-10 % slope, severe erosion, very gravelly (60-80 %) | 0.21 (0.05) |
| | NHA | Novinihala soils are shallow (25-50 cm), well drained. have very dark grayish brown to dark brown clay loam soils and occuring on nearly level to very gently sloping and moderately sloping uplands | | **54 (12.34)** |
| 2 | | NHAmA1 | Clay surface, 0-1% slope, slight erosion | 22(4.93) |
| 3 | | NHAmB1 | Clay surface, 1-3% slope, slight erosion | 32(7.41) |
| **Soils of Shales Landscape** | | | | |
| | SBD | Sumbda soils are shallow (25-50 cm), well drained, have very dark grayish brown to dark reddish brown clayey soils occuring on very gently sloping uplands | | **14 (3.29)** |
| 4 | | SBDmB1 | Clay surface, 1-3% slope, slight erosion | 13(3.02) |
| 5 | | SBDmB2 | Clay surface, 1-3% slope, moderate erosion | 1(0.27) |
| | BBT | Balbatti soils are deep (100-150 cm), moderately well drained. have very very dark gray to dark reddish brown calcareous, cracking clay brown soils, occuring on very gently sloping uplands | | **214 (48.95)** |
| 6 | | BBTmB1 | Clay surface, 1-3% slope, slight erosion | 115(26.28) |
| 7 | | BBTmB2 | Clay surface, 1-3% slope, moderate erosion | 99(22.67) |
| | YDM | Yedrami soils are deep (100-150 cm), moderately well drained have very very dark gray to dark reddish brown calcareous cracking clay soils and occur on nearly level to very gently sloping uplands | | **149 (34.18)** |
| 8 | | YDMmA1 | Clay surface, 0-1% slope, slight erosion | 22(4.98) |
| 9 | | YDMmB1 | Clay surface, 1-3% slope, slight erosion | 117(26.86) |
| 10 | | YDMmB2 | Clay surface, 1-3% slope, moderate erosion | 10(2.34) |
| 11 | | Others | Habitation & Waterbody | 5(1.19) |

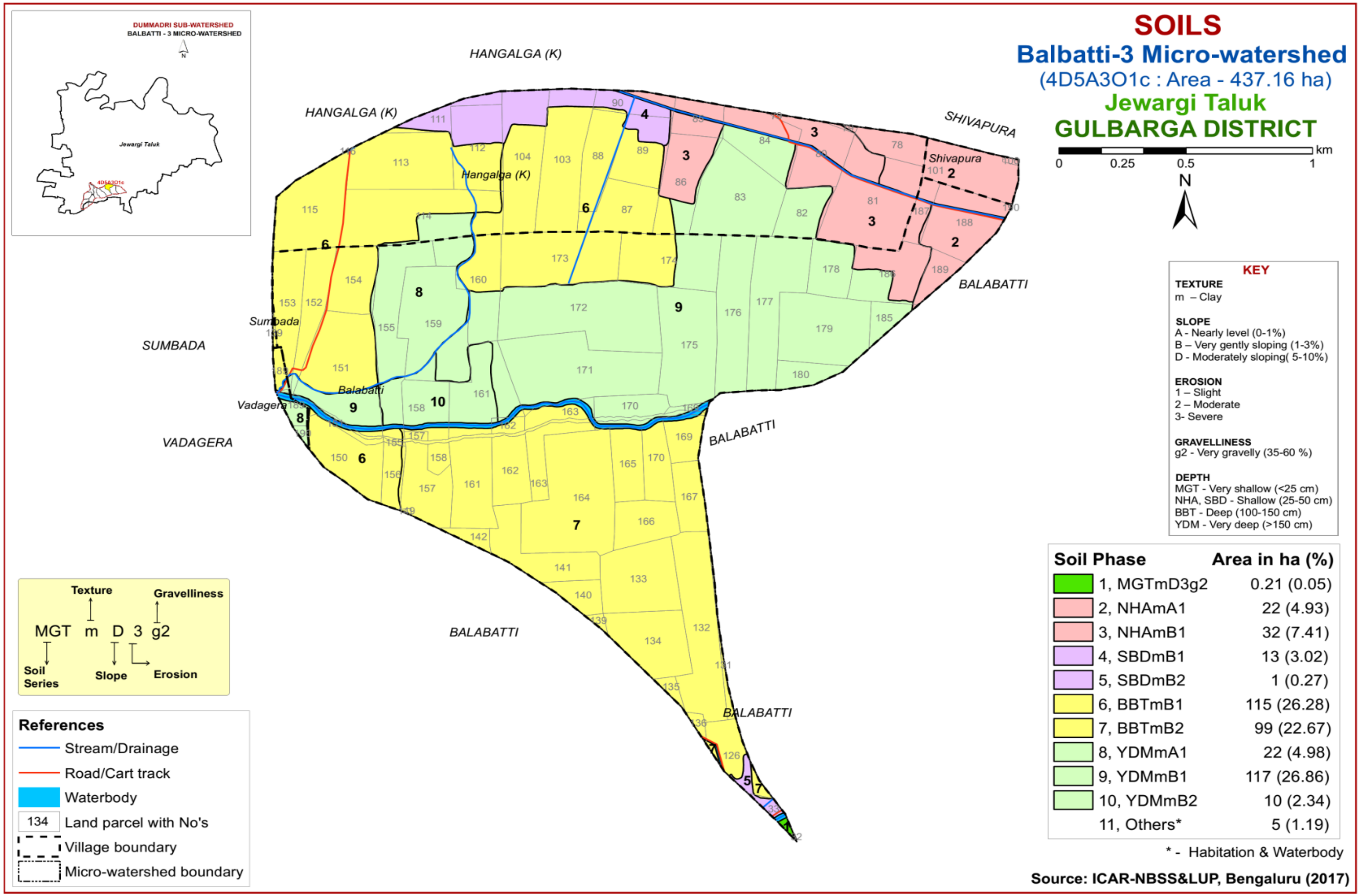



Fig 3.5 Soil Phase or Management Units - Balbatti-3 Microwatershed

*Chapter 4*

# THE SOILS

Detailed information pertaining to the nature, extent and distribution of different kinds of soils occurring in Balbatti-3 microwatershed is provided in this chapter. The microwatershed area has been identified as basalt and shales landscapes based on geology. In all, 5 soil series are identified. Soil formation is the result of the combined effect of environmental and terrain factors that are reflected in soil morphology. Soil formation is dominantly influenced by the parent material, climate and relief.

A brief description of each of the 5 soil series identified followed by 10 soil phases (management units) mapped (Fig. 3.5) are furnished below. The physical and chemical characteristics of soil series identified in Balbatti-3 microwatershed is given in Table 4.1. The soils in any one map unit differ from place to place in their depth, texture, slope, gravelliness, erosion or any other site characteristics that affect management. The soil phase map can be used for identifying the suitability of areas for growing specific crops or for other alternative uses and also for deciding the type of conservation structures needed. The detailed information on soil and site-characteristics like soil depth, surface soil texture, slope, erosion, gravelliness, AWC, LCC etc, with respect to each of the soil phase identified is given village/survey number wise for the microwatershed in Appendix-I.

## 4.1 Soils of Basalt Landscape

In this landscape, 2 soil series are identified and mapped. Brief description of each series and number of phases identified are given below. Of these, Novinahala (NHA) series occupy 54 ha (12%) and Margutti (MGT) series occupies very small area of about 0.21 ha (0.05%) in the microwatershed.

**4.1.1 Margutti (MGT) Series:** Marguti soils are very shallow (<25cm), well drained, have very dark grayish brown to dark brown clay soils. They have developed from basalt and occur on very gently sloping to moderately sloping uplands. Margutti series has been classified as clayey, mixed, isohyperthemic, family of (Paralithic) Ustorthents.

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


Landscape and Soil Profile characteristics of Marguti (MGT) Series

**4.1.2 Novanihala (NHA) Series:** Novinihala soils are shallow (25-50 cm), well drained, have very dark grayish brown to dark brown clay loam soils. They have developed from basalt and occur on very gently sloping uplands. Novinihala series has been classified as clayey, mixed, isohyperthemic, family of (Paralithic) Haplustepts.

The thickness of the solum ranges from 27 to 50 cm. The thickness of A horizon ranges from 12 to 20 cm. Its colour is in 7.5 YR and 10 YR hue with value 3 to 4 and chroma 2 to 4. The texture varies from sandy clay to clay with 10 to 20 per cent gravel. The thickness of B horizon ranges from 22 to 37 cm. Its colour is in 10 YR and 7.5 YR hue with value 3 to 4 and chroma 2 to 4. Its texture is clay loam with gravel content of 10-15 per cent. The available water capacity is low (51-100 mm/m). Two phases were identified and mapped.


Landscape and Soil Profile characteristics of Novinihala (NHA) Series

**4.2 Soils of Shale landscape**

In this landscape, 3 soil series are identified and mapped. Brief description of each series and their phases identified are given below. Of these, Balbatti (BBT) series occupies major area of 214 ha (49%), Yedrami (YDM) 149 ha 34% and Sumbda (SBD) 14 ha (3%) area in the microwatershed.

**4.2.1 Sumbda (SBD) Series:** Sumbda soils are shallow (25-50 cm), well drained. have very dark grayish brown to dark reddish brown clayey soils. They have developed from shale and occur on very gently sloping uplands. Sumbda series has been classified as clayey, mixed, isohyperthermic (calcareous), family of (Paralithic) Ustorthents.

The thickness of the soil ranges from 26 to 48 cm. The thickness of A horizon ranges from 10 to 19 cm. Its colour is in 7.5 YR and 10 YR hue with value 3 to 4 and chroma 2 to 4. The texture is clay. The thickness of subsoil horizons ranges from 26 to 37 cm. Its colour is in 10 YR hue with value 3 to 5 and chroma 2 to 6. Its texture is clay with gravel content of <15 per cent. The available water capacity is low (51-100 mm/m). Two phases were identified and mapped.

Landscape and Soil Profile characteristics of Sumbda (SBD) Series

**4.2.2 Balbatti Series (BBT):** Balbatti soils are deep (100-150 cm), moderately well drained. have very very dark gray to dark reddish brown calcareous cracking clay soils. They have developed from shale and occur on very gently sloping uplands. Balbatti series has been classified as fine, smectitic, isohyperthermic (calcareous), family of Vertic Haplustepts.

The thickness of the solum ranges from 125 to 140 cm. The thickness of A horizon ranges from 14 to 23 cm. Its colour is in 10 YR hue with value 3 and chroma 2. The texture is clay with no gravel. The thickness of B horizon ranges from 85 to 130 cm. Its colour is in 10 YR hue with value 3 to 4 and chroma 1 to 2. Its texture is clay with gravel content of less than 15 per cent. The available water capacity is very high (>200 mm/m). Two phases were identified and mapped.

Landscape and Soil Profile characteristics of Balbatti (BBT) Series

**4.2.3 Yedrami (YDM) Series:** Yedrami soils are deep (100-150 cm), moderately well drained, have very very dark gray to dark reddish brown calcareous cracking clay soils. They have developed from shale and occur on nearly level to very gently sloping uplands. Yedrami series has been classified as fine, mixed, isohyperthermic (calcareous) family of Typic Haplustepts.

The thickness of the solum ranges from 125 to 140 cm. The thickness of A horizon ranges from 14 to 23 cm. Its colour is in 10 YR hue with value 3 to 4 and chroma 1 to 2. The texture is clay. The thickness of B horizon ranges from 85 to 130 cm. Its colour is in 10 YR hue with value 2 to 4 and chroma 1 to 6. Its texture is clay with gravel content of less than 15 per cent. The available water capacity is very high (>200 mm/m). Three phases were identified and mapped.

Landscape and Soil Profile characteristics of Yedrami (YDM) Series

**Table 4.1 The physical and chemical characteristics of soil series identified in Balbatti-3 microwatershed**

**Series Name:** Marguti (MGT), **Pedon:** $T_2$/P1

**Location:** $17^0$62'72.3."N, $77^0$04'48.3"E, (4D5B7G1b), Marguthi village, Kalaburagi taluk and district

**Analysis at:** NBSS&LUP, Regional Centre, Bangalore. **Classification:** Clayey, mixed, isohyperthemic, (Paralithic) Ustorthents

| Depth (cm) | Horizon | Size class and particle diameter (mm) | | | | | | | | Coarse fragments w/w (%) | Texture Class (USDA) | % Moisture | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total | | | Sand | | | | | | | | |
| | | Sand (2.0-0.05) | Silt (0.05-0.002) | Clay (<0.002) | Very coarse (2.0-1.0) | Coarse (1.0-0.5) | Medium (0.5-0.25) | Fine (0.25-0.1) | Very fine (0.1-0.05) | | | 1/3 Bar | 15 Bar |
| 0-15 | Ap | 10.68 | 31.06 | 58.26 | 1.54 | 1.43 | 2.86 | 2.09 | 2.75 | 20 | c | - | - |
| 15-25 | AC | 38.07 | 20.72 | 41.21 | 8.17 | 11.31 | 7.95 | 6.27 | 4.37 | 80 | c | - | - |

| Depth (cm) | pH (1:2.5) | | | E.C. (1:2.5) | O.C. | $CaCO_3$ | Exchangeable bases | | | | | CEC | CEC/Clay | Base saturation | ESP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Ca | Mg | K | Na | Total | | | | |
| | Water | $CaCl_2$ | M KCl | dS $m^{-1}$ | % | % | cmol $kg^{-1}$ | | | | | | | % | % |
| 0-15 | 6.83 | - | - | 0.27 | 0.85 | 3.72 | - | - | 0.66 | 0.09 | - | 46.27 | 0.79 | 100 | 0.18 |
| 15-25 | 7.41 | - | - | 0.11 | 0.42 | 3.42 | - | - | 0.27 | 0.24 | - | 46.37 | 1.13 | 100 | 0.52 |

**Series Name:** Novinihala (NHA), **Pedon:** $T_2$/P2

**Location:** $17^0$60'34.5"N, $77^0$01'46.8"E, (4D5B8K1d), Kamalapur Tanda village, Kalaburagi taluk and district

**Analysis at:** NBSS&LUP, Regional Centre, Bangalore. **Classification:** Clayey, mixed, isohyperthemic, (paralithic) Haplustepts

| Depth (cm) | Horizon | Size class and particle diameter (mm) | | | | | | | | Coarse fragments w/w (%) | Texture Class (USDA) | % Moisture | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total | | | Sand | | | | | | | | |
| | | Sand (2.0-0.05) | Silt (0.05-0.002) | Clay (<0.002) | Very coarse (2.0-1.0) | Coarse (1.0-0.5) | Medium (0.5-0.25) | Fine (0.25-0.1) | Very fine (0.1-0.05) | | | 1/3 Bar | 15 Bar |
| 0-15 | Ap | 52.62 | 26.66 | 20.72 | 16.27 | 12.99 | 6.33 | 7.10 | 9.93 | 10 | scl | - | - |
| 15-40 | Bw | 41.84 | 21.29 | 36.87 | 14.06 | 9.79 | 5.74 | 5.74 | 6.52 | 20 | cl | - | - |

| Depth (cm) | pH (1:2.5) | | | E.C. (1:2.5) | O.C. | $CaCO_3$ | Exchangeable bases | | | | | CEC | CEC/Clay | Base saturation | ESP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Ca | Mg | K | Na | Total | | | | |
| | Water | $CaCl_2$ | M KCl | dS $m^{-1}$ | % | % | cmol $kg^{-1}$ | | | | | | | % | % |
| 0-15 | 7.09 | - | - | 0.11 | 0.70 | 0.00 | 18.96 | 9.75 | 0.08 | 0.06 | 28.85 | 30.55 | 1.47 | 94 | 0.20 |
| 15-40 | 7.79 | - | - | 0.05 | 0.66 | 0.00 | 27.56 | 14.20 | 0.09 | 0.32 | 42.18 | 48.11 | 1.30 | 88 | 0.67 |

**Series Name:** Sumbda (SBD), **Pedon:** T3/P2

**Location:** 16$^0$50'22.4"N, 76$^0$33'35.3"E (4D5A3O1e) Vadagera village, Jewargi taluk, Gulbarga district

**Analysis at:** NBSS&LUP, Regional Centre, Bangalore. **Classification:** Clayey, mixed, isohyperthermic (calcareous), (Paralithic) Ustorthents

| Depth (cm) | Horizon | Size class and particle diameter (mm) | | | | | | | | Coarse fragments w/w (%) | Texture Class (USDA) | % Moisture | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total | | | Sand | | | | | | | | |
| | | Sand (2.0-0.05) | Silt (0.05-0.002) | Clay (<0.002) | Very coarse (2.0-1.0) | Coarse (1.0-0.5) | Medium (0.5-0.25) | Fine (0.25-0.1) | Very fine (0.1-0.05) | | | 1/3 Bar | 15 Bar |
| 0-10 | Ap | 9.97 | 39.42 | 50.61 | 2.97 | 2.65 | 1.27 | 1.59 | 1.48 | - | c | - | - |
| 10-40 | AB | 11.88 | 37.63 | 50.48 | 4.07 | 2.89 | 1.61 | 1.50 | 1.82 | - | c | - | - |

| Depth (cm) | pH (1:2.5) | | | E.C. (1:2.5) | O.C. | $CaCO_3$ | Exchangeable bases | | | | | CEC | CEC/Clay | Base saturation | ESP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Ca | Mg | K | Na | Total | | | | |
| | Water | $CaCl_2$ | M KCl | dS $m^{-1}$ | % | % | cmol $kg^{-1}$ | | | | | | | % | % |
| 0-10 | 8.1 | - | - | 0.855 | 0.67 | 22.2 | - | - | 0.65 | 2.06 | - | 37.8 | 0.75 | 100.00 | 5.44 |
| 10-40 | 8.7 | - | - | 0.281 | 0.47 | 21.03 | - | - | 0.51 | 1.33 | - | 39.42 | 0.78 | 100.00 | 3.38 |

**Series Name:** Balbatti (BBT), **Pedon:** T4/P1

**Location:** $16^0$46’44.3”N, $76^0$34’53.0”E (4D5A3O1e) Vadagera village, Jewargi taluk, Gulbarga district

**Analysis at:** NBSS&LUP, Regional Centre, Bangalore. **Classification:** Fine, smectitic, isohyperthermic (calcareous), Vertic Haplustepts

| Depth (cm) | Horizon | Size class and particle diameter (mm) | | | | | | | | Coarse fragments w/w (%) | Texture Class (USDA) | % Moisture | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total | | | Sand | | | | | | | | |
| | | Sand (2.0-0.05) | Silt (0.05-0.002) | Clay (<0.002) | Very coarse (2.0-1.0) | Coarse (1.0-0.5) | Medium (0.5-0.25) | Fine (0.25-0.1) | Very fine (0.1-0.05) | | | 1/3 Bar | 15 Bar |
| 0-9 | Ap | 6.30 | 37.86 | 55.84 | 1.17 | 1.49 | 1.07 | 1.28 | 1.28 | - | c | - | - |
| 9-28 | AB | 13.38 | 34.29 | 52.33 | 4.82 | 3.43 | 2.03 | 1.71 | 1.39 | - | c | - | - |
| 28-83 | Bw1 | 10.43 | 33.31 | 56.26 | 2.90 | 3.12 | 1.61 | 1.72 | 1.08 | - | c | - | - |
| 83-118 | BW2 | 10.09 | 33.15 | 56.76 | 3.97 | 2.68 | 1.29 | 1.18 | 0.97 | - | c | - | - |

| Depth (cm) | pH (1:2.5) | | | E.C. (1:2.5) | O.C. | $CaCO_3$ | Exchangeable bases | | | | | CEC | CEC/Clay | Base saturation | ESP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Ca | Mg | K | Na | Total | | | | |
| | Water | $CaCl_2$ | M KCl | dS $m^{-1}$ | % | % | cmol $kg^{-1}$ | | | | | | | % | % |
| 0-9 | 8.06 | - | - | 0.612 | 1.26 | 16.45 | - | - | 1.01 | 1.02 | - | 49.68 | 0.89 | 100.00 | 2.06 |
| 9-28 | 8.35 | - | - | 0.358 | 1.18 | 19.5 | - | - | 0.74 | 1.15 | - | 42.98 | 0.82 | 100.00 | 2.68 |
| 28-83 | 8.53 | - | - | 0.2 | 0.67 | 19.27 | - | - | 0.52 | 0.96 | - | 44.28 | 0.79 | 100.00 | 2.17 |
| 83-118 | 8.55 | - | - | 0.196 | 0.47 | 20.32 | - | - | 0.54 | 0.63 | - | 43.74 | 0.77 | 100.00 | 1.44 |

**Series Name:** Yedrami (YDM), **Pedon: T2/P3**

**Location:** 16$^0$47'41.3"N 76$^0$33'21.6"E, (4D5A3O1e) Vadagera village, Jewargi taluk, Gulbarga district

**Analysis at:** NBSS&LUP, Regional Centre, Bangalore. **Classification:** Fine, mixed, isohyperthermic (calcareous), Typic Haplustepts

| Depth (cm) | Horizon | Size class and particle diameter (mm) | | | | | | | | Coarse fragments w/w (%) | Texture Class (USDA) | % Moisture | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total | | | Sand | | | | | | | | |
| | | Sand (2.0-0.05) | Silt (0.05-0.002) | Clay (<0.002) | Very coarse (2.0-1.0) | Coarse (1.0-0.5) | Medium (0.5-0.25) | Fine (0.25-0.1) | Very fine (0.1-0.05) | | | 1/3 Bar | 15 Bar |
| 0-10 | Ap | 19.06 | 31.08 | 49.87 | 6.53 | 4.28 | 2.25 | 2.36 | 3.64 | - | c | - | - |
| 10-45 | Bw1 | 18.93 | 30.39 | 50.68 | 7.07 | 4.24 | 2.07 | 2.18 | 3.37 | - | c | - | - |
| 45-93 | Bw2 | 20.00 | 32.76 | 47.24 | 3.68 | 2.27 | 2.59 | 5.30 | 6.16 | - | c | - | - |
| 93-155 | Bc | 58.67 | 18.04 | 23.29 | 15.58 | 12.88 | 10.18 | 13.19 | 6.85 | - | scl | - | - |

| Depth (cm) | pH (1:2.5) | | | E.C. (1:2.5) | O.C. | $CaCO_3$ | Exchangeable bases | | | | | CEC | CEC/Clay | Base saturation | ESP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Ca | Mg | K | Na | Total | | | | |
| | Water | $CaCl_2$ | M KCl | dS $m^{-1}$ | % | % | cmol $kg^{-1}$ | | | | | | | % | % |
| 0-10 | 8.68 | - | - | 0.219 | 0.63 | 16.45 | - | - | 1.25 | 1.09 | - | 50.76 | 1.02 | 100.00 | 2.15 |
| 10-45 | 8.54 | - | - | 0.177 | 0.47 | 13.04 | - | - | 0.49 | 0.20 | - | 48.17 | 0.95 | 100.00 | 0.42 |
| 45-93 | 8.64 | - | - | 0.205 | 0.43 | 12.1 | - | - | 0.43 | 0.88 | - | 45.36 | 0.96 | 100.00 | 1.94 |
| 93-155 | 8.76 | - | - | 0.203 | 0.23 | 13.20 | - | - | 0.22 | 0.62 | - | 26.57 | 1.14 | 100.00 | 2.32 |

*Chapter 5*

# INTERPRETATION FOR LAND RESOURCE MANAGEMENT

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

## 5.1 Land Capability Classification

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

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

*Land characteristics*: Slope, erosion, drainage, rock outcrops.

*Climate:* Total rainfall and its distribution, and length of crop growing period.

The land capability classification system is divided into land capability classes, subclasses and units based on the level of information available. Eight land capability classes are recognized. They are

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

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

*Class III*:They are moderately good lands that have 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. The 10 soil map units identified in the Balbatti-3 microwatershed are grouped under 3 land capability classes and 4 land capability subclasses. About 99% area in the microwatershed is suitable for agriculture and a very small area of one per cent is under habitation and waterbodies (Fig. 5.1). Good cultivable lands (Class II) cover a maximum area of about 83 per cent area and are distributed in all parts of the micowatershed with minor problems of soil and erosion. The fairly good cultivable lands (Class IV) cover a very small area of about 16 per cent. They have severe limitations of soil and are distributed in the northern part of the microwatershed.

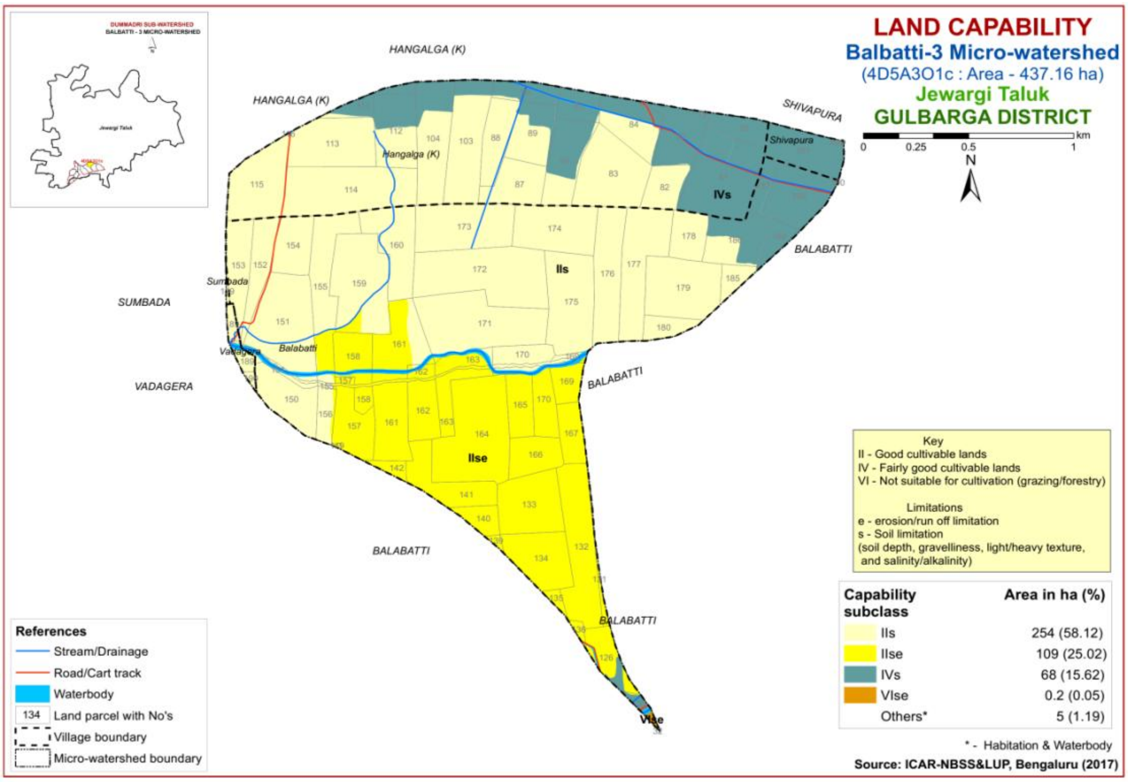


Fig. 5.1 Land Capability map of Balbatti-3 Microwatershed

## 5.2 Soil Depth

Soil depth refers to the depth of the soil occurring above the parent material or hard rock. The depth of the soil determines the effective rooting depth for plants and in accordance with soil texture, mineralogy and gravel content, the capacity of the soil column to hold water and nutrient availability. Soil depth is one of the most important soil characteristic that is used in differentiating soils into different soil series. The soil depth classes used in identifying soils in the field are very shallow (<25 cm), shallow (25-50 cm), moderately shallow (50-75 cm), moderately deep (75-100 cm), deep (100-150 cm) and very deep (>150 cm). They were used to classify the soils into different depth classes and a soil depth map was generated. The area extent and their geographical distribution in the microwatershed is shown in Figure 5.2. Shallow soils (25-50 cm) cover an area of about 68 ha (16%) and occur in the northern part of the microwatershed. Very deep (>150 cm) soils cover an area of 149 ha (34%) and are distributed in the central part of the microwatershed. Deep soils cover a maximum area of about 214 ha (49%) area and are distributed in the northern and southern part of the microwatershed.

The most productive lands covering 363 ha (83%) with respect to soil rooting depth where all climatically adapted annual and perennial crops can be grown are very deep (>150 cm) and deep (100-150 cm) occurring in major part of the microwatershed. The most problem lands with an area of about 68 ha (16%) having shallow (25-50 cm) rooting depth occur in the northern part of the microwatershed. They are not suitable for growing agricultural crops but well suited for pasture, forestry or other recreational purposes. Occasionally, short duration crops may be grown if rainfall is normal.

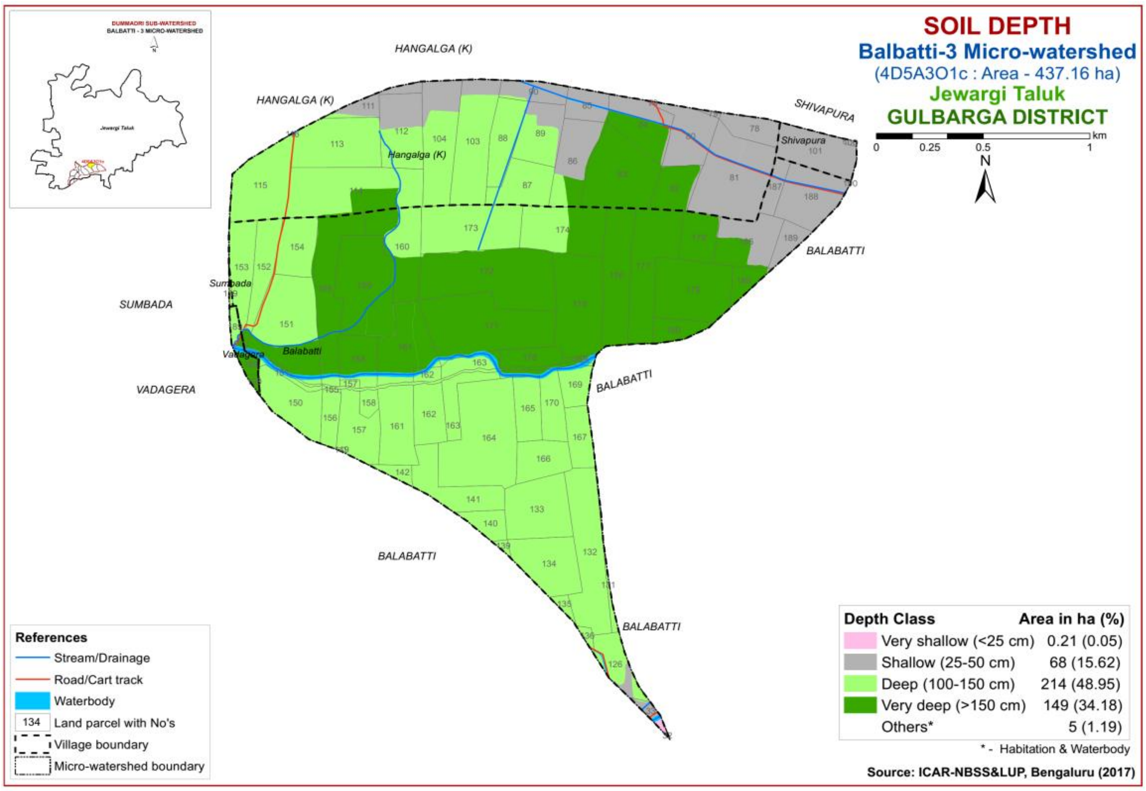



Fig. 5.2 Soil Depth map of Balbatti-3 Microwatershed

## 5.3 Surface Soil Texture

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

The entire area in the microwatershed is clayey at surface (Fig. 5.3). The most productive lands (99%) with respect to surface soil texture are the clayey soils that have high potential for soil-water retention and availability, and nutrient retention and availability, but have problems of drainage, infiltration, workability and other physical problems.

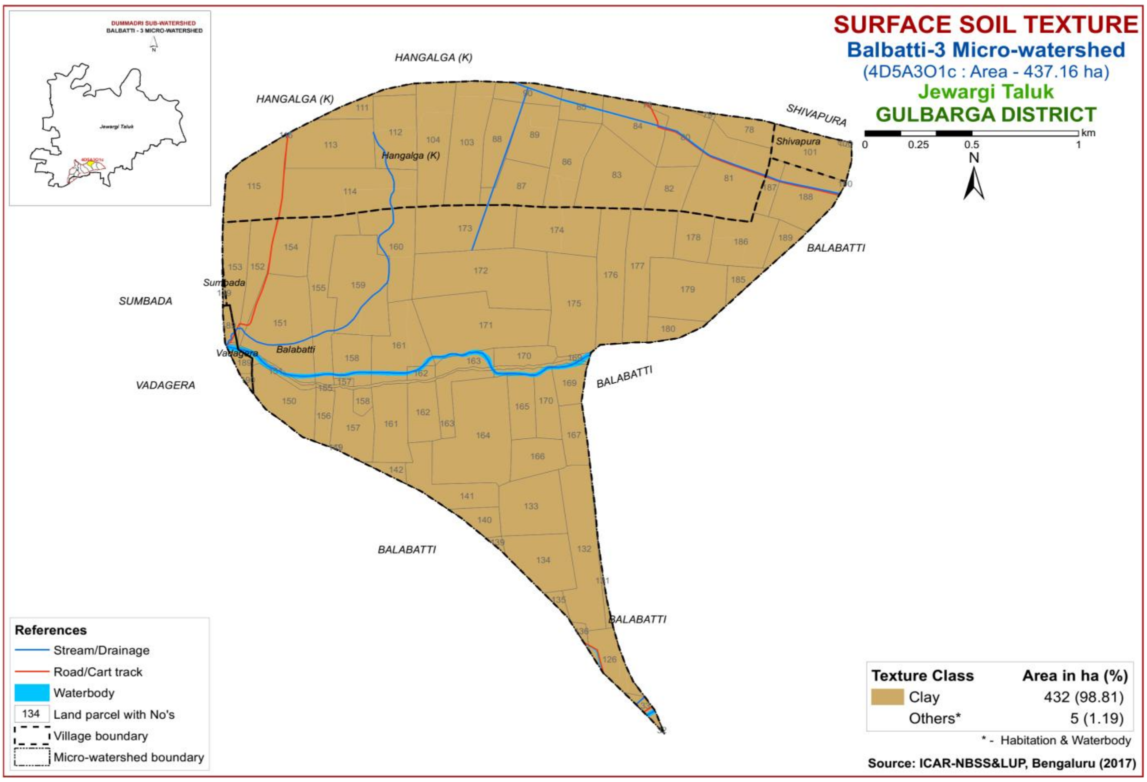



Fig. 5.3 Surface Soil Texture map of Balbatti-3 Microwatershed

## 5.4 Soil Gravelliness

Gravel is the term used for describing coarse fragments between 2 mm and 7.5 cm diameter and stones for those between 7.5 cm and 25 cm. The presence of gravel and stones in soil reduces the volume of soil responsible for moisture and nutrient storage, drainage, infiltration and runoff and hinders plant growth by impeding root growth and seedling emergence, intercultural operations and farm mechanization. The gravelliness classes used in LRI were used to classify the soils and using these classes a gravelliness map was generated. The area extent and their geographic distribution in the microwatershed is shown in Figure 5.4. The soils that are non-gravelly (<15%) cover a major area of about 432 ha (99%) and are distributed in all parts of the microwatershed is given in Fig. 5.4.

The most productive lands with respect to gravelliness are found to be 99%. They are non-gravelly with less than 15 per cent gravel and have potential for growing both annual and perennial crops.

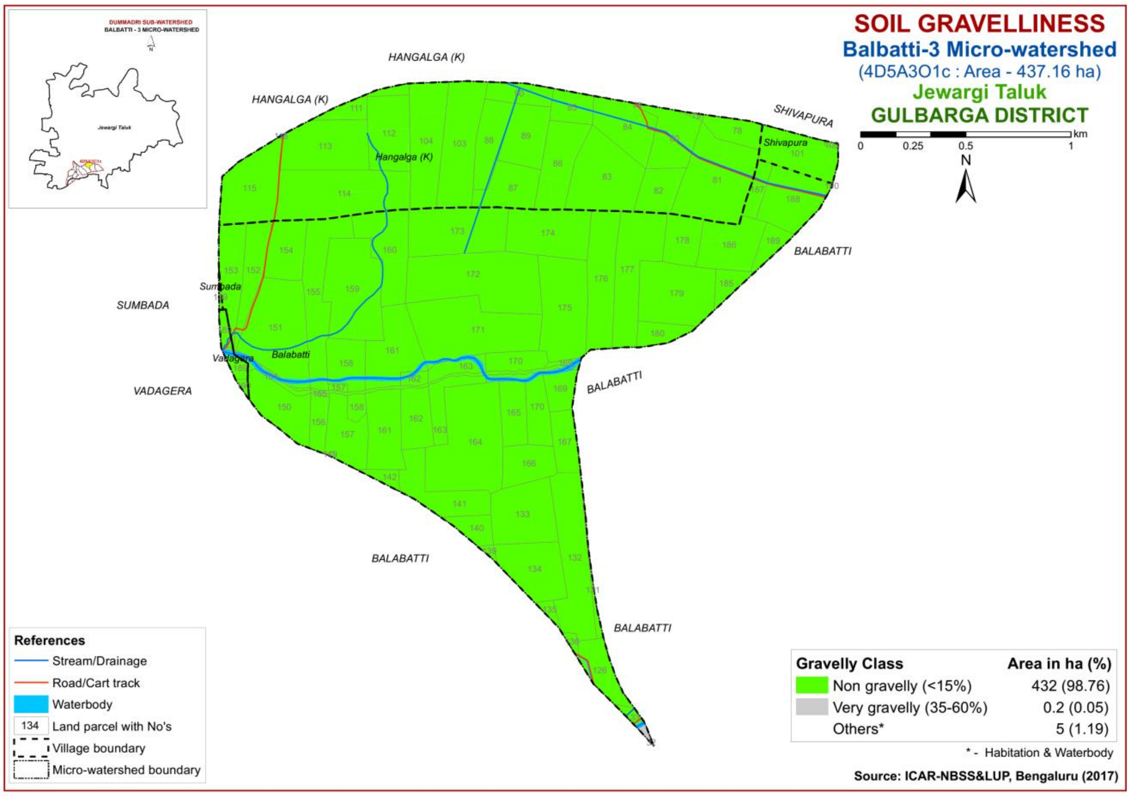



Fig. 5.4 Soil Gravelliness map of Balbatti-3 Microwatershed

### 5.5 Available Water Capacity

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

Very small area of about 0.21 ha (0.05%) in the microwatershed has soils that are very low (<50 mm/m) in available water capacity. An area of about 68 ha (16%) has soils that are low (51-100 mm/m) in available water capacity and are distributed in the northern part of the microwatershed. Major area of about 363 ha (83%) is very high (>200 mm/m) in available water capacity and are distributed in all parts of the microwateshed.

About 68 ha (16%) area in the microwatershed has soils that are problematic with regard to available water capacity. Here, only short or medium duration crops can be grown and the probability of crop failure is very high. These areas are best put to other alternative uses. An area of about 363 ha (83%) has soils that have high potential (>200 mm/m) with regard to available water capacity where all climatically adapted long duration crops can be grown successfully.

