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

DARGAH-2 (4D5B3L2c) MICROWATERSHED

Chitapur Taluk, Gulbarga District, Karnataka

Karnataka Watershed Development Project – II

SUJALA – III

World Bank funded Project

The World Bank

ICAR – NATIONAL BUREAU OF SOIL SURVEY AND LAND USE PLANNING

WATERSHED DEVELOPMENT DEPARTMENT
GOVT. OF KARNATAKA, BANGALORE

About ICAR - NBSS&LUP

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

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

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PREFACE

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

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

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

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

ICAR-NBSS&LUP, Regional Centre, Bangalore has taken up a project sponsored by the Karnataka Watershed Development Project-II, (Sujala-III), Government of Karnataka funded by the World Bank under Component-1 Land Resource Inventry. This study was taken up to demonstrate the utility of such a database in reviewing, monitoring and evaluating all the land based watershed development programs on a scientific footing. To meet the requirements of various land use planners at grassroots level, the present study on “Land Resource Inventory and Socio-Economic Status of Farm Households for Watershed Planning and Development of Dargah-2 Microwatershed, Chitapur Taluk and Gulbarga District, Karnataka” for integrated development was taken up in collaboration with the State Agricutural Universities, IISC, KSRSAC, KSNDMC as Consortia partners. The project provides detailed land resource information at cadastral level (1:7920 scale) for all the plotsand 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 **S.K. SINGH**

Date: 01.11.2017 Director, ICAR - NBSS&LUP, Nagpur

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PART-A

LAND RESOURCE INVENTORY

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EXECUTIVE SUMMARY

The land resource inventory of Dargah-2 Microwatershed was conducted using village cadastral maps and IRS satellite imagery on 1:7920 scale. The false colour composites of IRS imagery were interpreted for physiography and the physiographic delineations were used as base for mapping soils. The soils were studied in several transects and a soil map was prepared with phases of soil series as mapping units. Random checks were made all over the area outside the transects to confirm and validate the soil map unit boundaries. The soil map shows the geographic distribution and extent, characteristics, classification and use potentials of the soils in the microwatershed.

The present study covers an area of 467 ha in Chitapur taluk of Gulbarga district, Karnataka. The climate is semiarid and categorized as drought-prone with an average annual rainfall of 762 mm, of which about 571 mm is received during south-west monsoon, 99 mm during north-east and the remaining 92 mm during the rest of the year. Entire area of the microwatershed is covered by soils. The salient findings from the land resource inventory are summarized briefly below.

- ❖ *The soils belong to 3 soil series and 6 soil phases (management units) and 2 land use classes.*
- ❖ *The length of crop growing period is about 120-150 days varying from 2nd week of June to 3rd 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 was assessed and maps showing the degree of suitability along with constraints were generated.*
- ❖ *Entire area of the microwatershed is suitable for agriculture*
- ❖ *Entire area of the microwatershed has soils that are moderately deep (75-100 cm) to very deep (>150 cm).*
- ❖ *Entire area of the microwatershed has clayey soils at the surface*
- ❖ *All the soils of the microwatershed are non gravelly*
- ❖ *An area of about 7 per cent medium (101-150 mm/m) and 93 per cent very high (>200 mm/m) in available water capacity.*
- ❖ *About 80 per cent of the area has nearly level (0-1%) to very gently sloping (1-3% slope) lands and about 20 per cent of the area is gently sloping (3-5%).*
- ❖ *An area of about 1 per cent has soils that are slightly eroded (e1) and 99 per cent moderately eroded (e2).*
- ❖ *An area of about 90 per cent soils is moderately alkaline (pH 7.8-8.4) and 10 per cent strongly alkaline (pH 8.4-9.0).*

- *The Electrical Conductivity (EC) of the soils are dominantly <2 dsm^{-1}indicating that the soils are non-saline.*
- *An area about 1 per cent of the soils are low (<0.5%), 54 per cent medium (0.5-0.75%) and 44 per cent high (>0.75) in organic carbon.*
- *About 99 per cent of the area is low (<23 kg/ha) in available phosphorus and small area of 1 per cent medium (23-57 kg/ha).*
- *About 17 per cent of the soils are low (<145 kg/ha) and 83 per cent medium (145-337 kg/ha) in available potassium.*
- *Available sulphur is medium (10 -20 ppm) in an area of about 26 per cent, low (<10 ppm) in maximum area of about 73 per cent and high (>20 ppm) in an area of 3 per cent.*
- *Available boron is low (0.5 ppm) in maximum area of about 86 per cent, medium (0.5-1.0 ppm) in 14 per cent.*
- *Available iron is sufficient (>4.5 ppm) in the entire area.*
- *Available manganese and copper are sufficient in all the soils of the microwatershed.*
- *Available zinc is deficient (<0.6 ppm) in 90 per cent and sufficient (>0.6 ppm) in 10 per cent of soils in the microwatershed.*
- *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, 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	234 (50)	232(50)		Sapota	-	446(96)
Maize	-	-		Jackfruit	-	-
Redgram	-	467(100)		Jamun	-	446(96)
Sunflower	234 (50)	232(50)		Musambi	434(93)	12(3)
Cotton	234 (50)	232(50)		Lime	434(93)	12(3)
Sugarcane	-	-		Cashew	-	-
Soybean	234 (50)	232(50)		Custard apple	446(96)	20(4)
Bengal gram	467(100)	-		Amla	446(96)	20(4)
Guava	-	446(96)		Tamarind	-	446(96)
Mango	-	-				

Apart from the individual crop suitability, a proposed crop plan has been prepared for the 2 identified LUCs by considering only the highly and moderately suitable lands for different crops and cropping systems with food, fiber and horticulture crops.

- ❖ *Maintaining soil-health is vital to crop production and conserve soil and land resource base for maintaining ecological balance and to mitigate climate change. For this, several ameliorative measures have been suggested 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 and also in the hillocks, mounds and ridges. That would help in supplementing the income, provide fodder and fuel, generate lot of biomass, of which would help in maintaining ecological balance and help in mitigating climate change.*

Chapter 1

INTRODUCTION

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

In this critical juncture, the challenge before us is not only to increase the productivity per unit area which is steadily declining and showing a fatigue syndrome, but also to prevent or at least reduce the severity of degradation. If the situation is not reversed at the earliest, then the sustainability of the already fragile crop production system and the overall ecosystem will be badly affected in the state.

Added to this, every year there is a significant diversion of farm lands and water resources for non-agricultural purposes. Thus, developing strategies to slow down the degradation process or reclaim the soils to normal condition and ensure sustainability of production system are the major issues today. This demands a systematic appraisal of our soil and land resources with respect to their extent, geographic distribution, characteristics, behaviour and uses potential, which is very important for developing an effective land use and cropping systems for augmenting agricultural production on a sustainable basis.

The soil and land resource inventories made so far in Karnataka had limited utility because the surveys were of different types, scales and intensities carried out at different times with specific objectives. Hence, there is an urgent need to generate detailed site-specific farm level database on various land resources for all the villages/watersheds in a time bound manner that would help to protect the valuable soil and land resources and also to stabilize the farm production. Therefore, the land resource inventory required for farm level planning is the one which investigates all the parameters which are critical for productivity *viz.,* soils, site characteristics like slope, erosion, gravelliness and stoniness, climate, water, topography, geology, hydrology, vegetation, crops, land use pattern, animal population, socio-economic conditions, infrastructure, marketing facilities and various schemes and developmental works of the government etc. From the data collected at farm level, the specific problems and potentials of the area can be identified and highlighted, conservation measures required for the area can be planned on a scientific footing, suitability of the area for various uses can be worked out and finally viable and sustainable land use options suitable for each and every land holding can be prescribed.

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

The land resource inventory aims to provide site specific database for Dargah-2 microwatershed in Chitapur Taluk, Gulbarga 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. 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 study area of Dargah-2 microwatershed (Invi subwatershed) is located in the northern part of Karnataka in Chitapur Taluk, Gulbarga District, Karnataka State (Fig.2.1). It lies between $17^{0}13'$ and $17^{0}15'$ North latitudes and $77^{0}4'$ and $77^{0}6'$ East longitudes and comprises of Gundagurthi, Tengali and Dhandothi and covers an area of 467 ha. It is surrounded by Mopti on the northwest, Belgumpa on the west, Mudbol on the south, Kalgurki on the northeast, Baghwadi on the southwest and Tonsanhalli village on the eastern side. The Dargah-2 microwatershed is about 18 km from chitapur town.

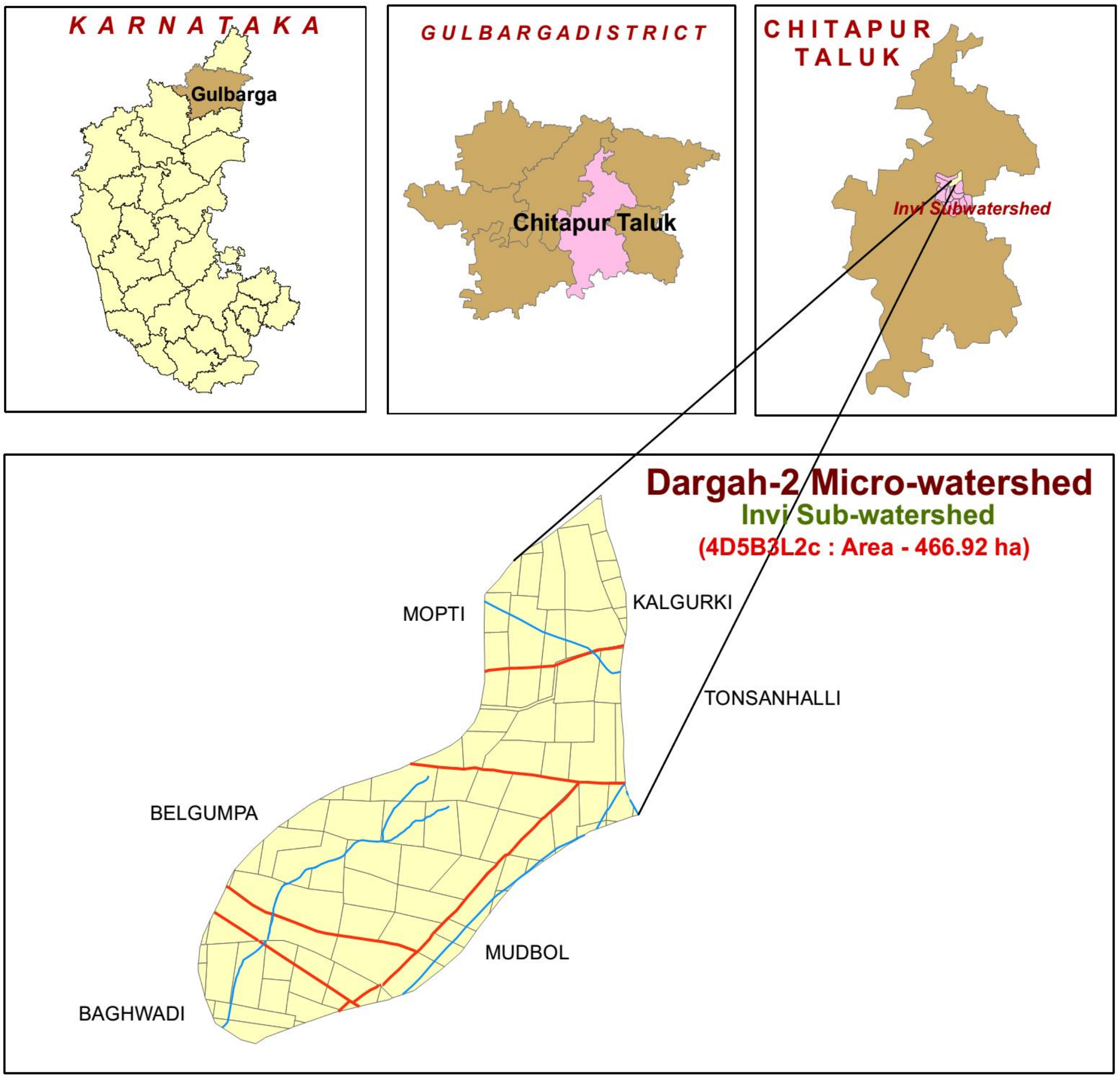

Fig.2.1 Location map of Dargah-2 Microwatershed

2.2 Geology

Major rock formation observed in the microwatershed belongs to Bhima Group of rocks exposed on either side of the Bhima river flowing through Gulbarga district. The Bhima Group is mainly made up of limestone. It has two subgroups the lower being dominantly clastic made up of sandstone and shale while the upper sequence is mainly of limestone and shale. Limestone is the most characteristic and economically important rock type. It is fine grained, dense, waxy-lustred and breaking with conchoidal fracture. Five types of limestone are recognized. They are

1. Flaggy dark gray argillaceous limestone
2. Massive dark gray to bluish gray limestone
3. Variegated silicified limestone with various coloured chert bands
4. Slabby to blocky blue gray limestone and
5. Flaggy impure limestone.

The slabby varieties are extensively quarried and make an excellent material for paving and take very good polish. The blocky limestone is of cement grade and forms the main raw material for cement factories.

Fig. 2.2 Limestone rock formation

2.3 Physiography

Physiographically, the area has been identified as limestone landscape based on geology. The area has been further subdivided into four landforms, viz; mounds/ridges, summits, side slopes and very gently sloping uplands based on slope and its relief features. The elevation ranges from 393-434 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 downstream joins Awarja river along its course. Though, it is not a perennial one, during rainy season it carries large quantities of rain water. The microwatershed has only few small tanks which are not capable of storing the water that flows during the rainy season. Due to this, the ground water recharge is very much affected. This is reflected in the failure of many bore wells in the villages. If the available rain water is properly harnessed by constructing new tanks and recharge structures at appropriate places in the villages, then the drinking and irrigation needs of the area can be easily met. The drainage network is parallel to subparallel and dendritic.

2.5 Climate

The Gulbarga district lies in the northern plains of Karnataka and falls under semiarid tract of the state and is categorized as drought-prone area. The average annual rainfall of Chitapur taluk is 762 mm (Table 2.1). Of the total rainfall, maximum of 571 mm is received during the south–west monsoon period from June to September, the north-east monsoon from October to early December contributes about 99 mm, and the remaining 92 mm during the rest of the year. December is the coldest month with mean daily maximum and minimum temperatures being 29.5^{0}C and 15^0 to 10^{0}C respectively. During peak summer, temperatures shoot up to 45^{0}C. Relative humidity varies from 26 per cent in summer to 62 per cent in winter. Rainfall distribution is shown in Figure 2.3. The average Potential Evapo-Transpiration (PET) is 159mm and varies from a low of 114 mm in December to 232 mm in the month of May. The PET is always higher than precipitation in all the months except August and September. Generally, the Length of crop Growing Period (LGP) is 120-150 days and starts from 2nd week of June to 3rd week of October.

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

Sl. No.	Months	Rainfall	PET	1/2 PET
1	January	5.10	126.80	63.40
2	February	5.70	143.90	71.95
3	March	17.70	189.90	94.95
4	April	26.30	209.80	104.90
5	May	32.80	232.20	116.10
6	June	98.30	186.40	93.20
7	July	145.20	152.80	76.40
8	August	149.20	147.60	73.80
9	September	178.30	131.70	65.85
10	October	76.30	145.50	72.75
11	November	22.70	129.80	64.90
12	December	4.30	114.80	57.40
Total		**761.90**		

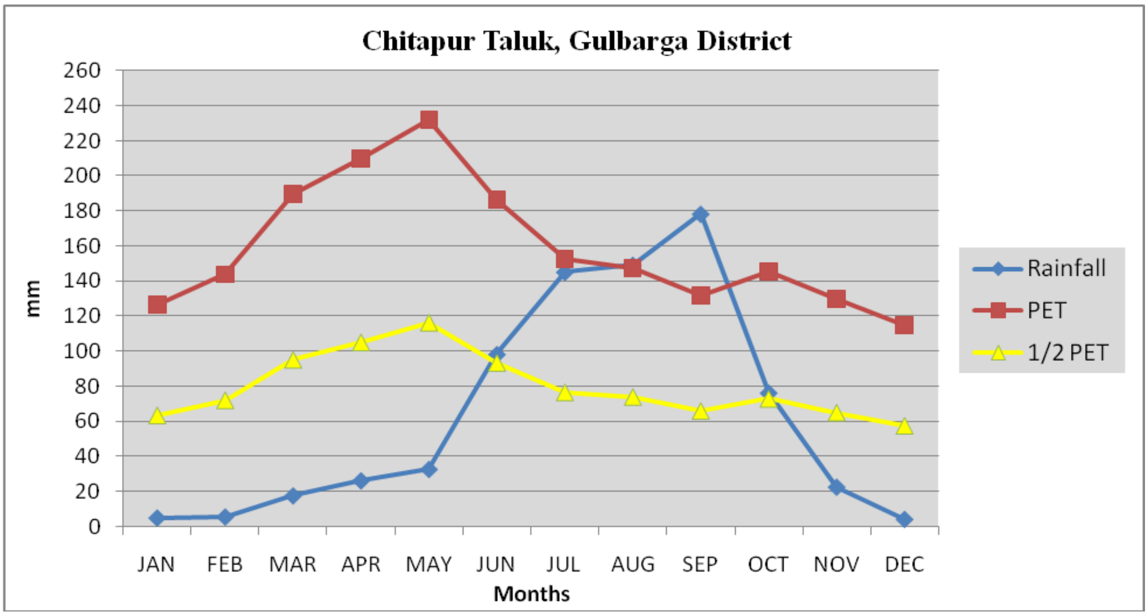

Fig 2.3 Rainfall distribution in Chitapur Taluk, Gulbarga District

2.6 Natural Vegetation

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

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

Fig. 2.4 Natural Vegetation of Dargah-2 Microwatershed

2.7 Land Utilization

About 84 per cent area (Table 2.2) in Chitapur taluk is cultivated at present. An area of <1 per cent is permanently under pasture, 1 per cent under current fallows and 7 per cent under nonagricultural land and currently barren. Forests occupy an area of about 3 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, cotton, sugarcane, red gram 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 prepared. The current land use map prepared shows the arable and non-arable lands, other land uses and different types of crops grown in the area. The current land use map of Dargah-2 microwatershed is presented in Fig.2.5. Simultaneously, enumeration of wells (bore wells and open wells) in the microwatershed was made and their location in different survey numbers is marked on the cadastral map.

Table 2.2 Land Utilization in Chitapur Taluk

Sl. No.	Agricultural land use	Area (ha)	Per cent
1.	Total geographical area	176447	-
2.	Total cultivated area	148239	84.01
3.	Area sown more than once	8155	-
4.	Cropping intensity	-	105.50
5.	Trees and grooves	21	0.01
6.	Forest	6150	3.49
7.	Cultivable wasteland	4530	2.57
8.	Permanent Pasture land	674	0.38
9.	Barren land	3689	2.09
10.	Non- Agriculture land	9368	5.30

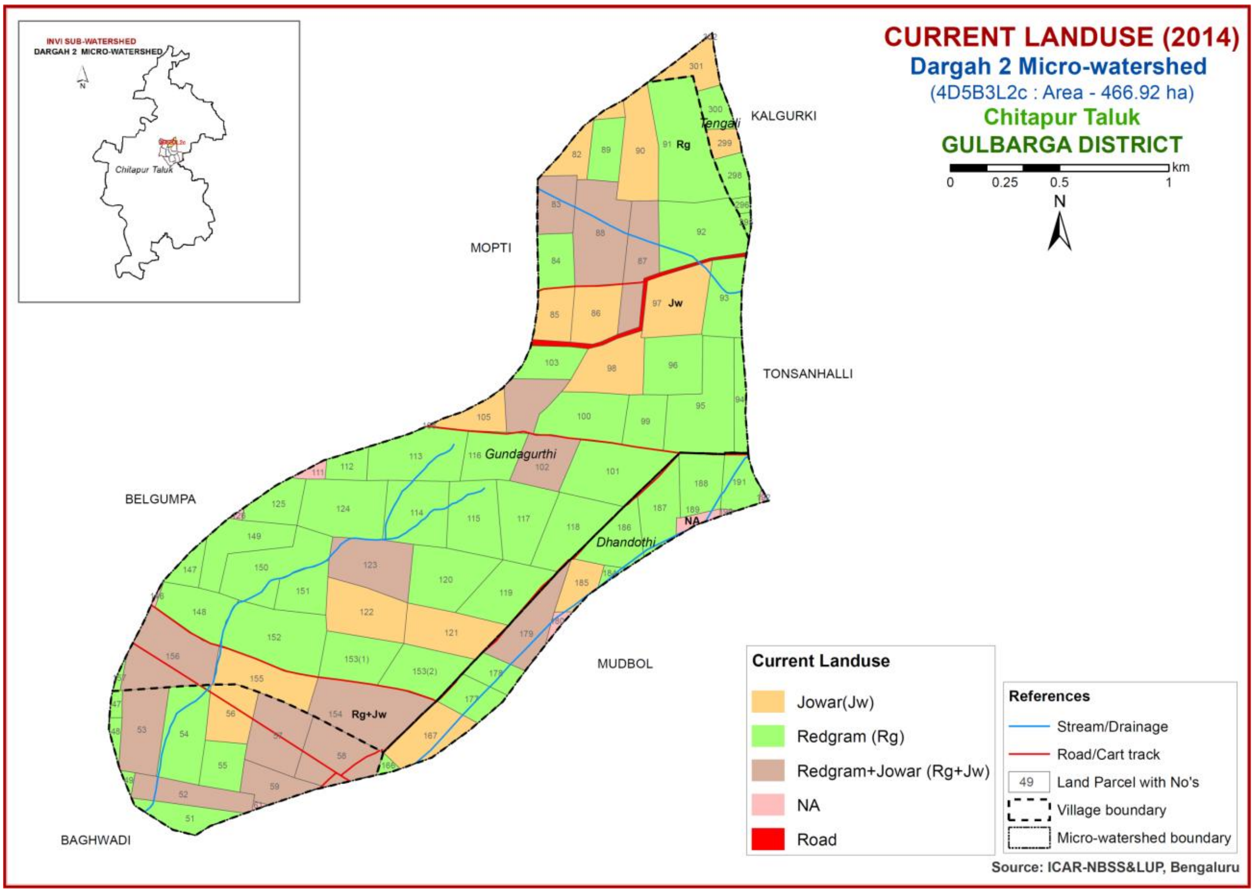

Fig.2.5 Current Land Use map of Dargah-2 Microwatershed

Fig.2.6 Different crops and cropping systems in Dargah-2 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 Dargah-2 microwatershed by the detailed study of all the soil characteristics (depth, texture, colour, structure, consistence, coarse fragments, porosity, soil reaction, soil horizons etc.) and site (slope of the land, erosion, drainage, occurrence of rock fragments etc.) followed by grouping of similar areas based on soil-site characteristics into homogeneous (management units) units and showing their area extent and geographic distribution on the microwatershed cadastral map. The detailed survey at 1:7920 scale was carried out in 467 ha area. The methodology followed for carrying out land resource inventory was as per the guidelines given in Soil Survey Manual (IARI, 1971; Soil Survey Staff, 2006; Natarajan *et al.*, 2015) which is briefly described below.

3.1 Base Maps

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

3.2 Image Interpretation for Physiography

False Colour Composites (FCCs) of Cartosat-I and LISS-IV merged satellite data covering microwatershed area was visually interpreted using image interpretation elements and all the available collateral data with local knowledge. The delineated physiographic boundaries were transferred on to a cadastral map overlaid on satellite imagery. Physiographically, the area has been identified as limestone landscapes. It was identified into three landforms, *viz;* ridges and mounds, uplands and lowlands based on slopes and image characteristics. They were further subdivided into physiographic/image interpretation units based on image characteristics.