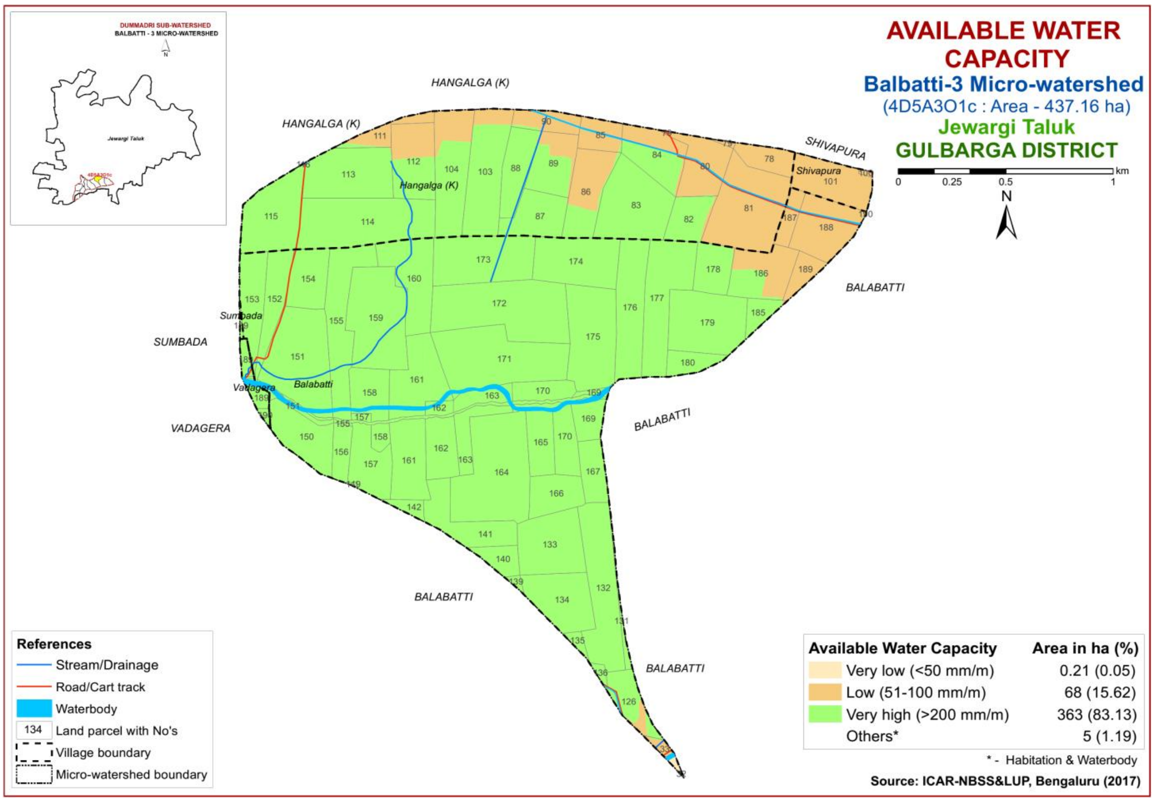



Fig. 5.5 Soil Available Water Capacity map of Balbatti-3 Microwatershed

### 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 their geographic distribution of different slope classes in the microwatershed (Fig. 5.6).

Major area of about 388 ha (89%) falls under very gently sloping (1-3% slope) lands and are distributed in all parts of the microwatershed. Nearly level (0-1% slope) lands cover a small area of about 43 ha (10%) and is distributed in the northeastern and northwestern part of the microwatershed.

An area of about 431 ha (99%) in the microwatershed has soils that have high potential in respect of soil slopes. In these areas, all climatically adapted annual and perennial crops can be grown without much soil and water conservation and other land development measures.

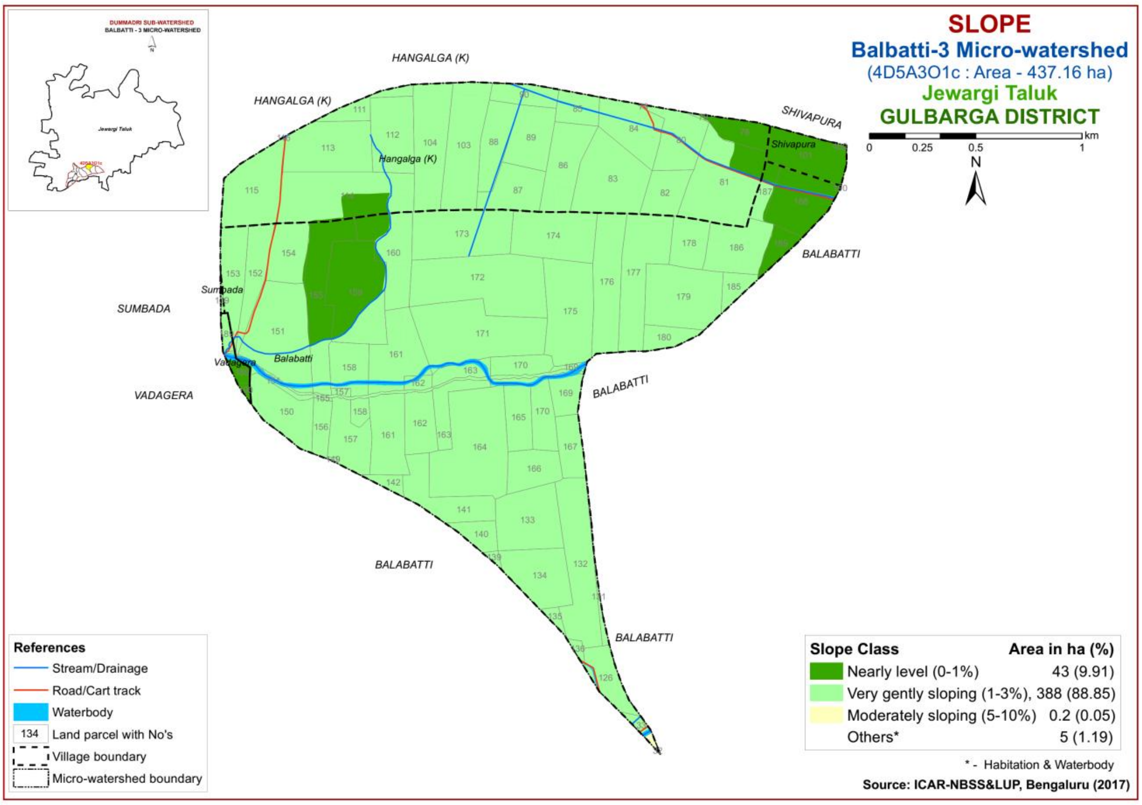



Fig. 5.6 Soil Slope map of Balbatti-3 Microwatershed

## 5.7 Soil Erosion

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

Soils that are moderately eroded (e2 class) cover an area of about 111 ha (25%) in the microwatershed. They are distributed in the southern part of the microwatershed. Slightly eroded (e1 class) soils cover a maximum area of about 321 ha (73%) and are distributed in the northern part of the microwatershed.

An area of about 111 ha (25%) in the microwatershed is problematic because of moderate erosion. To these areas taking up soil and water conservation and other land development measures is needed.

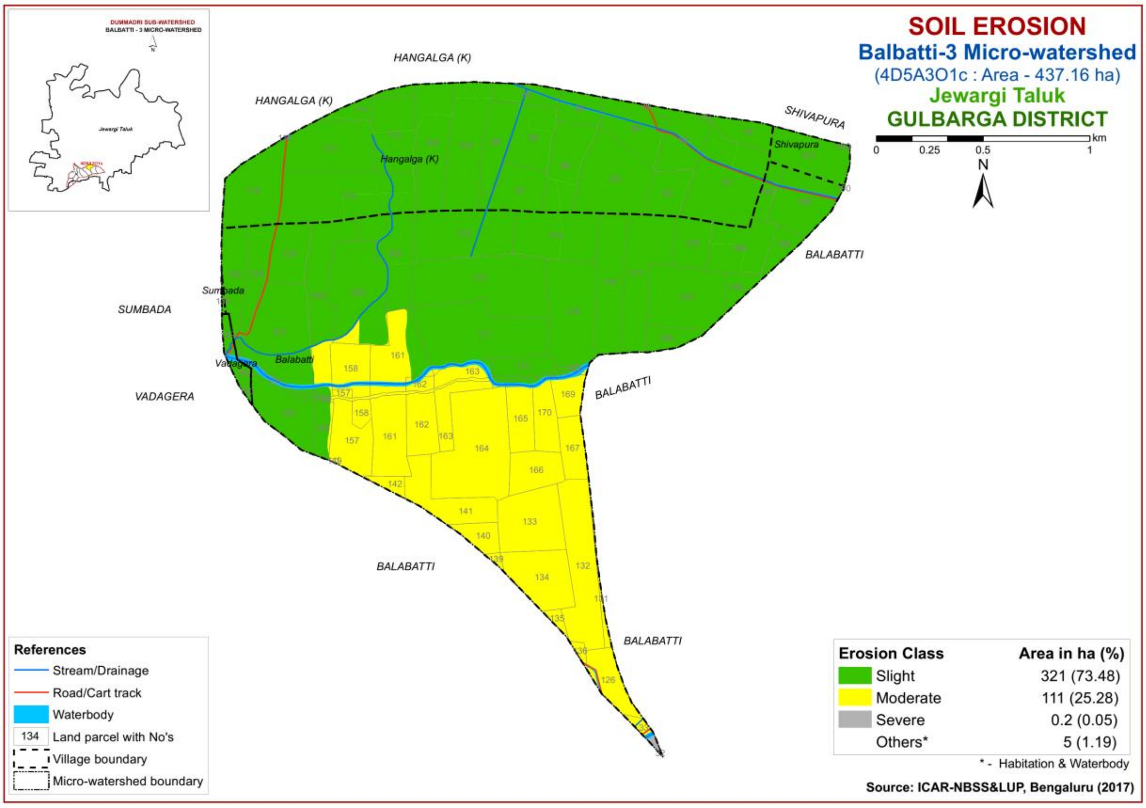



Fig. 5.7 Soil Erosion map of Balbatti-3 Microwatershed

*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 high temperatures and low rainfall. 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 (12 samples) from the grid points (one soil sample at every 250 m interval) all over the microwatershed through land resource inventory in the year 2016 were analysed for pH, EC, organic carbon, available phosphorus and potassium, and for micronutrients like zinc, boron, copper, iron and manganese, and secondary nutrient sulphur.

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

## 6.1 Soil Reaction (pH)

The soil analysis of the Balbatti-3 microwatershed for soil reaction (pH) showed that the entire area is strongly alkaline (pH 8.4-9.0) (Fig.6.1).

## 6.2 Electrical Conductivity (EC)

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

## 6.3 Organic Carbon

The soil organic carbon content in the soils of the microwatershed is medium (0.5-0.75%) in a maximum area of about 276 ha (63%) and is distributed in the major part of the microwatershed. An area of 137 ha (31%) under high (>0.75%) in organic carbon content and is distributed in the southern and northern part of the microwatershed. Organic carbon content is low (<0.5%) in a small area of 19 ha (4%) and is distributed in the eastern part of the microwatershed (Fig.6.3).

## 6.4 Available Phosphorus

Available phosphorus content is low (<23 kg/ha) in maximum area of about 318 ha (73%) and is distributed in major part of the microwatershed. An area of about 114 ha (26%) is medium (23-57 kg/ha) in available phosphorus and is distributed in the northeastern part of the microwatershed. (Fig 6.4).

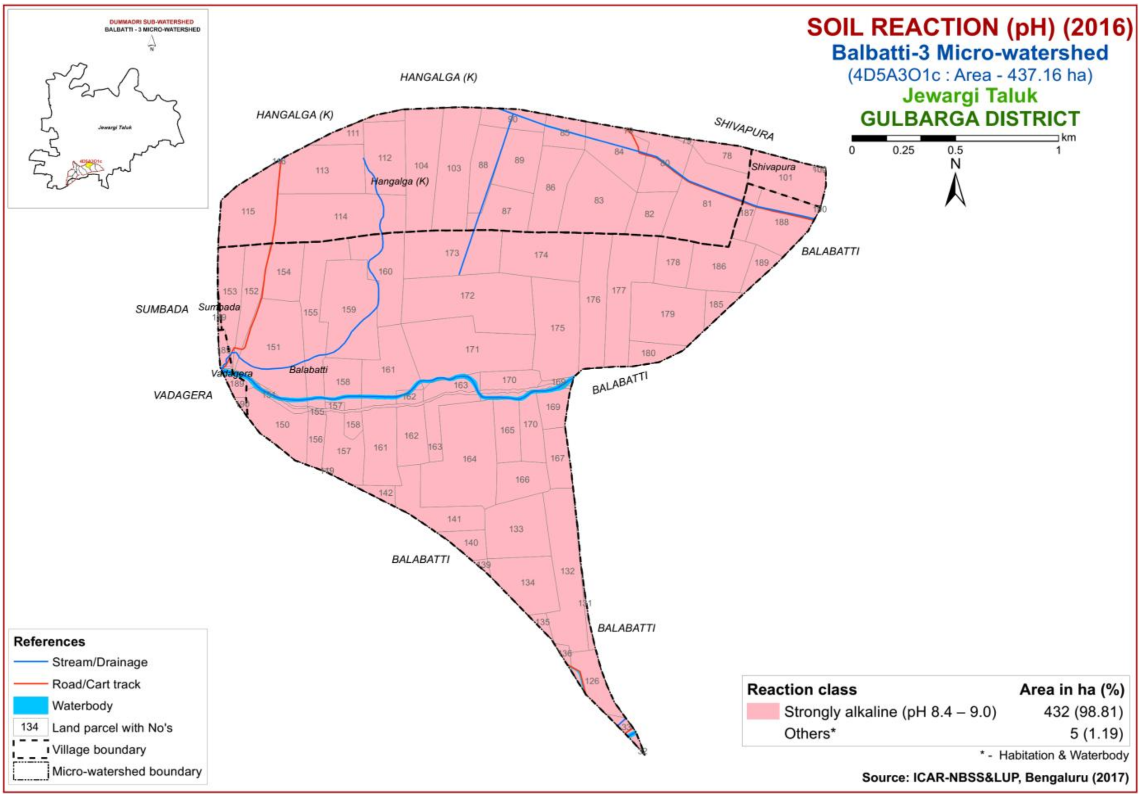



Fig.6.1 Soil Reaction (pH) map of Balbatti-3 Microwatershed

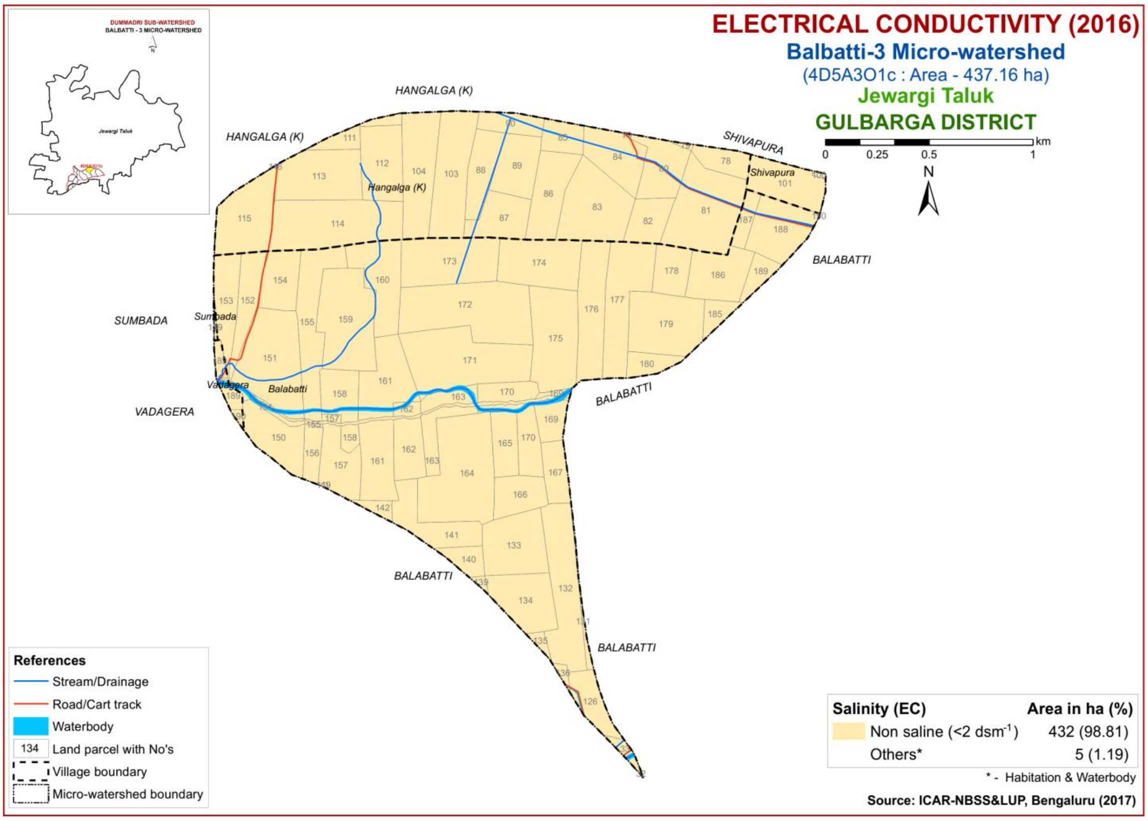



Fig.6.2 Electrical Conductivity (EC) map of Balbatti-3 Microwatershed

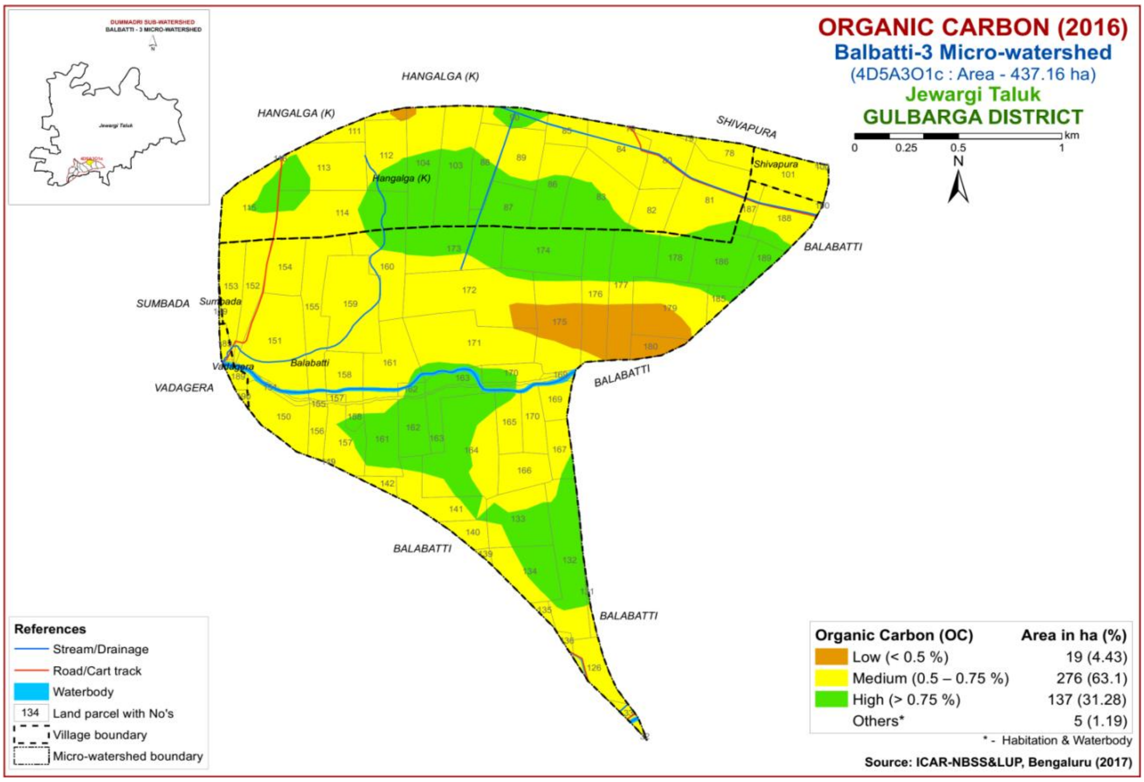



Fig.6.3 Soil Organic Carbon map of Balbatti-3 Microwatershed

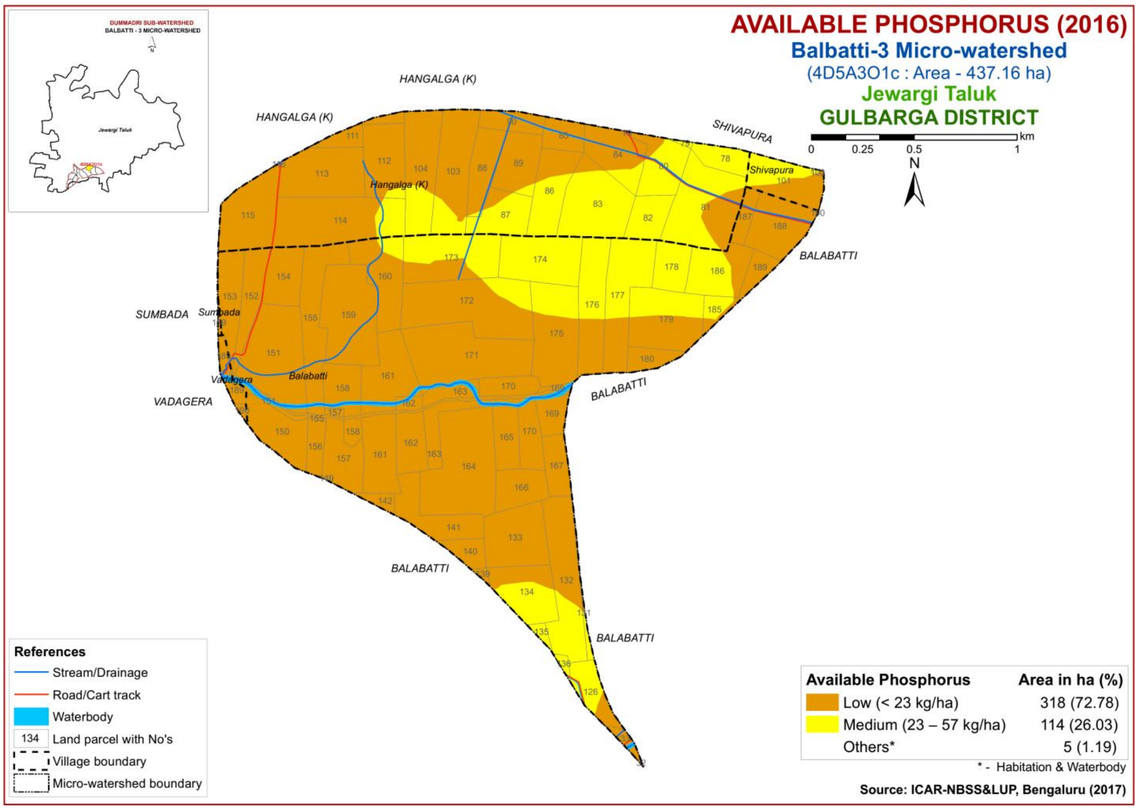



Fig.6.4 Soil Available Phosphorus map of Balbatti-3 Microwatershed

### 6.5 Available Potassium

It is high in available potassium (>337 kg/ ha) in an entire area of 432 ha (99%) and is distributed in all parts of the microwatershed (Fig.6.5).

### 6.6 Available Sulphur

Available sulphur content is low (<10 ppm) in a small area of 5 ha (1%) in the microwatershed and is distributed in the northern part of the microwatershed. An area of about 149 ha (34%) is medium (10-20 ppm) in available sulphur and is distributed in the southern and northern part of the microwatershed. available sulphur is high (>20 ppm) in about 278 ha (64%) and is distributed in the northern and 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 302 ha (69%) in the microwatershed and is distributed in the central, northeastern and northwestern part of the microwatershed. An area of about 130 ha (30%) is low (<0.5 ppm) in available boron and is distributed in the northern and southern part of the microwatershed (Fig.6.7).

### 6.8 Available Iron

Available iron content is sufficient (>4.5 ppm) in maximum area of 337 ha (77%) and is distributed in all parts of the microwatershed. An area of about 95 ha (22%) is deficient (<4.5 ppm) in available iron content and is distributed in the northwestern and central 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 deficient (<0.6 ppm) in 245 ha (56%) and about 187 ha (43%) is sufficient (>0.6 ppm) in available zinc (Fig 6.11).

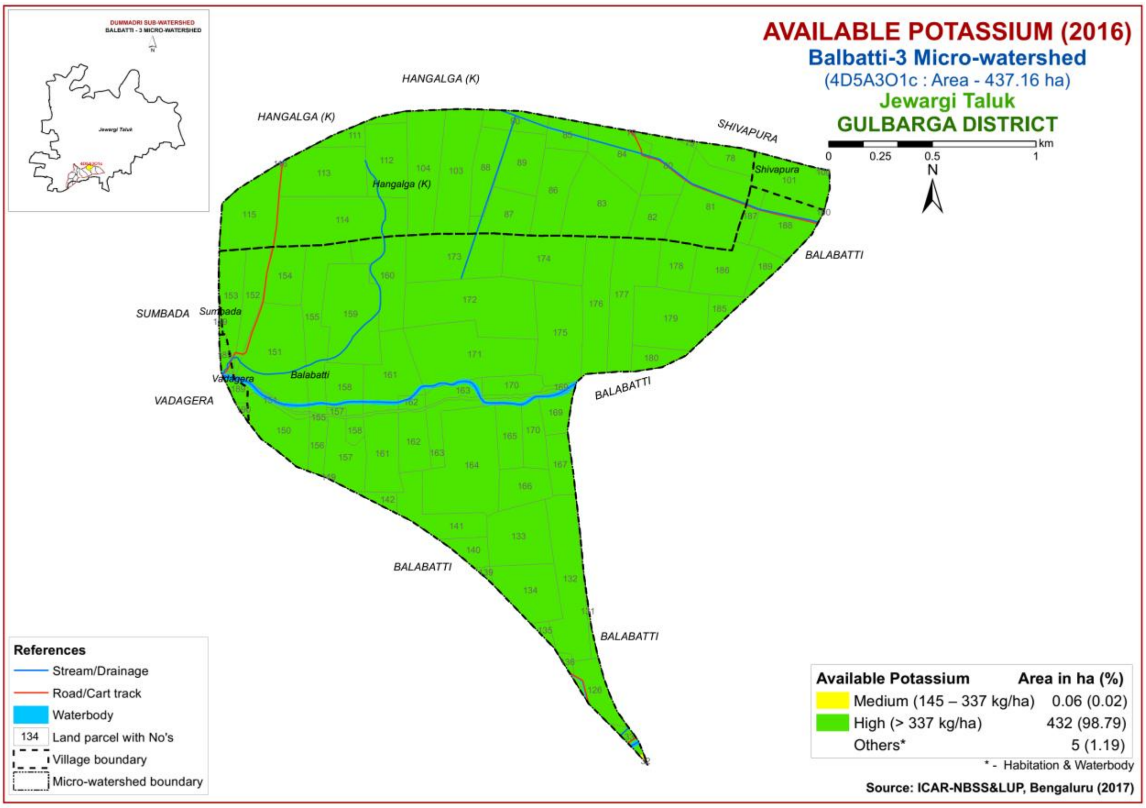



Fig.6.5 Soil Available Potassium map of Balbatti-3 Microwatershed

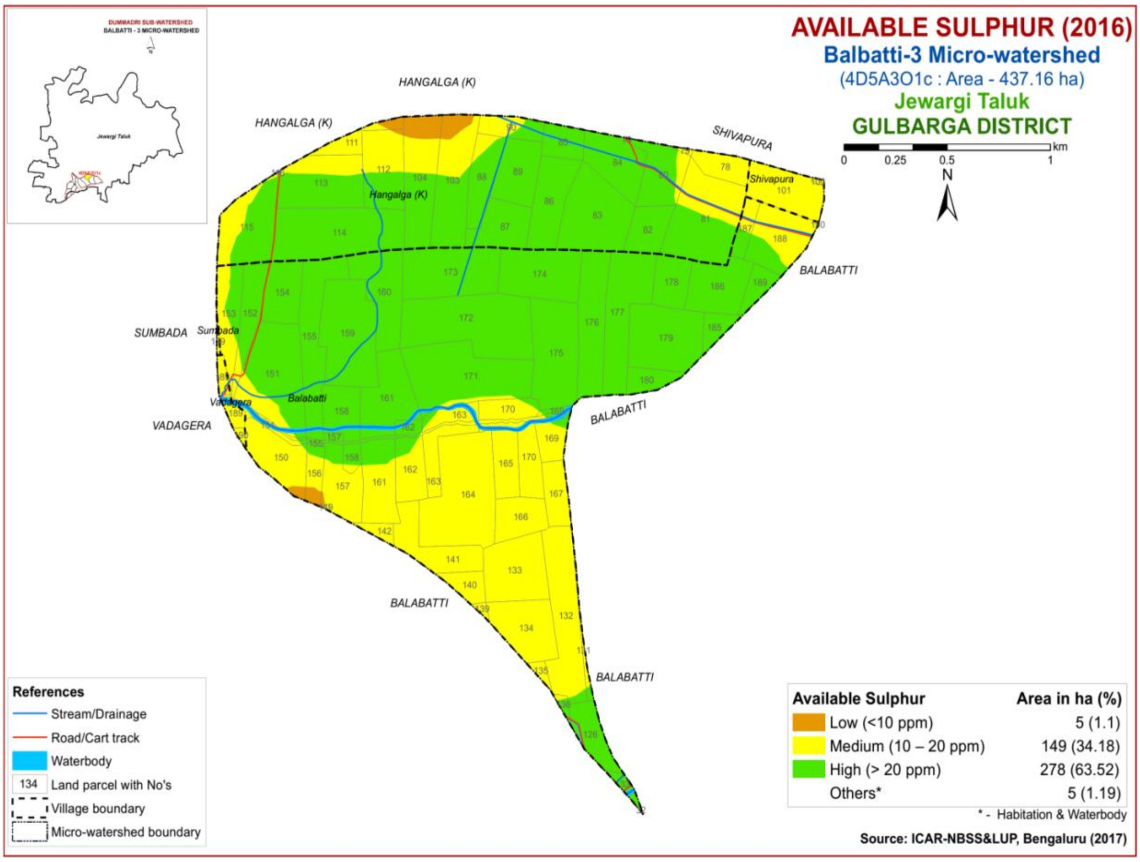



Fig.6.6 Soil Available Sulphur map of Balbatti-3 Microwatershed

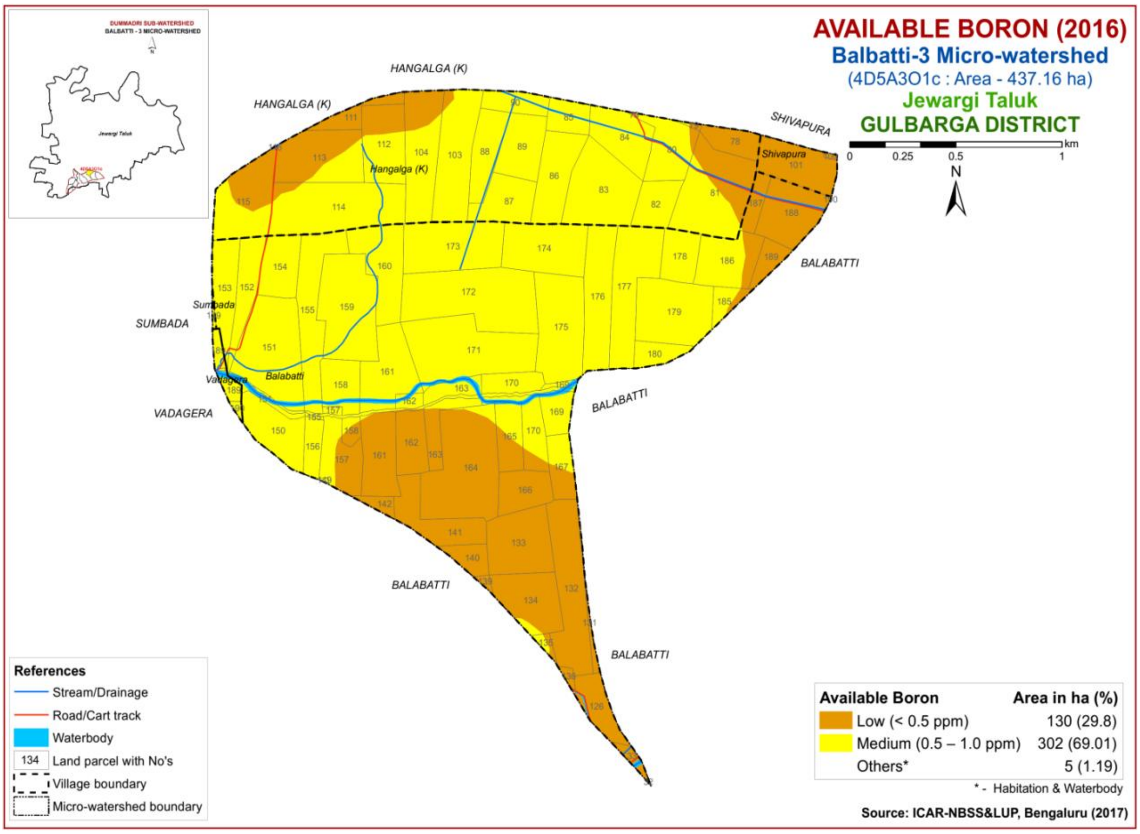



Fig.6.7 Soil Available Boron map of Balbatti-3 Microwatershed

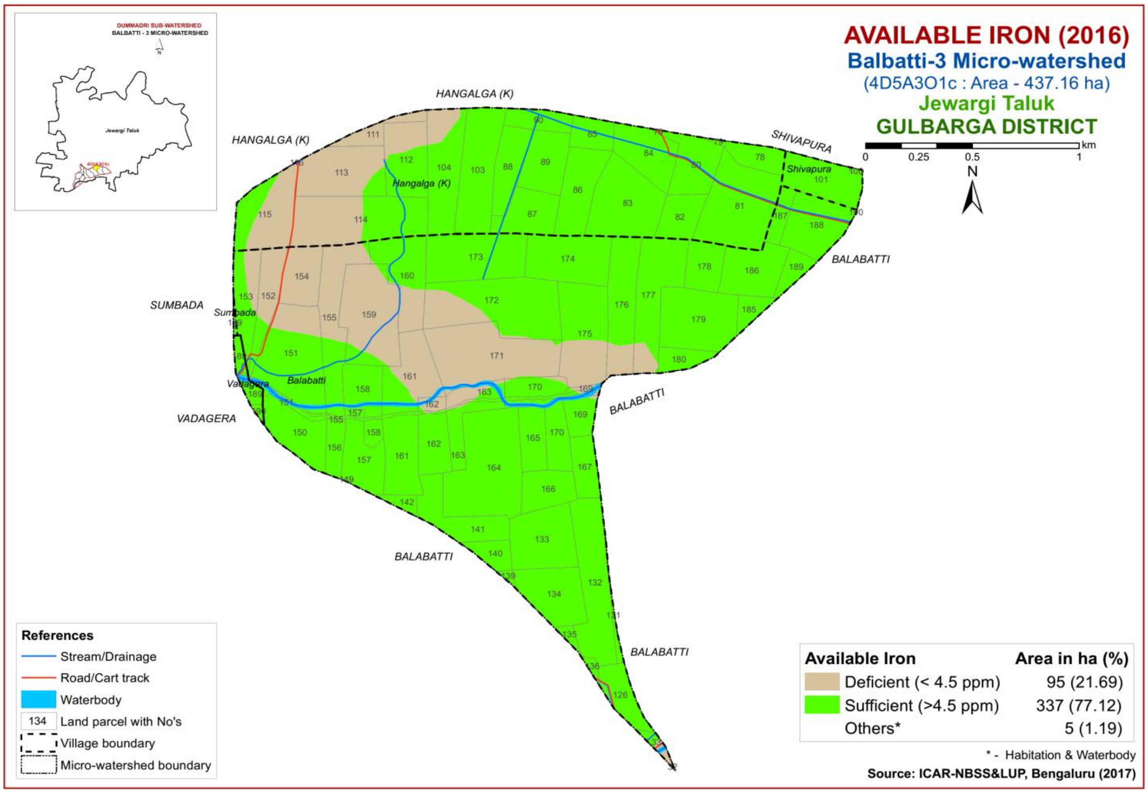



Fig.6.8 Soil Available Iron map of Balbatti-3 Microwatershed

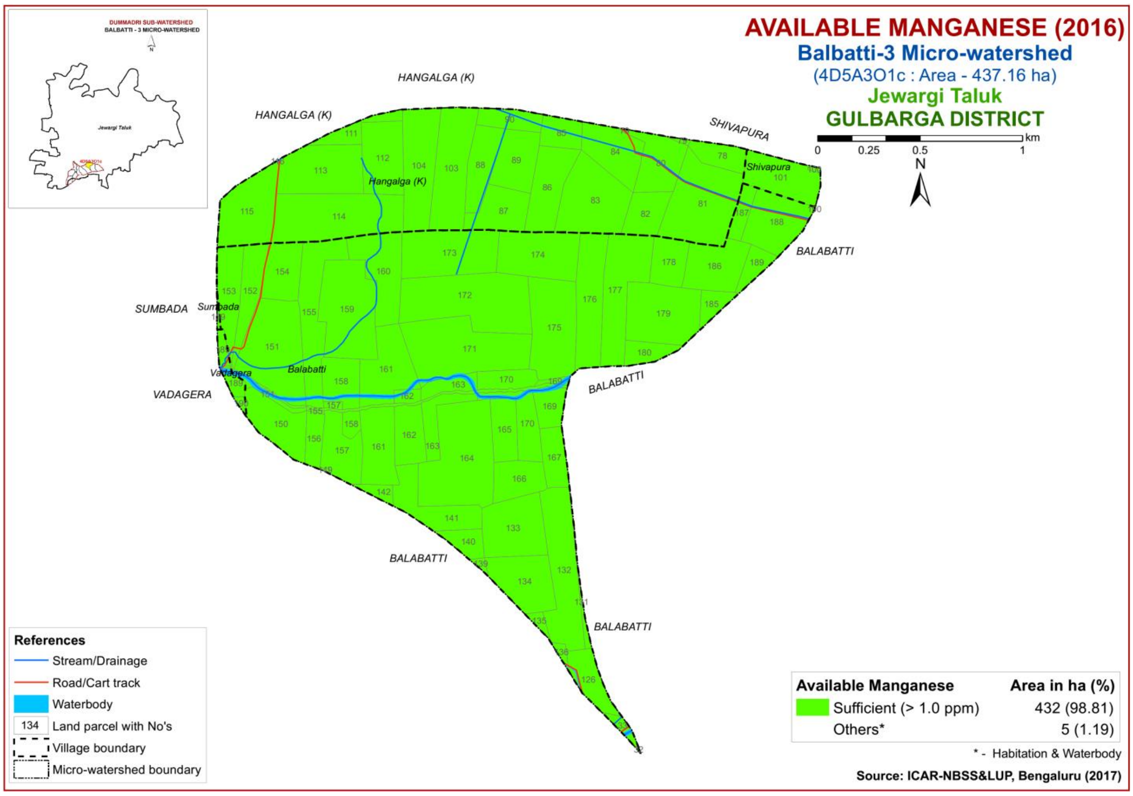



Fig.6.9 Soil Available Manganese map of Balbatti-3 Microwatershed

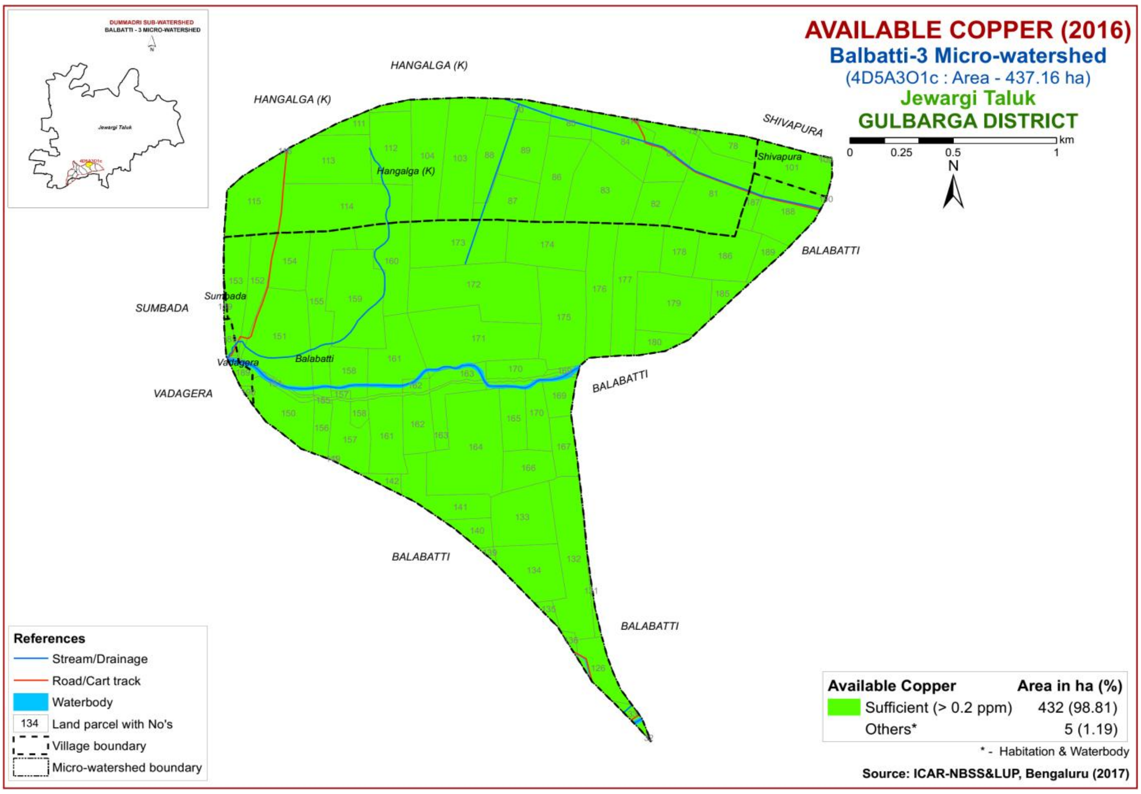



Fig.6.10 Soil Available Copper map of Balbatti-3 Microwatershed

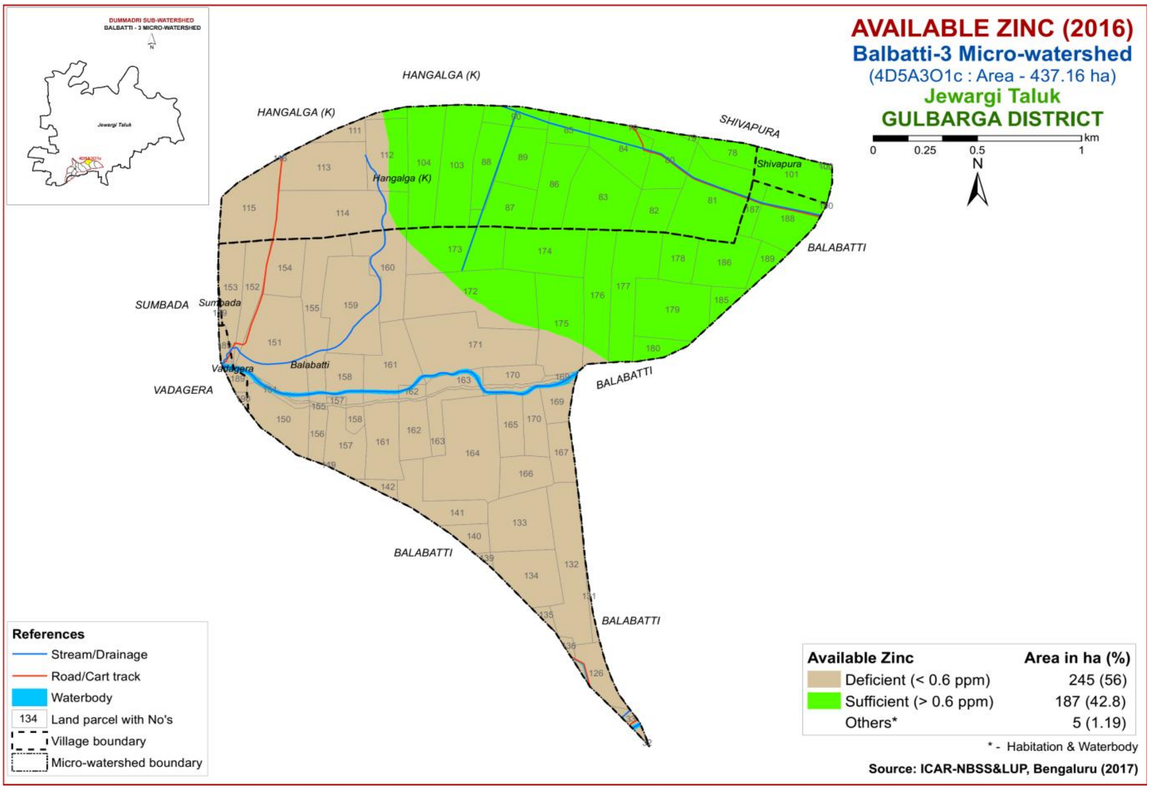



Fig.6.11 Soil Available Zinc map of Balbatti-3 Microwatershed

*Chapter 7*

# LAND SUITABILITY FOR MAJOR CROPS

The soil and land resource units (soil phases) of Balbatti-3 microwatershed were assessed for their suitability for growing food, fodder, fibre and other horticulture crops by following the procedure as outlined in FAO, 1976 and 1983. Crop requirements were developed for each of the crop from the available research data and also by referring to Naidu *et. al.* (2006) and Natarajan *et. al* (2015). The crop requirements were matched with the soil and land characteristics (Table 7.1) to arrive at the crop suitability. In FAO land suitability classification, two orders are recognized. Order S- Suitable and Order N- Not suitable. The orders have classes, subclasses and units. Order-S has three classes, Class S1- Highly Suitable, Class S2- Moderately Suitable and Class S3- Marginally Suitable. Order N has two classes, N1- Currently not Suitable and N2- Permanently not Suitable. There are no subclasses within the Class S1 as they will have very minor or no limitations for crop growth. Classes S2 and S3 are divided into subclasses based on the kinds of limitations encountered. The limitations that affect crop production are 'c' for erratic rainfall and its distribution and length of growing period (LGP), 'e' for erosion hazard, 'r' for rooting condition, 't' for lighter or heavy texture, 'g' for gravelliness or stoniness, 'n' for nutrient availability, 'l' for topography, 'm' for moisture availability and 'w' for drainage and 'z' for calcareousness. These limitations are indicated as lower case letters to the class symbol. For example, moderately suitable land with the limitations of soil depth and erosion are designated as S2re. For the microwatershed, the soil mapping units were evaluated and classified up to subclass level.

Using the above criteria, the soil map units of the microwatershed were evaluated and land suitability maps for 19 major annual and perennial crops were generated. The detailed information on the kind of suitability of each of the soil phase for the crops assessed are given village/ survey number wise for the microwatershed in Appendix-III.

## 7.1 Land Suitability for Sorghum (*Sorghum bicolor*)

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

An area of about 363 ha (83%) is highly suitable (Class S1) for growing sorghum and are distributed in the major part of the microwatershed.

Marginally suitable lands (Class S3) for growing sorghum occupy an area of about 68 ha (16%) and occur in the northern part of the microwatershed. They have moderate limitations of rooting depth. A minor area of 0.21 ha (<1%) is not suitable for growing sorghum. They have very severe limitations of gravelliness and slope.

**Table 7.1 Soil-Site Characteristics of Balbatti-3 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 (%) | | | | | | | | |
| BBTmB1 | 751 | 150 | MWD | 100-150 | c | c | - | <15 | >200 | 1-3 | Slight | 8.06 | 0.612 | 2.06 | 49.68 | 100 |
| BBTmB2 | 751 | 150 | MWD | 100-150 | c | c | - | <15 | >200 | 1-3 | Moderate | 8.06 | 0.612 | 2.06 | 49.68 | 100 |
| MGTmD3g2 | 751 | 150 | WD | <25 | c | c | 35-60 | 15-35 | <50 | 5-10 | severe | 6.83 | 0.27 | 0.18 | 46.27 | 100 |
| NHAmA1 | 751 | 150 | WD | 25-50 | c | c | - | <15 | 51-100 | 0-1 | slight | 7.09 | 0.11 | 0.20 | 30.55 | 94 |
| NHAmB1 | 751 | 150 | WD | 25-50 | c | c | - | <15 | 51-100 | 1-3 | slight | 7.09 | 0.11 | 0.20 | 30.55 | 94 |
| SBDmB1 | 751 | 150 | WD | 25-50 | c | c | - | <15 | 51-100 | 1-3 | slight | 8.1 | 0.85 | 5.44 | 37.8 | 100 |
| SBDmB2 | 751 | 150 | WD | 25-50 | c | c | - | <15 | 51-100 | 1-3 | moderate | 8.1 | 0.85 | 5.44 | 37.8 | 100 |
| YDMmA1 | 751 | 150 | MWD | >150 | c | c | - | <15 | >200 | 0-1 | slight | 8.68. | 0.219 | 2.15 | 50.76 | 100 |
| YDMmB1 | 751 | 150 | MWD | >150 | c | c | - | <15 | >200 | 1-3 | slight | 8.68. | 0.219 | 2.15 | 50.76 | 100 |
| YDMmB2 | 751 | 150 | MWD | >150 | c | c | - | <15 | >200 | 1-3 | moderate | 8.68. | 0.219 | 2.15 | 50.76 | 100 |

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

**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 | <5.58.6-9.0 | >9.0 |
| Surface soil texture | Class | C, cl, sicl, sc | l, sil, sic | Sl, ls | S, fragmental skeletal |
| Soil depth | Cm | 100-75 | 50-75 | 30-50 | <30 |
| Gravel content | %vol. | 5-15 | 15-30 | 30-60 | >60 |
| Salinity (EC) | $dSm^{-1}$ | 2-4 | 4-8 | 8-10 | >10 |
| Sodicity (ESP) | % | 5-8 | 8-10 | 10-15 | >15 |

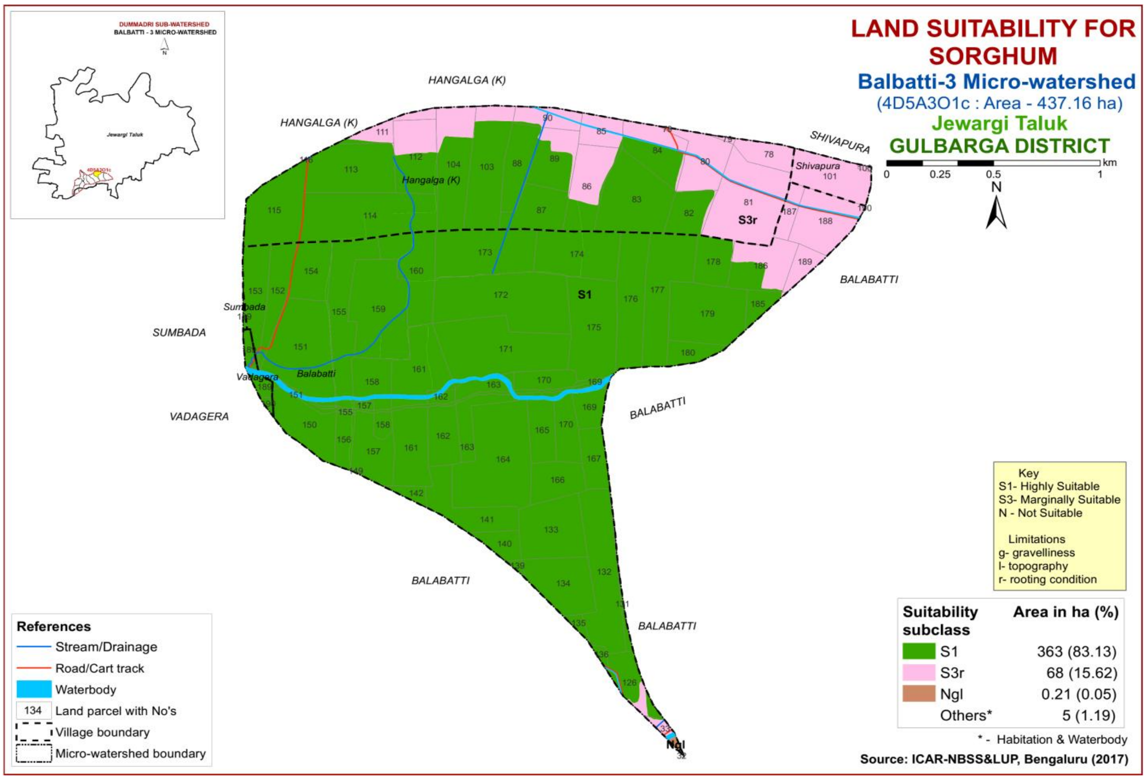



Fig. 7.1 Land Suitability map of Sorghum

## 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.

Marginally suitable lands (Class S3) for growing maize occupy a major area of about 431 ha (99%) and occur in all parts of the microwatershed. They have moderate limitations of rooting depth and texture. A very minor area of 0.21 ha (0.05%) is not suitable for growing maize. They have very severe limitations of gravelliness and texture.

**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 | |

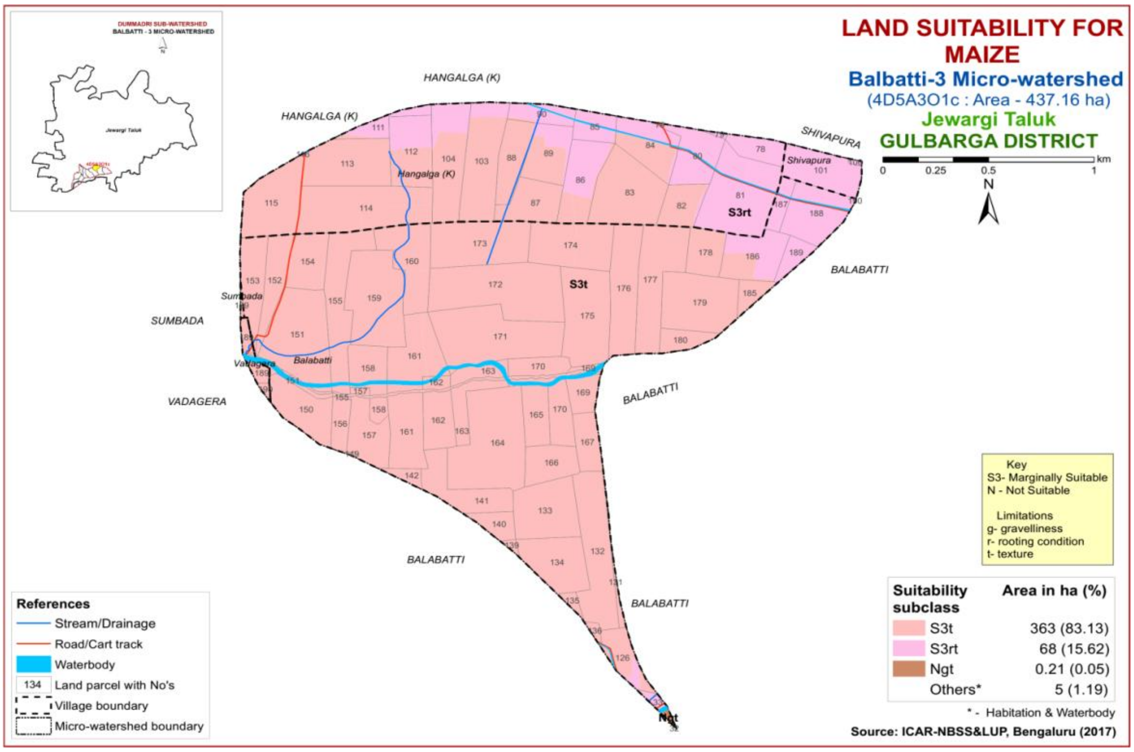



Fig. 7.2 Land Suitability map of Maize

## 7.3 Land Suitability for Redgram (*Cajanus cajan*)

Redgram is the most important pulse crop grown in an area of 7.28 lakh ha in almost all the districts of the State. The crop requirements for growing redgram (Table 7.4) were matched with the soil-site characteristics (Table 7.1) and a land suitability map for growing redgram was generated. The area extent and their geographical distribution of different suitability subclasses in the microwatershed is given in Figure 7.3.

Marginally suitable lands (Class S3) for growing redgram occupy a major area of about 431 ha (99%) and occur in all parts of the microwatershed. They have moderate limitations of rooting depth and texture. A very minor area of 0.21 ha (0.05%) is not suitable for growing redgram. They have very severe limitations of gravelliness and texture.

**Table 7.4 Land suitability criteria for Red gram**

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

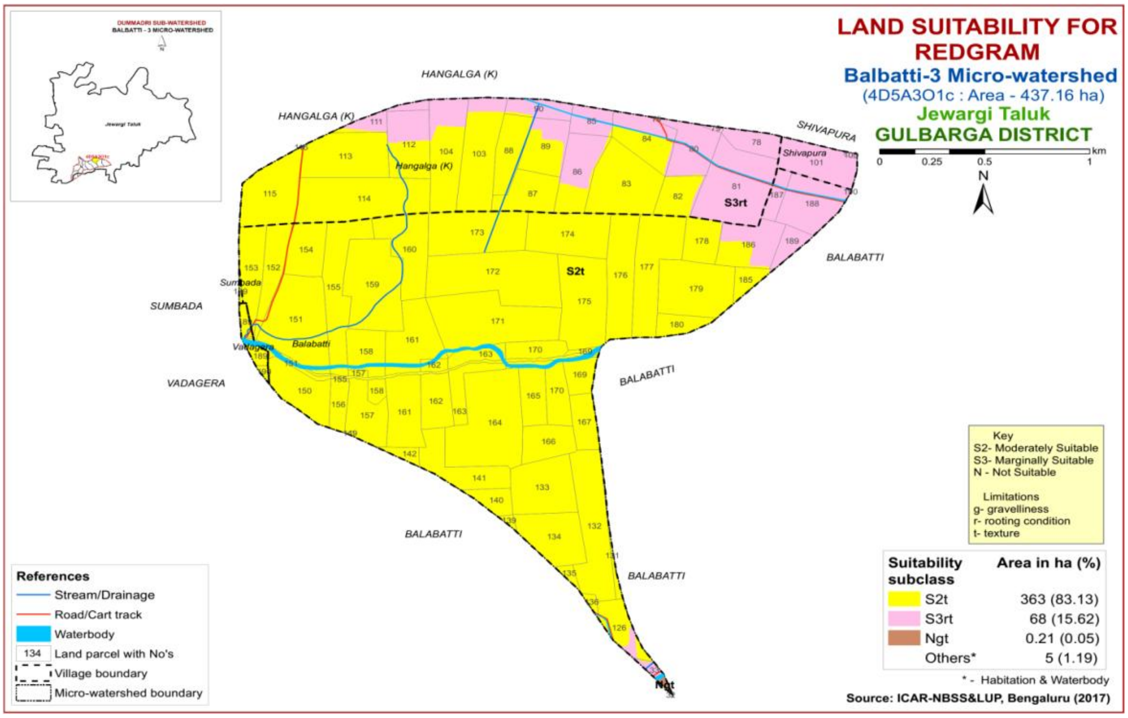



Fig. 7.3 Land Suitability map of Redgram

### 7.4 Land Suitability for Soybean (*Glycine max*)

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

Maximum area of about 363 ha (83%) in the microwatershed has soils that are highly suitable (Class S1) for growing Soybean. They have minor or no limitations for growing Soybean and are distributed in all parts of the microwatershed. A small area of about 68 ha (16%) is marginally suitable lands (Class S3) they have moderate limitations of rooting depth. A very minor area of about 0.21 ha (0.05%) is not suitable for growing Soyabean. They have very severe limitations of gravelliness and slope.

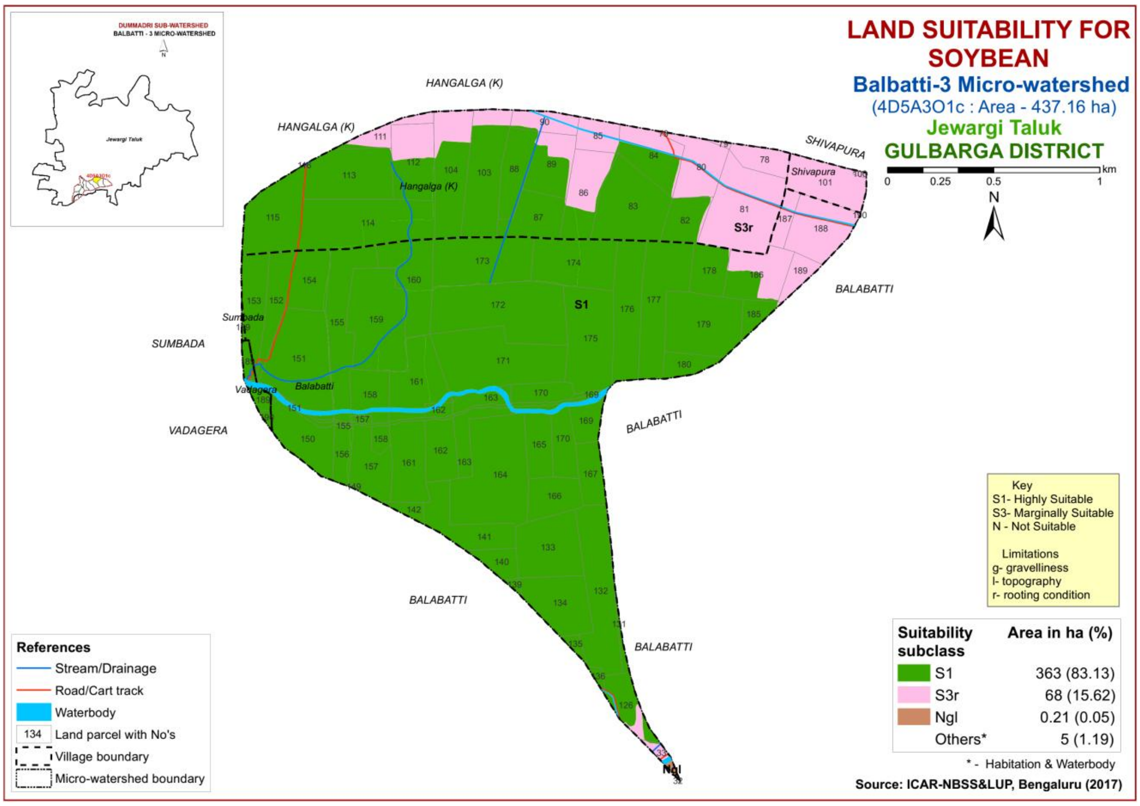



Fig. 7.4 Land Suitability map of Soybean

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

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

Maximum area of about 363 ha (83%) in the microwatershed has soils that are highly suitable (Class S1) for growing Bengalgram. They have minor or no limitations for growing Bengal gram and are distributed in all parts of the microwatershed. An area of about 68 ha (16%) is moderately suitable (Class S2) for Bengal gram. They are distributed in the northern part of the microwatershed. They have minor limitations of rooting depth. A very minor area of about 0.21 ha (0.05%) is not suitable for growing Bengalgram. They have very severe limitations of gravelliness and slope.

**Table 7.5 Crop suitability criteria for Bengal gram**

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

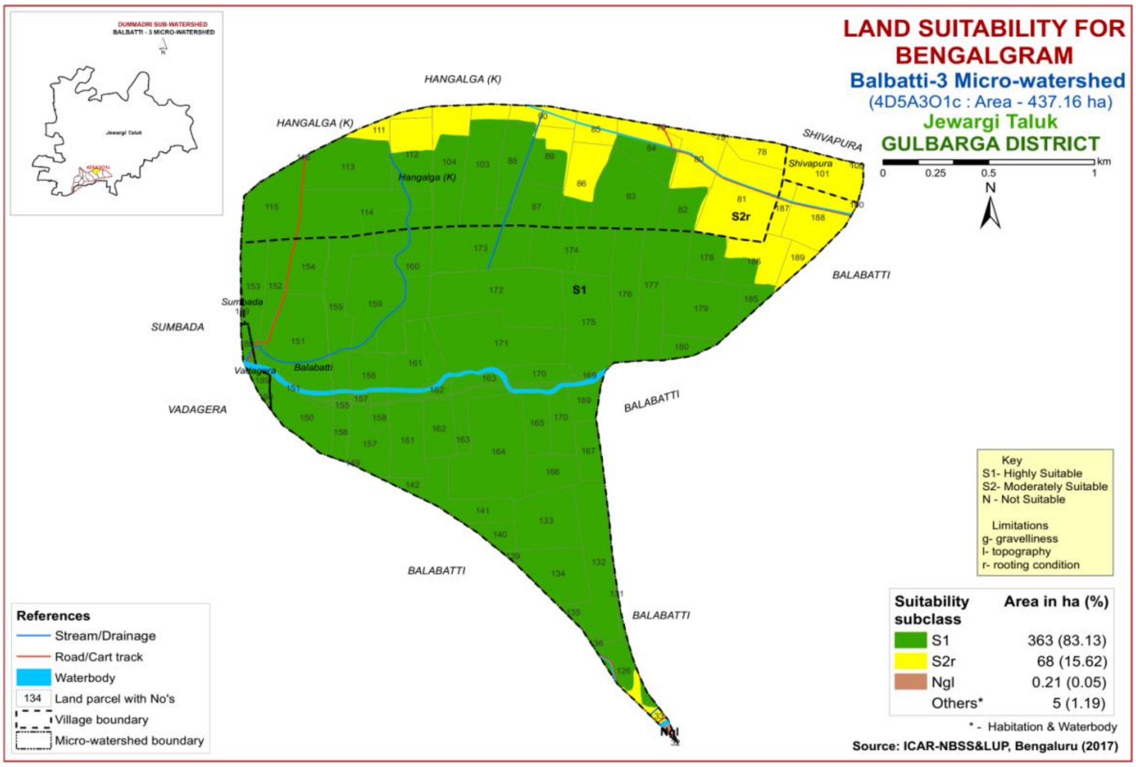



Fig. 7.5 Land Suitability map of Bengal gram

**7.6 Land Suitability for Sunflower (*Helianthus annus*)**

Sunflower is the most important oilseed crop grown in an area of 3.56 lakh ha in the State in all the districts. The crop requirements for growing sunflower (Table 7.6) were matched with the soil-site characteristics (Table 7.1) and a land suitability map for growing sunflower was generated. The area extent and their geographical distribution of different suitability subclasses in the micro watershed is given in Figure 7.6.

Maximum area of about 363 ha (83%) is highly suitable (Class S1) for growing sunflower and are distributed in all parts of the microwatershed. A small area of about 68 ha (16%) is not suitable for growing sunflower and occur in the northern part of the microwatershed. They have very severe limitations of gravelliness, slope and rooting depth.

**Table 7.6 Crop suitability criteria for Sunflower**

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

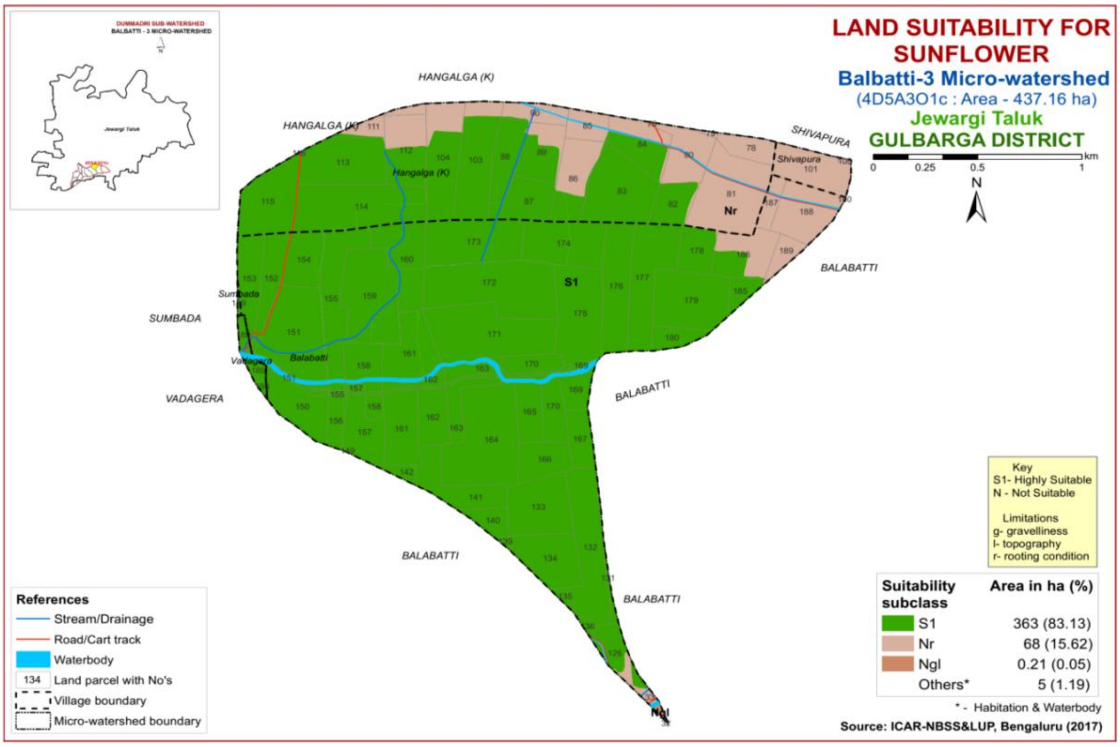



Fig. 7.6 Land Suitability map of Sunflower

## 7.7 Land Suitability for Cotton (*Gossypium hirsutum*)

Cotton is the most important fibre crop grown in the State in about 8.75 lakh ha area in Raichur, Dharwad, Belgaum, Gulbarga, Bijapur, Bidar, Bellary, Chitradurga and

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

Maximum area of about 363 ha (83%) has soils that are highly suitable (Class S1) and are distributed in all parts of the microwatershed. The marginally suitable (Class S3) lands cover an area of about 68 ha (16%) and occur in northern part of the microwatershed. They have moderate limitations of rooting depth. A very minor area of about 0.21 ha (0.05%) is not suitable for growing cotton. They have very severe limitations of gravelliness and slope.

**Table 7.7 Crop suitability criteria for Cotton**

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

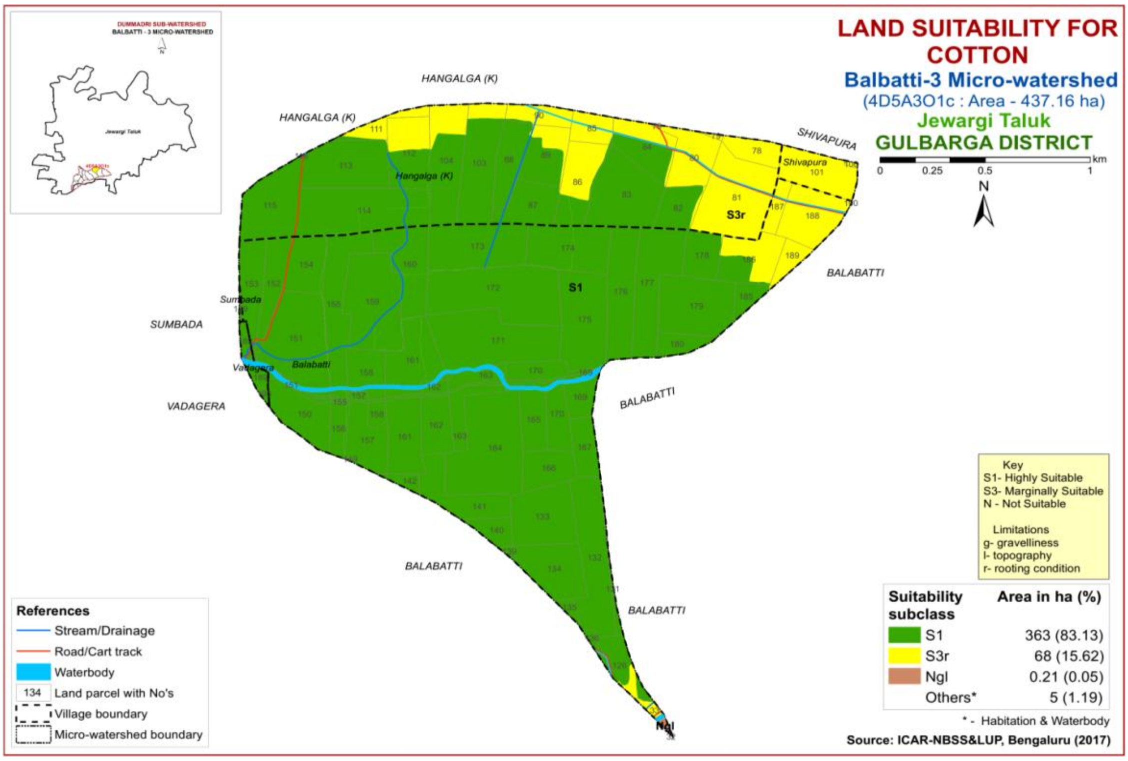



Fig. 7.7 Land Suitability map of Cotton

## 7.8 Land Suitability for Sugarcane (*Saccharum officinarum*)

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

The marginally suitable (Class S3) lands cover a maximum area of about 363 ha (83%) and occur in all parts of the microwatershed. They have moderate limitations of texture. An area of about 68 ha (16%) is not suitable (Class N) for growing sugarcane and occur in the northern part of the microwatershed. They have very severe limitations of rooting depth, gravelliness and texture.

**Table 7.8 Crop suitability criteria for Sugarcane**

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

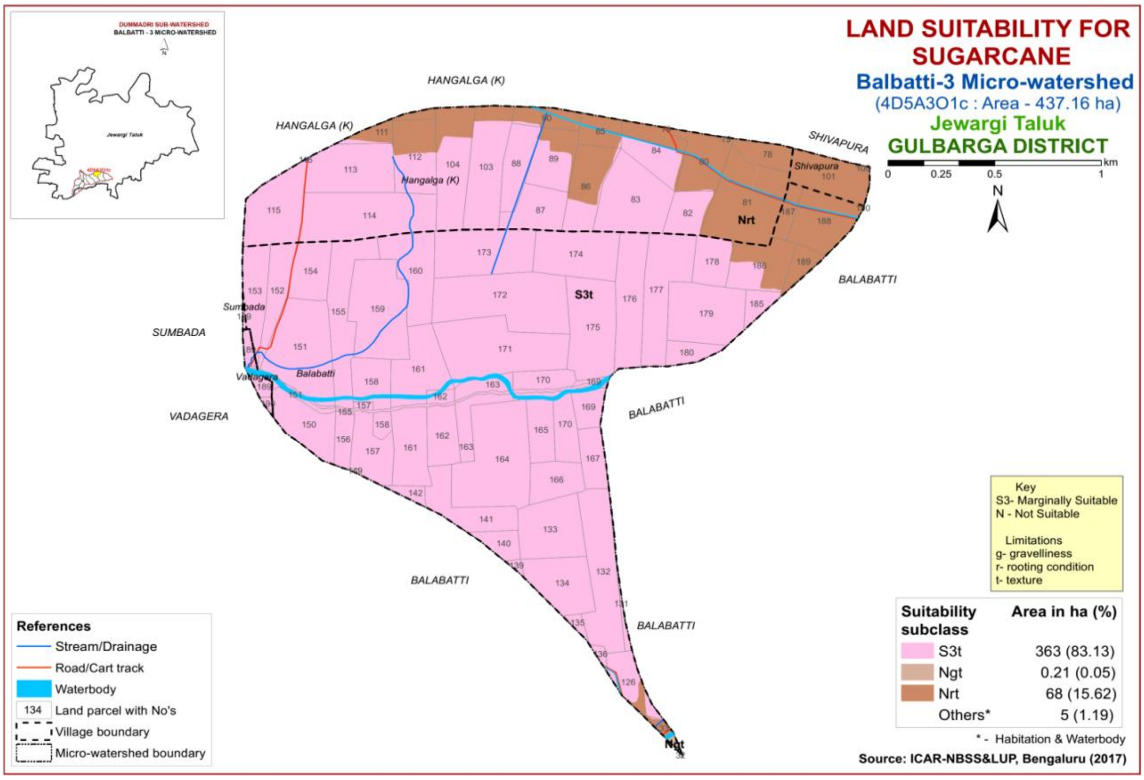



Fig. 7.8 Land Suitability map of Sugarcane

### 7.9 Land suitability for Mango (*Mangifera indica*)

Mango is the most important fruit crop grown in 1.73 lakh ha in almost all the districts of the State. The crop requirements (Table 7.9) for growing mango were matched with the soil-site characteristics (Table 7.1) and a land suitability map for growing mango was generated. The area extent and their geographical distribution of different suitability subclasses in the microwatershed are given in Figure 7.9.

The marginally suitable (Class S3) lands cover an area of about 363 ha (83%) and are distributed in all parts of the microwatershed. They have moderate limitations of texture. An area of about 68 ha (16%) is not suitable (Class N) for growing mango in the microwatershed and are distributed in the northern part of the microwatershed. They have very severe limitations of rooting depth, gravelliness and texture.