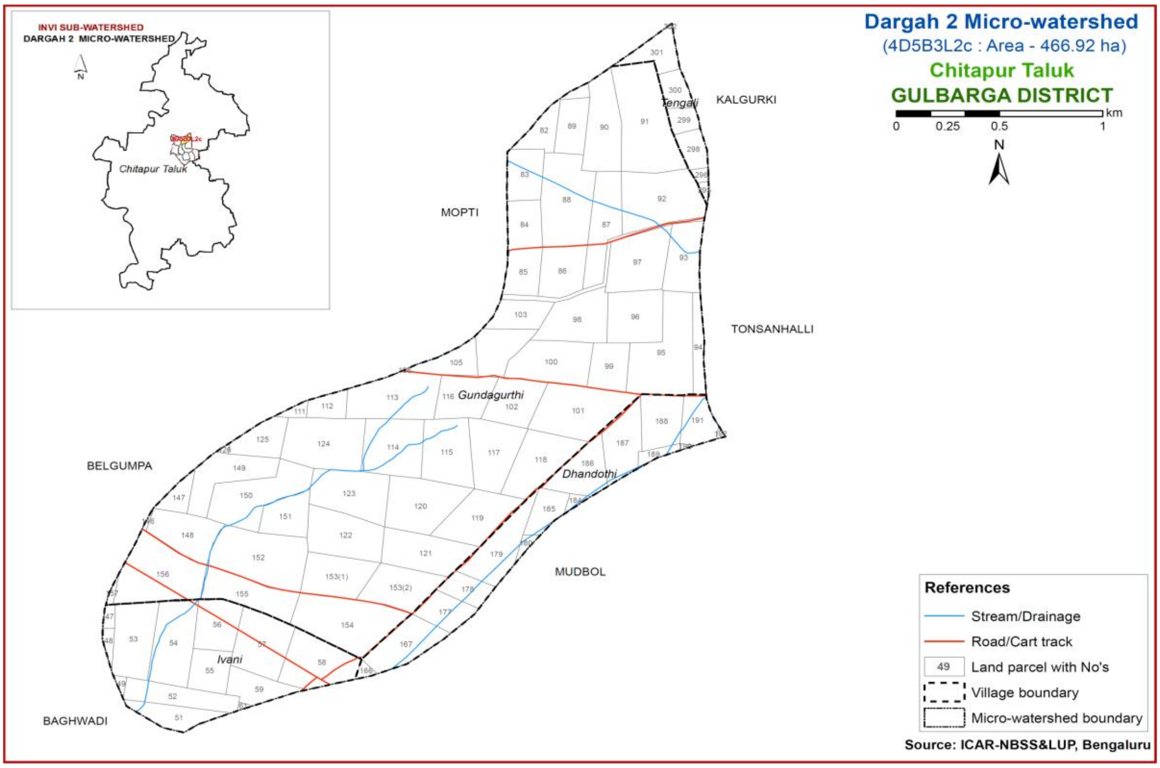

Fig 3.1 Scanned and Digitized Cadastral map of Dargah-2 Microwatershed

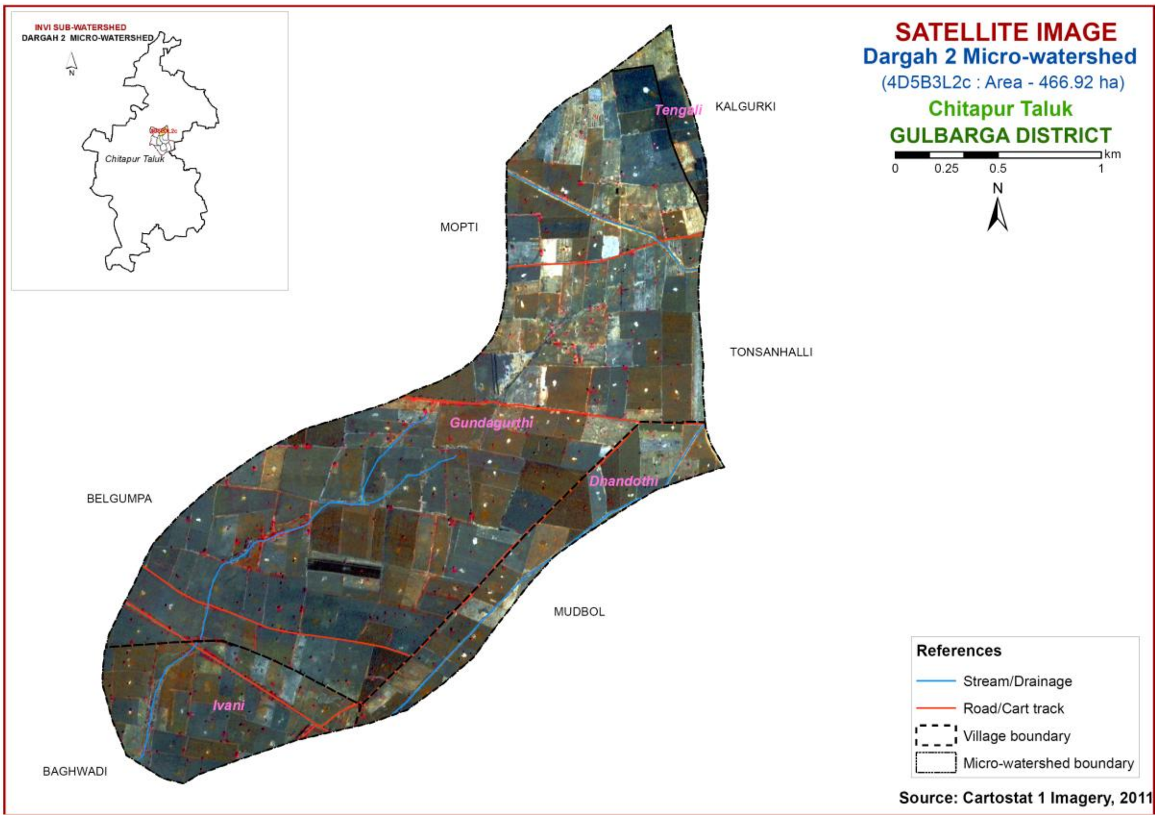

Fig.3.2 Satellite Image of Dargah-2 Microwatershed

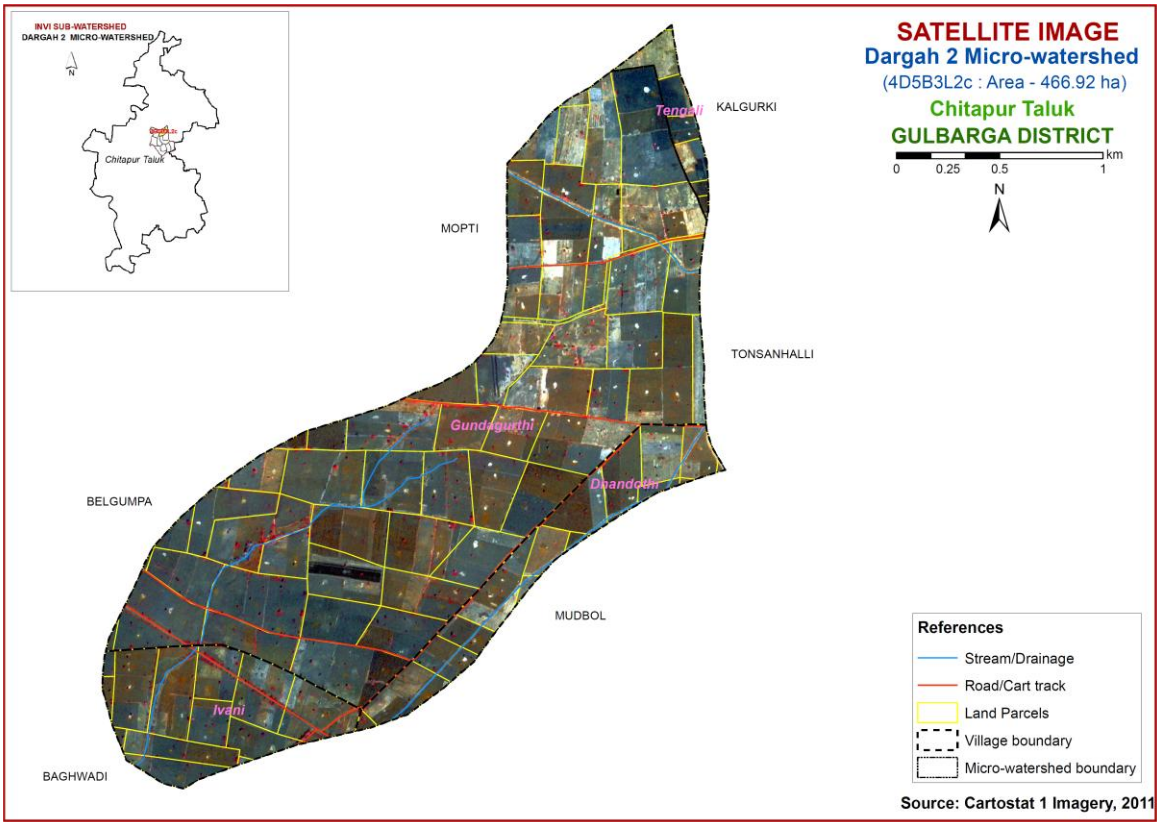

Fig.3.3 Cadastral map overlaid on IRS PAN+LISS IV merged imagery of Dargah-2 Microwatershed

3.3 Field Investigation

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 a few selected places. 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. Then, intensive traversing of each physiographic unit like hills, ridges and uplands was carried out. Based on the variability observed on the surface, transects were selected across the slope covering all the landform units in the microwatershed (Natarajan and Dipak Sarkar, 2010).

In the selected transect, soil profiles 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-site characteristics, the soils were grouped into different soil series (soil series is the most homogeneous unit having similar horizons and properties and behaves similarly for a given level of management). Soil depth, texture, colour, kind of horizon and horizon sequence, amount and nature of gravel present, nature of substratum etc, were used as the major differentiating characteristics for identifying soil series occurring in the area. The differentiating characteristics used for identifying soil series are given in Table 3.1. Based on the above characteristics, 3 soil series were identified in the Dargah-2 microwatershed.

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

SOILS OF LIMESTONE LANDSCAPE							
Sl. No.	**Soil Series**	**Depth (cm)**	**Colour (moist)**	**Texture**	**Gravel (%)**	**Horizon sequence**	**Calcar-eousness**
1	Dhandothi (DDT)	>150	10YR 3/2,3/1,4/3 4/2,2/2,2/1	c	<15	Ap-BA-Bss-cr	e-es
2	Dargah (DRG)	100-150	10YR 3/2,4/3,3/1,2/2,2/1	c	<15	Ap-BA-Bss-cr	e-es
3	Mathimuda (MTM)	75-100	10YR 3/2,4/3,3/1	c	<15	Ap-Bw-cr	e-es

3.4 Laboratory Characterization

Soil samples were collected from representative master profiles for laboratory characterization by following the methods outlined in the Laboratory Manual (Sarma *et al*, 1987). Surface soil samples collected from farmer's fields (76 samples) for fertility status (major and micronutrients) at 250 m grid interval were analyzed in the laboratory. (Katyal and Rattan, 2003) By linking the soil fertility data to the survey numbers through GIS, soil fertility maps for 11 elements including pH and EC were generated using kriging method for the microwatershed.

3.5 Finalization of Soil Map

The area under each soil series was further separated and mapped as soil phases and their boundaries delineated on the cadastral map based on the variations observed in the texture of the surface soil, slope, erosion, presence of gravel, stoniness etc. A soil phase is a subdivision of soil series based mostly on surface features that affect its use and management.

The soil mapping units are shown on the map (Fig.3.4) in the form of symbols. During the survey about 13 profile pits, few minipits and a few auger bores representing different landforms occurring in the microwatershed were studied. All the profile locations are indicated on the village cadastral map in the form of a triangle. 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 6 mapping units representing 3 soil series occurring in the microwatershed. The soil map unit (soil legend) description is presented in Table 3.2.

The soil phase map (management units) shows the distribution of 6 phases identified and 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 they to be treated accordingly.

The 6 soil phases identified and mapped in the microwatershed were regrouped into 2 Land Use Classes (LUC's) for the purpose of preparing a proposed crop plan for sustained development of the microwatershed. The database (soil phases) generated under LRI was utilized for identifying Land Use Classes (LUCs) based on the management needs. One or more than one soil site characteristic having influence on the management have been choosen for identification and delineation of LUCs. For Dargah-2 microwatershed, five soil and site characteristics, namely soil depth, soil texture, slope, erosion and gravel content have been considered for defining LUCs. The Land Use Classes are expected to behave similarly for a given level of management.