**Table 7.9 Crop suitability criteria for Mango**

| Crop requirement | | | Rating | | | |
|---|---|---|---|---|---|---|
| Soil-site characteristics | | Unit | Highly suitable(S1) | Moderately suitable(S2) | Marginally suitable(S3) | Not suitable(N) |
| Climate | Temp. in growing season | $^0C$ | 28-32 | 24-27<br>33-35 | 36-40 | 20-24 |
| | Min. temp. before flowering | $^0C$ | 10-15 | 15-22 | >22 | |
| Soilmoisture | Growing period | Days | >180 | 150-180 | 120-150 | <120 |
| Soil aeration | Soil drainage | class | Well drained | Mod. To imperfectly drained | Poor drained | Very poorly drained |
| | Water table | M | >3 | 2.50-3.0 | 2.5-1.5 | <1.5 |
| Nutrient availability | Texture | Class | Sc, l, sil, cl | Sl, sc, sic,l,c | C (<60%) | C (>60%), |
| | pH | 1:2.5 | 5.5-7.5 | 7.6-8.5,5.0-5.4 | 8.6-9.0,4.0-4.9 | >9.0<4.0 |
| | OC | % | High | medium | low | |
| | $CaCO_3$ in root zone | % | Non calcareous | <5 | 5-10 | >10 |
| Rooting conditions | Soildepth | cm | >200 | 125-200 | 75-125 | <75 |
| | Gravel content | %vol | Non-gravelly | <15 | 15-35 | >35 |
| Soil toxicity | Salinity | $dS/m^{-1}$ | Non saline | <2.0 | 2.0-3.0 | >3.0 |
| | Sodicity | % | Non sodic | <10 | 10-15 | >15 |
| Erosion | Slope | % | <3 | 3-5 | 5-10 | |

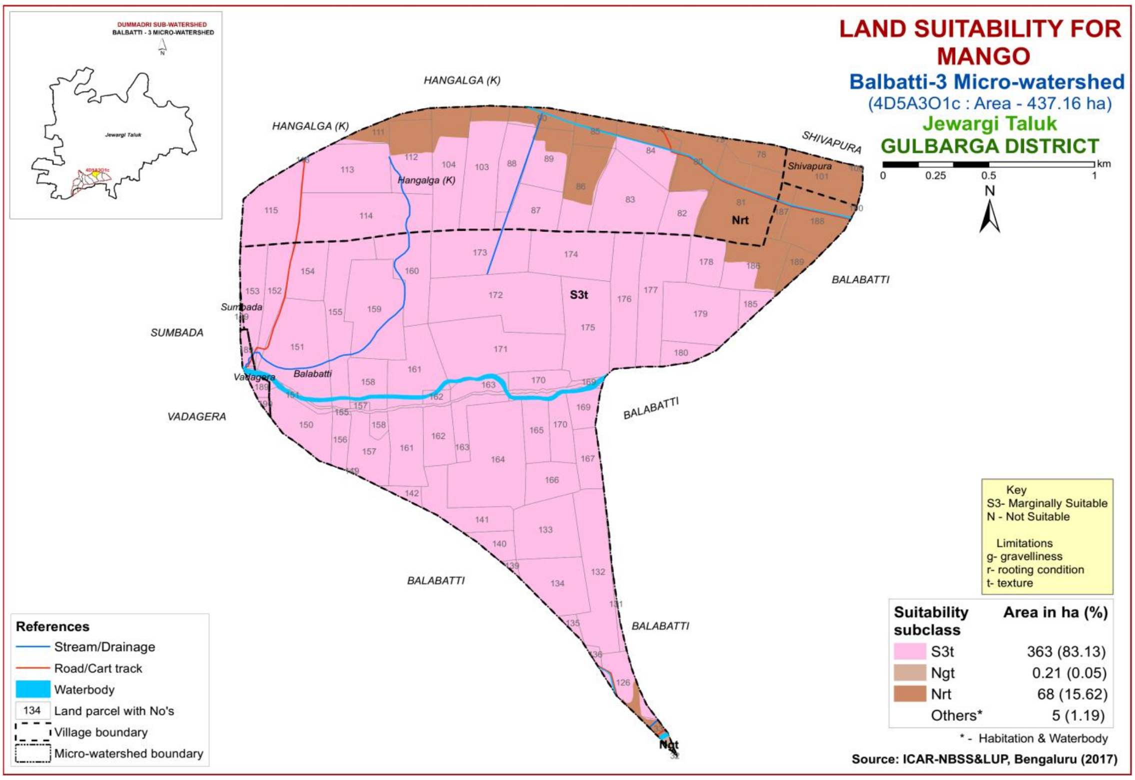



Fig. 7.9 Land Suitability map of Mango

### 7.10 Land suitability for Sapota (*Manilkara zapota*)

Sapota is the most important fruit crop grown in an area of 0.29 lakh ha in almost all the districts of the State. The crop requirements (Table 7.10) for growing sapota were matched with the soil-site characteristics (Table 7.1) and a land suitability map for growing sapota was generated. The area extent and their geographical distribution of different suitability subclasses in the microwatershed is given in Figure 7.10.

**Table 7.10 Crop suitability criteria for Sapota**

| Crop requirement | | | Rating | | | |
|---|---|---|---|---|---|---|
| Soil –site characteristics | | Unit | Highly suitable(S1) | Moderately suitable(S2) | Marginally suitable(S3) | Not suitable(N) |
| Climate | Temperature in growing season | $^0$ C | 28-32 | 33-36<br>24-27 | 37-42<br>20-23 | >42<br><18 |
| Soilmoisture | 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 |
| | Gravelcontent | %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 |

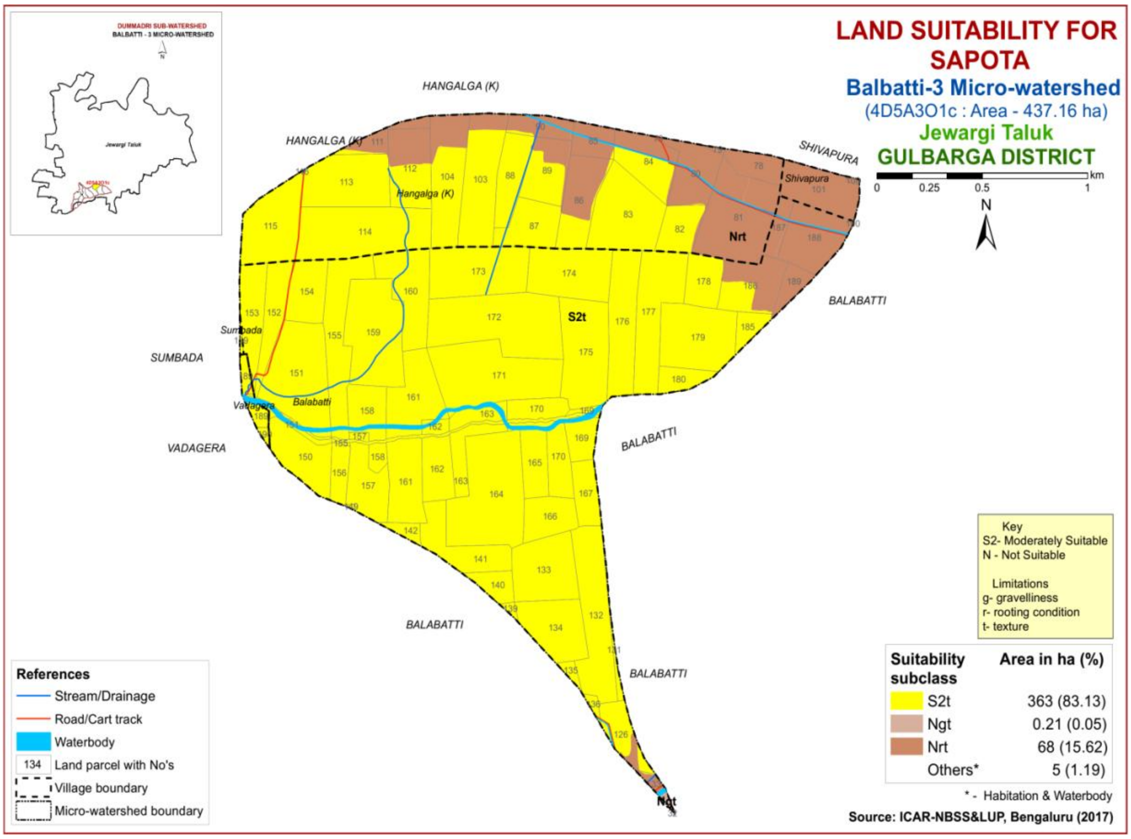



Fig. 7.10 Land Suitability map of Sapota

An area of about 363 ha (83%) is moderately suitable (Class S2) and are distributed in all parts and they have minor limitations of texture. An area of about 68 ha (16%) is not suitable (Class N) for growing sapota in the microwatershed and are distributed in the northern part of the microwatershed. They have very severe limitations of rooting depth, gravelliness and texture.

### 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 7.11) for growing guava were matched with the soil-site characteristics (7.1) and a land suitability map for growing guava was generated The area extent and their geographical distribution of different suitability subclasses in the microwatershed is given in Figure 7.11.

Maximum area of about 363 ha (83%) is moderately suitable (Class S2) and are distributed in all parts and have minor limitations of texture. An area of about 68 ha (16%) is not suitable (Class N) for growing guava and are distributed in the northern part of the microwatershed. They have severe limitations of rooting depth, gravelliness and texture.

**Table 7.11 Crop suitability criteria for Guava**

| Crop requirement | | | Rating | | | |
|---|---|---|---|---|---|---|
| **Soil –site characteristics** | | **Unit** | **Highly suitable(S1)** | **Moderately suitable (S2)** | **Marginally suitable(S3)** | **Not suitable(N)** |
| Climate | Temperature in growing season | $^{0}$C | 28-32 | 33-36<br>24-27 | 37-42<br>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 |
| | Gravelcontent | %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 |

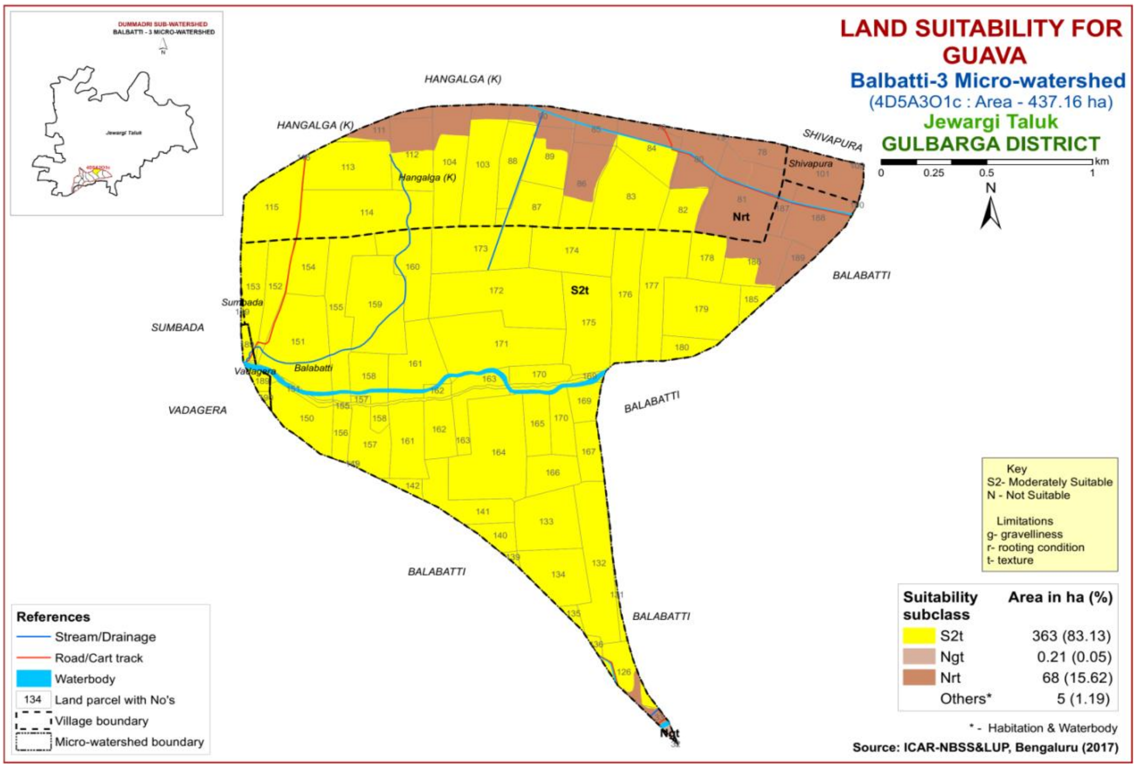



Fig. 7.11 Land Suitability map of Guava

### 7.12 Land Suitability for Jackfruit (*Artocarpus heterophyllus*)

Jackfruit is the most important fruit crop grown in 5368 ha almost all the districts of the State. The crop requirements for growing jackfruit were matched with the soil-site characteristics and a land suitability map for growing jackfruit was generated. The area extent and their geographic distribution of different suitability subclasses in the microwatershed are given in Figure 7.12.

Marginally suitable (Class S3) lands for growing jackfruit occupy a maximum area of about 363 ha (83%) and are distributed in the major part of the microwatershed. They have moderate limitation of texture. An area of about 68 ha (16%) is not suitable (Class N) for growing jackfruit in the microwatershed and occur in the northern part of the microwatershed. They have severe limitations of gravelliness, texture and rooting depth.

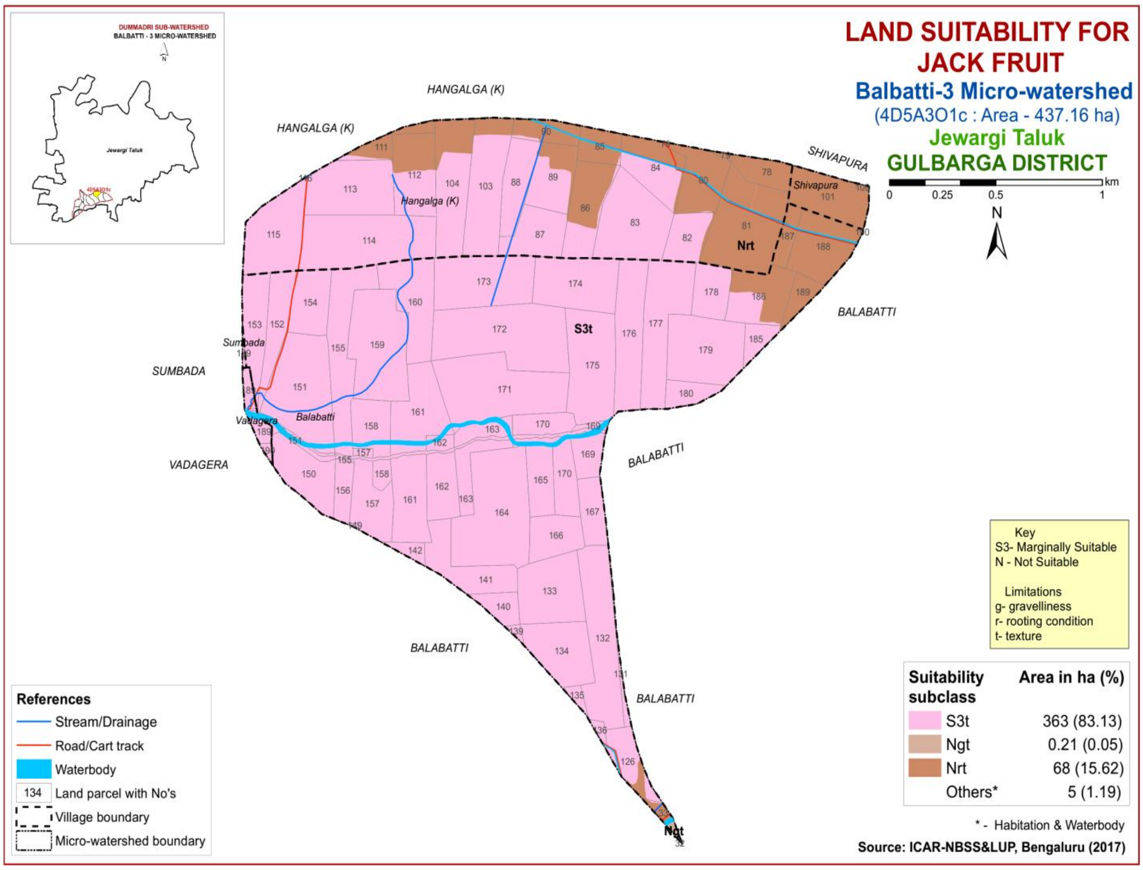



Fig. 7.12 Land Suitability map of Jackfruit

### 7.13 Land Suitability for Jamun (*Syzygium cumini*)

Jamun is an important fruit crop grown in almost all the districts of the State. The crop requirements for growing jamun were matched with the soil-site characteristics and a land suitability map for growing jamun was generated. The area extent and their geographic distribution of different suitability subclasses in the microwatershed are given in Figure 7.13.

Maximum area of 363 ha (83%) is moderately suitable (Class S2) and are distributed in all parts of the microwatershed. They have minor limitation of texture. An area of about 68 ha (16%) is not suitable (Class N) for growing jamun and occur in the northern part of the microwatershed. They have very severe limitations of rooting depth, gravelliness and texture.

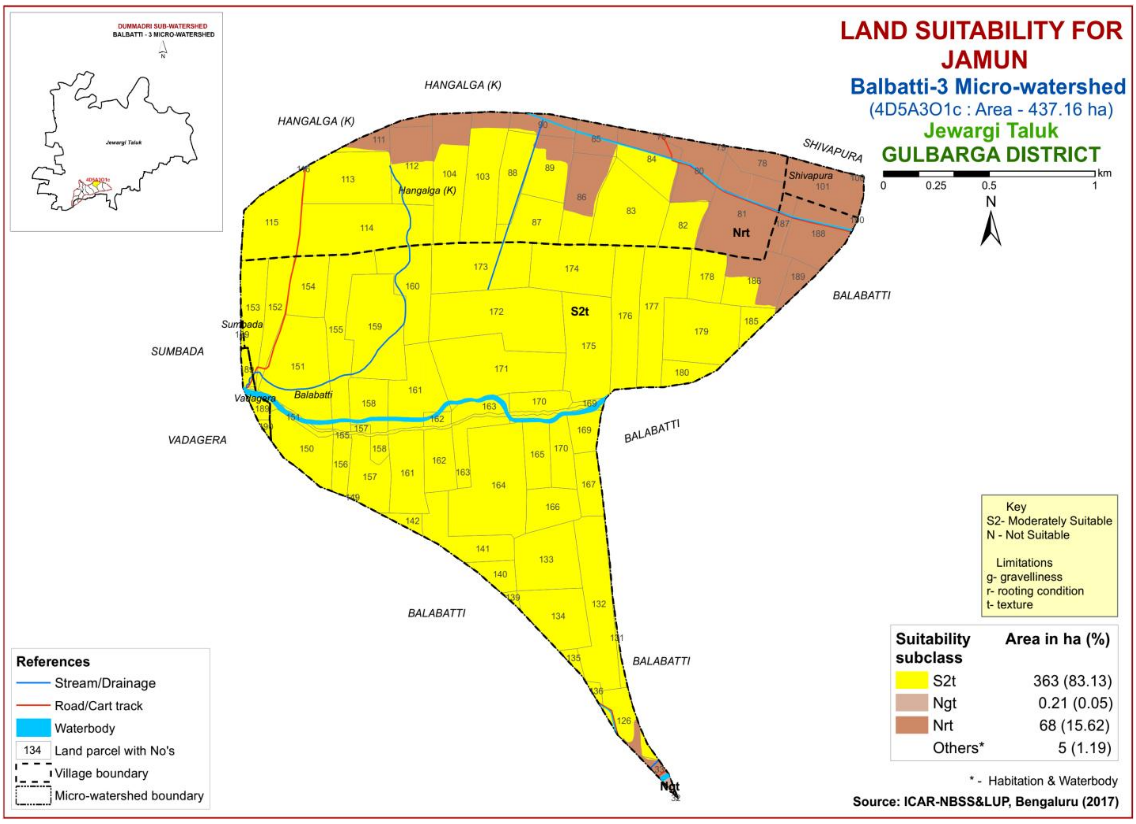



Fig. 7.13 Land Suitability map of Jamun

### 7.14 Land Suitability for Musambi (*Citrus limetta*)

Musambi is the most important fruit crop grown in 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 geographic distribution of different suitability subclasses in the microwatershed are given in Figure 7.14.

Maximum area of about 363 ha (83%) has soils that are highly suitable (Class S1) for growing musambi and are distributed in all parts of the microwatershed. An area of about 68 ha (16%) is not suitable (Class N) for growing musambi and are distributed in the northern part of the microwatershed. They have very severe limitations of gravelliness, slope and rooting depth.

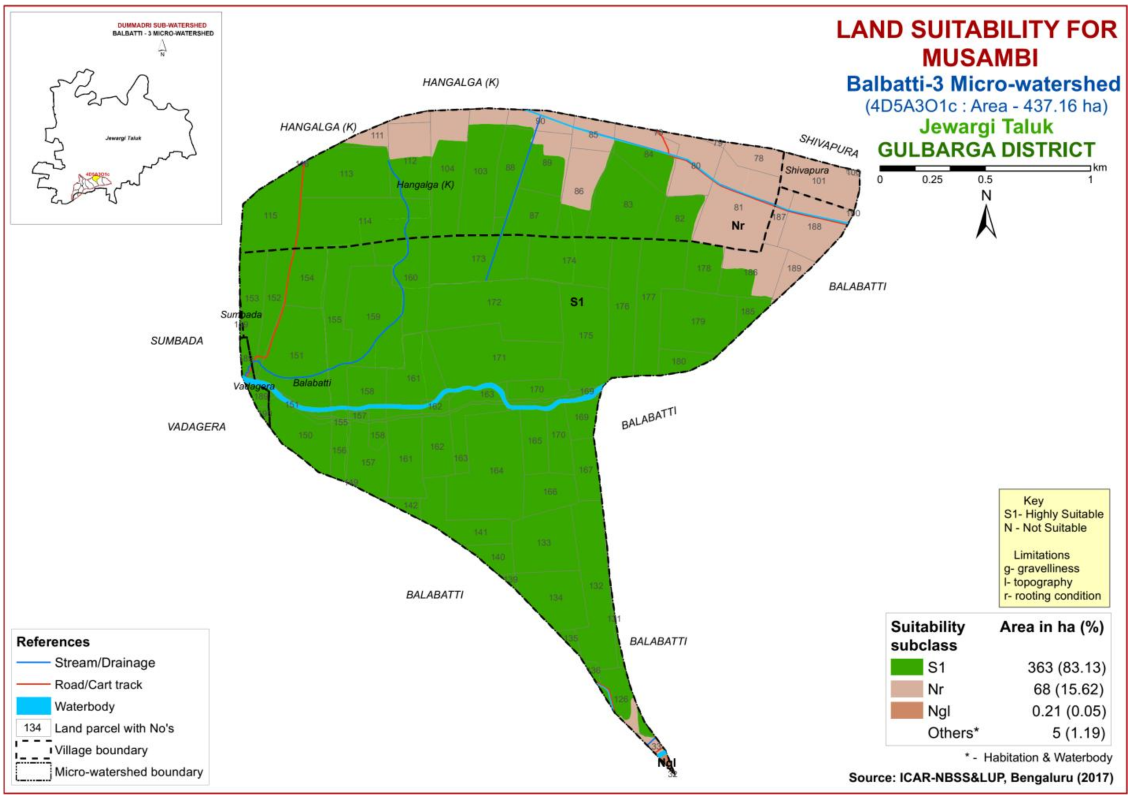



Fig. 7.14 Land Suitability map of Musambi

### 7.15 Land Suitability for Lime (*Citrus sp*)

Lime is one of the most important fruit crop grown in an area of 0.11 lakh ha in almost all the districts of the State. The crop requirements for growing lime (Table 7.12) were matched with the soil-site characteristics (Table 7.1) and a land suitability map for growing lime was generated. The area extent and their geographic distribution of different suitability subclasses in the microwatershed are given in Figure 7.15.

Maximum area of about 363 ha (83%) has soils that are highly suitable (Class S1) for growing lime and are distributed in the all parts of the microwatershed. An area of about 68 ha (16%) is not suitable (Class N) for growing lime and are distributed in the northern part of the microwatershed. They have very severe limitations of gravelliness, slope and rooting depth.

**Table 7.12 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<br>24-27 | 36-40<br>20-23 | >40<br><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 | 5.5-6.4,7.6-8.0 | 4.0-5.4,8.1-8.5 | <4.0,>8.5 |
| | $CaCO_3$ in root zone | % | Non 34calcareous | Upto 5 | 5-10 | >10 |
| Rooting conditions | Soil depth | Cm | >150 | 100-150 | 50-100 | <50 |
| | Gravelcontent | %vol. | Nongravelly | 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 | |

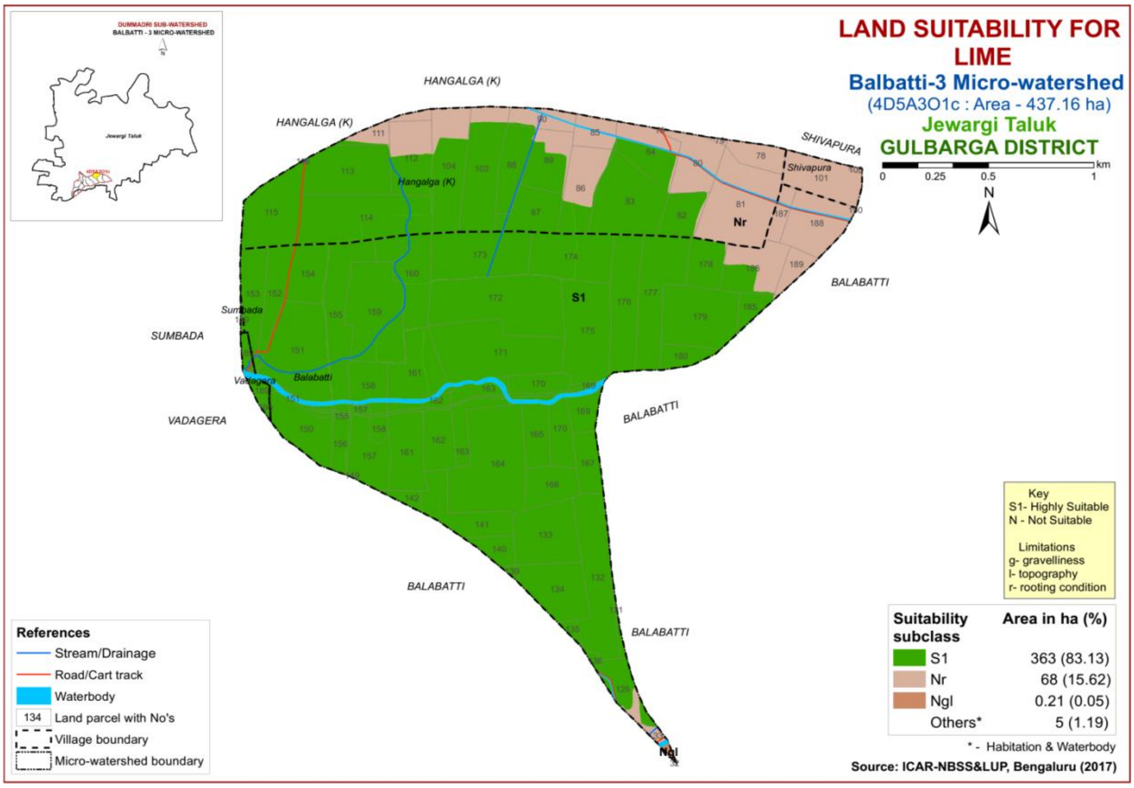



Fig. 7.15 Land Suitability map of Lime

### 7.16 Land Suitability for Cashew (*Anacardium occidentale)*

Cashew is one of the most important nut crop grown in an area of 0.70 lakh ha in almost all the districts of the State. The crop requirements for growing cashew were matched with the soil-site characteristics and a land suitability map for growing cashew was generated. The area extent and their geographic distribution of different suitability subclasses in the microwatershed are given in Figure 7.16.

Entire area is not suitable (Class N) for growing cashew in the microwatershed.they have very severe limitations of texture, gravelliness and rooting depth.

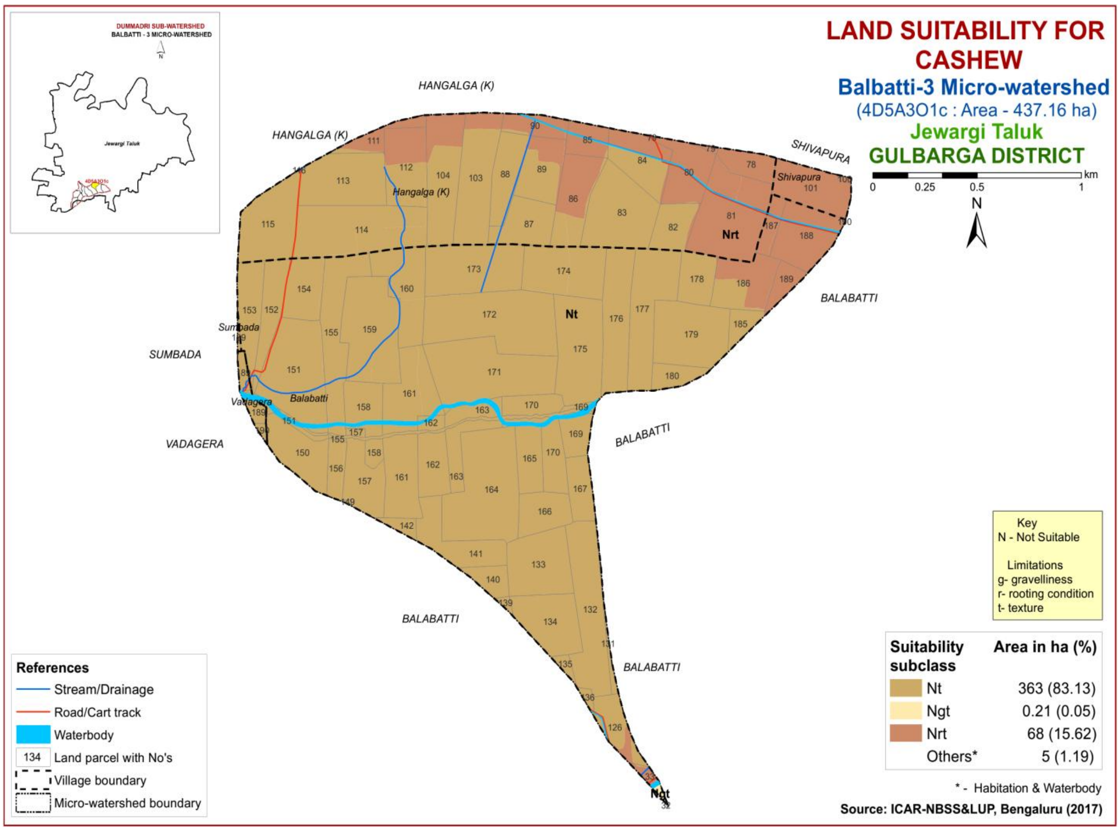



Fig. 7.16 Land Suitability map of Cashew

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

Custard apple is one of the most important fruit crop grown in 1426 ha almost all the districts of the State. The crop requirements for growing custard apple were matched with the soil-site characteristics and a land suitability map for growing custard apple was generated. The area extent and their geographic distribution of different suitability subclasses in the microwatershed are given in Figure 7.17.

Maximum area of about 363 ha (83%) has soils that are highly suitable (Class S1) for growing custard apple and are distributed in all parts of the microwatershed. The marginally suitable (Class S3) lands cover a small area of about 68 ha (16%) and occur in the northern part of the microwatershed. They have moderate limitations of rooting depth. A very minor area of about 0.21 ha (0.05%) is not suitable (Class N) for growing custard apple. They have very severe limitations of gravelliness and slope.

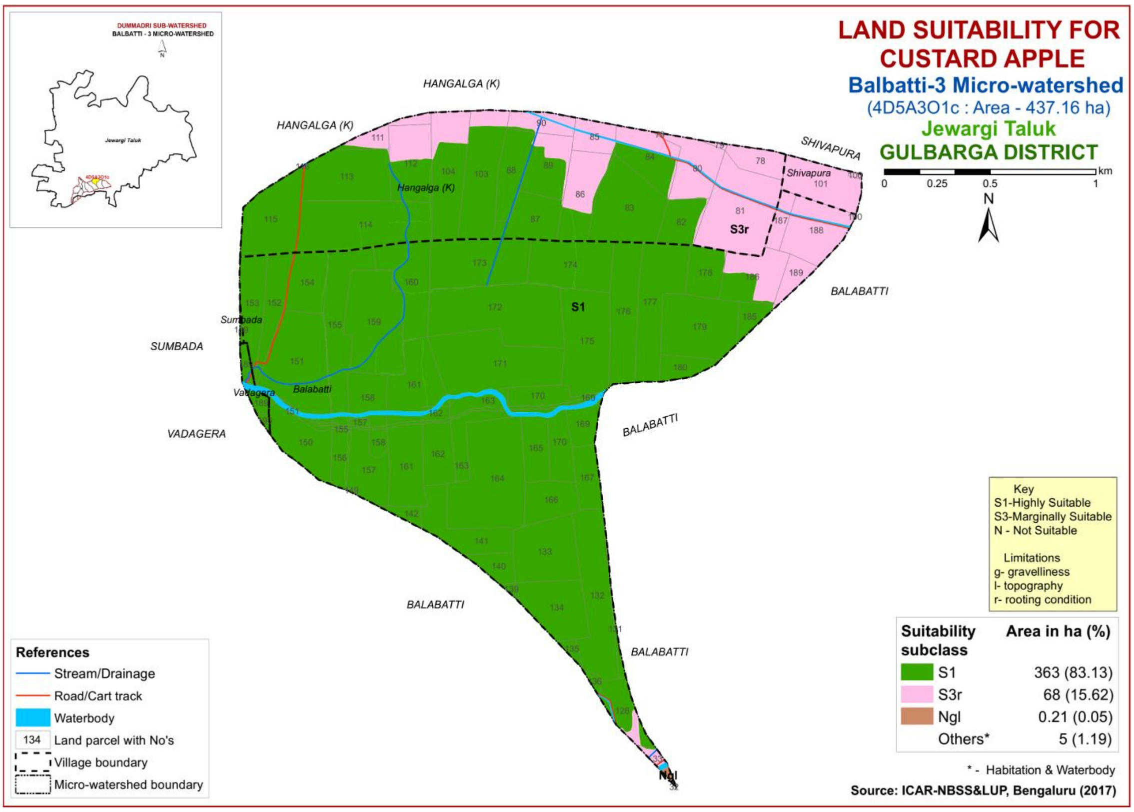



Fig. 7.17 Land Suitability map of Custard Apple

### 7.18 Land Suitability for Amla (*Phyllanthus emblica*)

Amla is one of the fruit and medicinal crop grown in 151 ha almost all the districts of the State. The crop requirements for growing amla were matched with the soil-site characteristics and a land suitability map for growing amla was generated. The area extent and their geographic distribution of different suitability subclasses in the microwatershed are given in Figure 7.18.

An area of about 363 ha (83%) has soils that are highly suitable (Class S1) and are distributed in all parts of the microwatershed. The marginally suitable (Class S3) lands cover a small area of about 68 ha (16%) and occur in the northern part of the microwatershed. They have moderate limitations of rooting depth. A very minor area of about 0.21 ha (0.05%) is not suitable (Class N) for growing custard apple. They have very severe limitations of gravelliness and slope.

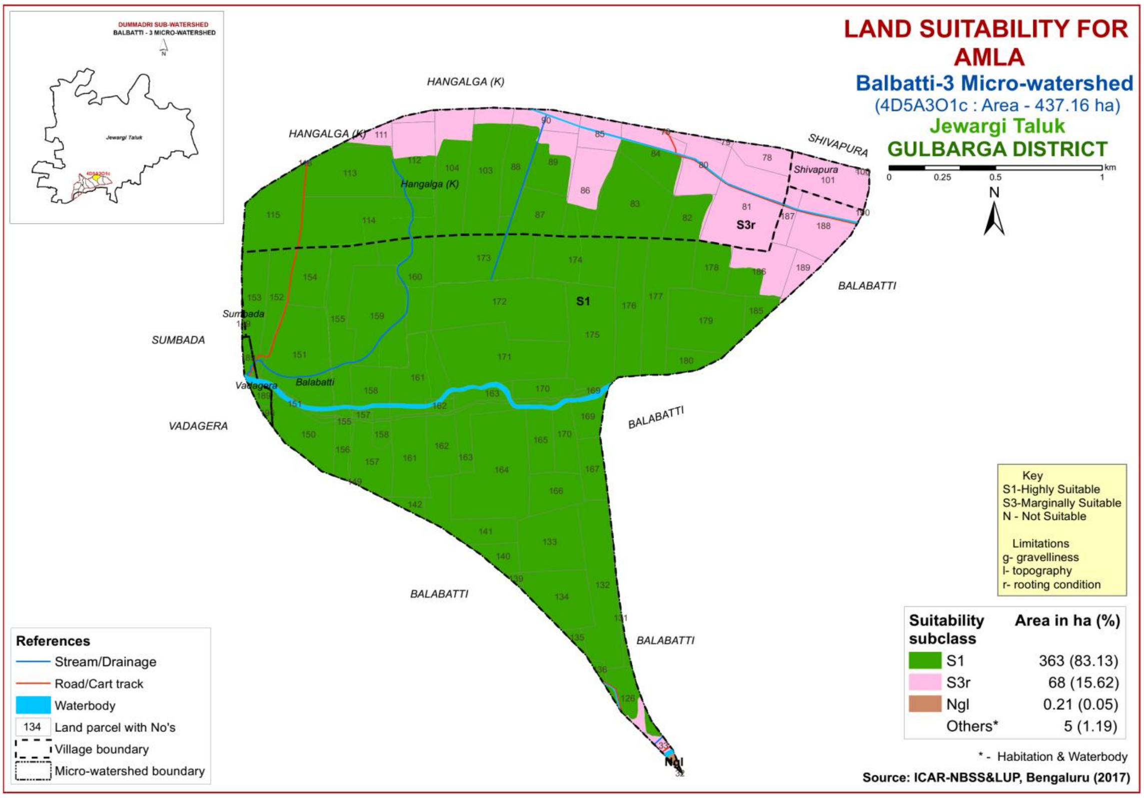



Fig. 7.18 Land Suitability map of Amla

### 7.19 Land Suitability for Tamarind (*Tamarindus indica*)

Tamarind is the most important spice crop grown in 0.14 ha almost all the districts of the state. The crop requirements for growing tamarind were matched with the soil-site characteristics and a land suitability map for growing tamarind was generated. The area extent and their geographical distribution of different suitability subclasses in the microwatershed is given in Figure 7.19.

Maximum area of about 363 ha (83%) has soils that are moderately suitable (Class S2) with minor limitations of texture and are distributed in all parts of the microwatershed. An area of about 68 ha (16%) is not suitable (Class N) for growing tamarind and are distributed in the northern part of the microwatershed. They have very severe limitations of gravelliness, texture and rooting depth.

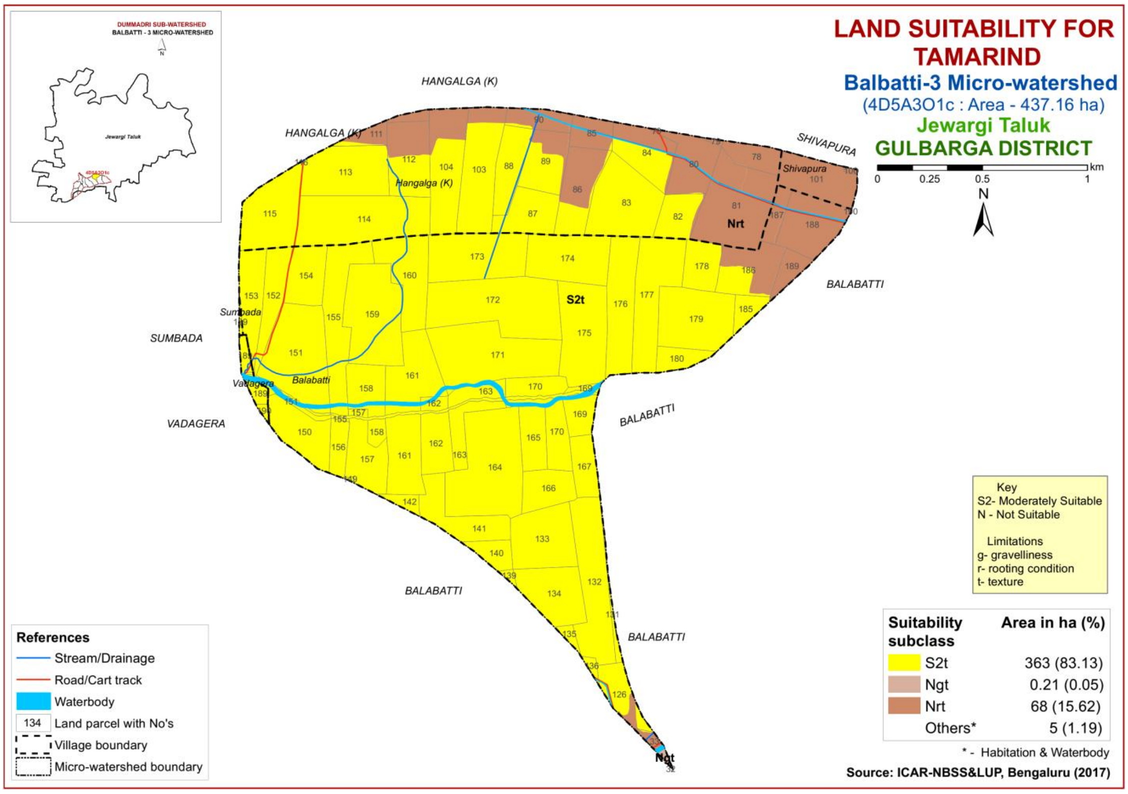



Fig. 7.19 Land Suitability map of Tamarind

### 7.20 Land Use Classes (LUCs)

The 10 soil map units identified in Balbatti-3 microwatershed have been regrouped into 3 Land Use Classes (LUCs) for the purpose of preparing Proposed Crop Plan. Land Use Classes are grouped based on the similarities in respect of the type of soil, the depth of the soil, the surface soil texture, gravel content, AWC, slope, erosion etc. and a Land Use Classes map (Fig.7.20) has been generated. These Land Use Classes are expected to behave similarly for a given level of management.

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

| LUCs | Soil map units | Soil and site characteristics |
|---|---|---|
| 1 | MGTmD3g2 | Very shallow (<25 cm), black clayey soils with slopes of 5-10%, severe erosion and very gravelly (35-60%) |
| 2 | NHAmA1,NHAmB1 SBDmB1 SBDmB2 | Shallow (25-50 cm), black clayey soils with slopes of 0-3%, slight to moderate erosion |
| 3 | BBTmB1, BBTmB2 YDMmA1,YDMmB1, YDMmB2 | Deep to very deep (100 - >150 cm), black calcareous soils with slopes of 0-3%, slight to moderate erosion |

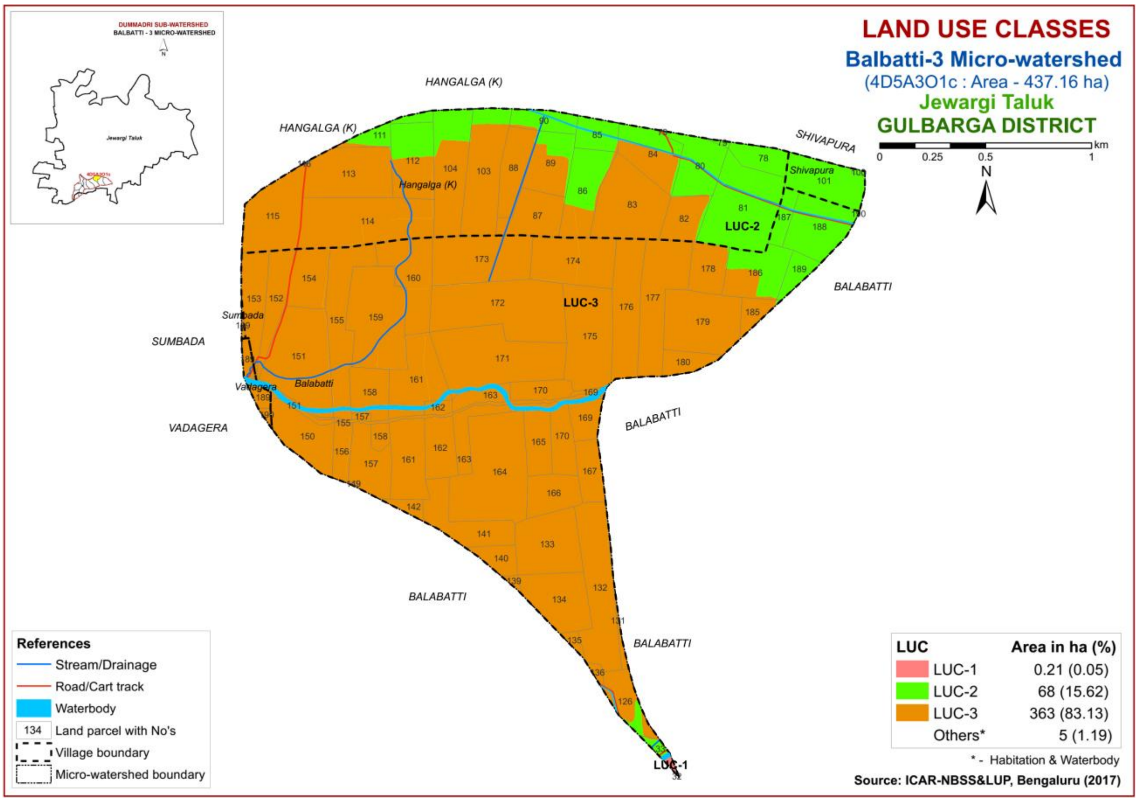



Fig. 7.20 Land Use Classes Map- Balbatti-3 Microwatershed

## 7.21 Proposed Crop Plan for Balbatti-3 Microwatershed

After assessing the land suitability for the 19 crops, the proposed crop plan has been generated for the 3 identified (LUCS) by considering only the highly (Class S1) and moderately (Class S2) suitable lands for each of the 19 crops. The resultant proposed crop plan is presented below in Table 7.13

**Table 7.13 Proposed Crop Plan for Balbatti-3 Microwatershed**

| LUC NO | Mapping unit | Survey No's | Crops proposed | | | | Suitable Intervention |
|---|---|---|---|---|---|---|---|
| | | | Field crops | Forestry Crop/Grasses | Horticulture crops (Rainfed Condition) | Horticulture crops with suitable intervention | |
| LUC-1 0.21ha (0.05%) | MGTmD3g2 | Balabatti: 32 | - | Neem, Glyricydia Silviculture, Agave, Simaroba | - | - | Cresent bunds |
| LUC-2 68 ha (16%) | NHAmA1 NHAmB1 SBDmB1 SBDmB2 | Balabatti: 33,186,187,188, 189,190 Hangalaga: 78,79,80,81,85,86,90,111 Shivapura: 100,101 | Bajra, Linseed, Green gram, Black gram, Chick pea | Neem, Teak | Custard apple, Charoli, Ber, Amla **Vegetables:** Ladies finger, Brinjal, Cowpea, **Flowers:** Marigold, Chrysanthemum | Custard apple, Charoli, Ber, Amla **Vegetables:** Onion, Tomato, Brinjal, Chillies, Bhendi **Flowers:** Marigold, Chrysanthemum | Drip irrigation, suitable soil and water conservations like cultivation on raised beds with mulches and drip |
| LUC-3 363 ha (83%) | BBTmB1 BBTmB2 YDMmA1 YDMmB1 YDMmB2 | Balabatti: 126,131,132,133,134,135,136,139, 140,141,142,149,150,151,152,153, 154,155,156,157,158,159,160,161, 162,163,164,165,166,167,169,170, 171,172,173,174,175,176,177,178, 179, 180,185 Hangalaga: 82,83,84,87,88,89,103,104,112,113, 114,115,116 Sumbada: 139 Vadagera:189,190,STREAM | Sorghum, Cotton, Red Gram Black gram, Green gram, Soybean, Sesame, Sunflower, Safflower, **Rabi:** Sorghum, Chickpea | - | **Vegetables:** Ladies finger, Brinjal, Cowpea, coriander **Perennial component:** Guava, Tamarind, Sapota, Lime, Mosambi **Flowers:** Marigold, Chrysanthemum | Banana, Papaya, Lime. Mosambi, Guava, Tamrind **Vegetables:** Onion, Tomato, Brinjal, Chillies, Bhendi **Flowers:**Marigold , Chrysanthemum | Drip irrigation, suitable soil and water conservations like cultivation on raised beds with mulches and drip, Graded bunds, Strengthening of field bunds |

*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 soil degradation
- Resilience when unfavourable conditions occur

**Characteristics of Balbatti-3 Microwatershed**

- The soil phases with sizeable area identified in the microwatershed belonged to the soil series of (BBT) 214 ha, (YDM) 149 ha, (NHA) 54 ha, (SBD) 14 ha and (MGT) 0.21 ha.
- As per land capability classification, entire area in the microwatershed falls under arable land category (Class II and IV). The major limitations identified in the arable lands were soil and erosion.
- On the basis of soil reaction, entire area is strongly alkaline (pH 8.4 - 9.0) in the microwatershed.

**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 strongly alkaline soils)

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

**Neutral soils**

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

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

**Soil Degradation**

Soil erosion is one of the major factor affecting the soil health in the microwatershed. Out of total 437 ha area in the microwatershed, about of 111 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 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 Plan for each plot or farm.
2. Productivity enhancement measures/ interventions for existing crops/livestock/other farm enterprises.
3. Diversification of farming mainly with perennial horticultural crops and livestock.
4. Improving livelihood opportunities and income generating activities.

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

- **Soil Depth:** The depth of a soil decides the amount of moisture and nutrients it can hold, what crops can be taken up or not, depending on the rooting depth and the length of growing period available for raising any crop. Deeper the soil, better for a wide variety of crops. If sufficient depth is not available for growing deep rooted crops, either choose medium or short duration crops or deeper planting pits need to be opened and additional good quality soil brought from outside has to be filled into the planting pits.
- **Surface soil texture:** Lighter soil texture in the top soil means, better rain water infiltration, less run-off and soil moisture conservation, less capillary rise and less evaporation losses. Lighter surface textured soils are amenable to good soil tilth and are highly suitable for crops like groundnut, root vegetables (carrot, raddish, potato etc) but not ideal for crops that need stagnant water like lowland paddy. Heavy textured soils are poor in water infiltration and percolation. They are prone for sheet erosion; such soils can be improved by sand mulching. The technology that is developed by the AICRP-Dryland Agriculture, Vijayapura, Karnataka can be adopted.
- **Gravelliness:** More gravel content is favorable for run-off harvesting but poor in soil moisture storage and nutrient availability. It is a significant parameter that decides the kind of crop to be raised.
- **Land Capability Classification:** The land capability map shows the areas suitable and not suitable for agriculture and the major constraints in each of the plot/survey number. Hence, one can decide what kind of enterprise is possible in each of these units. In general, erosion and soil are the major constraints in Balbatti-3 microwatershed.
- **Organic Carbon:** The OC content is medium (0.5-0.75%) in maximum area of about 276 ha (63%) area, low (<0.5%) in about 19 ha (4%) and high (>0.5%) in 137 ha (31%). 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

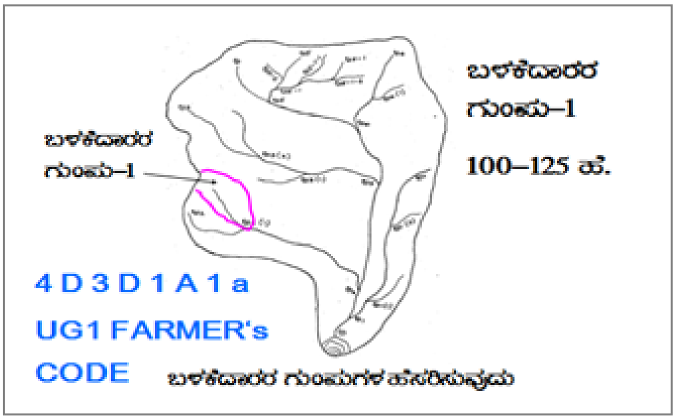
Rs. 5000/ha. The practice needs to be continued for 2-3 years or more. Nitrogen fertilizer needs to be supplemented by 25% in addition to the recommended level in 295 ha out of 437 ha area where OC is medium (0.5-0.75%) and low (<0.5%) For example, for rainfed maize, recommended level is 50 kg N per ha and an additional 12 kg /ha needs to be applied for all the crops grown in these plots.

- **Available Phosphorus**: In 318 ha (73%) area, the available phosphorus is low (<23 kg/ha), medium (23-57 kg/ha) in about 114 ha (26%) area. Hence for all the crops, 25% additional P-needs to be applied.
- **Available Potassium:** Available potassium is high (>337 kg/ha) in the entire area in the microwatershed.
- **Available Sulphur:** Available sulphur is a very critical nutrient for oilseed crops. It is low in 5 ha (1%) area of the microwatershed, medium in an area of about 149 ha (34%) and high (>20 ppm) in about 278 ha (64%). The areas that are low and medium need to be applied with magnesium sulphate or gypsum or Factamphos (p) fertitilizer (13% sulphur) for 2-3 years for the deficiency to be corrected.
- **Available Boron:** It is medium in major area of 302 ha (69%) in the microwatershed, low in an area of 130 ha (30%).These areas need to be applied with sodium borate @ 10kg/ha as a soil application or 0.2% borax as foliar spray to correct the deficiency and high in about 200 ha (24%) area.
- **Available Iron:** It is deficient in an area of 95 ha (22%) 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 337 ha (77 %) in the microwatershed.
- **Available Zinc:** It is deficient (<0.6 ppm) in maximum area 245 ha (56%) of the microwatershed. Application of zinc sulphate @25kg/ha is to be recommended. Sufficient (>0.6 ppm) in 187 ha (43%) area.
- **Soil alkalinity:** The microwatershed has 432 ha (99%) area with soils that are strongly alkaline. These areas need application of gypsum and wherever calcium is in excess, iron pyrites and element sulphur can be recommended. Management practices like treating repeatedly with good quality water to drain out the excess salts and provision of subsurface drainage and growing of salt tolerant crops like Casuarina, Acasia, Neem, Ber etc, are recommended.

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

## SOIL AND WATER CONSERVATION TREATMENT PLAN

For preparing soil and water conservation treatment plan for Balabtti-3 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 has to be collected.

### Steps for Survey and Preparation of Treatment Plan

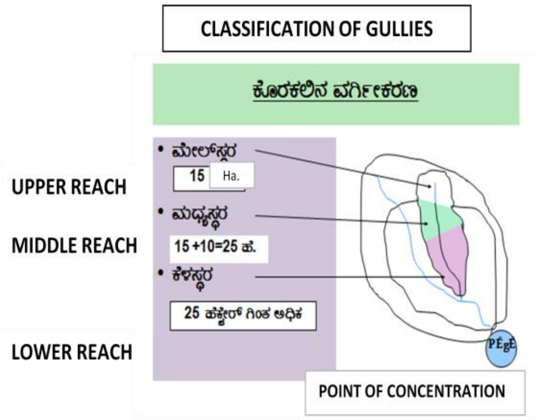
The boundaries of Land User Groups’ and Survey No. boundaries are traced in the field.

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

## 9.1 Treatment Plan

The treatment plan recommended for arable lands is briefly described below

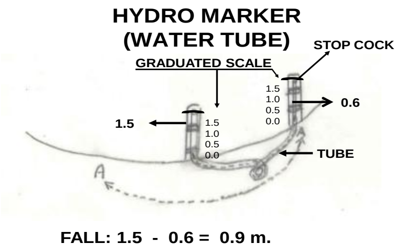
### 9.1.1 Arable Land Treatment

<table>
<tr><td colspan="2">Steps for Survey and Preparation of Treatment Plan</td><td rowspan="6">USER GROUP-1<br>
</td></tr>
<tr><td colspan="2">Cadastral map (1:7920 scale) is enlarged to a scale of 1:2500 scale<br>Existing network of waterways, pothissa boundaries, grass belts, natural drainage lines/ watercourse, cut ups/ terraces are marked on the cadastral map to the scale<br>Drainage lines are demarcated into</td></tr>
<tr><td>Small gullies</td><td>(up to 5 ha catchment)</td></tr>
<tr><td>Mediumgullies</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>

### A. BUNDING

**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

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

**Note:** i) The above intervals are maximum.

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

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

### Section of the Bund

Bund section is decided considering the soil texture class and gravelliness class ($bg_0$.....b= loamy sand, g0=<15% gravel). The recommended Sections for different soils are given below.

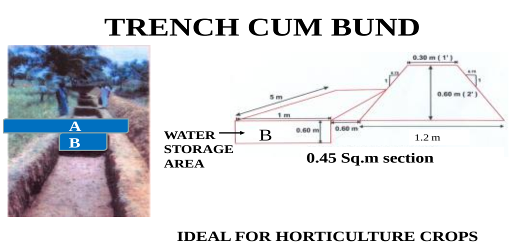
**Recommended Bund Section**

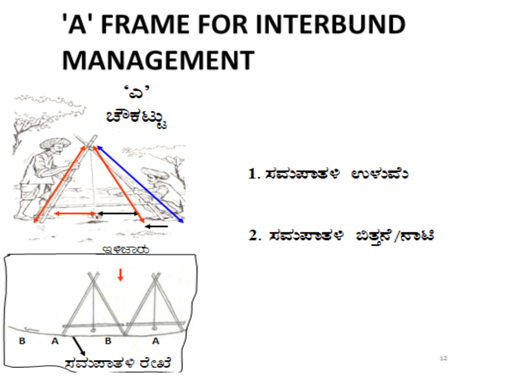
| Top width(m) | Base width(m) | Height (m) | Side slope (Z:1;H:V) | Cross section(sq m) | Soil Texture | Remarks |
|---|---|---|---|---|---|---|
| 0.3 | 0.9 | 0.3 | 01:01 | 0.18 | Sandy loam | Vegetative bund |
| 0.3 | 1.2 | 0.3 | 1.5:1 | 0.225 | Sandy clay | |
| 0.3 | 1.2 | 0.5 | 0.9:1 | 0.375 | Red gravelly soil | |
| 0.3 | 1.2 | 0.6 | 0.75:1 | 0.45 | | |
| 0.3 | 1.5 | 0.6 | 01:01 | 0.54 | Red sandy loam | |
| 0.3 | 2.1 | 0.6 | 1.5:1 | 0.72 | Very shallow blacksoils | |
| 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 water ways 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 Bunds are formed in the field.

### 9.1.3 Treatment of Natural Water Course/ Drainage Lines

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

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

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

d) Number of storage structures (Check dam/ *Nala* bund/ Percolation tank) will be decided considering the commitments and available runoff 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 earthen checks in the natural water course. Location and design details are given in the Manual.

### 9.2 Recommended Soil and Water Conservation Measures

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

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

A map **(Fig. 9.1)** showing soil and water conservation plan with different kinds of structures recommended has been generated which shows the spatial distribution and extent of area. A maximum area of about 363 ha (83%) needs graded bunds or strengthening of existing bunds and about 69 ha (16%) area requires crescent bunding. The conservation plan generated 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.

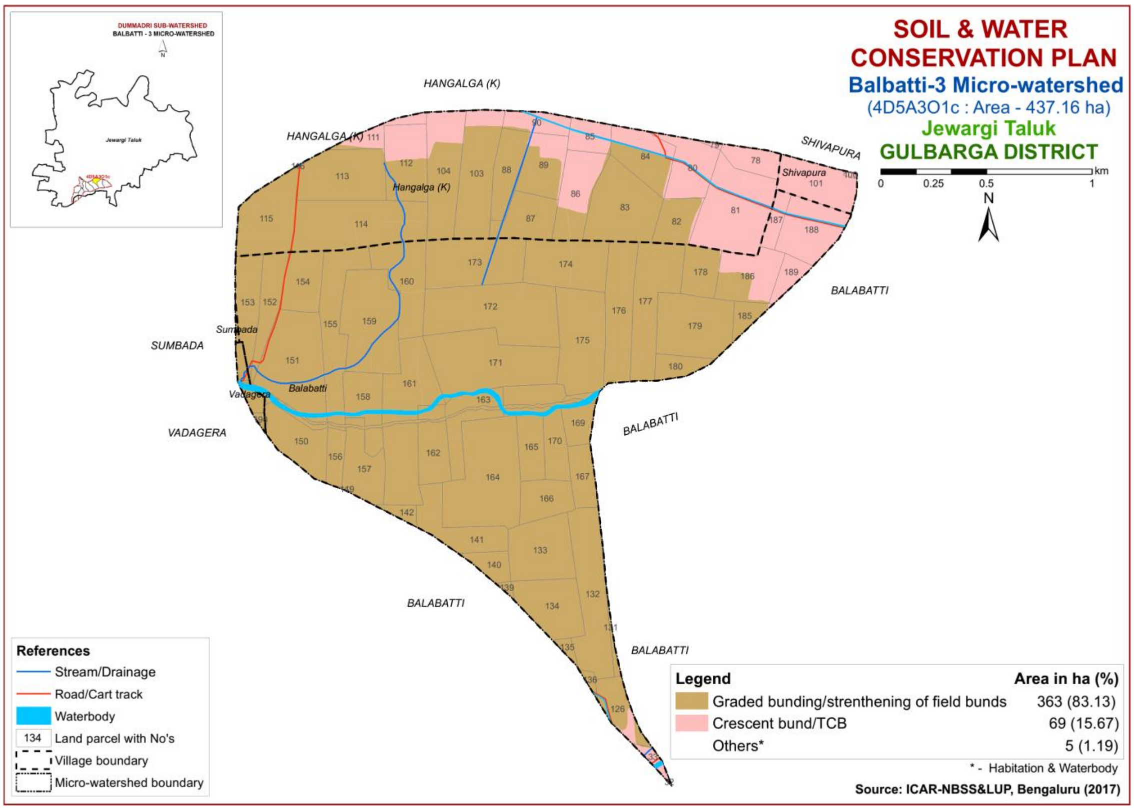



Fig. 9.1 Soil and Water Conservation Plan map of Balbatti-3 Microwatershed

### 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** | | | **Temp (°C)** | **Rainfall (mm)** |
| 15. | Teak | *Tectona grandis* | 20 - 50 | 500-5000 |
| 16. | Nandi | *Legarstroemia lanceolata* | 20 - 40 | 500 - 4000 |
| 17. | Honne | *Pterocarpus marsupium* | 20 - 40 | 500 - 3000 |
| 18. | Mathi | *Terminalia alata* | 20 -50 | 500 - 2000 |
| 19. | Shivane | *Gmelina arboria* | 20 -50 | 500 -2000 |
| 20. | Kindal | *T.Paniculata* | 20 - 40 | 500 - 1500 |
| 21. | Beete | *Dalbargia latifolia* | 20 - 40 | 500 - 1500 |
| 22. | Tare | *T. belerica* | 20 - 40 | 500 - 2000 |
| 23. | Bamboo | *Bambusa arundinasia* | 20 - 40 | 500 - 2500 |
| 24. | Bamboo | *Dendrocalamus strictus* | 20 – 40 | 500 – 2500 |
| 25. | Muthuga | *Butea monosperma* | 20 - 40 | 400 - 1500 |
| 26. | Hippe | *Madhuca latifolia* | 20 - 40 | 500 - 2000 |
| 27. | Sandal | *Santalum album* | 20 - 50 | 400 - 1000 |
| 28. | Nelli | *Emblica officinalis* | 20 - 40 | 500 - 2000 |
| 29. | Nerale | *Sizyzium cumini* | 20 - 40 | 500 - 2000 |
| 30. | Dhaman | *Grevia tilifolia* | 20 - 40 | 500 - 2000 |
| 31. | Kaval | *Careya arborea* | 20 - 40 | 500 - 2000 |
| 32. | Harada | *Terminalia chebula* | 20 - 40 | 500 - 2000 |

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# Appendix I

## Balbatti-3 Microwatershed

## Soil Phase Information

| Village | Sy. No | Total 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Balabatti | 32 | 0.02 | MGTmD3g2 | LUC-1 | Very shallow (<25 cm) | Clay | Very gravelly (35-60%) | Very low (<50 mm/m) | Moderately sloping (5-10%) | Severe | Not Available (NA) | Not Available | VIse | Crescent bund/TCB |
| Balabatti | 33 | 0.87 | SBDmB2 | LUC-2 | Shallow (25-50 cm) | Clay | Non gravelly (<15%) | Low (51-100 mm/m) | Very gently sloping (1-3%) | Moderate | Not Available (NA) | Not Available | IVs | Crescent bund/TCB |
| Balabatti | 126 | 3.87 | BBTmB2 | LUC-3 | Deep (100-150 cm) | Clay | Non gravelly (<15%) | Very high (>200 mm/m) | Very gently sloping (1-3%) | Moderate | Paddy(Pd) | Not Available | IIse | Graded bunding/strenthening of field bunds |
| Balabatti | 131 | 0.74 | BBTmB2 | LUC-3 | Deep (100-150 cm) | Clay | Non gravelly (<15%) | Very high (>200 mm/m) | Very gently sloping (1-3%) | Moderate | Not Available (NA) | Not Available | IIse | Graded bunding/strenthening of field bunds |
| Balabatti | 132 | 11.2 | BBTmB2 | LUC-3 | Deep (100-150 cm) | Clay | Non gravelly (<15%) | Very high (>200 mm/m) | Very gently sloping (1-3%) | Moderate | Paddy(Pd) | Not Available | IIse | Graded bunding/strenthening of field bunds |
| Balabatti | 133 | 8.42 | BBTmB2 | LUC-3 | Deep (100-150 cm) | Clay | Non gravelly (<15%) | Very high (>200 mm/m) | Very gently sloping (1-3%) | Moderate | Paddy(Pd) | Not Available | IIse | Graded bunding/strenthening of field bunds |
| Balabatti | 134 | 7.2 | BBTmB2 | LUC-3 | Deep (100-150 cm) | Clay | Non gravelly (<15%) | Very high (>200 mm/m) | Very gently sloping (1-3%) | Moderate | Paddy(Pd) | Not Available | IIse | Graded bunding/strenthening of field bunds |
| Balabatti | 135 | 0.64 | BBTmB2 | LUC-3 | Deep (100-150 cm) | Clay | Non gravelly (<15%) | Very high (>200 mm/m) | Very gently sloping (1-3%) | Moderate | Not Available (NA) | Not Available | IIse | Graded bunding/strenthening of field bunds |
| Balabatti | 136 | 0.47 | BBTmB2 | LUC-3 | Deep (100-150 cm) | Clay | Non gravelly (<15%) | Very high (>200 mm/m) | Very gently sloping (1-3%) | Moderate | Not Available (NA) | Not Available | IIse | Graded bunding/strenthening of field bunds |
| Balabatti | 139 | 0.33 | BBTmB2 | LUC-3 | Deep (100-150 cm) | Clay | Non gravelly (<15%) | Very high (>200 mm/m) | Very gently sloping (1-3%) | Moderate | Not Available (NA) | Not Available | IIse | Graded bunding/strenthening of field bunds |
| Balabatti | 140 | 2.23 | BBTmB2 | LUC-3 | Deep (100-150 cm) | Clay | Non gravelly (<15%) | Very high (>200 mm/m) | Very gently sloping (1-3%) | Moderate | Paddy(Pd) | Not Available | IIse | Graded bunding/strenthening of field bunds |
| Balabatti | 141 | 6.24 | BBTmB2 | LUC-3 | Deep (100-150 cm) | Clay | Non gravelly (<15%) | Very high (>200 mm/m) | Very gently sloping (1-3%) | Moderate | Paddy(Pd) | Not Available | IIse | Graded bunding/strenthening of field bunds |
| Balabatti | 142 | 1.06 | BBTmB2 | LUC-3 | Deep (100-150 cm) | Clay | Non gravelly (<15%) | Very high (>200 mm/m) | Very gently sloping (1-3%) | Moderate | Not Available (NA) | Not Available | IIse | Graded bunding/strenthening of field bunds |
| Balabatti | 149 | 0.08 | BBTmB2 | LUC-3 | Deep (100-150 cm) | Clay | Non gravelly (<15%) | Very high (>200 mm/m) | Very gently sloping (1-3%) | Moderate | Not Available (NA) | Not Available | IIse | Graded bunding/strenthening of field bunds |
| Balabatti | 150 | 6.16 | BBTmB1 | LUC-3 | Deep (100-150 cm) | Clay | Non gravelly (<15%) | Very high (>200 mm/m) | Very gently sloping (1-3%) | Slight | Redgram+Cotton (Rg+Ct) | Not Available | IIs | Graded bunding/strenthening of field bunds |
| Balabatti | 151 | 13.62 | BBTmB1 | LUC-3 | Deep (100-150 cm) | Clay | Non gravelly (<15%) | Very high (>200 mm/m) | Very gently sloping (1-3%) | Slight | Redgram+Cotton (Rg+Ct) | Not Available | IIs | Graded bunding/strenthening of field bunds |
| Balabatti | 152 | 4.57 | BBTmB1 | LUC-3 | Deep (100-150 cm) | Clay | Non gravelly (<15%) | Very high (>200 mm/m) | Very gently sloping (1-3%) | Slight | Not Available (NA) | Not Available | IIs | Graded bunding/strenthening of field bunds |
| Balabatti | 153 | 5.13 | BBTmB1 | LUC-3 | Deep (100-150 cm) | Clay | Non gravelly (<15%) | Very high (>200 mm/m) | Very gently sloping (1-3%) | Slight | Not Available (NA) | Not Available | IIs | Graded bunding/strenthening of field bunds |
| Balabatti | 154 | 4.96 | BBTmB1 | LUC-3 | Deep (100-150 cm) | Clay | Non gravelly (<15%) | Very high (>200 mm/m) | Very gently sloping (1-3%) | Slight | Redgram(Rg) | Not Available | IIs | Graded bunding/strenthening of field bunds |
| Balabatti | 155 | 9.49 | YDMmA1 | LUC-3 | Very deep (>150 cm) | Clay | Non gravelly (<15%) | Very high (>200 mm/m) | Nearly level (0-1%) | Slight | Cotton(Ct) | Not Available | IIs | Graded bunding/strenthening of field bunds |
| Balabatti | 156 | 2.17 | BBTmB1 | LUC-3 | Deep (100-150 cm) | Clay | Non gravelly (<15%) | Very high (>200 mm/m) | Very gently sloping (1-3%) | Slight | Redgram(Rg) | Not Available | IIs | Graded bunding/strenthening of field bunds |
| Balabatti | 157 | 5.54 | BBTmB2 | LUC-3 | Deep (100-150 cm) | Clay | Non gravelly (<15%) | Very high (>200 mm/m) | Very gently sloping (1-3%) | Moderate | Cotton+Paddy (Ct+Pd) | Not Available | IIse | Graded bunding/strenthening of field bunds |

| Village | Sy. No | Total 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Balabatti | 158 | 5.23 | YDMmB2 | LUC-3 | Very deep (>150 cm) | Clay | Non gravelly (<15%) | Very high (>200 mm/m) | Very gently sloping (1-3%) | Moderate | Paddy(Pd) | Not Available | IIse | Graded bunding/strenthening of field bunds |
| Balabatti | 159 | 12.1 | YDMmA1 | LUC-3 | Very deep (>150 cm) | Clay | Non gravelly (<15%) | Very high (>200 mm/m) | Nearly level (0-1%) | Slight | Cotton+Redgram (Ct+Rg) | Not Available | IIs | Graded bunding/strenthening of field bunds |
| Balabatti | 160 | 7.65 | BBTmB1 | LUC-3 | Deep (100-150 cm) | Clay | Non gravelly (<15%) | Very high (>200 mm/m) | Very gently sloping (1-3%) | Slight | Cotton+Redgram (Ct+Rg) | Not Available | IIs | Graded bunding/strenthening of field bunds |
| Balabatti | 161 | 13.89 | BBTmB2 | LUC-3 | Deep (100-150 cm) | Clay | Non gravelly (<15%) | Very high (>200 mm/m) | Very gently sloping (1-3%) | Moderate | Paddy(Pd) | Not Available | IIse | Graded bunding/strenthening of field bunds |
| Balabatti | 162 | 5.03 | BBTmB2 | LUC-3 | Deep (100-150 cm) | Clay | Non gravelly (<15%) | Very high (>200 mm/m) | Very gently sloping (1-3%) | Moderate | Paddy(Pd) | Not Available | IIse | Graded bunding/strenthening of field bunds |
| Balabatti | 163 | 4.98 | BBTmB2 | LUC-3 | Deep (100-150 cm) | Clay | Non gravelly (<15%) | Very high (>200 mm/m) | Very gently sloping (1-3%) | Moderate | Not Available (NA) | Not Available | IIse | Graded bunding/strenthening of field bunds |
| Balabatti | 164 | 15.6 | BBTmB2 | LUC-3 | Deep (100-150 cm) | Clay | Non gravelly (<15%) | Very high (>200 mm/m) | Very gently sloping (1-3%) | Moderate | Paddy(Pd) | Not Available | IIse | Graded bunding/strenthening of field bunds |
| Balabatti | 165 | 3.78 | BBTmB2 | LUC-3 | Deep (100-150 cm) | Clay | Non gravelly (<15%) | Very high (>200 mm/m) | Very gently sloping (1-3%) | Moderate | Paddy(Pd) | Not Available | IIse | Graded bunding/strenthening of field bunds |
| Balabatti | 166 | 4.36 | BBTmB2 | LUC-3 | Deep (100-150 cm) | Clay | Non gravelly (<15%) | Very high (>200 mm/m) | Very gently sloping (1-3%) | Moderate | Paddy(Pd) | Not Available | IIse | Graded bunding/strenthening of field bunds |
| Balabatti | 167 | 3.32 | BBTmB2 | LUC-3 | Deep (100-150 cm) | Clay | Non gravelly (<15%) | Very high (>200 mm/m) | Very gently sloping (1-3%) | Moderate | Paddy(Pd) | Not Available | IIse | Graded bunding/strenthening of field bunds |
| Balabatti | 169 | 3.13 | BBTmB2 | LUC-3 | Deep (100-150 cm) | Clay | Non gravelly (<15%) | Very high (>200 mm/m) | Very gently sloping (1-3%) | Moderate | Not Available (NA) | Not Available | IIse | Graded bunding/strenthening of field bunds |
| Balabatti | 170 | 6.79 | BBTmB2 | LUC-3 | Deep (100-150 cm) | Clay | Non gravelly (<15%) | Very high (>200 mm/m) | Very gently sloping (1-3%) | Moderate | Paddy(Pd) | Not Available | IIse | Graded bunding/strenthening of field bunds |
| Balabatti | 171 | 14.42 | YDMmB1 | LUC-3 | Very deep (>150 cm) | Clay | Non gravelly (<15%) | Very high (>200 mm/m) | Very gently sloping (1-3%) | Slight | Paddy(Pd) | Not Available | IIs | Graded bunding/strenthening of field bunds |
| Balabatti | 172 | 15.51 | YDMmB1 | LUC-3 | Very deep (>150 cm) | Clay | Non gravelly (<15%) | Very high (>200 mm/m) | Very gently sloping (1-3%) | Slight | Paddy(Pd) | Not Available | IIs | Graded bunding/strenthening of field bunds |
| Balabatti | 173 | 10.28 | BBTmB1 | LUC-3 | Deep (100-150 cm) | Clay | Non gravelly (<15%) | Very high (>200 mm/m) | Very gently sloping (1-3%) | Slight | Paddy(Pd) | Not Available | IIs | Graded bunding/strenthening of field bunds |
| Balabatti | 174 | 8.72 | BBTmB1 | LUC-3 | Deep (100-150 cm) | Clay | Non gravelly (<15%) | Very high (>200 mm/m) | Very gently sloping (1-3%) | Slight | Paddy(Pd) | Not Available | IIs | Graded bunding/strenthening of field bunds |
| Balabatti | 175 | 10.63 | YDMmB1 | LUC-3 | Very deep (>150 cm) | Clay | Non gravelly (<15%) | Very high (>200 mm/m) | Very gently sloping (1-3%) | Slight | Paddy(Pd) | Not Available | IIs | Graded bunding/strenthening of field bunds |
| Balabatti | 176 | 8.56 | YDMmB1 | LUC-3 | Very deep (>150 cm) | Clay | Non gravelly (<15%) | Very high (>200 mm/m) | Very gently sloping (1-3%) | Slight | Paddy(Pd) | Not Available | IIs | Graded bunding/strenthening of field bunds |
| Balabatti | 177 | 10 | YDMmB1 | LUC-3 | Very deep (>150 cm) | Clay | Non gravelly (<15%) | Very high (>200 mm/m) | Very gently sloping (1-3%) | Slight | Paddy(Pd) | Not Available | IIs | Graded bunding/strenthening of field bunds |
| Balabatti | 178 | 3.9 | YDMmB1 | LUC-3 | Very deep (>150 cm) | Clay | Non gravelly (<15%) | Very high (>200 mm/m) | Very gently sloping (1-3%) | Slight | Redgram(Rg) | Not Available | IIs | Graded bunding/strenthening of field bunds |
| Balabatti | 179 | 9.95 | YDMmB1 | LUC-3 | Very deep (>150 cm) | Clay | Non gravelly (<15%) | Very high (>200 mm/m) | Very gently sloping (1-3%) | Slight | Paddy(Pd) | Not Available | IIs | Graded bunding/strenthening of field bunds |
| Balabatti | 180 | 2.34 | YDMmB1 | LUC-3 | Very deep (>150 cm) | Clay | Non gravelly (<15%) | Very high (>200 mm/m) | Very gently sloping (1-3%) | Slight | Not Available (NA) | Not Available | IIs | Graded bunding/strenthening of field bunds |
| Balabatti | 185 | 1.84 | YDMmB1 | LUC-3 | Very deep (>150 cm) | Clay | Non gravelly (<15%) | Very high (>200 mm/m) | Very gently sloping (1-3%) | Slight | Not Available (NA) | Not Available | IIs | Graded bunding/strenthening of field bunds |
| Balabatti | 186 | 6.56 | NHAmB1 | LUC-2 | Shallow (25-50 cm) | Clay | Non gravelly (<15%) | Low (51-100 mm/m) | Very gently sloping (1-3%) | Slight | Redgram(Rg) | Not Available | IVs | Crescent bund/TCB |