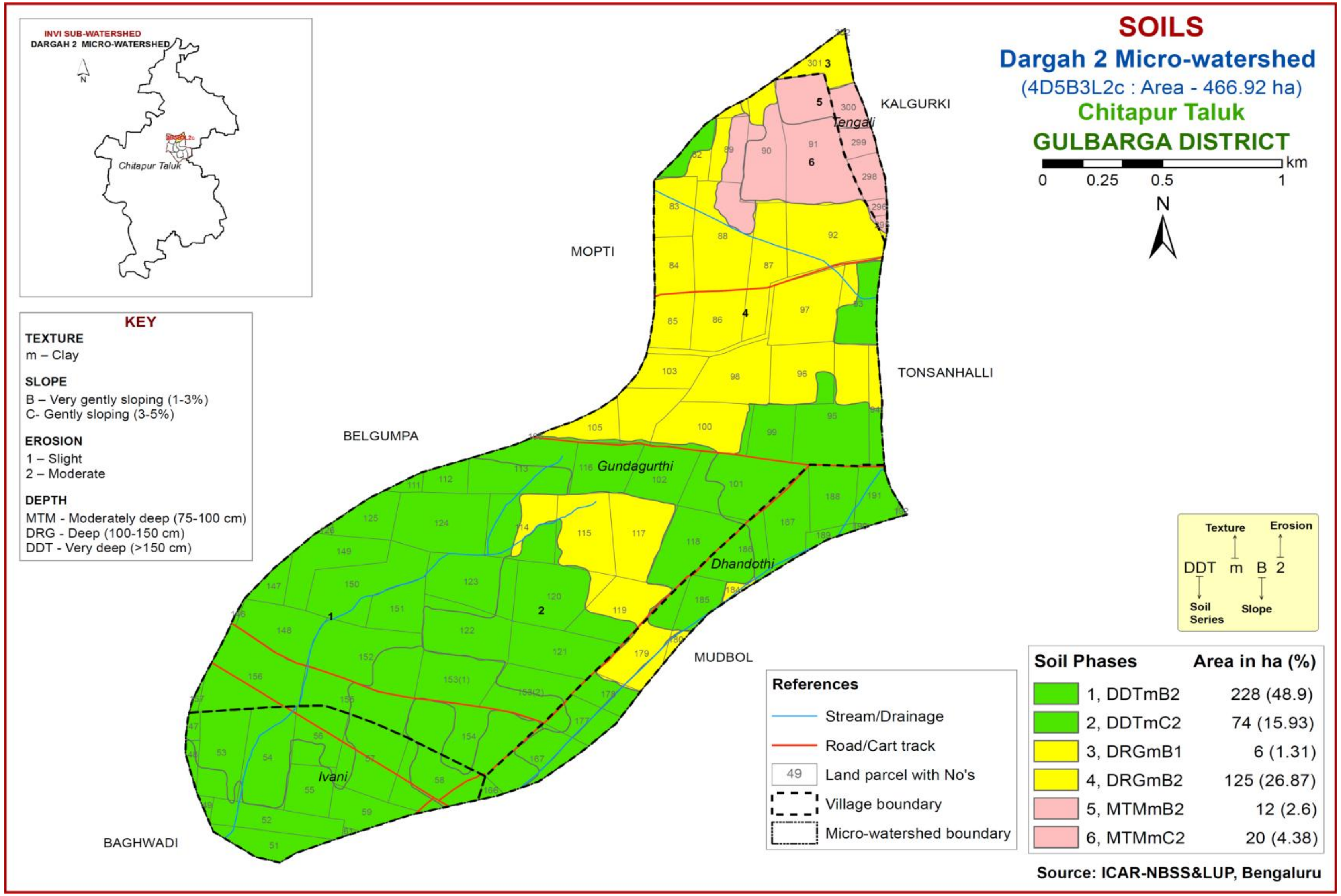

Fig 3.4 Soil phase or management units map of Dargah-2 Microwatershed

Table 3.2 Soil map unit description of Dargah-2 Microwatershed

Soil No.	Soil Series	Soil phase	Mapping Unit Description	Area in ha (%)
Soils of Limestone Landscape				
	DDT	Dhondothi soils are very deep (>150 cm), moderately well drained, have very dark brown to dark brown calcareous cracking clay soils occurring on very gently to gently sloping uplands under cultivation		**302.71 (64.83)**
1		DDTmB2	clay surface, 1-3% slope, moderately eroded	228.31 (48.90)
2		DDTmC2	clay surface, 3-5% slope, moderately eroded	74.40 (15.93)
	DRG	Dargah soils are deep (100-150 cm), moderately well drained, have very dark brown to dark brown calcareous cracking clay soils occurring on very gently sloping uplands under cultivation		**131.6 (28.18)**
3		DRGmB1	clay surface, 1-3% slope, slightly eroded	6.13 (1.31)
4		DRGmB2	clay surface, 1-3% slope, moderately eroded	125.47 (26.87)
	MTM	Mathimuda soils are moderately deep (75-100 cm), moderately well drained, have very dark gray to dark brown calcareous cracking clay soils occurring on very gently to gently sloping uplands under cultivation		**32.61 (6.98)**
5		MTMmB2	clay surface, 1-3% slope, moderately eroded	12.15 (2.60)
6		MTMmC2	clay surface, 3-5% slope, moderately eroded	20.46 (4.38)

Chapter 4

THE SOILS

Detailed information pertaining to the nature, extent and distribution of different kinds of soils occurring in Dargah-2 microwatershed is provided in this chapter. The microwatershed area has been identified as limestone landscape. In all, 3 soil series were identified in this landscape. Soil formation is the result of the combined effect of environmental and terrain factors that are reflected in soil morphology. In the limestone landscape, it is by parent material and climate. A brief description of each of the 3 soil series identified followed by 6 soil phases (management units) mapped under each series are furnished below. The soils in any one map unit differ from place to place in their depth, texture, slope, gravelliness, erosion or any other site 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 Limestone Landscape

In this landscape, 3 soil series are identified and mapped. Among these, Dhondothi (DDT) soil series occupies maximum area of about 303 ha (65%) followed by Dargah (DRG) about 132 ha (28%). The brief description of each soil series is given below.

4.1.1 Dhandothi series (DDT): Dhondothi soils are very deep (>150 cm), moderately well drained, have very dark brown to dark brown calcareous cracking clay soils. They have developed from limestone and occur on very gently to gently sloping uplands under cultivation.

The thickness of the solum is >150 cm. The thickness of A horizon ranges from 9 to 20 cm. Its colour is in 10 YR hue with value 3 and chroma 2 to 3. The texture is dominantly clay. The thickness of B horizon is more than 150 cm. Its colour is in 10 YR hue with value 3 to 4 and chroma 1 to 4. Its texture is clay and are calcareous. The available water capacity is very high (>200 mm/m). Two phases were identified and mapped.

Soil Profile and Landscape characteristics of Dhandothi series (DDT)

4.1.2 Dargah series (DRG): Dargah soils are deep (100-150 cm), moderately well drained, very dark grayish brown to dark brown, calcareous cracking clay black soils. They have developed from limestone and occur on nearly level to gently sloping uplands under cultivation.

The thickness of the solum ranges from 101-148 cm. The thickness of A horizon ranges from 8 to 20 cm. Its colour is in 10 YR hue with value 3 and chroma 2 to 3. The texture is clay. The thickness of B horizon ranges from 100 to 140 cm. Its colour is in 10 YR hue with value 3 and chroma 1 to 4. Its texture is clay and are calcareous. The available water capacity is very high (>200 mm/m). Two phases were identified and mapped.

Soil Profile and Landscape characteristics of Darga series (DRG)

4.1.3 Mathimuda series (MTM): Mathimuda soils are moderately deep (75-100 cm), moderately well drained, have very dark grayish brown to dark brown calcareous cracking clay soils. They have developed from limestone and occur on nearly level to very gently sloping uplands under cultivation.

The thickness of the solum ranges from 75-100 cm. The thickness of A horizon ranges from 10 to 20 cm. Its colour is in 10 YR hue with value 3 and chroma 2 to 3. The texture is clay. The thickness of B horizon ranges from 68 to 80 cm. Its colour is in 10 YR hue with value 3 and chroma 2 to 4. Its texture is clay and are calcareous. The available water capacity is low (51-100 mm/m). Two phase were identified and mapped.

Soil Profile and Landscape characteristics of Mathimuda series (MTM)

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

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

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

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

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

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

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

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

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

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

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

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

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

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

The 6 soil map units identified in the Dargah-2 microwatershed are grouped under 2 land capability classes and 3 land capability subclasses. Complete microwatershed is suitable for agriculture (Fig. 5.1).

Good cultivable lands (Class II) cover maximum area about 93 per cent and are distributed in all the parts of the microwatershed with minor problems of soil. Moderately good cultivable lands (Class III) cover an area of about 7 per cent and are distributed in the northeastern part of the microwatershed with moderate problems of erosion and soil.

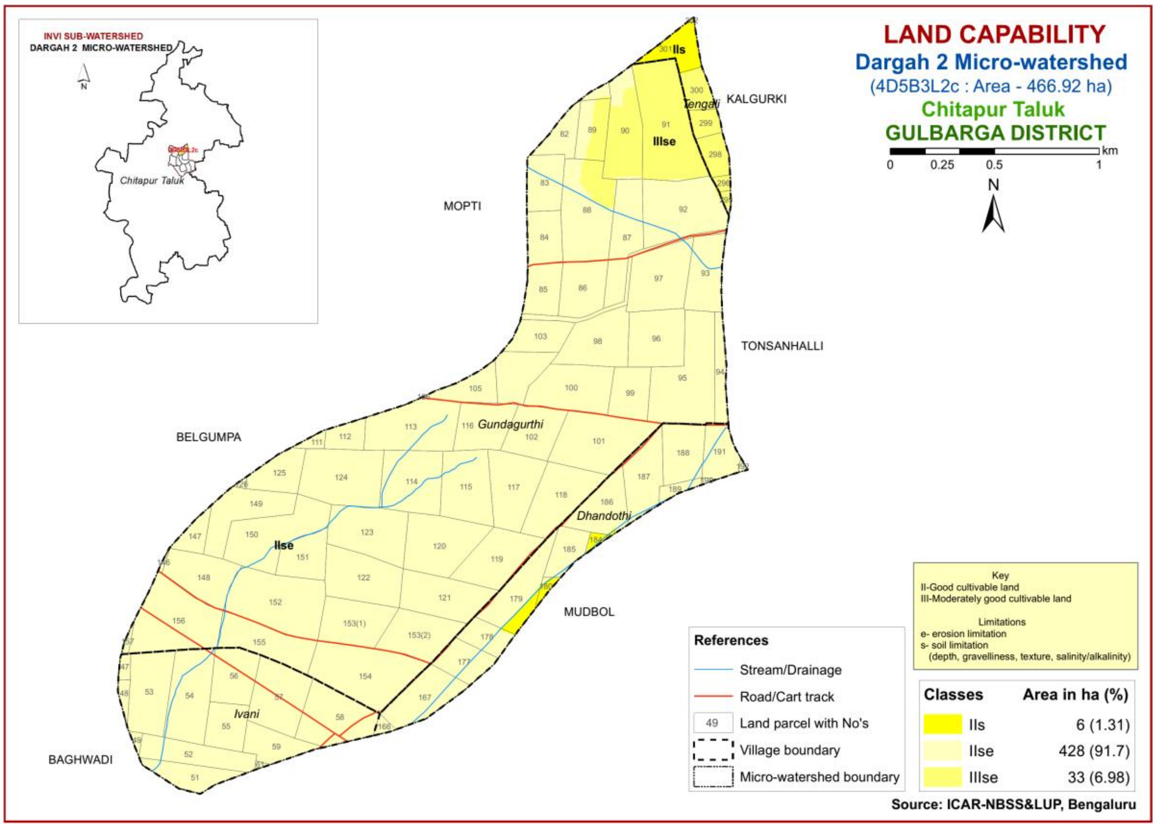

Fig. 5.1 Land Capability map of Dargah-2 Microwatershed

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.

Moderately deep (75-100 cm) soils occupy an area of about 33 ha (7%) and are distributed in the northeastern part of the microwatershed. Deep soils (100-150 cm) occur in about 132 ha (28%) and are distributed in the central, northern, western and southeastern part of the microwatershed and very deep soils (>150 cm) occur in maximum area of about 303 ha (65%) and are distributed in all parts of the microwatershed.

The most productive lands of about 435 ha (93%) with respect to soil rooting depth where all climatically adapted annual and perennial crops can be grown are deep (100-150 cm) to very deep soils (>150 cm) occurring in all parts of the microwatershed.

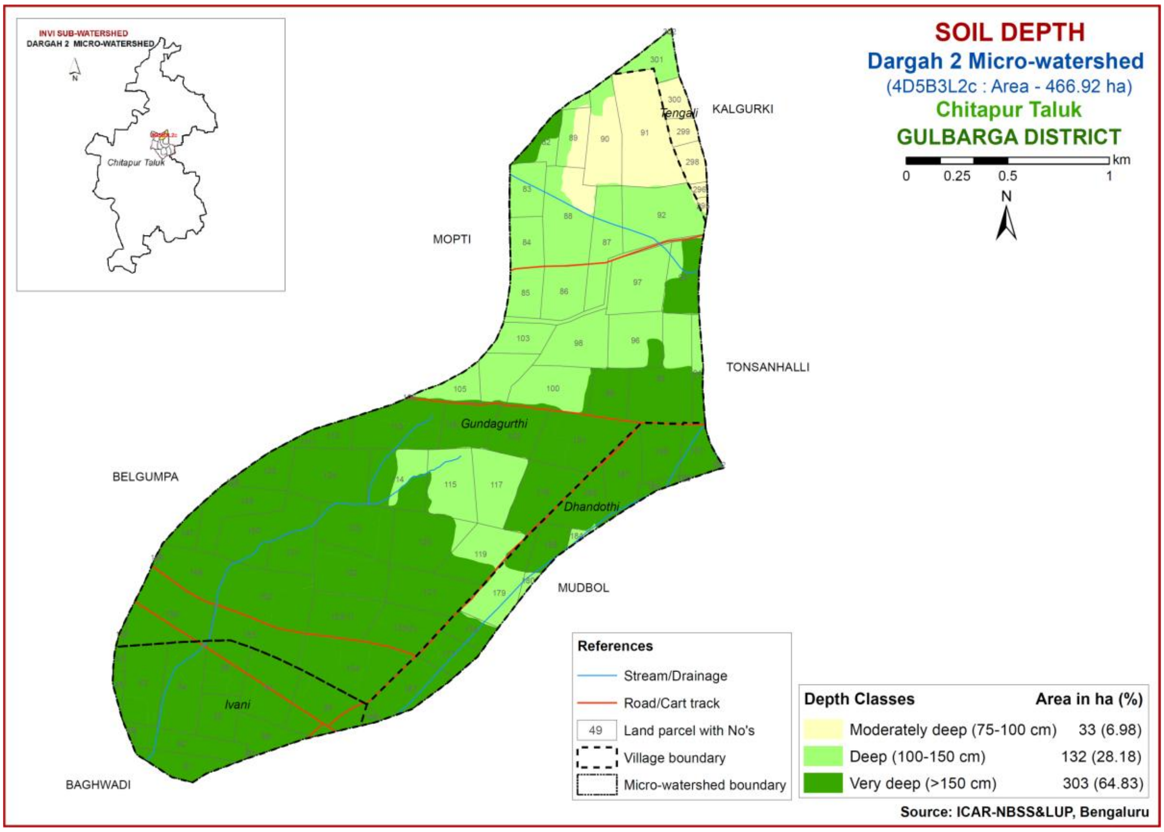

Fig. 5.2 Soil Depth map of Dargah-2 Microwatershed

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 and a surface soil texture map was generated. The area extent and their geographical distribution in the microwatershed is shown in Figure 5.3.

The entire area of about 467 ha (100%) of soils are clayey at the surface. They are the most productive lands with respect to surface soil texture that have high potential for soil-water retention and availability, and nutrient retention and availability, but have more problems of drainage, infiltration, workability and other physical problems.

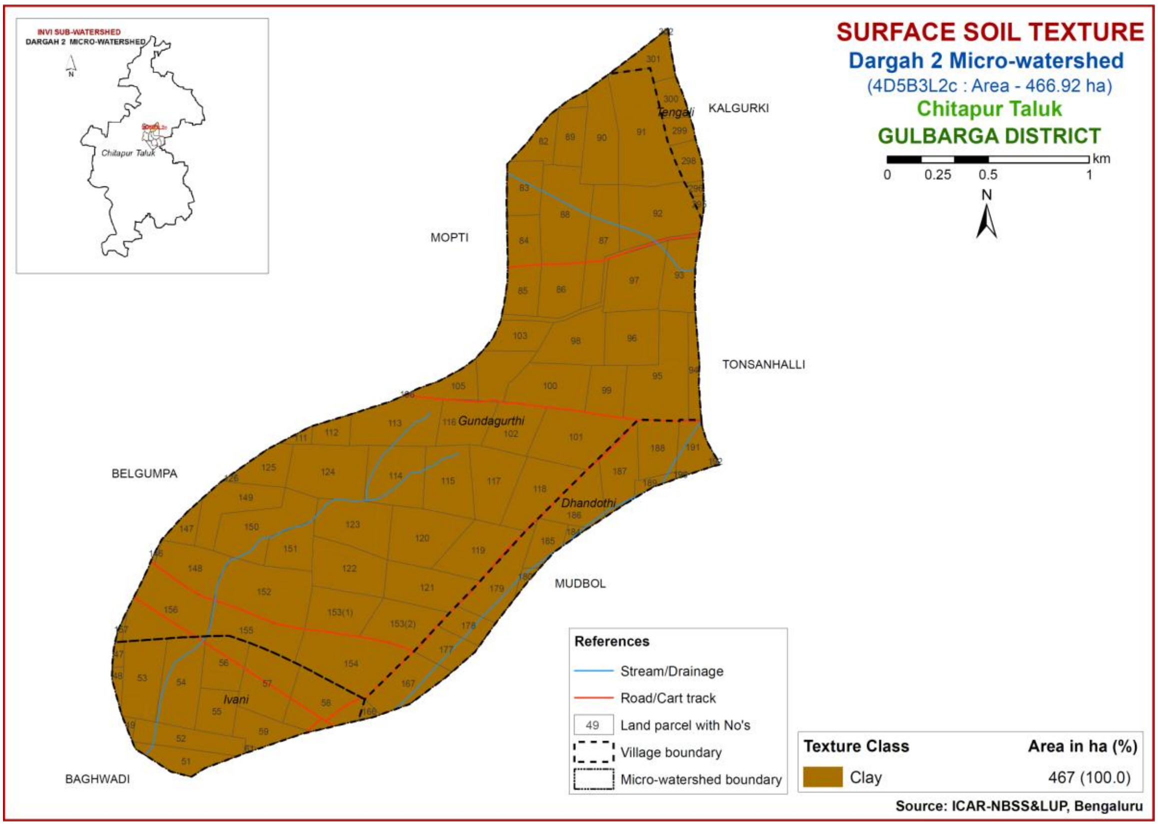

Fig. 5.3 Surface Soil Texture map of Dargah-2 Microwatershed

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 geographical distribution in the microwatershed is shown in Figure 5.4.

Entire area of 467 (100 %) is non gravelly (<15%) and are distributed in all the parts of the microwatershed.

Thus the entire area is most productive lands with respect to gravelliness. They are non gravelly with less than 15 per cent gravel and have potential for growing both annual and perennial crops.

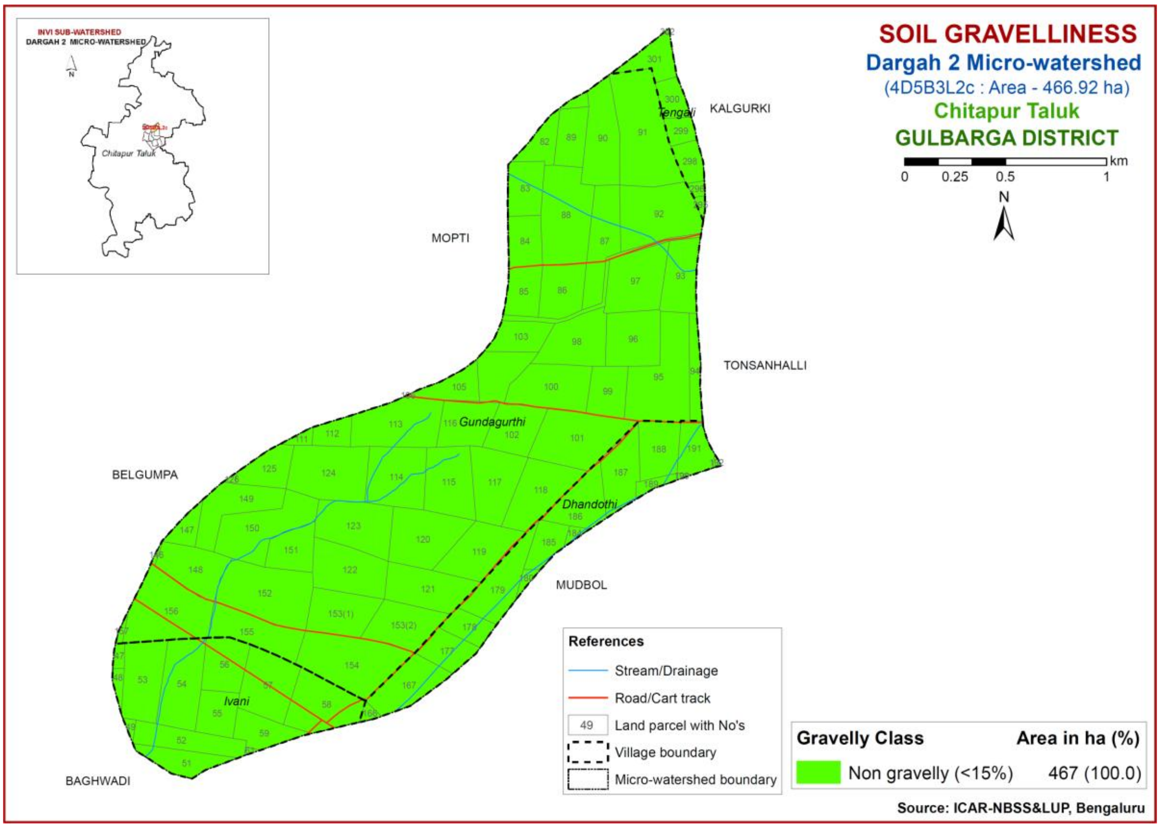

Fig. 5.4 Soil Gravelliness map of Dargah-2 Microwatershed

5.5 Available Water Capacity

The soil available water capacity (AWC) is estimated based on the ability of the soil column to retain water between the tensions of 0.33 and 15 bar in a depth of 100 cm or the entire solum if the soil is shallower. The AWC of the soils (soil series) as estimated by considering the soil texture, mineralogy, soil depth and gravel content (Sehgal *et al.*, 1990) and accordingly the soil map units were grouped into five AWC classes *viz,* very low (<50 mm/m), low (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 geographical distribution in the microwatershed is shown in Figure 5.5.

Major area of about 434 ha (93%) has soils that are very high (>200 mm/m) in available water capacity and are distributed in all parts of the microwatershed. An area of about 33 ha (7%) has soils that are medium (101-150 mm/m) in available water capacity and are distributed in the northeastern part of the microwatershed.

Thus in an area of about 434 ha (93%) has soils that have very high potential (>200 mm/m) with regard to available water capacity and are distributed in all parts of the microwatershed. In these areas, if the rainfall is normal and well distributed, all climatically adapted long duration annual and perennial crops can be grown.

About 33 ha (7%) area in the microwatershed has soils that are slightly problematic with regard to available water capacity. Here, only the medium duration crops can be grown and the probability of crop failure is minimum.