| Village | Sy. No | Total 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Balabatti | 187 | 1.96 | NHAmB1 | LUC-2 | Shallow (25-50 cm) | Clay | Non gravelly (<15%) | Low (51-100 mm/m) | Very gently sloping (1-3%) | Slight | Not Available (NA) | Not Available | IVs | Crescent bund/TCB |
| Balabatti | 188 | 7.23 | NHAmA1 | LUC-2 | Shallow (25-50 cm) | Clay | Non gravelly (<15%) | Low (51-100 mm/m) | Nearly level (0-1%) | Slight | Cotton(Ct) | Not Available | IVs | Crescent bund/TCB |
| Balabatti | 189 | 2.03 | NHAmA1 | LUC-2 | Shallow (25-50 cm) | Clay | Non gravelly (<15%) | Low (51-100 mm/m) | Nearly level (0-1%) | Slight | Cotton(Ct) | Not Available | IVs | Crescent bund/TCB |
| Balabatti | 190 | 0.01 | NHAmA1 | LUC-2 | Shallow (25-50 cm) | Clay | Non gravelly (<15%) | Low (51-100 mm/m) | Nearly level (0-1%) | Slight | Not Available (NA) | Not Available | IVs | Crescent bund/TCB |
| Hangalga (K) | 78 | 2.94 | NHAmA1 | LUC-2 | Shallow (25-50 cm) | Clay | Non gravelly (<15%) | Low (51-100 mm/m) | Nearly level (0-1%) | Slight | Cotton(Ct) | Not Available | IVs | Crescent bund/TCB |
| Hangalga (K) | 79_GF | 0.26 | NHAmB1 | LUC-2 | Shallow (25-50 cm) | Clay | Non gravelly (<15%) | Low (51-100 mm/m) | Very gently sloping (1-3%) | Slight | Not Available (NA) | Not Available | IVs | Crescent bund/TCB |
| Hangalga (K) | 80 | 5.68 | NHAmB1 | LUC-2 | Shallow (25-50 cm) | Clay | Non gravelly (<15%) | Low (51-100 mm/m) | Very gently sloping (1-3%) | Slight | Redgram(Rg) | Not Available | IVs | Crescent bund/TCB |
| Hangalga (K) | 81 | 12.56 | NHAmB1 | LUC-2 | Shallow (25-50 cm) | Clay | Non gravelly (<15%) | Low (51-100 mm/m) | Very gently sloping (1-3%) | Slight | Redgram+Cotton (Rg+Ct) | Not Available | IVs | Crescent bund/TCB |
| Hangalga (K) | 82 | 3.9 | YDMmB1 | LUC-3 | Very deep (>150 cm) | Clay | Non gravelly (<15%) | Very high (>200 mm/m) | Very gently sloping (1-3%) | Slight | Redgram(Rg) | Not Available | IIs | Graded bunding/strenthening of field bunds |
| Hangalga (K) | 83 | 10.41 | YDMmB1 | LUC-3 | Very deep (>150 cm) | Clay | Non gravelly (<15%) | Very high (>200 mm/m) | Very gently sloping (1-3%) | Slight | Redgram+Cotton (Rg+Ct) | Not Available | IIs | Graded bunding/strenthening of field bunds |
| Hangalga (K) | 84 | 6.23 | YDMmB1 | LUC-3 | Very deep (>150 cm) | Clay | Non gravelly (<15%) | Very high (>200 mm/m) | Very gently sloping (1-3%) | Slight | Redgram(Rg) | Not Available | IIs | Graded bunding/strenthening of field bunds |
| Hangalga (K) | 85 | 2.9 | NHAmB1 | LUC-2 | Shallow (25-50 cm) | Clay | Non gravelly (<15%) | Low (51-100 mm/m) | Very gently sloping (1-3%) | Slight | Redgram(Rg) | Not Available | IVs | Crescent bund/TCB |
| Hangalga (K) | 86 | 6.8 | NHAmB1 | LUC-2 | Shallow (25-50 cm) | Clay | Non gravelly (<15%) | Low (51-100 mm/m) | Very gently sloping (1-3%) | Slight | Redgram+Cotton (Rg+Ct) | Not Available | IVs | Crescent bund/TCB |
| Hangalga (K) | 87 | 5.31 | BBTmB1 | LUC-3 | Deep (100-150 cm) | Clay | Non gravelly (<15%) | Very high (>200 mm/m) | Very gently sloping (1-3%) | Slight | Cotton(Ct) | Not Available | IIs | Graded bunding/strenthening of field bunds |
| Hangalga (K) | 88 | 4.94 | BBTmB1 | LUC-3 | Deep (100-150 cm) | Clay | Non gravelly (<15%) | Very high (>200 mm/m) | Very gently sloping (1-3%) | Slight | Redgram+Cotton (Rg+Ct) | Not Available | IIs | Graded bunding/strenthening of field bunds |
| Hangalga (K) | 89 | 5.63 | BBTmB1 | LUC-3 | Deep (100-150 cm) | Clay | Non gravelly (<15%) | Very high (>200 mm/m) | Very gently sloping (1-3%) | Slight | Redgram+Cotton (Rg+Ct) | Not Available | IIs | Graded bunding/strenthening of field bunds |
| Hangalga (K) | 90 | 2.94 | SBDmB1 | LUC-2 | Shallow (25-50 cm) | Clay | Non gravelly (<15%) | Low (51-100 mm/m) | Very gently sloping (1-3%) | Slight | Redgram(Rg) | Not Available | IVs | Crescent bund/TCB |
| Hangalga (K) | 103 | 10.04 | BBTmB1 | LUC-3 | Deep (100-150 cm) | Clay | Non gravelly (<15%) | Very high (>200 mm/m) | Very gently sloping (1-3%) | Slight | Paddy+Redgram (Pd+Rg) | Not Available | IIs | Graded bunding/strenthening of field bunds |
| Hangalga (K) | 104 | 9.23 | BBTmB1 | LUC-3 | Deep (100-150 cm) | Clay | Non gravelly (<15%) | Very high (>200 mm/m) | Very gently sloping (1-3%) | Slight | Redgram+Paddy (Rg+Pd) | Not Available | IIs | Graded bunding/strenthening of field bunds |
| Hangalga (K) | 111 | 2.49 | SBDmB1 | LUC-2 | Shallow (25-50 cm) | Clay | Non gravelly (<15%) | Low (51-100 mm/m) | Very gently sloping (1-3%) | Slight | Not Available (NA) | Not Available | IVs | Crescent bund/TCB |
| Hangalga (K) | 112 | 7.12 | BBTmB1 | LUC-3 | Deep (100-150 cm) | Clay | Non gravelly (<15%) | Very high (>200 mm/m) | Very gently sloping (1-3%) | Slight | Redgram(Rg) | Not Available | IIs | Graded bunding/strenthening of field bunds |
| Hangalga (K) | 113 | 9.33 | BBTmB1 | LUC-3 | Deep (100-150 cm) | Clay | Non gravelly (<15%) | Very high (>200 mm/m) | Very gently sloping (1-3%) | Slight | Redgram(Rg) | Not Available | IIs | Graded bunding/strenthening of field bunds |
| Hangalga (K) | 114 | 13.69 | BBTmB1 | LUC-3 | Deep (100-150 cm) | Clay | Non gravelly (<15%) | Very high (>200 mm/m) | Very gently sloping (1-3%) | Slight | Redgram+Cotton (Rg+Ct) | Not Available | IIs | Graded bunding/strenthening of field bunds |
| Hangalga (K) | 115 | 8.86 | BBTmB1 | LUC-3 | Deep (100-150 cm) | Clay | Non gravelly (<15%) | Very high (>200 mm/m) | Very gently sloping (1-3%) | Slight | Redgram(Rg) | Not Available | IIs | Graded bunding/strenthening of field bunds |

| Village | Sy. No | Total 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hangalga (K) | 116 | 0.01 | BBTmB1 | LUC-3 | Deep (100-150 cm) | Clay | Non gravelly (<15%) | Very high (>200 mm/m) | Very gently sloping (1-3%) | Slight | Not Available (NA) | Not Available | IIs | Graded bunding/strenthening of field bunds |
| Shivapura | 100 | 0.15 | NHAmA1 | LUC-2 | Shallow (25-50 cm) | Clay | Non gravelly (<15%) | Low (51-100 mm/m) | Nearly level (0-1%) | Slight | Not Available (NA) | Not Available | IVs | Crescent bund/TCB |
| Shivapura | 101 | 6.49 | NHAmA1 | LUC-2 | Shallow (25-50 cm) | Clay | Non gravelly (<15%) | Low (51-100 mm/m) | Nearly level (0-1%) | Slight | Cotton(Ct) | Not Available | IVs | Crescent bund/TCB |
| Vadagera | 189 | 1.81 | YDMmA1 | LUC-3 | Very deep (>150 cm) | Clay | Non gravelly (<15%) | Very high (>200 mm/m) | Nearly level (0-1%) | Slight | Not Available (NA) | Not Available | IIs | Graded bunding/strenthening of field bunds |
| Vadagera | 190 | 0.3 | YDMmA1 | LUC-3 | Very deep (>150 cm) | Clay | Non gravelly (<15%) | Very high (>200 mm/m) | Nearly level (0-1%) | Slight | Not Available (NA) | Not Available | IIs | Graded bunding/strenthening of field bunds |
| Sumbada | 139 | 0.17 | BBTmB1 | LUC-3 | Deep (100-150 cm) | Clay | Non gravelly (<15%) | Very high (>200 mm/m) | Very gently sloping (1-3%) | Slight | Not Available (NA) | Not Available | IIs | Graded bunding/strenthening of field bunds |

# Appendix II

## Balbatti-3 Microwatershed

## Soil Fertility Information

| Village | Sy. No | Soil Reaction | Salinity | Organic Carbon | Available Phosphorus | Available Potassium | Available Sulphur | Available Boron | Available Iron | Available Manganese | Available Copper | Available Zinc |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Balabatti | 32 | Strongly alkaline (pH 8.4 – 9.0) | Non saline (<2 dsm) | Medium (0.5 – 0.75 %) | Low (< 23 kg/ha) | Medium (145 – 337 kg/ha) | High (> 20 ppm) | Low (< 0.5 ppm) | Deficient (< 4.5 ppm) | Sufficient (> 1.0 ppm) | Sufficient (> 0.2 ppm) | Deficient (< 0.6 ppm) |
| Balabatti | 33 | Strongly alkaline (pH 8.4 – 9.0) | Non saline (<2 dsm) | Medium (0.5 – 0.75 %) | Low (< 23 kg/ha) | High (> 337 kg/ha) | High (> 20 ppm) | Low (< 0.5 ppm) | Sufficient (>4.5 ppm) | Sufficient (> 1.0 ppm) | Sufficient (> 0.2 ppm) | Deficient (< 0.6 ppm) |
| Balabatti | 126 | 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) | Low (< 0.5 ppm) | Sufficient (>4.5 ppm) | Sufficient (> 1.0 ppm) | Sufficient (> 0.2 ppm) | Deficient (< 0.6 ppm) |
| Balabatti | 131 | 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) | Low (< 0.5 ppm) | Sufficient (>4.5 ppm) | Sufficient (> 1.0 ppm) | Sufficient (> 0.2 ppm) | Deficient (< 0.6 ppm) |
| Balabatti | 132 | Strongly alkaline (pH 8.4 – 9.0) | Non saline (<2 dsm) | High (> 0.75 %) | Low (< 23 kg/ha) | High (> 337 kg/ha) | Medium (10 – 20 ppm) | Low (< 0.5 ppm) | Sufficient (>4.5 ppm) | Sufficient (> 1.0 ppm) | Sufficient (> 0.2 ppm) | Deficient (< 0.6 ppm) |
| Balabatti | 133 | Strongly alkaline (pH 8.4 – 9.0) | Non saline (<2 dsm) | High (> 0.75 %) | Low (< 23 kg/ha) | High (> 337 kg/ha) | Medium (10 – 20 ppm) | Low (< 0.5 ppm) | Sufficient (>4.5 ppm) | Sufficient (> 1.0 ppm) | Sufficient (> 0.2 ppm) | Deficient (< 0.6 ppm) |
| Balabatti | 134 | Strongly alkaline (pH 8.4 – 9.0) | Non saline (<2 dsm) | High (> 0.75 %) | Medium (23 – 57 kg/ha) | High (> 337 kg/ha) | Medium (10 – 20 ppm) | Low (< 0.5 ppm) | Sufficient (>4.5 ppm) | Sufficient (> 1.0 ppm) | Sufficient (> 0.2 ppm) | Deficient (< 0.6 ppm) |
| Balabatti | 135 | 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) |
| Balabatti | 136 | 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) | Low (< 0.5 ppm) | Sufficient (>4.5 ppm) | Sufficient (> 1.0 ppm) | Sufficient (> 0.2 ppm) | Deficient (< 0.6 ppm) |
| Balabatti | 139 | Strongly alkaline (pH 8.4 – 9.0) | Non saline (<2 dsm) | Medium (0.5 – 0.75 %) | Low (< 23 kg/ha) | High (> 337 kg/ha) | Medium (10 – 20 ppm) | Low (< 0.5 ppm) | Sufficient (>4.5 ppm) | Sufficient (> 1.0 ppm) | Sufficient (> 0.2 ppm) | Deficient (< 0.6 ppm) |
| Balabatti | 140 | Strongly alkaline (pH 8.4 – 9.0) | Non saline (<2 dsm) | Medium (0.5 – 0.75 %) | Low (< 23 kg/ha) | High (> 337 kg/ha) | Medium (10 – 20 ppm) | Low (< 0.5 ppm) | Sufficient (>4.5 ppm) | Sufficient (> 1.0 ppm) | Sufficient (> 0.2 ppm) | Deficient (< 0.6 ppm) |
| Balabatti | 141 | Strongly alkaline (pH 8.4 – 9.0) | Non saline (<2 dsm) | Medium (0.5 – 0.75 %) | Low (< 23 kg/ha) | High (> 337 kg/ha) | Medium (10 – 20 ppm) | Low (< 0.5 ppm) | Sufficient (>4.5 ppm) | Sufficient (> 1.0 ppm) | Sufficient (> 0.2 ppm) | Deficient (< 0.6 ppm) |
| Balabatti | 142 | Strongly alkaline (pH 8.4 – 9.0) | Non saline (<2 dsm) | Medium (0.5 – 0.75 %) | Low (< 23 kg/ha) | High (> 337 kg/ha) | Medium (10 – 20 ppm) | Low (< 0.5 ppm) | Sufficient (>4.5 ppm) | Sufficient (> 1.0 ppm) | Sufficient (> 0.2 ppm) | Deficient (< 0.6 ppm) |
| Balabatti | 149 | Strongly alkaline (pH 8.4 – 9.0) | Non saline (<2 dsm) | Medium (0.5 – 0.75 %) | Low (< 23 kg/ha) | High (> 337 kg/ha) | Medium (10 – 20 ppm) | Medium (0.5 – 1.0 ppm) | Sufficient (>4.5 ppm) | Sufficient (> 1.0 ppm) | Sufficient (> 0.2 ppm) | Deficient (< 0.6 ppm) |
| Balabatti | 150 | Strongly alkaline (pH 8.4 – 9.0) | Non saline (<2 dsm) | Medium (0.5 – 0.75 %) | Low (< 23 kg/ha) | High (> 337 kg/ha) | Medium (10 – 20 ppm) | Medium (0.5 – 1.0 ppm) | Sufficient (>4.5 ppm) | Sufficient (> 1.0 ppm) | Sufficient (> 0.2 ppm) | Deficient (< 0.6 ppm) |
| Balabatti | 151 | Strongly alkaline (pH 8.4 – 9.0) | Non saline (<2 dsm) | Medium (0.5 – 0.75 %) | Low (< 23 kg/ha) | High (> 337 kg/ha) | High (> 20 ppm) | Medium (0.5 – 1.0 ppm) | Sufficient (>4.5 ppm) | Sufficient (> 1.0 ppm) | Sufficient (> 0.2 ppm) | Deficient (< 0.6 ppm) |
| Balabatti | 152 | Strongly alkaline (pH 8.4 – 9.0) | Non saline (<2 dsm) | Medium (0.5 – 0.75 %) | Low (< 23 kg/ha) | High (> 337 kg/ha) | High (> 20 ppm) | Medium (0.5 – 1.0 ppm) | Deficient (< 4.5 ppm) | Sufficient (> 1.0 ppm) | Sufficient (> 0.2 ppm) | Deficient (< 0.6 ppm) |
| Balabatti | 153 | Strongly alkaline (pH 8.4 – 9.0) | Non saline (<2 dsm) | Medium (0.5 – 0.75 %) | Low (< 23 kg/ha) | High (> 337 kg/ha) | Medium (10 – 20 ppm) | Medium (0.5 – 1.0 ppm) | Sufficient (>4.5 ppm) | Sufficient (> 1.0 ppm) | Sufficient (> 0.2 ppm) | Deficient (< 0.6 ppm) |
| Balabatti | 154 | Strongly alkaline (pH 8.4 – 9.0) | Non saline (<2 dsm) | Medium (0.5 – 0.75 %) | Low (< 23 kg/ha) | High (> 337 kg/ha) | High (> 20 ppm) | Medium (0.5 – 1.0 ppm) | Deficient (< 4.5 ppm) | Sufficient (> 1.0 ppm) | Sufficient (> 0.2 ppm) | Deficient (< 0.6 ppm) |
| Balabatti | 155 | Strongly alkaline (pH 8.4 – 9.0) | Non saline (<2 dsm) | Medium (0.5 – 0.75 %) | Low (< 23 kg/ha) | High (> 337 kg/ha) | High (> 20 ppm) | Medium (0.5 – 1.0 ppm) | Deficient (< 4.5 ppm) | Sufficient (> 1.0 ppm) | Sufficient (> 0.2 ppm) | Deficient (< 0.6 ppm) |
| Balabatti | 156 | Strongly alkaline (pH 8.4 – 9.0) | Non saline (<2 dsm) | Medium (0.5 – 0.75 %) | Low (< 23 kg/ha) | High (> 337 kg/ha) | Medium (10 – 20 ppm) | Medium (0.5 – 1.0 ppm) | Sufficient (>4.5 ppm) | Sufficient (> 1.0 ppm) | Sufficient (> 0.2 ppm) | Deficient (< 0.6 ppm) |
| Balabatti | 157 | Strongly alkaline (pH 8.4 – 9.0) | Non saline (<2 dsm) | Medium (0.5 – 0.75 %) | Low (< 23 kg/ha) | High (> 337 kg/ha) | Medium (10 – 20 ppm) | Low (< 0.5 ppm) | Sufficient (>4.5 ppm) | Sufficient (> 1.0 ppm) | Sufficient (> 0.2 ppm) | Deficient (< 0.6 ppm) |

| Village | Sy. No | Soil Reaction | Salinity | Organic Carbon | Available Phosphorus | Available Potassium | Available Sulphur | Available Boron | Available Iron | Available Manganese | Available Copper | Available Zinc |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Balabatti | 158 | Strongly alkaline (pH 8.4 – 9.0) | Non saline (<2 dsm) | Medium (0.5 – 0.75 %) | Low (< 23 kg/ha) | High (> 337 kg/ha) | High (> 20 ppm) | Medium (0.5 – 1.0 ppm) | Sufficient (>4.5 ppm) | Sufficient (> 1.0 ppm) | Sufficient (> 0.2 ppm) | Deficient (< 0.6 ppm) |
| Balabatti | 159 | Strongly alkaline (pH 8.4 – 9.0) | Non saline (<2 dsm) | Medium (0.5 – 0.75 %) | Low (< 23 kg/ha) | High (> 337 kg/ha) | High (> 20 ppm) | Medium (0.5 – 1.0 ppm) | Deficient (< 4.5 ppm) | Sufficient (> 1.0 ppm) | Sufficient (> 0.2 ppm) | Deficient (< 0.6 ppm) |
| Balabatti | 160 | Strongly alkaline (pH 8.4 – 9.0) | Non saline (<2 dsm) | Medium (0.5 – 0.75 %) | Low (< 23 kg/ha) | High (> 337 kg/ha) | High (> 20 ppm) | Medium (0.5 – 1.0 ppm) | Sufficient (>4.5 ppm) | Sufficient (> 1.0 ppm) | Sufficient (> 0.2 ppm) | Deficient (< 0.6 ppm) |
| Balabatti | 161 | Strongly alkaline (pH 8.4 – 9.0) | Non saline (<2 dsm) | Medium (0.5 – 0.75 %) | Low (< 23 kg/ha) | High (> 337 kg/ha) | High (> 20 ppm) | Medium (0.5 – 1.0 ppm) | Sufficient (>4.5 ppm) | Sufficient (> 1.0 ppm) | Sufficient (> 0.2 ppm) | Deficient (< 0.6 ppm) |
| Balabatti | 162 | Strongly alkaline (pH 8.4 – 9.0) | Non saline (<2 dsm) | High (> 0.75 %) | Low (< 23 kg/ha) | High (> 337 kg/ha) | Medium (10 – 20 ppm) | Low (< 0.5 ppm) | Sufficient (>4.5 ppm) | Sufficient (> 1.0 ppm) | Sufficient (> 0.2 ppm) | Deficient (< 0.6 ppm) |
| Balabatti | 163 | Strongly alkaline (pH 8.4 – 9.0) | Non saline (<2 dsm) | High (> 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) |
| Balabatti | 164 | Strongly alkaline (pH 8.4 – 9.0) | Non saline (<2 dsm) | High (> 0.75 %) | Low (< 23 kg/ha) | High (> 337 kg/ha) | Medium (10 – 20 ppm) | Low (< 0.5 ppm) | Sufficient (>4.5 ppm) | Sufficient (> 1.0 ppm) | Sufficient (> 0.2 ppm) | Deficient (< 0.6 ppm) |
| Balabatti | 165 | Strongly alkaline (pH 8.4 – 9.0) | Non saline (<2 dsm) | Medium (0.5 – 0.75 %) | Low (< 23 kg/ha) | High (> 337 kg/ha) | Medium (10 – 20 ppm) | Low (< 0.5 ppm) | Sufficient (>4.5 ppm) | Sufficient (> 1.0 ppm) | Sufficient (> 0.2 ppm) | Deficient (< 0.6 ppm) |
| Balabatti | 166 | Strongly alkaline (pH 8.4 – 9.0) | Non saline (<2 dsm) | Medium (0.5 – 0.75 %) | Low (< 23 kg/ha) | High (> 337 kg/ha) | Medium (10 – 20 ppm) | Low (< 0.5 ppm) | Sufficient (>4.5 ppm) | Sufficient (> 1.0 ppm) | Sufficient (> 0.2 ppm) | Deficient (< 0.6 ppm) |
| Balabatti | 167 | Strongly alkaline (pH 8.4 – 9.0) | Non saline (<2 dsm) | Medium (0.5 – 0.75 %) | Low (< 23 kg/ha) | High (> 337 kg/ha) | Medium (10 – 20 ppm) | Medium (0.5 – 1.0 ppm) | Sufficient (>4.5 ppm) | Sufficient (> 1.0 ppm) | Sufficient (> 0.2 ppm) | Deficient (< 0.6 ppm) |
| Balabatti | 169 | Strongly alkaline (pH 8.4 – 9.0) | Non saline (<2 dsm) | Medium (0.5 – 0.75 %) | Low (< 23 kg/ha) | High (> 337 kg/ha) | Medium (10 – 20 ppm) | Medium (0.5 – 1.0 ppm) | Sufficient (>4.5 ppm) | Sufficient (> 1.0 ppm) | Sufficient (> 0.2 ppm) | Deficient (< 0.6 ppm) |
| Balabatti | 170 | Strongly alkaline (pH 8.4 – 9.0) | Non saline (<2 dsm) | Medium (0.5 – 0.75 %) | Low (< 23 kg/ha) | High (> 337 kg/ha) | Medium (10 – 20 ppm) | Medium (0.5 – 1.0 ppm) | Sufficient (>4.5 ppm) | Sufficient (> 1.0 ppm) | Sufficient (> 0.2 ppm) | Deficient (< 0.6 ppm) |
| Balabatti | 171 | Strongly alkaline (pH 8.4 – 9.0) | Non saline (<2 dsm) | Medium (0.5 – 0.75 %) | Low (< 23 kg/ha) | High (> 337 kg/ha) | High (> 20 ppm) | Medium (0.5 – 1.0 ppm) | Deficient (< 4.5 ppm) | Sufficient (> 1.0 ppm) | Sufficient (> 0.2 ppm) | Deficient (< 0.6 ppm) |
| Balabatti | 172 | Strongly alkaline (pH 8.4 – 9.0) | Non saline (<2 dsm) | Medium (0.5 – 0.75 %) | Low (< 23 kg/ha) | High (> 337 kg/ha) | High (> 20 ppm) | Medium (0.5 – 1.0 ppm) | Sufficient (>4.5 ppm) | Sufficient (> 1.0 ppm) | Sufficient (> 0.2 ppm) | Sufficient (> 0.6 ppm) |
| Balabatti | 173 | Strongly alkaline (pH 8.4 – 9.0) | Non saline (<2 dsm) | High (> 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) | Sufficient (> 0.6 ppm) |
| Balabatti | 174 | Strongly alkaline (pH 8.4 – 9.0) | Non saline (<2 dsm) | High (> 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) | Sufficient (> 0.6 ppm) |
| Balabatti | 175 | Strongly alkaline (pH 8.4 – 9.0) | Non saline (<2 dsm) | Medium (0.5 – 0.75 %) | Low (< 23 kg/ha) | High (> 337 kg/ha) | High (> 20 ppm) | Medium (0.5 – 1.0 ppm) | Sufficient (>4.5 ppm) | Sufficient (> 1.0 ppm) | Sufficient (> 0.2 ppm) | Sufficient (> 0.6 ppm) |
| Balabatti | 176 | Strongly alkaline (pH 8.4 – 9.0) | Non saline (<2 dsm) | High (> 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) | Sufficient (> 0.6 ppm) |
| Balabatti | 177 | Strongly alkaline (pH 8.4 – 9.0) | Non saline (<2 dsm) | High (> 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) | Sufficient (> 0.6 ppm) |
| Balabatti | 178 | Strongly alkaline (pH 8.4 – 9.0) | Non saline (<2 dsm) | High (> 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) | Sufficient (> 0.6 ppm) |
| Balabatti | 179 | Strongly alkaline (pH 8.4 – 9.0) | Non saline (<2 dsm) | Medium (0.5 – 0.75 %) | Low (< 23 kg/ha) | High (> 337 kg/ha) | High (> 20 ppm) | Medium (0.5 – 1.0 ppm) | Sufficient (>4.5 ppm) | Sufficient (> 1.0 ppm) | Sufficient (> 0.2 ppm) | Sufficient (> 0.6 ppm) |
| Balabatti | 180 | Strongly alkaline (pH 8.4 – 9.0) | Non saline (<2 dsm) | Low (< 0.5 %) | Low (< 23 kg/ha) | High (> 337 kg/ha) | High (> 20 ppm) | Medium (0.5 – 1.0 ppm) | Sufficient (>4.5 ppm) | Sufficient (> 1.0 ppm) | Sufficient (> 0.2 ppm) | Sufficient (> 0.6 ppm) |
| Balabatti | 185 | Strongly alkaline (pH 8.4 – 9.0) | Non saline (<2 dsm) | High (> 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) | Sufficient (> 0.6 ppm) |
| Balabatti | 186 | Strongly alkaline (pH 8.4 – 9.0) | Non saline (<2 dsm) | High (> 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) | Sufficient (> 0.6 ppm) |

| Village | Sy. No | Soil Reaction | Salinity | Organic Carbon | Available Phosphorus | Available Potassium | Available Sulphur | Available Boron | Available Iron | Available Manganese | Available Copper | Available Zinc |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Balabatti | 187 | Strongly alkaline (pH 8.4 – 9.0) | Non saline (<2 dsm) | Medium (0.5 – 0.75 %) | Low (< 23 kg/ha) | High (> 337 kg/ha) | Medium (10 – 20 ppm) | Low (< 0.5 ppm) | Sufficient (>4.5 ppm) | Sufficient (> 1.0 ppm) | Sufficient (> 0.2 ppm) | Sufficient (> 0.6 ppm) |
| Balabatti | 188 | Strongly alkaline (pH 8.4 – 9.0) | Non saline (<2 dsm) | Medium (0.5 – 0.75 %) | Low (< 23 kg/ha) | High (> 337 kg/ha) | Medium (10 – 20 ppm) | Low (< 0.5 ppm) | Sufficient (>4.5 ppm) | Sufficient (> 1.0 ppm) | Sufficient (> 0.2 ppm) | Sufficient (> 0.6 ppm) |
| Balabatti | 189 | Strongly alkaline (pH 8.4 – 9.0) | Non saline (<2 dsm) | High (> 0.75 %) | Low (< 23 kg/ha) | High (> 337 kg/ha) | High (> 20 ppm) | Low (< 0.5 ppm) | Sufficient (>4.5 ppm) | Sufficient (> 1.0 ppm) | Sufficient (> 0.2 ppm) | Sufficient (> 0.6 ppm) |
| Balabatti | 190 | Strongly alkaline (pH 8.4 – 9.0) | Non saline (<2 dsm) | Medium (0.5 – 0.75 %) | Low (< 23 kg/ha) | High (> 337 kg/ha) | Medium (10 – 20 ppm) | Low (< 0.5 ppm) | Sufficient (>4.5 ppm) | Sufficient (> 1.0 ppm) | Sufficient (> 0.2 ppm) | Sufficient (> 0.6 ppm) |
| Hangalga (K) | 78 | 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) | Low (< 0.5 ppm) | Sufficient (>4.5 ppm) | Sufficient (> 1.0 ppm) | Sufficient (> 0.2 ppm) | Sufficient (> 0.6 ppm) |
| Hangalga (K) | 79_ GF | 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) | Low (< 0.5 ppm) | Sufficient (>4.5 ppm) | Sufficient (> 1.0 ppm) | Sufficient (> 0.2 ppm) | Sufficient (> 0.6 ppm) |
| Hangalga (K) | 80 | 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) | Sufficient (> 0.6 ppm) |
| Hangalga (K) | 81 | 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) | Sufficient (> 0.6 ppm) |
| Hangalga (K) | 82 | 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) | Sufficient (> 0.6 ppm) |
| Hangalga (K) | 83 | Strongly alkaline (pH 8.4 – 9.0) | Non saline (<2 dsm) | High (> 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) | Sufficient (> 0.6 ppm) |
| Hangalga (K) | 84 | Strongly alkaline (pH 8.4 – 9.0) | Non saline (<2 dsm) | Medium (0.5 – 0.75 %) | Low (< 23 kg/ha) | High (> 337 kg/ha) | High (> 20 ppm) | Medium (0.5 – 1.0 ppm) | Sufficient (>4.5 ppm) | Sufficient (> 1.0 ppm) | Sufficient (> 0.2 ppm) | Sufficient (> 0.6 ppm) |
| Hangalga (K) | 85 | Strongly alkaline (pH 8.4 – 9.0) | Non saline (<2 dsm) | Medium (0.5 – 0.75 %) | Low (< 23 kg/ha) | High (> 337 kg/ha) | High (> 20 ppm) | Medium (0.5 – 1.0 ppm) | Sufficient (>4.5 ppm) | Sufficient (> 1.0 ppm) | Sufficient (> 0.2 ppm) | Sufficient (> 0.6 ppm) |
| Hangalga (K) | 86 | Strongly alkaline (pH 8.4 – 9.0) | Non saline (<2 dsm) | High (> 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) | Sufficient (> 0.6 ppm) |
| Hangalga (K) | 87 | Strongly alkaline (pH 8.4 – 9.0) | Non saline (<2 dsm) | High (> 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) | Sufficient (> 0.6 ppm) |
| Hangalga (K) | 88 | Strongly alkaline (pH 8.4 – 9.0) | Non saline (<2 dsm) | High (> 0.75 %) | Low (< 23 kg/ha) | High (> 337 kg/ha) | High (> 20 ppm) | Medium (0.5 – 1.0 ppm) | Sufficient (>4.5 ppm) | Sufficient (> 1.0 ppm) | Sufficient (> 0.2 ppm) | Sufficient (> 0.6 ppm) |
| Hangalga (K) | 89 | Strongly alkaline (pH 8.4 – 9.0) | Non saline (<2 dsm) | Medium (0.5 – 0.75 %) | Low (< 23 kg/ha) | High (> 337 kg/ha) | High (> 20 ppm) | Medium (0.5 – 1.0 ppm) | Sufficient (>4.5 ppm) | Sufficient (> 1.0 ppm) | Sufficient (> 0.2 ppm) | Sufficient (> 0.6 ppm) |
| Hangalga (K) | 90 | Strongly alkaline (pH 8.4 – 9.0) | Non saline (<2 dsm) | High (> 0.75 %) | Low (< 23 kg/ha) | High (> 337 kg/ha) | Medium (10 – 20 ppm) | Medium (0.5 – 1.0 ppm) | Sufficient (>4.5 ppm) | Sufficient (> 1.0 ppm) | Sufficient (> 0.2 ppm) | Sufficient (> 0.6 ppm) |
| Hangalga (K) | 103 | Strongly alkaline (pH 8.4 – 9.0) | Non saline (<2 dsm) | High (> 0.75 %) | Low (< 23 kg/ha) | High (> 337 kg/ha) | High (> 20 ppm) | Medium (0.5 – 1.0 ppm) | Sufficient (>4.5 ppm) | Sufficient (> 1.0 ppm) | Sufficient (> 0.2 ppm) | Sufficient (> 0.6 ppm) |
| Hangalga (K) | 104 | Strongly alkaline (pH 8.4 – 9.0) | Non saline (<2 dsm) | High (> 0.75 %) | Low (< 23 kg/ha) | High (> 337 kg/ha) | High (> 20 ppm) | Medium (0.5 – 1.0 ppm) | Sufficient (>4.5 ppm) | Sufficient (> 1.0 ppm) | Sufficient (> 0.2 ppm) | Sufficient (> 0.6 ppm) |
| Hangalga (K) | 111 | Strongly alkaline (pH 8.4 – 9.0) | Non saline (<2 dsm) | Medium (0.5 – 0.75 %) | Low (< 23 kg/ha) | High (> 337 kg/ha) | Medium (10 – 20 ppm) | Low (< 0.5 ppm) | Deficient (< 4.5 ppm) | Sufficient (> 1.0 ppm) | Sufficient (> 0.2 ppm) | Deficient (< 0.6 ppm) |
| Hangalga (K) | 112 | Strongly alkaline (pH 8.4 – 9.0) | Non saline (<2 dsm) | Medium (0.5 – 0.75 %) | Low (< 23 kg/ha) | High (> 337 kg/ha) | Medium (10 – 20 ppm) | Medium (0.5 – 1.0 ppm) | Sufficient (>4.5 ppm) | Sufficient (> 1.0 ppm) | Sufficient (> 0.2 ppm) | Deficient (< 0.6 ppm) |
| Hangalga (K) | 113 | Strongly alkaline (pH 8.4 – 9.0) | Non saline (<2 dsm) | Medium (0.5 – 0.75 %) | Low (< 23 kg/ha) | High (> 337 kg/ha) | High (> 20 ppm) | Low (< 0.5 ppm) | Deficient (< 4.5 ppm) | Sufficient (> 1.0 ppm) | Sufficient (> 0.2 ppm) | Deficient (< 0.6 ppm) |
| Hangalga (K) | 114 | Strongly alkaline (pH 8.4 – 9.0) | Non saline (<2 dsm) | Medium (0.5 – 0.75 %) | Low (< 23 kg/ha) | High (> 337 kg/ha) | High (> 20 ppm) | Medium (0.5 – 1.0 ppm) | Deficient (< 4.5 ppm) | Sufficient (> 1.0 ppm) | Sufficient (> 0.2 ppm) | Deficient (< 0.6 ppm) |
| Hangalga (K) | 115 | Strongly alkaline (pH 8.4 – 9.0) | Non saline (<2 dsm) | Medium (0.5 – 0.75 %) | Low (< 23 kg/ha) | High (> 337 kg/ha) | High (> 20 ppm) | Medium (0.5 – 1.0 ppm) | Deficient (< 4.5 ppm) | Sufficient (> 1.0 ppm) | Sufficient (> 0.2 ppm) | Deficient (< 0.6 ppm) |

| Village | Sy. No | Soil Reaction | Salinity | Organic Carbon | Available Phosphorus | Available Potassium | Available Sulphur | Available Boron | Available Iron | Available Manganese | Available Copper | Available Zinc |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hangalga (K) | 116 | Strongly alkaline (pH 8.4 – 9.0) | Non saline (<2 dsm) | Medium (0.5 – 0.75 %) | Low (< 23 kg/ha) | High (> 337 kg/ha) | Medium (10 – 20 ppm) | Low (< 0.5 ppm) | Deficient (< 4.5 ppm) | Sufficient (> 1.0 ppm) | Sufficient (> 0.2 ppm) | Deficient (< 0.6 ppm) |
| Shivapura | 100 | 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) | Low (< 0.5 ppm) | Sufficient (>4.5 ppm) | Sufficient (> 1.0 ppm) | Sufficient (> 0.2 ppm) | Sufficient (> 0.6 ppm) |
| Shivapura | 101 | Strongly alkaline (pH 8.4 – 9.0) | Non saline (<2 dsm) | Medium (0.5 – 0.75 %) | Low (< 23 kg/ha) | High (> 337 kg/ha) | Medium (10 – 20 ppm) | Low (< 0.5 ppm) | Sufficient (>4.5 ppm) | Sufficient (> 1.0 ppm) | Sufficient (> 0.2 ppm) | Sufficient (> 0.6 ppm) |
| Vadagera | 189 | Strongly alkaline (pH 8.4 – 9.0) | Non saline (<2 dsm) | Medium (0.5 – 0.75 %) | Low (< 23 kg/ha) | High (> 337 kg/ha) | Medium (10 – 20 ppm) | Medium (0.5 – 1.0 ppm) | Sufficient (>4.5 ppm) | Sufficient (> 1.0 ppm) | Sufficient (> 0.2 ppm) | Deficient (< 0.6 ppm) |
| Vadagera | 190 | Strongly alkaline (pH 8.4 – 9.0) | Non saline (<2 dsm) | Medium (0.5 – 0.75 %) | Low (< 23 kg/ha) | High (> 337 kg/ha) | Medium (10 – 20 ppm) | Medium (0.5 – 1.0 ppm) | Sufficient (>4.5 ppm) | Sufficient (> 1.0 ppm) | Sufficient (> 0.2 ppm) | Deficient (< 0.6 ppm) |
| Sumbada | 139 | Strongly alkaline (pH 8.4 – 9.0) | Non saline (<2 dsm) | Medium (0.5 – 0.75 %) | Low (< 23 kg/ha) | High (> 337 kg/ha) | Medium (10 – 20 ppm) | Medium (0.5 – 1.0 ppm) | Sufficient (>4.5 ppm) | Sufficient (> 1.0 ppm) | Sufficient (> 0.2 ppm) | Deficient (< 0.6 ppm) |

# Appendix III

## Balbatti-3 Microwatershed

## Soil Suitability Information

| Village | Sy No. | Mango | Maize | Sapota | Sorg ham | Guava | Cotton | Tamarind | Lime | Bengal gram | Sun flower | Red gram | Amla | Jack fruit | Custard-apple | Cashew | Jamun | Musambi | Sugar cane | Soyabean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Balabatti | 32 | Ngt | Ngt | Ngt | Ngl | Ngt | Ngl | Ngt | Ngl | Ngl | Ngl | Ngt | Ngl | Ngt | Ngl | Ngt | Ngt | Ngl | Ngt | Ngl |
| Balabatti | 33 | Nrt | S3rt | Nrt | S3r | Nrt | S3r | Nrt | Nr | S2r | Nr | S3rt | S3r | Nrt | S3r | Nrt | Nrt | Nr | Nrt | S3r |
| Balabatti | 126 | S3t | S3t | S2t | S1 | S2t | S1 | S2t | S1 | S1 | S1 | S2t | S1 | S3t | S1 | Nt | S2t | S1 | S3t | S1 |
| Balabatti | 131 | S3t | S3t | S2t | S1 | S2t | S1 | S2t | S1 | S1 | S1 | S2t | S1 | S3t | S1 | Nt | S2t | S1 | S3t | S1 |
| Balabatti | 132 | S3t | S3t | S2t | S1 | S2t | S1 | S2t | S1 | S1 | S1 | S2t | S1 | S3t | S1 | Nt | S2t | S1 | S3t | S1 |
| Balabatti | 133 | S3t | S3t | S2t | S1 | S2t | S1 | S2t | S1 | S1 | S1 | S2t | S1 | S3t | S1 | Nt | S2t | S1 | S3t | S1 |
| Balabatti | 134 | S3t | S3t | S2t | S1 | S2t | S1 | S2t | S1 | S1 | S1 | S2t | S1 | S3t | S1 | Nt | S2t | S1 | S3t | S1 |
| Balabatti | 135 | S3t | S3t | S2t | S1 | S2t | S1 | S2t | S1 | S1 | S1 | S2t | S1 | S3t | S1 | Nt | S2t | S1 | S3t | S1 |
| Balabatti | 136 | S3t | S3t | S2t | S1 | S2t | S1 | S2t | S1 | S1 | S1 | S2t | S1 | S3t | S1 | Nt | S2t | S1 | S3t | S1 |
| Balabatti | 139 | S3t | S3t | S2t | S1 | S2t | S1 | S2t | S1 | S1 | S1 | S2t | S1 | S3t | S1 | Nt | S2t | S1 | S3t | S1 |
| Balabatti | 140 | S3t | S3t | S2t | S1 | S2t | S1 | S2t | S1 | S1 | S1 | S2t | S1 | S3t | S1 | Nt | S2t | S1 | S3t | S1 |
| Balabatti | 141 | S3t | S3t | S2t | S1 | S2t | S1 | S2t | S1 | S1 | S1 | S2t | S1 | S3t | S1 | Nt | S2t | S1 | S3t | S1 |
| Balabatti | 142 | S3t | S3t | S2t | S1 | S2t | S1 | S2t | S1 | S1 | S1 | S2t | S1 | S3t | S1 | Nt | S2t | S1 | S3t | S1 |
| Balabatti | 149 | S3t | S3t | S2t | S1 | S2t | S1 | S2t | S1 | S1 | S1 | S2t | S1 | S3t | S1 | Nt | S2t | S1 | S3t | S1 |
| Balabatti | 150 | S3t | S3t | S2t | S1 | S2t | S1 | S2t | S1 | S1 | S1 | S2t | S1 | S3t | S1 | Nt | S2t | S1 | S3t | S1 |
| Balabatti | 151 | S3t | S3t | S2t | S1 | S2t | S1 | S2t | S1 | S1 | S1 | S2t | S1 | S3t | S1 | Nt | S2t | S1 | S3t | S1 |
| Balabatti | 152 | S3t | S3t | S2t | S1 | S2t | S1 | S2t | S1 | S1 | S1 | S2t | S1 | S3t | S1 | Nt | S2t | S1 | S3t | S1 |
| Balabatti | 153 | S3t | S3t | S2t | S1 | S2t | S1 | S2t | S1 | S1 | S1 | S2t | S1 | S3t | S1 | Nt | S2t | S1 | S3t | S1 |
| Balabatti | 154 | S3t | S3t | S2t | S1 | S2t | S1 | S2t | S1 | S1 | S1 | S2t | S1 | S3t | S1 | Nt | S2t | S1 | S3t | S1 |
| Balabatti | 155 | S3t | S3t | S2t | S1 | S2t | S1 | S2t | S1 | S1 | S1 | S2t | S1 | S3t | S1 | Nt | S2t | S1 | S3t | S1 |
| Balabatti | 156 | S3t | S3t | S2t | S1 | S2t | S1 | S2t | S1 | S1 | S1 | S2t | S1 | S3t | S1 | Nt | S2t | S1 | S3t | S1 |
| Balabatti | 157 | S3t | S3t | S2t | S1 | S2t | S1 | S2t | S1 | S1 | S1 | S2t | S1 | S3t | S1 | Nt | S2t | S1 | S3t | S1 |
| Balabatti | 158 | S3t | S3t | S2t | S1 | S2t | S1 | S2t | S1 | S1 | S1 | S2t | S1 | S3t | S1 | Nt | S2t | S1 | S3t | S1 |
| Balabatti | 159 | S3t | S3t | S2t | S1 | S2t | S1 | S2t | S1 | S1 | S1 | S2t | S1 | S3t | S1 | Nt | S2t | S1 | S3t | S1 |
| Balabatti | 160 | S3t | S3t | S2t | S1 | S2t | S1 | S2t | S1 | S1 | S1 | S2t | S1 | S3t | S1 | Nt | S2t | S1 | S3t | S1 |
| Balabatti | 161 | S3t | S3t | S2t | S1 | S2t | S1 | S2t | S1 | S1 | S1 | S2t | S1 | S3t | S1 | Nt | S2t | S1 | S3t | S1 |
| Balabatti | 162 | S3t | S3t | S2t | S1 | S2t | S1 | S2t | S1 | S1 | S1 | S2t | S1 | S3t | S1 | Nt | S2t | S1 | S3t | S1 |
| Balabatti | 163 | S3t | S3t | S2t | S1 | S2t | S1 | S2t | S1 | S1 | S1 | S2t | S1 | S3t | S1 | Nt | S2t | S1 | S3t | S1 |

| Village | Sy No. | Mango | Maize | Sapota | Sorg ham | Guava | Cotton | Tamarind | Lime | Bengal gram | Sun flower | Red gram | Amla | Jack fruit | Custard-apple | Cashew | Jamun | Musambi | Sugar cane | Soyabean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Balabatti | 164 | S3t | S3t | S2t | S1 | S2t | S1 | S2t | S1 | S1 | S1 | S2t | S1 | S3t | S1 | Nt | S2t | S1 | S3t | S1 |
| Balabatti | 165 | S3t | S3t | S2t | S1 | S2t | S1 | S2t | S1 | S1 | S1 | S2t | S1 | S3t | S1 | Nt | S2t | S1 | S3t | S1 |
| Balabatti | 166 | S3t | S3t | S2t | S1 | S2t | S1 | S2t | S1 | S1 | S1 | S2t | S1 | S3t | S1 | Nt | S2t | S1 | S3t | S1 |
| Balabatti | 167 | S3t | S3t | S2t | S1 | S2t | S1 | S2t | S1 | S1 | S1 | S2t | S1 | S3t | S1 | Nt | S2t | S1 | S3t | S1 |
| Balabatti | 169 | S3t | S3t | S2t | S1 | S2t | S1 | S2t | S1 | S1 | S1 | S2t | S1 | S3t | S1 | Nt | S2t | S1 | S3t | S1 |
| Balabatti | 170 | S3t | S3t | S2t | S1 | S2t | S1 | S2t | S1 | S1 | S1 | S2t | S1 | S3t | S1 | Nt | S2t | S1 | S3t | S1 |
| Balabatti | 171 | S3t | S3t | S2t | S1 | S2t | S1 | S2t | S1 | S1 | S1 | S2t | S1 | S3t | S1 | Nt | S2t | S1 | S3t | S1 |
| Balabatti | 172 | S3t | S3t | S2t | S1 | S2t | S1 | S2t | S1 | S1 | S1 | S2t | S1 | S3t | S1 | Nt | S2t | S1 | S3t | S1 |
| Balabatti | 173 | S3t | S3t | S2t | S1 | S2t | S1 | S2t | S1 | S1 | S1 | S2t | S1 | S3t | S1 | Nt | S2t | S1 | S3t | S1 |
| Balabatti | 174 | S3t | S3t | S2t | S1 | S2t | S1 | S2t | S1 | S1 | S1 | S2t | S1 | S3t | S1 | Nt | S2t | S1 | S3t | S1 |
| Balabatti | 175 | S3t | S3t | S2t | S1 | S2t | S1 | S2t | S1 | S1 | S1 | S2t | S1 | S3t | S1 | Nt | S2t | S1 | S3t | S1 |
| Balabatti | 176 | S3t | S3t | S2t | S1 | S2t | S1 | S2t | S1 | S1 | S1 | S2t | S1 | S3t | S1 | Nt | S2t | S1 | S3t | S1 |
| Balabatti | 177 | S3t | S3t | S2t | S1 | S2t | S1 | S2t | S1 | S1 | S1 | S2t | S1 | S3t | S1 | Nt | S2t | S1 | S3t | S1 |
| Balabatti | 178 | S3t | S3t | S2t | S1 | S2t | S1 | S2t | S1 | S1 | S1 | S2t | S1 | S3t | S1 | Nt | S2t | S1 | S3t | S1 |
| Balabatti | 179 | S3t | S3t | S2t | S1 | S2t | S1 | S2t | S1 | S1 | S1 | S2t | S1 | S3t | S1 | Nt | S2t | S1 | S3t | S1 |
| Balabatti | 180 | S3t | S3t | S2t | S1 | S2t | S1 | S2t | S1 | S1 | S1 | S2t | S1 | S3t | S1 | Nt | S2t | S1 | S3t | S1 |
| Balabatti | 185 | S3t | S3t | S2t | S1 | S2t | S1 | S2t | S1 | S1 | S1 | S2t | S1 | S3t | S1 | Nt | S2t | S1 | S3t | S1 |
| Balabatti | 186 | Nrt | S3rt | Nrt | S3r | Nrt | S3r | Nrt | Nr | S2r | Nr | S3rt | S3r | Nrt | S3r | Nrt | Nrt | Nr | Nrt | S3r |
| Balabatti | 187 | Nrt | S3rt | Nrt | S3r | Nrt | S3r | Nrt | Nr | S2r | Nr | S3rt | S3r | Nrt | S3r | Nrt | Nrt | Nr | Nrt | S3r |
| Balabatti | 188 | Nrt | S3rt | Nrt | S3r | Nrt | S3r | Nrt | Nr | S2r | Nr | S3rt | S3r | Nrt | S3r | Nrt | Nrt | Nr | Nrt | S3r |
| Balabatti | 189 | Nrt | S3rt | Nrt | S3r | Nrt | S3r | Nrt | Nr | S2r | Nr | S3rt | S3r | Nrt | S3r | Nrt | Nrt | Nr | Nrt | S3r |
| Balabatti | 190 | Nrt | S3rt | Nrt | S3r | Nrt | S3r | Nrt | Nr | S2r | Nr | S3rt | S3r | Nrt | S3r | Nrt | Nrt | Nr | Nrt | S3r |
| Hangalga (K) | 78 | Nrt | S3rt | Nrt | S3r | Nrt | S3r | Nrt | Nr | S2r | Nr | S3rt | S3r | Nrt | S3r | Nrt | Nrt | Nr | Nrt | S3r |
| Hangalga (K) | 79_GF | Nrt | S3rt | Nrt | S3r | Nrt | S3r | Nrt | Nr | S2r | Nr | S3rt | S3r | Nrt | S3r | Nrt | Nrt | Nr | Nrt | S3r |
| Hangalga (K) | 80 | Nrt | S3rt | Nrt | S3r | Nrt | S3r | Nrt | Nr | S2r | Nr | S3rt | S3r | Nrt | S3r | Nrt | Nrt | Nr | Nrt | S3r |
| Hangalga (K) | 81 | Nrt | S3rt | Nrt | S3r | Nrt | S3r | Nrt | Nr | S2r | Nr | S3rt | S3r | Nrt | S3r | Nrt | Nrt | Nr | Nrt | S3r |
| Hangalga (K) | 82 | S3t | S3t | S2t | S1 | S2t | S1 | S2t | S1 | S1 | S1 | S2t | S1 | S3t | S1 | Nt | S2t | S1 | S3t | S1 |
| Hangalga (K) | 83 | S3t | S3t | S2t | S1 | S2t | S1 | S2t | S1 | S1 | S1 | S2t | S1 | S3t | S1 | Nt | S2t | S1 | S3t | S1 |
| Hangalga (K) | 84 | S3t | S3t | S2t | S1 | S2t | S1 | S2t | S1 | S1 | S1 | S2t | S1 | S3t | S1 | Nt | S2t | S1 | S3t | S1 |
| Hangalga (K) | 85 | Nrt | S3rt | Nrt | S3r | Nrt | S3r | Nrt | Nr | S2r | Nr | S3rt | S3r | Nrt | S3r | Nrt | Nrt | Nr | Nrt | S3r |

| Village | Sy No. | Mango | Maize | Sapota | Sorg ham | Guava | Cotton | Tamarind | Lime | Bengal gram | Sun flower | Red gram | Amla | Jack fruit | Custard-apple | Cashew | Jamun | Musambi | Sugar cane | Soyabean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hangalga (K) | 86 | Nrt | S3rt | Nrt | S3r | Nrt | S3r | Nrt | Nr | S2r | Nr | S3rt | S3r | Nrt | S3r | Nrt | Nrt | Nr | Nrt | S3r |
| Hangalga (K) | 87 | S3t | S3t | S2t | S1 | S2t | S1 | S2t | S1 | S1 | S1 | S2t | S1 | S3t | S1 | Nt | S2t | S1 | S3t | S1 |
| Hangalga (K) | 88 | S3t | S3t | S2t | S1 | S2t | S1 | S2t | S1 | S1 | S1 | S2t | S1 | S3t | S1 | Nt | S2t | S1 | S3t | S1 |
| Hangalga (K) | 89 | S3t | S3t | S2t | S1 | S2t | S1 | S2t | S1 | S1 | S1 | S2t | S1 | S3t | S1 | Nt | S2t | S1 | S3t | S1 |
| Hangalga (K) | 90 | Nrt | S3rt | Nrt | S3r | Nrt | S3r | Nrt | Nr | S2r | Nr | S3rt | S3r | Nrt | S3r | Nrt | Nrt | Nr | Nrt | S3r |
| Hangalga (K) | 103 | S3t | S3t | S2t | S1 | S2t | S1 | S2t | S1 | S1 | S1 | S2t | S1 | S3t | S1 | Nt | S2t | S1 | S3t | S1 |
| Hangalga (K) | 104 | S3t | S3t | S2t | S1 | S2t | S1 | S2t | S1 | S1 | S1 | S2t | S1 | S3t | S1 | Nt | S2t | S1 | S3t | S1 |
| Hangalga (K) | 111 | Nrt | S3rt | Nrt | S3r | Nrt | S3r | Nrt | Nr | S2r | Nr | S3rt | S3r | Nrt | S3r | Nrt | Nrt | Nr | Nrt | S3r |
| Hangalga (K) | 112 | S3t | S3t | S2t | S1 | S2t | S1 | S2t | S1 | S1 | S1 | S2t | S1 | S3t | S1 | Nt | S2t | S1 | S3t | S1 |
| Hangalga (K) | 113 | S3t | S3t | S2t | S1 | S2t | S1 | S2t | S1 | S1 | S1 | S2t | S1 | S3t | S1 | Nt | S2t | S1 | S3t | S1 |
| Hangalga (K) | 114 | S3t | S3t | S2t | S1 | S2t | S1 | S2t | S1 | S1 | S1 | S2t | S1 | S3t | S1 | Nt | S2t | S1 | S3t | S1 |
| Hangalga (K) | 115 | S3t | S3t | S2t | S1 | S2t | S1 | S2t | S1 | S1 | S1 | S2t | S1 | S3t | S1 | Nt | S2t | S1 | S3t | S1 |
| Hangalga (K) | 116 | S3t | S3t | S2t | S1 | S2t | S1 | S2t | S1 | S1 | S1 | S2t | S1 | S3t | S1 | Nt | S2t | S1 | S3t | S1 |
| Shivapura | 100 | Nrt | S3rt | Nrt | S3r | Nrt | S3r | Nrt | Nr | S2r | Nr | S3rt | S3r | Nrt | S3r | Nrt | Nrt | Nr | Nrt | S3r |
| Shivapura | 101 | Nrt | S3rt | Nrt | S3r | Nrt | S3r | Nrt | Nr | S2r | Nr | S3rt | S3r | Nrt | S3r | Nrt | Nrt | Nr | Nrt | S3r |
| Vadagera | 189 | S3t | S3t | S2t | S1 | S2t | S1 | S2t | S1 | S1 | S1 | S2t | S1 | S3t | S1 | Nt | S2t | S1 | S3t | S1 |
| Vadagera | 190 | S3t | S3t | S2t | S1 | S2t | S1 | S2t | S1 | S1 | S1 | S2t | S1 | S3t | S1 | Nt | S2t | S1 | S3t | S1 |
| Sumbada | 139 | S3t | S3t | S2t | S1 | S2t | S1 | S2t | S1 | S1 | S1 | S2t | S1 | S3t | S1 | Nt | S2t | S1 | S3t | S1 |

# PART-B

## SOCIO-ECONOMIC STATUS OF FARM HOUSEHOLDS

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*Chapter 1*

## *EXECUTIVE SUMMARY*

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

***Methodology:*** *Balbatti-3 micro-watershed (Dummadri sub-watershed, Jewargi taluk, Gulbarga district) is located in between $16^{0}46'$ – $16^{0}48'$ North latitudes and $76^{0}34'$ – $76^{0}36'$ East longitudes, covering an area of about 437.16 ha, bounded by Balbatti, Vadagera, Sumbada, Shivapura and Hangalga (K) villages with a length of growing period (LGP) 120-150 days. We used soil resource map as basis for sampling farm households to test the hypothesis that soil quality influence crop selection, and conservation investment of farm households. The level of technology adoption and productivity gaps and livelihood patterns were analyses. The cost of soil degradation and ecosystem services were quantified.*

***Results:*** *The socio-economic outputs for Balbatti 3 Microwatershed (Dummadri sub-watershed, Jewargi taluk, Gulbarga district) are presented here.*

***Social Indicators;***

- *Male and female ratio is 61.9 to 38.1 per cent to the total sample population.*
- *Younger age 18 to 50 years group of population is around 66.7 per cent to the total population.*
- *Literacy population is around 76.2 per cent.*
- *Social groups belong to other backward castes (OBC) of all sample farmers.*
- *Fire wood is the source of energy for a cooking among 90 per cent.*
- *About 50 per cent of households have a yashaswini health card.*
- *About 50 per cent of the sample farm households are having MGNREGA card for rural employment.*
- *Dependence on ration cards for food grains through public distribution system of all sample households.*
- *Swach bharath program providing closed toilet facilities around 30 per cent of sample households.*
- *Women participation in decisions making for agriculture production among all of sample households.*

***Economic Indicators;***

- *The average land holding is 1.4 ha indicates that majority of farm households are belong to marginal and small farmers. The total land cultivated on dry land condition among the sample farmers.*
- *Agriculture is the main occupation among 59.5 per cent and agriculture is the main and agriculture labour is subsidiary occupation for 31 per cent of sample households.*
- *The average value of domestic assets is around Rs. 38206 per household. Mobile and television are popular media mass communication.*
- *The average value of farm assets value is around Rs. 8270 per household, about 20 per cent of sample farmers having plough and sprayer (50 %).*
- *The average value of livestock is around Rs. 7500 per household; about 20.0 per cent of household are having livestock.*
- *The average per capita food consumption is around 892.3 grams (2082.5 kilo calories) against national institute of nutrition (NIN) recommendation at 827 gram. Around 30 per cent of sample households are consuming less than the NIN recommendation.*
- *The annual average income is around Rs. 32636 per household. About 80.0 per cent of farm households are below poverty line.*
- *The per capita average monthly expenditure is around Rs. 1958 per household.*

***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.680 per ha/year. The total cost of annual soil nutrients is around Rs.293762 per year for the total area of 437.16 ha.*
- *The average value of ecosystem service for food grains production is around Rs. 15325/ ha/year. Per hectare food grains production services is maximum in cotton (Rs. 21581) followed by red gram (Rs. 19148), and paddy (Rs. 5245).*
- *The average value of ecosystem service for fodder production is around Rs. 9959/ ha/year of paddy.*
- *The data on water requirement for producing one quintal of grain is considered for estimating the total value of water required for crop production. The per hectare value of water used and value of water was maximum in redgram (Rs. 61447) followed by cotton (Rs. 51622) and paddy (Rs. 33325).*

***Economic Land Evaluation;***

- *The major cropping pattern is red gram (56.6 %) followed by cotton (39.7 %) and paddy (3.7 %).*
- *In Balbatti 3 micro-watershed, major soils are soil of Balbatti (BBT) series is having shallow soil depth cover around 48.95 % of area. On this soil farmers are presently growing cotton (16.8 %) and redgram (83.2 %), Novinihala (NHA) soil series having shallow soil depth cover around 54.0 % of area, the crops are cotton (60.4 %) and red gram (39.6 %). Yedrami (YDM) soil series having deep soil depth cover around 34.18 % of areas, crops are cotton.*
- *The total cost of cultivation and benefit cost ratio (BCR) in study area for cotton ranges between Rs.35129 /ha in YDM soil (with BCR of 1.98) and Rs. 20615/ha in BBT soil (with BCR of 1.92).*
- *In red gram the cost of cultivation range between Rs 27848/ha in NHA soil (with BCR of 2.08) and Rs.26102/ha in BBT soil (with BCR of 1.96).*
- *In paddy the cost of cultivation is Rs. 38578/ha in YDM soil (with BCR of 1.39).*
- *The land management practices reported by the farmers are crop rotation, tillage practices, fertilizer application and use of farm yard manure (FYM). Due to higher wages farmer are following labour saving strategies is not prating soil and water conservation measures. Less ownership of livestock limiting application of FYM.*
- *It was observed soil quality influences on the type and intensity of land use. More fertilizer applications in deeper soil to maximize returns.*

***Suggestions;***

- *Involving farmers is watershed planning helps in strengthing institutional participation.*
- *The per capita food consumption and monthly income is very low. Diversifying income generation activities from crop and livestock production in order to reduce risk related to drought and market prices.*
- *Majority of farmers reported that they are not getting timely support/extension services from the concerned development departments.*
- *By strengthing agricultural extension for providing timely advice improved technology there is scope to increase in net income of farm households.*
- *By adopting recommended package of practices by following the soil test fertiliser recommendation, there is scope to increase yield in cotton (42.2 to 18.1 %), red gram (10.1 %) and paddy (66.0 %).*

*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***

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

Balbatti-3 micro-watershed (Dummadri sub-watershed, Jewargi taluk, Gulbarga district) is located in between $16^{0}46'$ – $16^{0}48'$ North latitudes and $76^{0}34'$ – $76^{0}36'$ East longitudes, covering an area of about 437.16 ha, bounded by Balbatti, Vadagera, Sumbada, Shivapura and Hangalga (K) villages.

**Sampling Procedure:**

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

**Sources of data and analysis:**

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

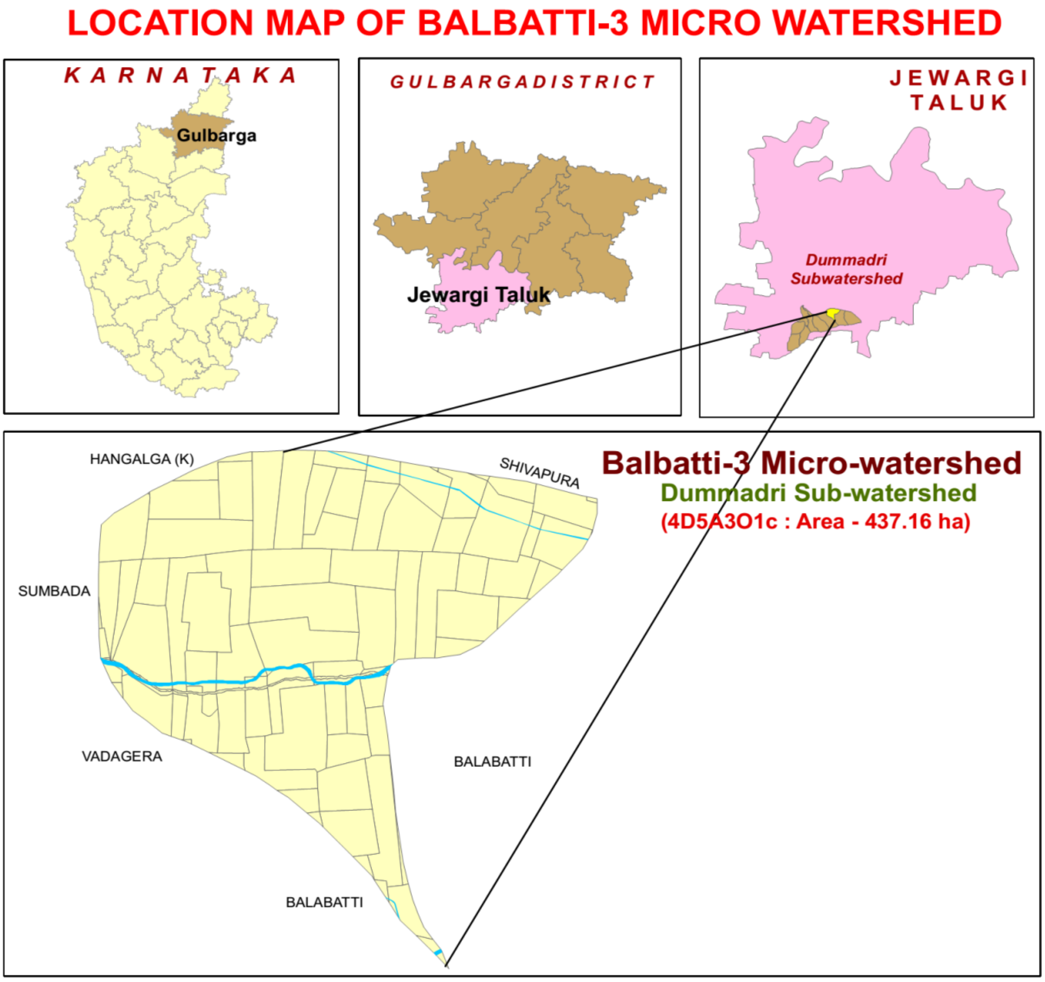


Figure 1: Location of study area

**Steps followed in socio-economic assessment**

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

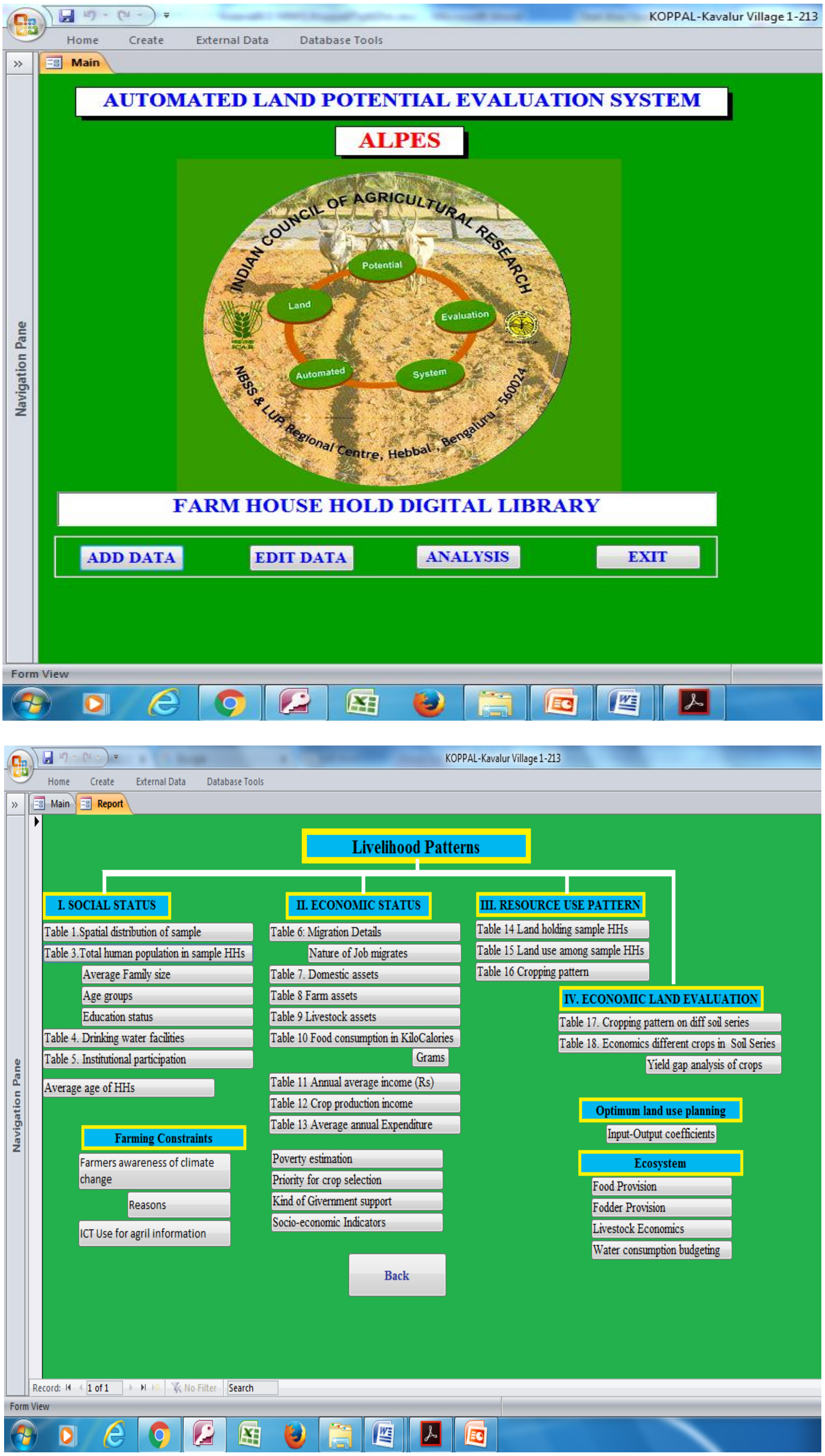


Figure 2: ALPES FRAMEWORK

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

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

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

**Economic Valuation of Soil ecosystem services:**

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

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

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

2
- Integrate the erosion rates per SMU/LUT.

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

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

*Chapter 4*

# RESULTS AND DISCUSSIONS

The demographic information shows that the household population dynamics encompasses the socioeconomic status of the farmer. For a rural family, the household size should be optimal to earn a comfortable livelihood through farm and non-farm wage earning. The total number of population in watershed area was 42, out of which 61.9 per cent were males and 38.1 per cent females. Average family size of the households is 4.2. 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 18 to 30 years (42.9 %) followed by more than 50 years (32.8 %) , 30 to 50 years (23.8 %) and 0 to 18 years (14.3 %). Hence, in the study area in general, the respondents were of young and middle age, indicating thereby that the households had almost settled with whatever livelihood options they were practicing and sample respondents were young by age who could venture into various options of livelihood sources. Data on literacy indicated that 76.2 per cent of respondents were illiterate and 23.8 per cent literate (Table 1).

**Table 1: Human population among sample households in Balbatti 3 Microwatershed**

| **Particulars** | **Units** | **Value** |
|---|---|---|
| Total human population in sample HHs | Number | 42 |
| Male | % to total Population | 61.9 |
| Female | % to total Population | 38.1 |
| Average family size | Number | 4.2 |
| **Age group** | | |
| 0 to 18 years | % to total Population | 14.3 |
| 18 to 30 years | % to total Population | 42.9 |
| 30 to 50 years | % to total Population | 23.8 |
| >50 years | % to total Population | 19.0 |
| Average age | Age in years | 32.8 |
| **Education Status** | | |
| Illiterates | % to total Population | 23.8 |
| Literates | % to total Population | 76.2 |
| Primary School (<5 class) | % to total Population | 28.6 |
| Middle School (6- 8 Class) | % to total Population | 7.1 |
| High School (9- 10 Class) | % to total Population | 23.8 |
| Others | % to total Population | 16.6 |

The ethnic groups among the sample farm households found to be 100.0 per cent belonging to other backward castes (OBC) (Table 2 and Figure 3). About 90.0 per cent of sample households are using Fire wood as source of fuel for cooking. All the sample farmers are having electricity connection. About 50 per cent are sample households having health cards. Around 30 per cent are having MNREGA job cards for employment generation. All the farm households are having ration cards for taking food grains from public distribution system. About 80 per cent of farm households are having toilet facilities.

**Table 2: Basic needs of sample households in Balbatti 3 Microwatershed**

| **Particulars** | **Units** | **Value** |
|---|---|---|
| **Social groups** | | |
| OBC | % of Households | 100 |
| **Types of fuel use for cooking** | | |
| Fire wood | % of Households | 90.0 |
| Gas | % of Households | 10.0 |
| **Energy supply for home** | | |
| Electricity | % of Households | 100 |
| **Number of households having Health card** | | |
| Yes | % of Households | 50.0 |
| No | % of Households | 50.0 |
| **MGNREGA Card** | | |
| Yes | % of Households | 30.0 |
| No | % of Households | 70.0 |
| **Ration Card** | | |
| Yes | % of Households | 100 |
| No | % of Households | 0.0 |
| **Households with toilet** | | |
| Yes | % of Households | 30.0 |
| No | % of Households | 70.0 |
| **Drinking water facilities** | | |
| Tube well | % of Households | 80.0 |
| Dug well | % of Households | 20.0 |

The data collected on the source of drinking water in the study area is presented in Table 2. Majority of the sample respondents are having tube well source for water supply for domestic purpose (80%).

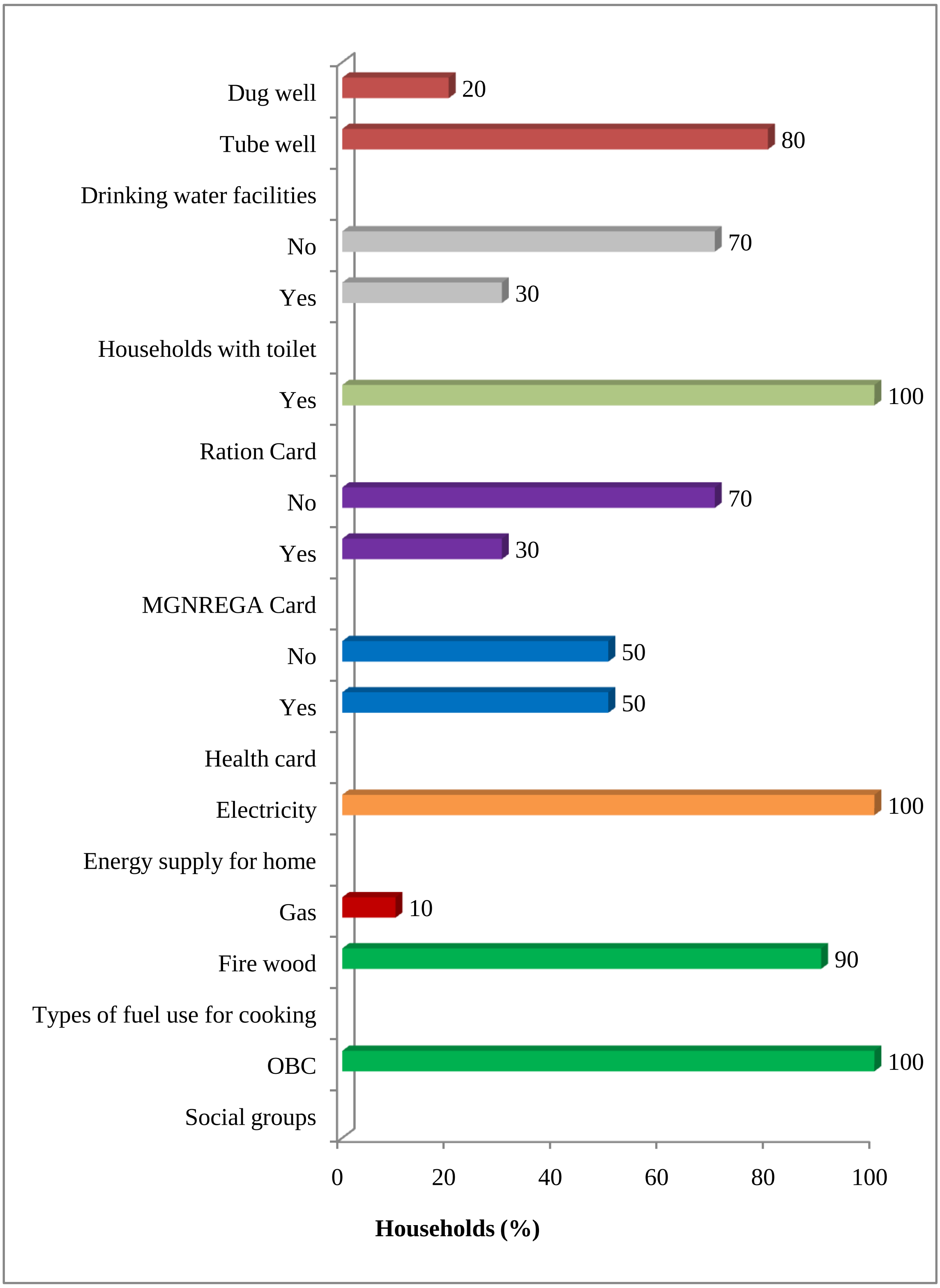


Figure 3: Basic needs of sample households in Balbatti 3 Microwatershed

The occupational pattern (Table 3) among sample households shows that agriculture is the main occupation around 59.5 per cent of farmers followed by subsidiary occupations like agricultural labour (31.0 %), self employed (2.4 %) and main occupation is self employed of around 7.1 per cent.

**Table 3: Occupational pattern in sample households in Balbatti 3 Microwatershed**

| Occupation | | % to total population |
|---|---|---|
| **Main** | **Subsidiary** | |
| Agriculture | Agriculture | 59.5 |
| | Agriculture labour | 31.0 |
| | Self employed | 2.4 |
| Self employed | | 7.1 |
| Grand Total | | 100 |
| **Family labour availability** | | **Man days/month** |
| Male | | 35.0 |
| Female | | 20.0 |
| Total | | 55.0 |

The important assets especially with reference to domestic assets were analyzed and are given in Table 4 and Figure 4. The important domestic assets possessed by all categories of farmers are television (100 %) followed by mobile phones (100 %), mixer/grinder (70 %), motorcycle (30 %), and auto (10 %). The average value of domestic assets is around Rs 38206 per households.