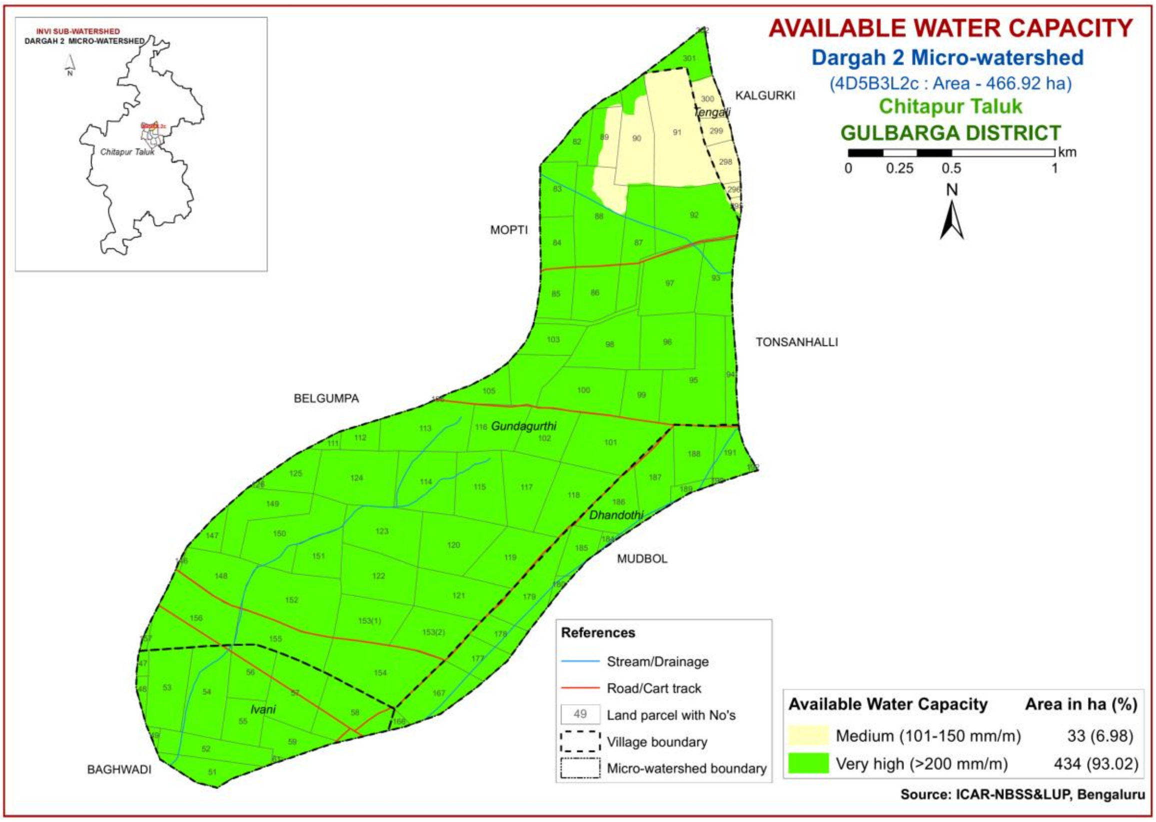

Fig. 5.5 Soil Available Water Capacity map of Dargah-2 Microwatershed

5.6 Soil Slope

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

Major area of the microwatershed falls under very gently sloping (1-3%) slope class. It covers maximum area of about 372 ha (80%) and is distributed in all parts of the microwatershed. An area of about 95 ha (20 %) falls under gently sloping (3-5%) slope class and is distributed in the central, northeastern and southeastern part of the microwatershed.

An area of about 372 ha (80%) 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.

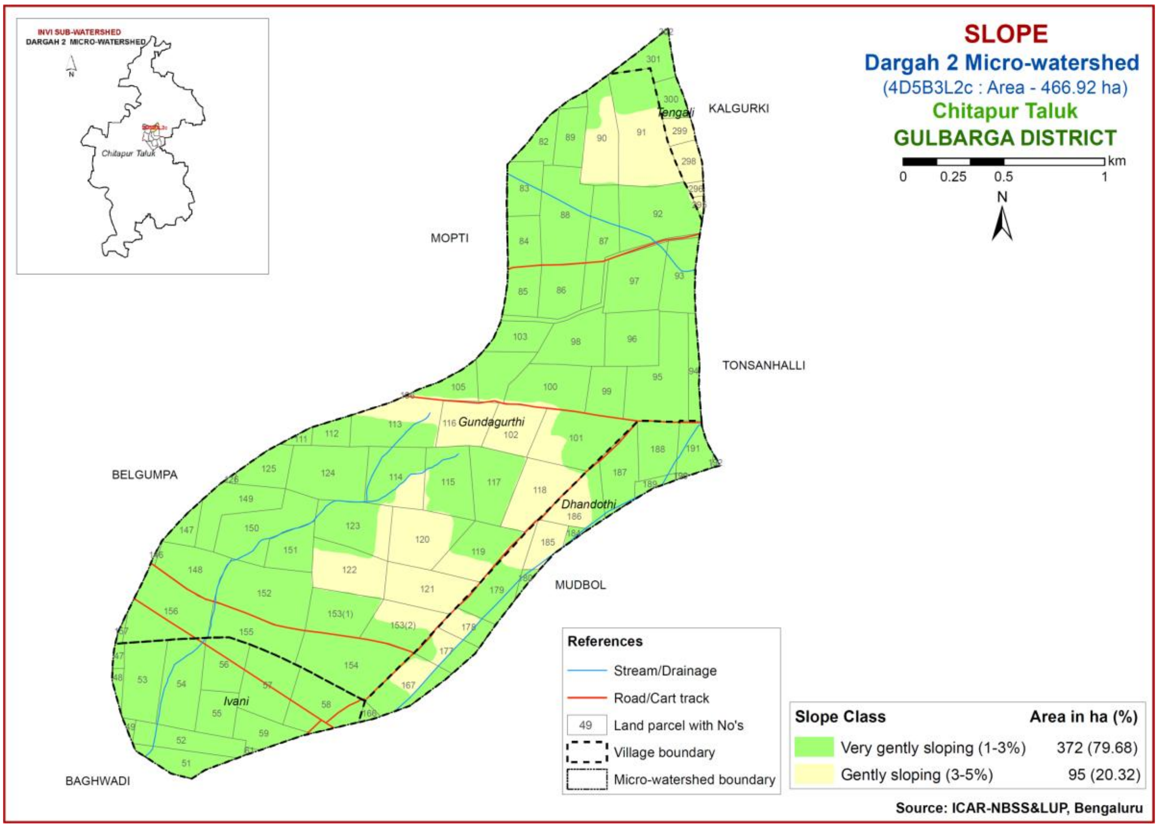

Fig. 5.6 Soil Slope map of Dargah-2 Microwatershed

5.7 Soil Erosion

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

Soils that are slightly eroded (e1 class) cover about an area of 6 ha (1%) and are distributed in the northeastern part of the microwatershed. Soils that are moderately eroded (e2 class) cover a maximum area of about 461 ha (99%) and are distributed in all parts of the microwatershed.

In moderately eroded areas, the soil and water conservation and other land development measures should be carried out in order to control the soil erosion.

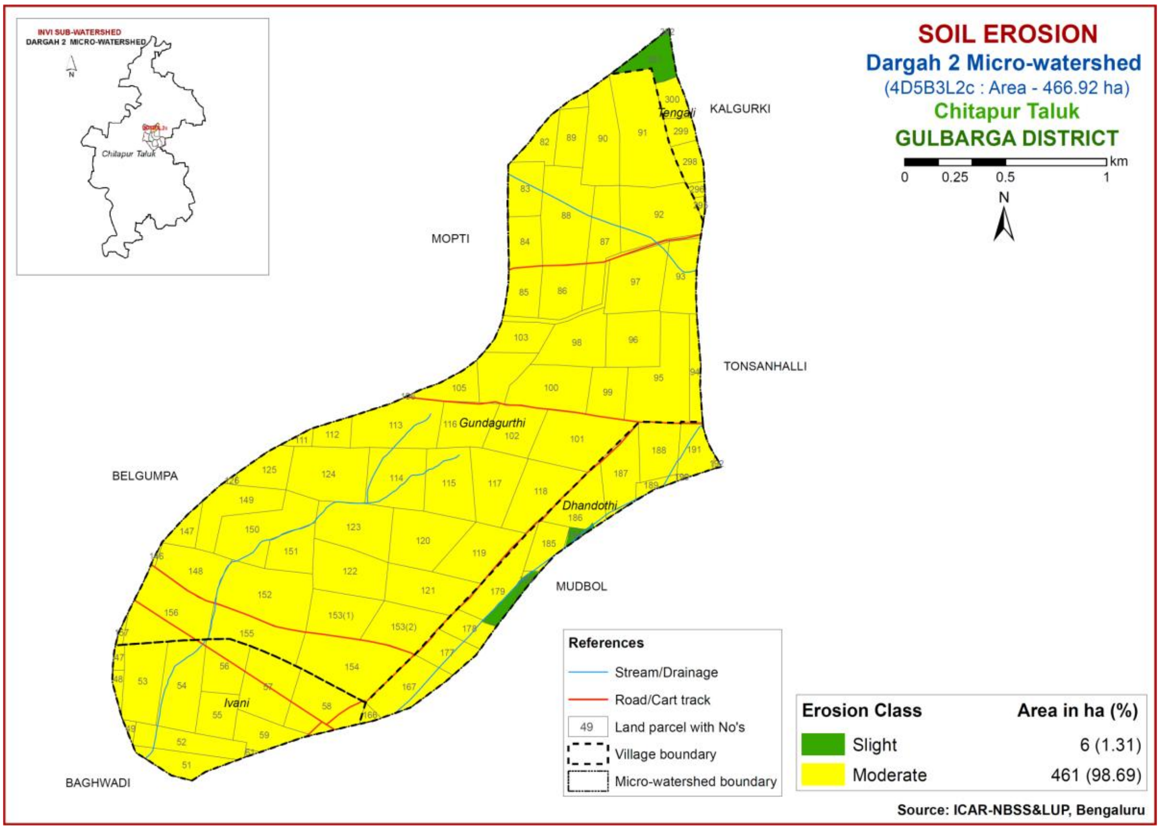

Fig. 5.7 Soil Erosion map of Dargah-2 Microwatershed

Chapter 6

FERTILITY STATUS

Soil fertility plays an important role in increasing crop yield. The adoption of high yielding varieties that require high amounts of nutrients has resulted in deficiency symptoms in crops and plants due to imbalanced fertilization and poor inherent fertility status as these soils are characterized by low rainfall and high temperatures. Hence, it is necessary to know the fertility (macro and micro nutrients) status of the soils of the watersheds for assessing the kind and amount of fertilizers required for each of the crop intended to be grown. For this purpose, the surface soil samples collected from the grid points (one soil sample at every 250 m interval) all over the microwatershed through land resource inventory in the year 2014 were analysed for pH, EC, organic carbon, available phosphorus and potassium and for micronutrients like zinc, 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 fertility analysis of the Dargah-2 microwatershed for soil reaction (pH) showed that maximum area of about 422 ha (90%) is moderately alkaline (pH 7.8-8.4) in reaction and is distributed in all parts of the microwatershed (Fig.6.1). Strongly alkaline (pH 8.4-9.0) cover around 44 ha (10%) area and are distributed in the central, northeastern and southwestern part of the microwatershed.

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 in the microwatershed are nonsaline.

6.3 Organic Carbon

The soil organic carbon content (an index of available Nitrogen) of the soils in the microwatershed is high (>0.75%) in an area of about 207 ha (44%) that are distributed in all parts of the microwatershed (Fig.6.3). Medium (0.5-0.75%) organic carbon content accounts for major area of about 253 ha (54%) and are distributed in all parts of the microwatershed. Low (<0.5%) organic carbon content accounts for a very small area of 7 ha (1%) and is distributed in the northeastern part of the microwatershed.