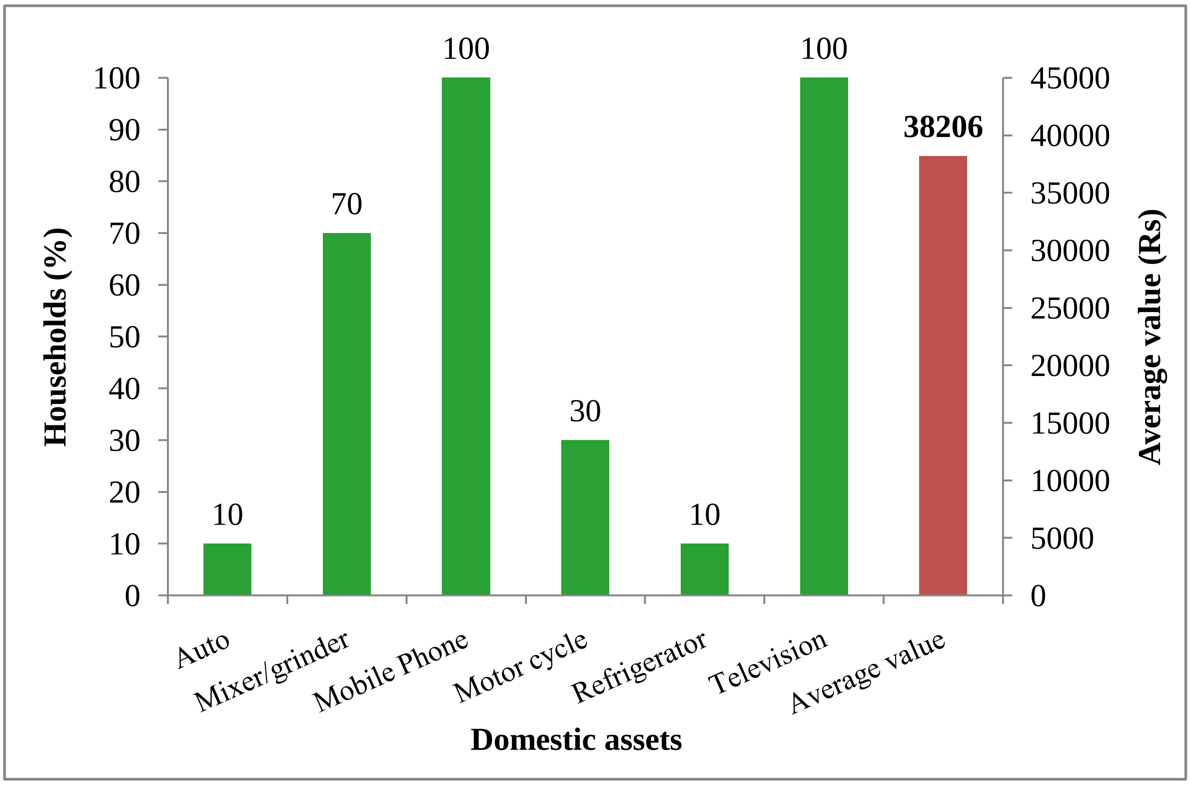


Figure 4: Domestic assets among the sample households in Balbatti 3 Micro watershed

**Table 4: Domestic assets among the sample households in Balbatti 3 Micro watershed**

| Particulars | % of households | Average value in Rs |
|---|---|---|
| Auto | 10.0 | 150000 |
| Mixer/grinder | 70.0 | 1714 |
| Mobile Phone | 100 | 5990 |
| Motor cycle | 30.0 | 53333 |
| Refrigerator | 10.0 | 10000 |
| Television | 100 | 8200 |
| Average value | 38206 | |

The most popularly owned farm equipments were sickles, plough, cattle shed; pump sets, chaff cutter, bullock cart, sprayer and thresher. plough and sickle were commonly present in all the sampled farmers; these were primary implements in agriculture. The per cent of households owned plough (20%), bullock cart (20 %) and sprayer (50%), was found highest among the sample farmers. The average value of farm assets is around Rs 8270 per households (Table 5 and Figure 5).

**Table 5: Farm assets among samples households in Balbatti 3 Microwatershed**

| Particulars | % of households | Average value in Rs |
|---|---|---|
| Bullock cart | 20.0 | 20000 |
| Plough | 20.0 | 1250 |
| Sprayer | 50.0 | 3560 |
| Average value | 8270 | |

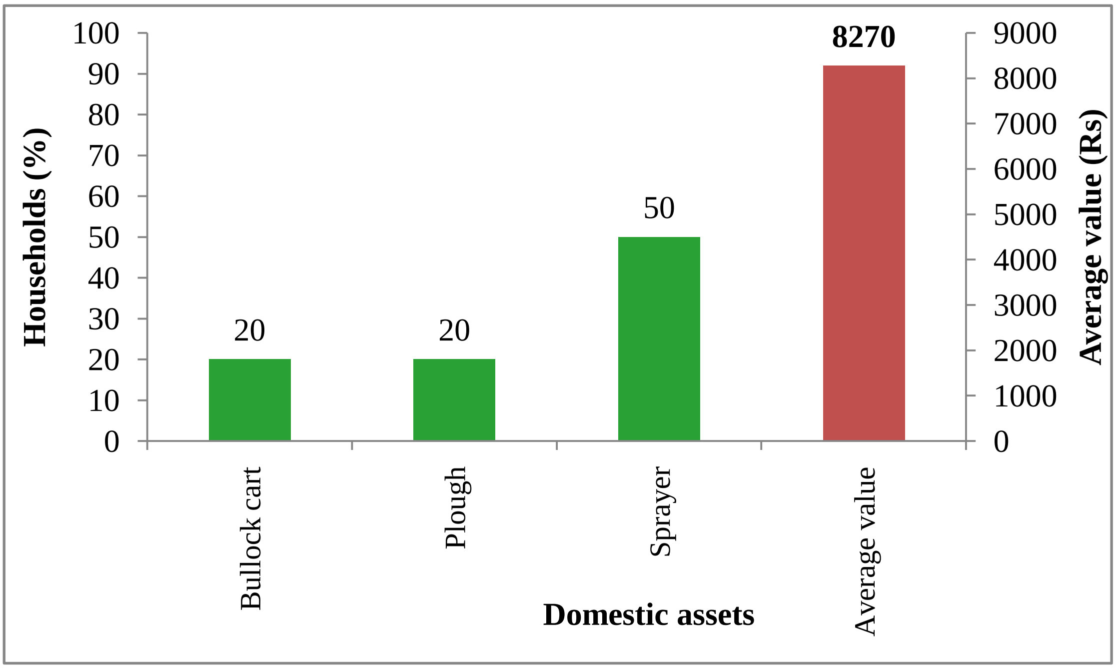


Figure 5: Farm assets among samples households in Balbatti 3 Microwatershed

Livestock is an integral component of the conventional farming systems. The highest livestock population is bullocks were around (100 %) per cent. The average value of livestock is Rs 7500 per household (Table 6).

**Table 6: Livestock assets among sample households in Balbatti 3 Microwatershed**

| Particulars | % of livestock population | Average value in Rs |
|---|---|---|
| Bullocks | 100 | 7500 |

Among the farm households, paddy is the main crop grown for the domestic food grain and fodder for animals. About 2083 kg /ha of average fodder is available per season for the livestock feeding (Table 7).

**Table 7: Fodder availability of sample households in Balbatti 3 Microwatershed**

| Particulars | Fodder yield (kg/ha.) |
|---|---|
| Paddy | 2083 |
| Average food availability | 2083 |
| Livestock having households (%) | 20.0 |
| Livestock population (Numbers) | 4 |

A woman participation in decision making is in this Microwatershed is presented in Table 8. All sample households of women taking decision in her family and agriculture related activities and women earning for her family requirement.

**Table 8: Women empowerment of sample households in Balbatti 3 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 9 and Figure 6. More quantity of cereals is consumed by sample farmers which accounted for 148.8 kcal per person. The other important food items consumed was pulses 202.6 kcal followed by cooking oil 206.9 kcal, milk 117.7 kcal, vegetables 37.6 kcal, egg 29.2 kcal and meat 5.8 kcal. In the sampled households, farmers were consuming less (2082.5 kcal) than NIN- recommended food requirement (2250 kcal).

**Table 9: Per capita daily consumption of food among the sample households in Balbatti 3 Micro watershed**

| Particulars | NIN recommendation (gram/ per day/ person) | Present level of consumption (gram/ per day/ person) | Kilo Calories /day/person |
|---|---|---|---|
| Cereals | 396.0 | 436.1 | 1482.8 |
| Pulses | 43.0 | 59.0 | 202.6 |
| Milk | 200.0 | 181.0 | 117.7 |
| Vegetables | 143.0 | 156.5 | 37.6 |
| Cooking Oil | 31.0 | 36.3 | 206.9 |
| Egg | 0.5 | 19.4 | 29.2 |
| Meat | 14.2 | 3.9 | 5.8 |
| Total | **827.7** | **892.3** | **2082.5** |
| Threshold of NIN recommendation | | 827 gram* | 2250 Kcal* |
| % Below NIN | | 30.0 | 50.0 |
| % Above NIN | | 70.0 | 50.0 |

Note: * day/person

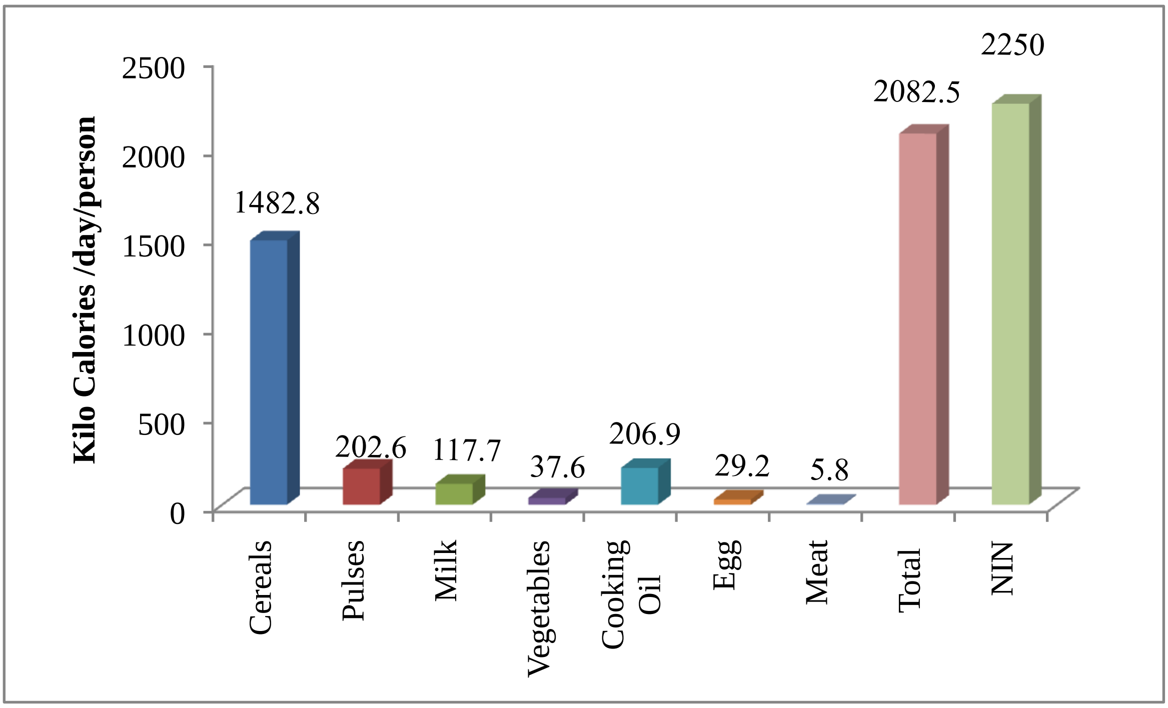


Figure 6: Per capita daily consumption of food among the sample households in Balbatti 3 Microwatershed

**Annual income of the sample HHs:** The average annual household income is around Rs 32636. Major source of income to the farmers in the study area is from crop production (Rs 32636). The monthly per capita income is Rs.647 which is less than the threshold monthly income of Rs 975 for considering above poverty line. Due to the fact that erratic rainfall and shortage of water, farmers are diverting from crop production activities to enable the household for a comfortable livelihood. The incomes from the other aforesaid sources are very meagre (Table 10).

**Table 10: Annual average income of HHs from various sources in Balbatti 3 Microwatershed**

| Particulars | Income * |
|---|---|
| Nonfarm income | 0(0) |
| Livestock income | 0(0) |
| Crop Production (Rs) | 32636(100) |
| ***Total Annual Income (Rs)*** | ***32636*** |
| Average monthly per capita income (Rs) | 647 |
| **Threshold for Poverty level (Rs 975 per month/person)** | |
| % of households below poverty line | 80.0 |
| % of households above poverty line | 20.0 |

* Figure in the parenthesis indicates % of Households

The average annual expenditure of farm households indicated that farmers in the study area spend highest on food (Rs. 39390) 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 1958 and about 80 per cent of farm households are below poverty line and 20 per of farm households are above poverty line (Table 11 and Figure 7).

**Table 11: Average annual expenditure of sample HHs in Balbatti 3 Micro watershed**

| Particulars | Value in Rupees | Per cent |
|---|---|---|
| Food | 39390 | 40 |
| Education | 6300 | 6 |
| Clothing | 9700 | 10 |
| Social functions | 33000 | 33 |
| Health | 10300 | 10 |
| Total Expenditure (Rs/year) | 98690 | 100 |
| Monthly per capita expenditure (Rs) | 1958 | |

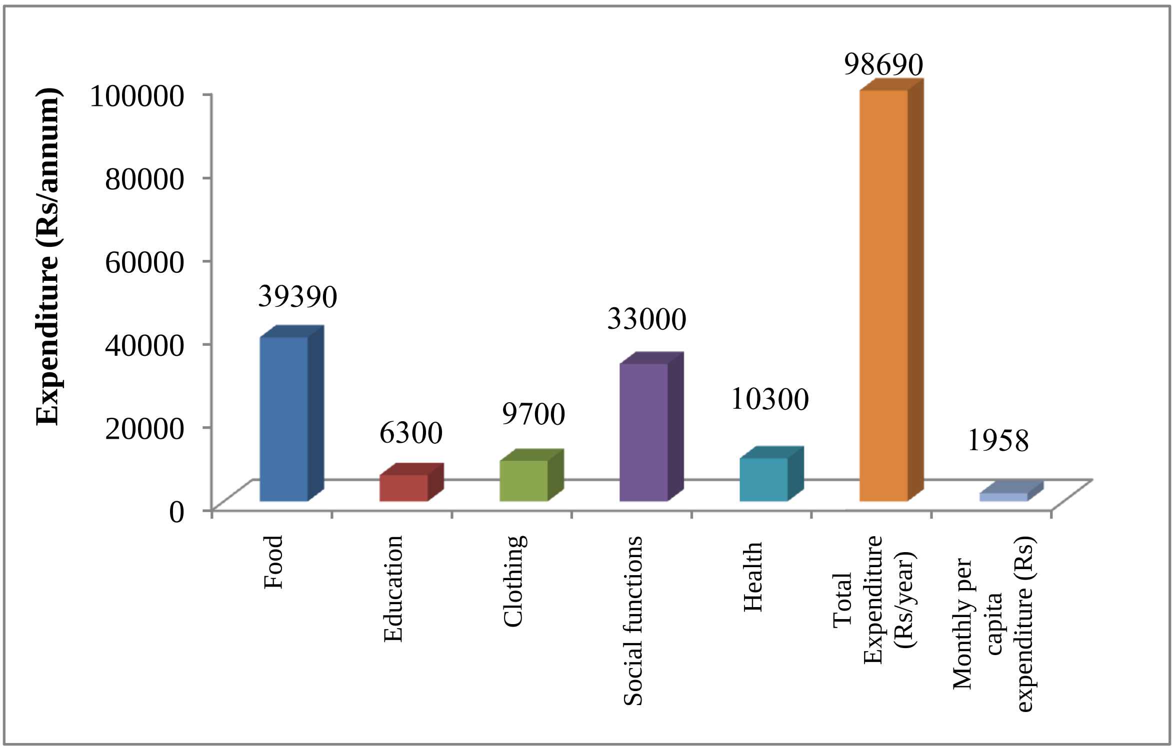


Figure 7: Average annual expenditure of sample HHs in Balbatti 3 Microwatershed

**Land holding:** The total area cultivated by them is 13.6 ha. The average land holding of sample HHs is 1.4 hectare. Large number of sample HHs (90 %) belong to small size group with an average holding size of 1.1 ha followed by large farmer (10 %) with a average land holding size of 4.1 hectare (Table 12).

**Table 12: Distribution of land holding among the sample households in Belhatti 3 Microwatershed**

| Particulars | Units | Values |
|---|---|---|
| **Small farmers** | | |
| Sample size | Per cent | 90.0 |
| Total land | ha | 9.5 |
| Average land holding | ha | 1.1 |
| **Large farmers** | | |
| Sample size | Per cent | 10.0 |
| Total land | ha | 4.1 |
| Average land holding | ha | 4.1 |
| **Total sample households** | | |
| Sample size | Per cent | 100.0 |
| Total land | ha | 13.6 |
| Average land holding | ha | 1.4 |

**Land use**: The total land holding in the Balbatti 3 Microwatershed is 13.6 ha which is under dry land. The average land holding per household is worked out to be 1.4 ha (Table 13)

**Table 13: Land use among samples households in Balbatti 3 Microwatershed**

| Particulars | Per cent | Area in ha |
|---|---|---|
| Irrigated land | 0.0 | 0.0 |
| Dry Land | 100 | 13.6 |
| Fallow Land | 0.0 | 0.0 |
| Total land holding | 100 | 13.6 |
| Average land holding | 1.4 | |

In the Microwatershed, the prevalent present land uses under perennial plants are neem trees (92.1 %) and banyan tree (7.9) (Table 14).

**Table 14: Number of trees/plants covered in sample farm households in Balbatti 3 Microwatershed**

| Particulars | Number of Plants/trees | Per cent |
|---|---|---|
| Banyan tree(Alada) | 3 | 7.9 |
| Neem trees | 35 | 92.1 |
| Grand Total | 38 | 100 |

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

The present dominant crops grown dry lands in the study area were by redgram (56.6 %) followed by cotton (39.7. %) and paddy (3.7 %) which are taken during Kharif season (Table 15 and Figure 8).

**Table 15: Present cropping pattern and cropping intensity in Balbatti 3 Microwatershed** (% to grand total)

| **Crops** | **Kharif** | **Grand Total** |
|---|---|---|
| Cotton | 39.7 | 39.7 |
| Paddy | 3.7 | 3.7 |
| Redgram | 56.6 | 56.6 |
| ***Grand Total*** | 100 | 100 |

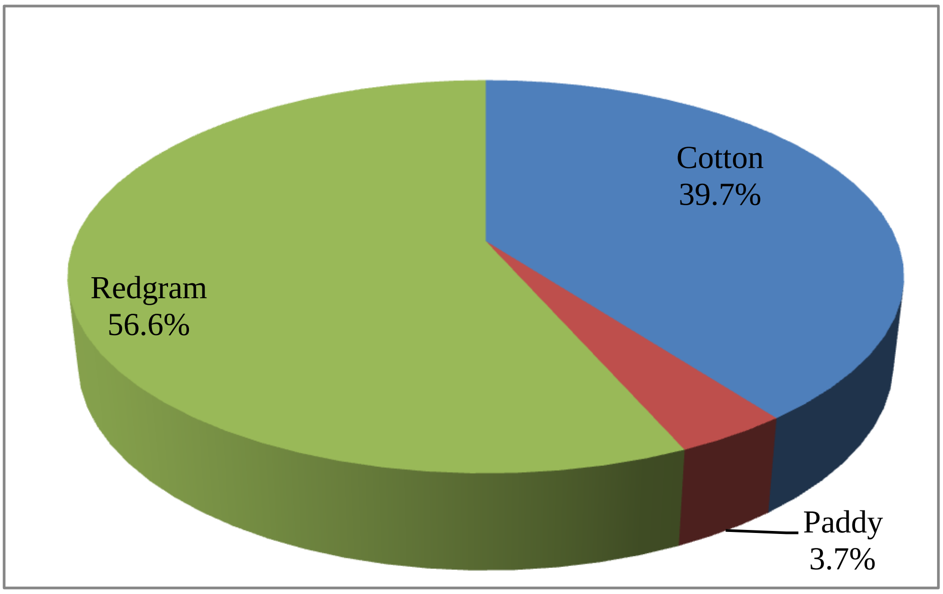


Figure 8: Present cropping pattern in Balbatti 3 Microwatershed

**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 Balbatti 3 Microwatershed, 5 soil series are identified and mapped (Table 16). The distribution of major soil series are Maguti covering an area around 0.21 ha (0.05 %) followed by Navinihala 54 ha (12.34 %), Sumbda 14 ha (3.29 %), Balbatti 214 ha (48.95 %), and Yedrami 149 ha (34.18 %).

**Table 16: Distribution of soil series in Balbatti 3 Microwatershed**

| Sl. No. | Soil Series | Mapping unit description | Area in ha (%) |
|---|---|---|---|
| 1 | MGT | Marguti soils are very shallow (<25cm), well drained. They have very dark grayish brown to dark brown, clayey soils and occur on very gently sloping to moderately sloping uplands | 0.21 (0.05) |
| 2 | NHA | Novinihala soils are shallow (25-50 cm), well drained. They have very dark grayish brown to dark brown clayey soils and occur on nearly level to very gently sloping to moderately sloping uplands | 54 (12.34) |
| 3 | SBD | Sumbda soils are shallow (25-50 cm), well drained. They have very dark grayish brown to dark reddish brown clayey soils and occur on very gently sloping uplands | 14 (3.29) |

| | | | |
|---|---|---|---|
| 4 | BBT | Balbatti soils are deep (100-150 cm), moderately well drained. They have very dark gray to dark reddish brown soils and occur on very gently sloping uplands | 214 (48.95) |
| 5 | YDM | Yedrami soils are deep (100-150 cm), moderately well drained. They have very dark gray to dark reddish brown soils and occur on nearly level to very gently sloping uplands | 149 (34.18) |

Present cropping pattern on different soil series are given in Table 17. Crops grown on Balbatti soils are cotton and redgram, cotton and redgram on Navinihala soils is grown and cotton on Yedrami soils is grown.

**Table 17: Cropping pattern on major soil series in Balbatti 3 Microwatershed**

(Area in per cent)

| Soil Series | Soil Depth | Crops | Dry Kharif | Grand Total |
|---|---|---|---|---|
| NHA | Shallow (25-50 cm) | Cotton | 60.4 | 60.4 |
| | | Redgram | 39.6 | 39.6 |
| BBT | Deep (100-150 cm) | Cotton | 16.8 | 16.8 |
| | | Redgram | 83.2 | 83.2 |
| YDM | Very deep (>150 cm) | Cotton | 100.0 | 100.0 |

Land is used for agricultural use for growing cereals, pulse, oilseeds and commercial crops. The soil/ land potential are measures in terms of physical yield and net income. The alternative land use options for each micro-watershed are given below (Table 18).

**Table 18: Alternative land use options for different size group of farmers (Benefit Cost Ratio) in Balbatti 3 Microwatershed.**

| Soil Series | Small Farmers | Large Farmers |
|---|---|---|
| BBT | Redgram(1.8) | Cotton(1.9), Redgram(2.6) |
| NHA | Cotton (1.6), Redgram (2.1) | |
| YDM | Cotton (2.0), Paddy (1.4) | |

The productivity of different crops grown in Balbatti-3 Microwatershed under potential yield of the crops is given in Table 19.

The data on cost of cultivation and benefit cost ratio (BCR) of different crops is given in Table 19. The total cost of cultivation in study area for cotton ranges between Rs. 35129 /ha in YDM soil (with BCR of 1.98) and Rs 20615/ha in BBT soil (with BCR of 1.92), red gram range between Rs 27848/ha in NHA soil (with BCR of 2.08) and

Rs.26102/ha in BBT soil (with BCR of 1.96) and paddy cost of cultivation in YDM soil is Rs. 38578/ha (with BCR of 1.39).

**Table 19: Economic land evaluation and bridging yield gap for different crops in Balbatti 3 Microwatershed**

| Particulars | NHA (25-50 cm) | | BBT (100-150 cm) | | YDM (>150 cm) | |
|---|---|---|---|---|---|---|
| | Cotton | Redgram | Cotton | Redgram | Cotton | Paddy |
| Total cost (Rs/ha) | 34502 | 27848 | 20615 | 26102 | 35129 | 38578 |
| Gross Return (Rs/ha) | 53506 | 57816 | 39520 | 48052 | 69201 | 53782 |
| Net returns (Rs/ha) | 19004 | 29968 | 18905 | 21949 | 34073 | 15204 |
| BCR | 1.64 | 2.08 | 1.92 | 1.96 | 1.98 | 1.39 |
| **Farmers Practices (FP)** | | | | | | |
| FYM (t/ha) | 2.4 | 2.5 | 1.7 | 2.3 | 2.1 | 4.0 |
| Nitrogen (kg/ha) | 48.2 | 27.8 | 28.3 | 25.3 | 30.4 | 64.5 |
| Phosphorus (kg/ha) | 70.9 | 71.0 | 47.9 | 54.9 | 53.8 | 46.4 |
| Potash (kg/ha) | 33.7 | 0.0 | 0.0 | 0.0 | 15.4 | 0.0 |
| Grain (Qtl/ha) | 13.3 | 12.3 | 10.0 | 11.1 | 14.2 | 20.2 |
| Price of Yield (Rs/Qtl) | 4000 | 4500 | 4000 | 3940 | 4450 | 2200 |
| **Soil test based fertilizer Recommendation (STBR)** | | | | | | |
| FYM (t/ha) | 12.4 | 7.4 | 12.4 | 7.4 | 12.4 | 9.9 |
| Nitrogen (kg/ha) | 129.7 | 24.7 | 111.2 | 21.0 | 148.2 | 98.8 |
| Phosphorus (kg/ha) | 83.4 | 61.8 | 92.6 | 56.8 | 92.6 | 61.8 |
| Potash (kg/ha) | 55.6 | 18.5 | 55.6 | 18.5 | 55.6 | 37.1 |
| Grain (Qtl/ha) | 17.3 | 12.4 | 17.3 | 12.4 | 17.3 | 59.3 |
| **% of Adoption/yield gap (STBR-FP) / (STBR)** | | | | | | |
| FYM (%) | 80.4 | 66.7 | 86.5 | 69.3 | 83.1 | 59.2 |
| Nitrogen (%) | 62.8 | -12.5 | 74.5 | -20.5 | 79.5 | 34.7 |
| Phosphorus (%) | 15.0 | -15.0 | 48.3 | 3.4 | 42.0 | 24.9 |
| Potash (%) | 39.4 | 100.0 | 100.0 | 100.0 | 72.3 | 100.0 |
| Grain (%) | 23.3 | 0.0 | 42.2 | 10.1 | 18.1 | 66.0 |
| **Value of yield and Fertilizer (Rs)** | | | | | | |
| Additional Cost (Rs/ha) | 11890 | 4868 | 14756 | 5539 | 14194 | 7677 |
| Additional Benefits (Rs/ha) | 16145 | 19 | 29160 | 4933 | 13899 | 86061 |
| Net change Income (Rs/ha) | 4255 | -4849 | 14404 | -606 | -295 | 78384 |

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 19. 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 78384 in maize and a minimum of Rs 4255 in cotton cultivation.

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

The onsite cost of different soil nutrients lost due to soil erosion is given in Table 20 and Figure 9. The average value of soil nutrient loss is around Rs 680 per ha/year. The total cost of annual soil nutrients is around Rs 293762 per year for the total area of 437.16 ha.

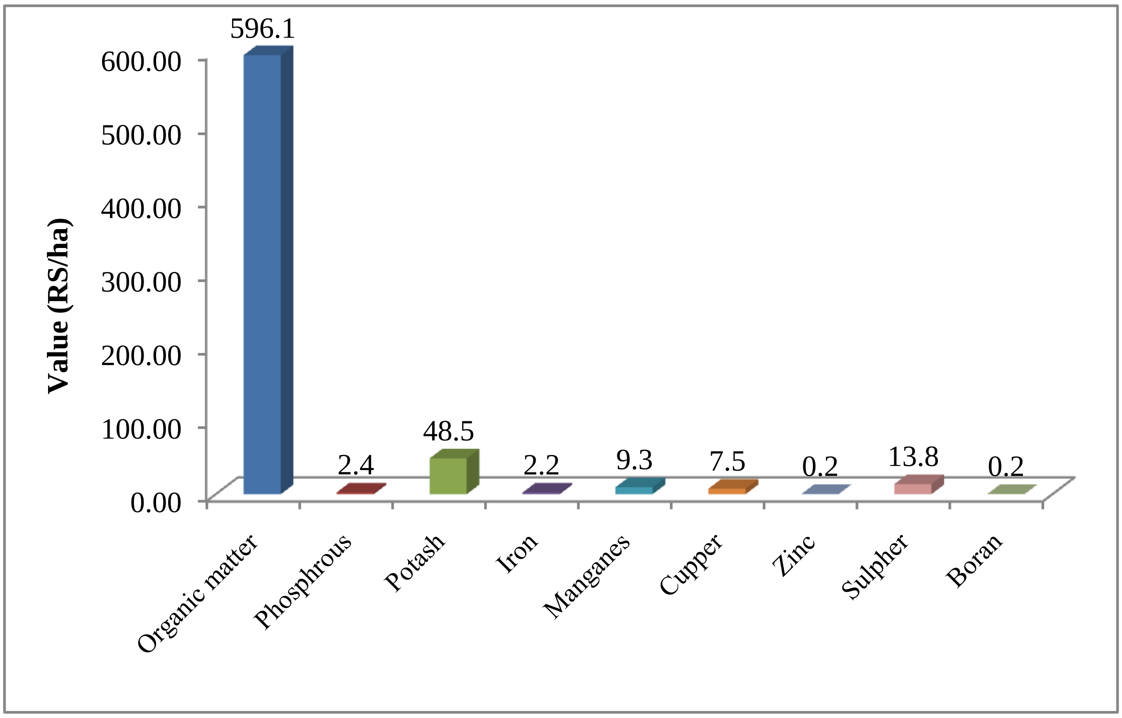


Figure 9: Estimation of onsite cost of soil erosion in Balbatti 3 Microwatershed

The average value of ecosystem service for food grain production is round Rs 15325 ha/year (Table 21 and Figure 10). Per ha food grain production services is maximum in cotton (Rs. 21581) followed by redgram (Rs. 19148) and paddy (Rs. 5245).

**Table 20: Estimation of onsite cost of soil erosion in Balbatti 3 Microwatershed**

| Particulars | Quantity(kg) | | Value (Rs) | |
|---|---|---|---|---|
| | Per ha | Total | Per ha | Total |
| Organic matter | 94.61 | 40872 | 596.05 | 257494 |
| Phosphorus | 0.05 | 23 | 2.36 | 1019 |
| Potash | 2.42 | 1047 | 48.49 | 20946 |
| Iron | 0.05 | 19 | 2.16 | 935 |
| Manganese | 0.03 | 15 | 9.35 | 4039 |
| Cupper | 0.01 | 6 | 7.47 | 3228 |
| Zinc | 0.01 | 2 | 0.20 | 87 |
| Sulpher | 0.34 | 149 | 13.76 | 5944 |
| Boron | 0.00 | 2 | 0.16 | 70 |
| Total | 97.53 | 42135 | 680 | 293762 |

**Table 21: Ecosystem services of food production in Balbatti 3 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 | Paddy | 0.5 | 19.9 | 2200 | 43823 | 38578 | 5245 |
| Pulses | Redgram | 7.6 | 11.3 | 4040 | 45600 | 26452 | 19148 |
| Commercial Crops | Cotton | 5.3 | 12.8 | 4180 | 53556 | 31975 | 21581 |
| Average value | | 13.5 | 14.7 | 3473 | 47660 | 32335 | 15325 |

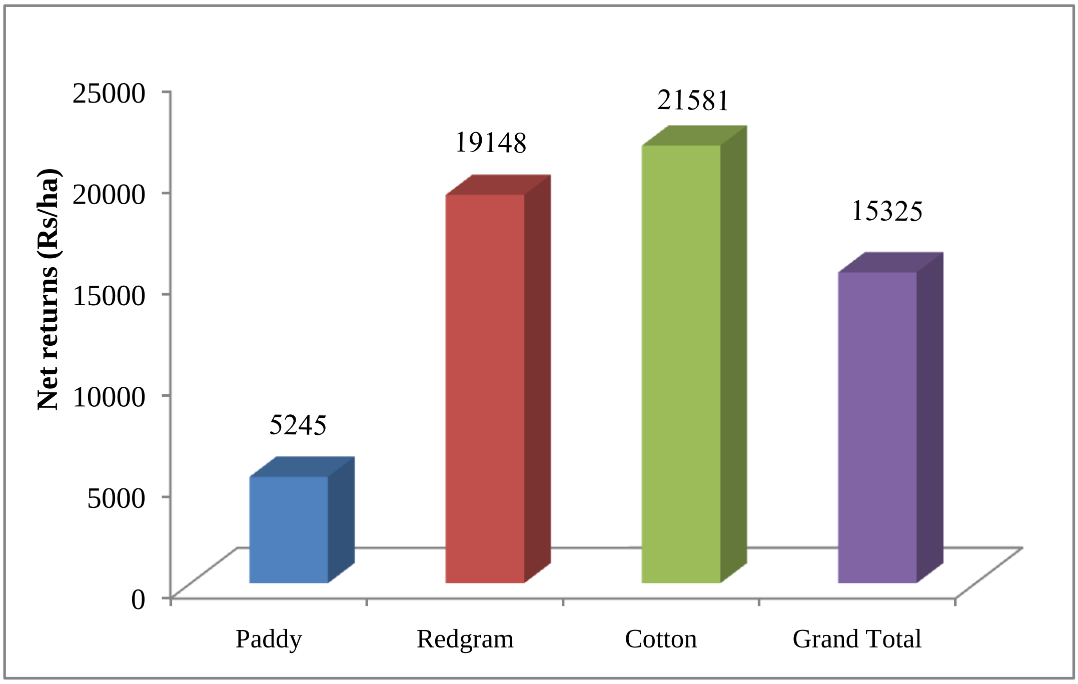


Figure 10: Ecosystem services of food production in Balbatti 3 Micro watershed

The average value of ecosystem service for fodder production is around Rs 9959/ha/year in paddy (Table 22).

**Table 22: Ecosystem services of fodder production in Balbatti 3 Micro watershed**

| Production items | Crops | Area in ha | Yield (Qtl/ha) | Price (Rs/Qtl) | Net Returns (Rs/ha) |
|---|---|---|---|---|---|
| Cereals | Paddy | 0.50 | 3.98 | 2500 | 9959 |

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 23 and Figure 11) in redgram (Rs 61447) followed by cotton (Rs 51622) and paddy (Rs 33325).

**Table 23: Ecosystem services of water supply in Balbatti 3 Micro watershed**

| Crops | Yield (Qtl/ha) | Virtual water (cubic meter) per ha | Value of Water (Rs/ha) | Water consumption (Cubic meters/Qtl) |
|---|---|---|---|---|
| Cotton | 12.8 | 5162 | 51622 | 403 |
| Paddy | 19.9 | 3333 | 33325 | 167 |
| Redgram | 11.3 | 6145 | 61447 | 544 |
| Average value | 44 | 4880 | 48798 | 371 |

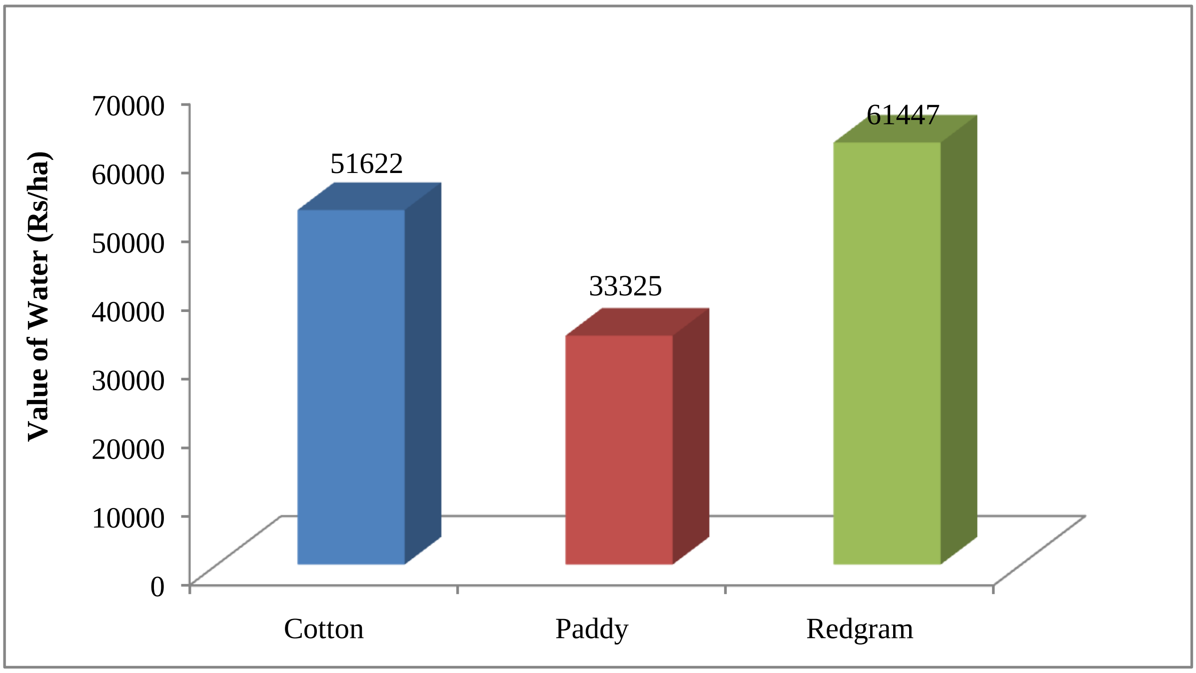


Figure 11: Ecosystem services of water supply in Balbatti 3 Micro watershed

The main farming constraints in Balbatti 3 Micro watershed to be found are less rainfall, non availability fertilizers, high crop pests & diseases, animal pests & diseases, damage of crops by wild animals, lack of transportation 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 television. Farmers reported that they are not getting timely support/extension services from the concerned development department (Table 24).

**Table 24: Farming constraints related land resources of sample households in Balbatti 3 Micro watershed**

| Sl.No | **Particulars** | **Per cent** |
|---|---|---|
| 1 | Less Rainfall | 100.0 |
| 2 | Non availability Fertilizers | 50.0 |
| 3 | High Crop Pests & Diseases | 80.0 |
| 4 | Animal Pests & Diseases | 30.0 |
| 5 | Lack of transportation | 30.0 |
| 6 | Lack of storage | 60.0 |
| 7 | Damage of crops by Wild Animals | 100.0 |
| 8 | Non availability of Plant Protection Chemicals | 100.0 |
| 9 | **Source of loan** | |
| | Village merchants | 10.0 |
| 10 | **Market for selling** | |
| | Regulated | 100.0 |
| 11 | **Sources of Agri-Technology information** | |
| | Television | 100.0 |

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