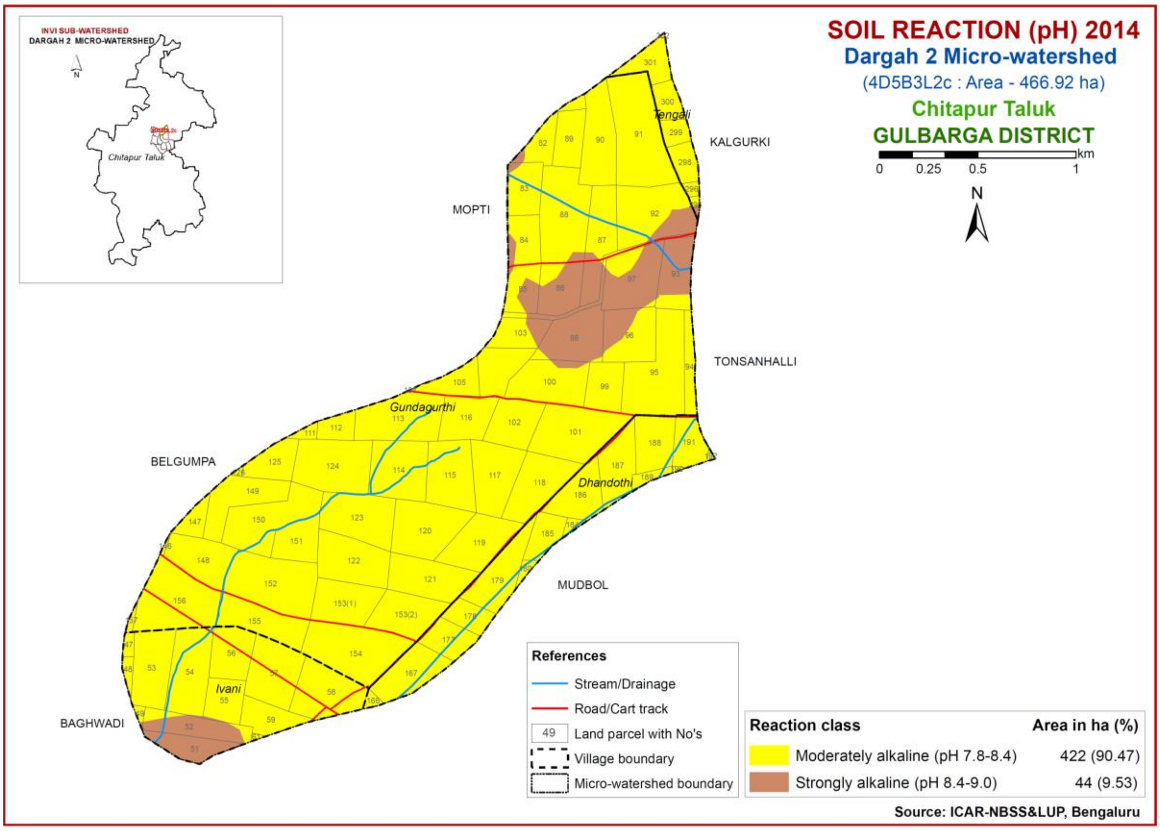

Fig.6.1 Soil Reaction (pH) map of Dargah-2 Microwatershed

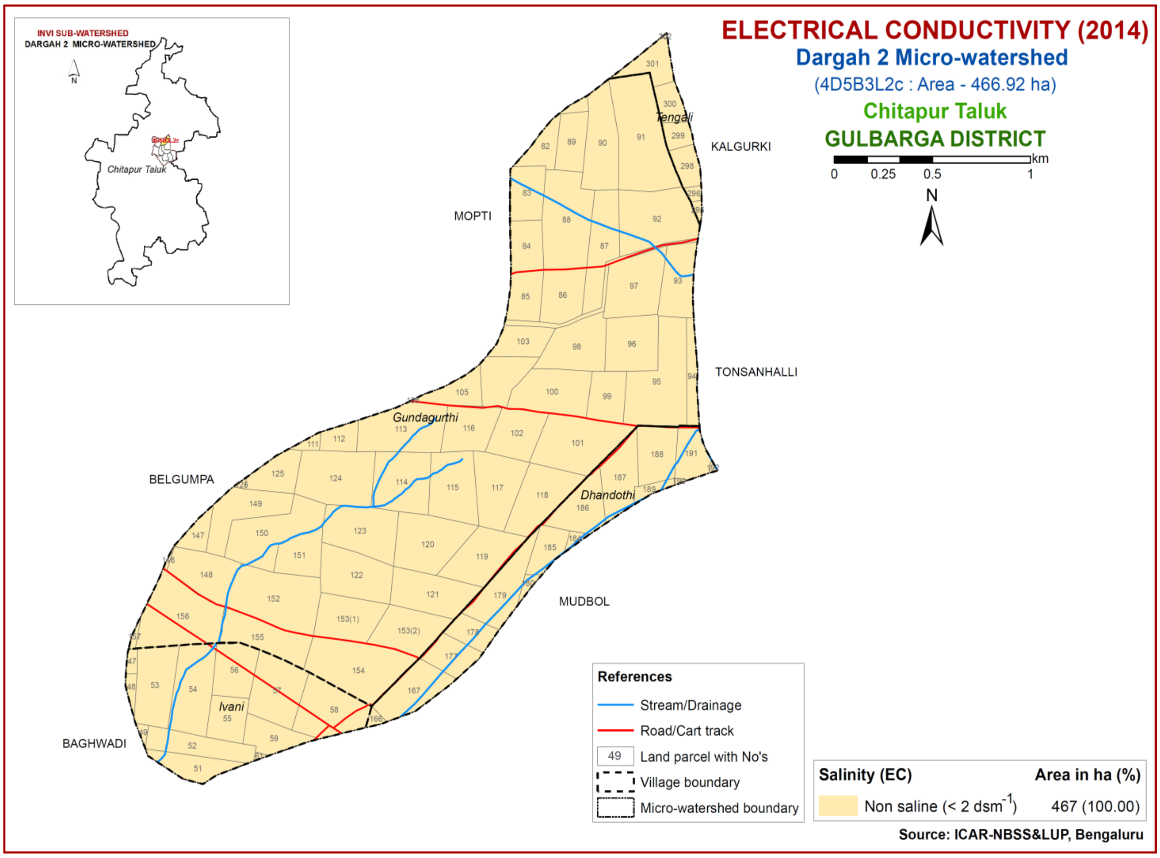

Fig.6.2 Electrical Conductivity (EC) map of Dargah-2 Microwatershed

6.4 Available Phosphorus

The soil fertility analysis revealed that available phosphorus is low (<23 kg/ha) in major area of about 461 ha (99%) and is distributed in all parts of the microwatershed (Fig.6.4). There is an urgent need to increase the dose of phosphorous for all the crops by 25 per cent over the recommended dose to realize better crop performance. About 5 ha (1%) area in the microwatershed is medium (23-57 kg/ha) and is distributed in the northeastern part of the microwatershed.

6.5 Available Potassium

Available potassium content is medium (145-337 kg/ha) in major area of about 387 ha (83%) and is distributed in all parts of the microwatershed (Fig.6.5). Low available potassium (<145 kg/ha) content accounts for an area of 79 ha (17%) and is distributed in the northeastern and eastern part of the microwatershed.

6.6 Available Sulphur

Available sulphur content is low (<10 ppm) in major area of about 342 ha (73%) and is distributed in all parts of the microwatershed. Small area of about 3 ha (1%) is high (>20 ppm) in available sulphur and is distributed in southwestern part of the microwatershed (Fig.6.6). Available sulphur is medium (10-20 ppm) in 122 ha (26%) area and are distributed in the southern, eastern and northeastern part of the microwatershed.

6.7 Available Boron

Available boron content is medium (0.5-1.0 ppm) in an area of about 66 ha (14%) and is distributed in the central, southern and southwestern part of the microwatershed (Fig 6.7). Maximum area of about 401 ha (86%) is low (<0.5 ppm) in available boron and are distributed in all parts of the microwatershed.

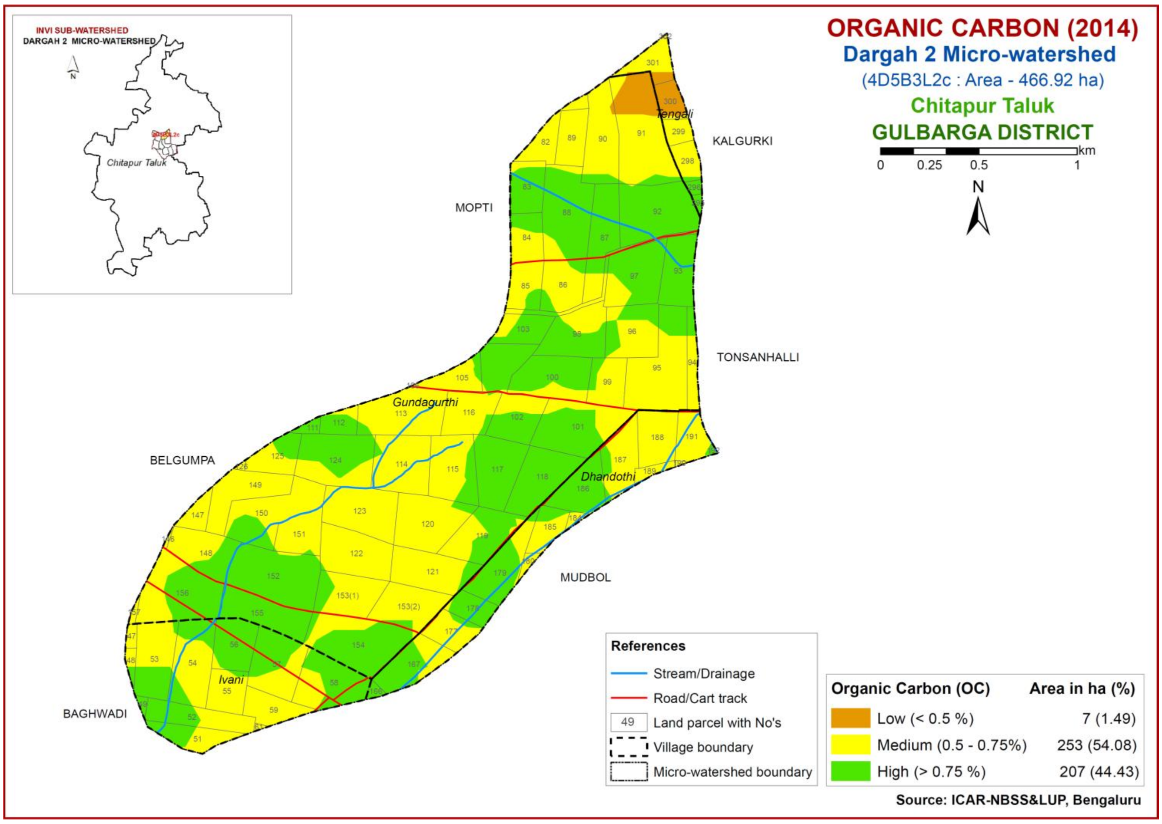

Fig.6.3 Soil Organic Carbon map of Dargah-2 Microwatershed

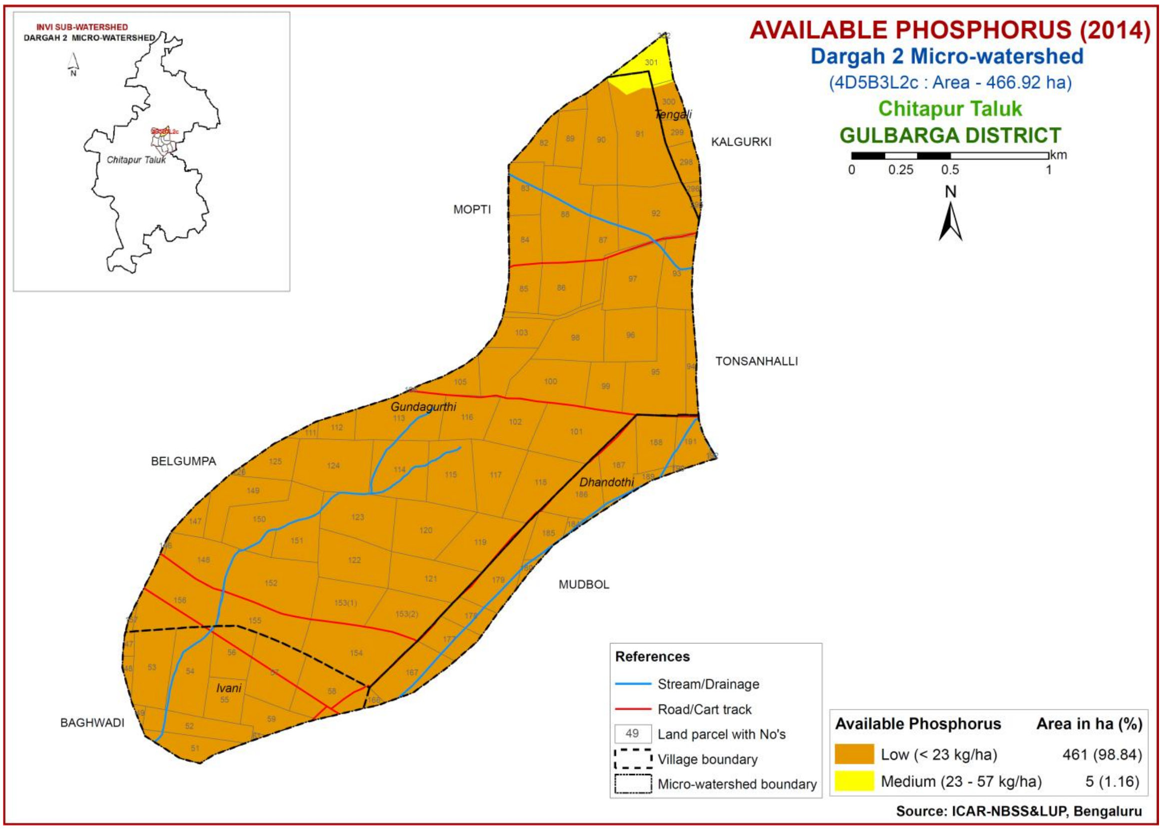

Fig.6.4 Soil available Phosphorus map of Dargah-2 Microwatershed

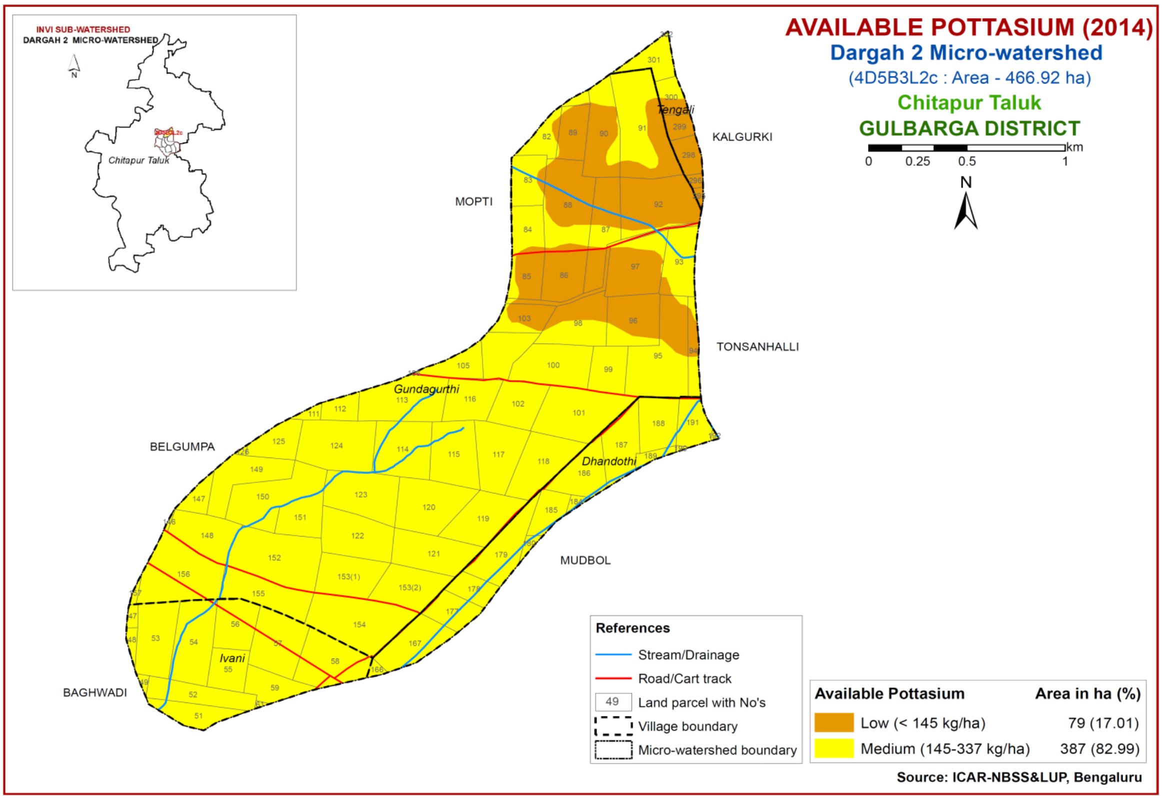

Fig.6.5 Soil available Potassium map of Dargah-2 Microwatershed

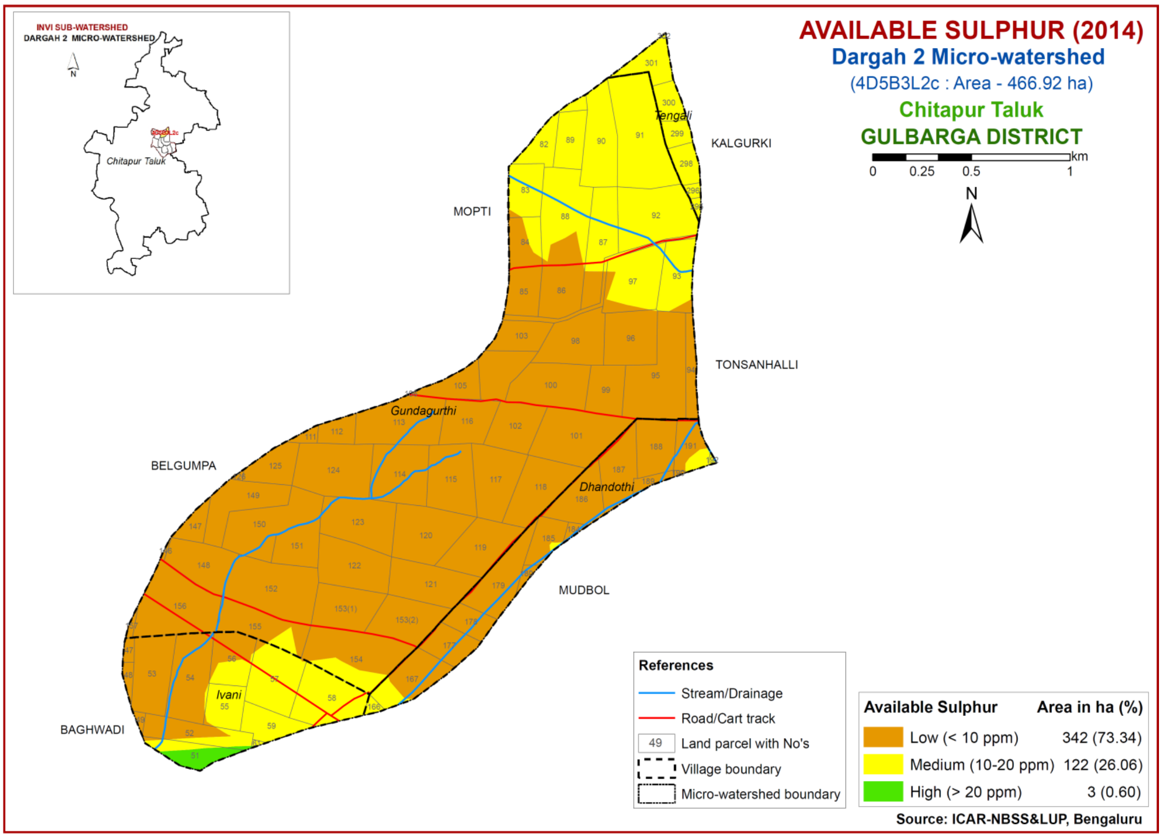

Fig.6.6 Soil available Sulphur map of Dargah-2 Microwatershed

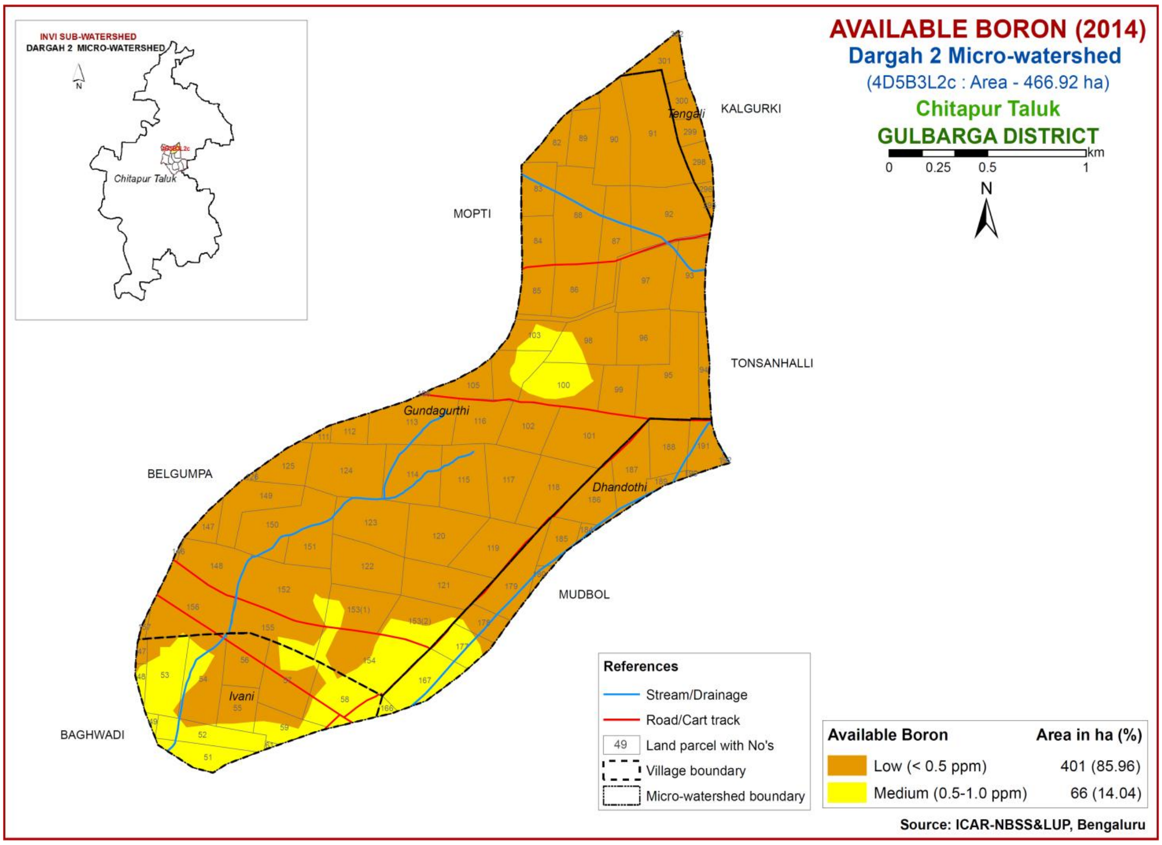

Fig.6.7 Soil available Boron map of Dargah-2 Microwatershed

6.8 Available Iron

Available iron content is sufficient (>4.5 ppm) in the entire microwatershed area (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 maximum area of about 419 ha (90%) and is distributed in all parts of the microwatershed (Fig 6.11). It is sufficient (>0.6 ppm) in an area of about 47 ha (10%) and is distributed in the eastern, southern and southeastern part of the microwatershed.

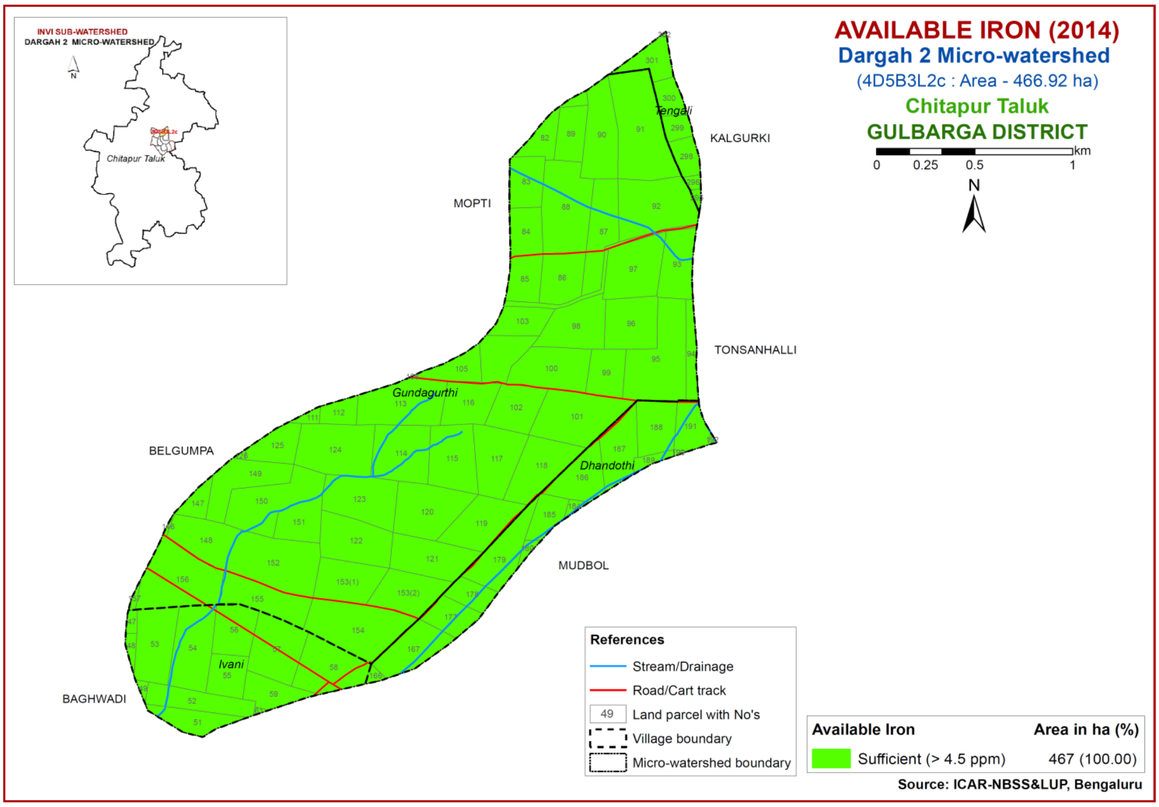

Fig.6.8 Soil available Iron map of Dargah-2 Microwatershed

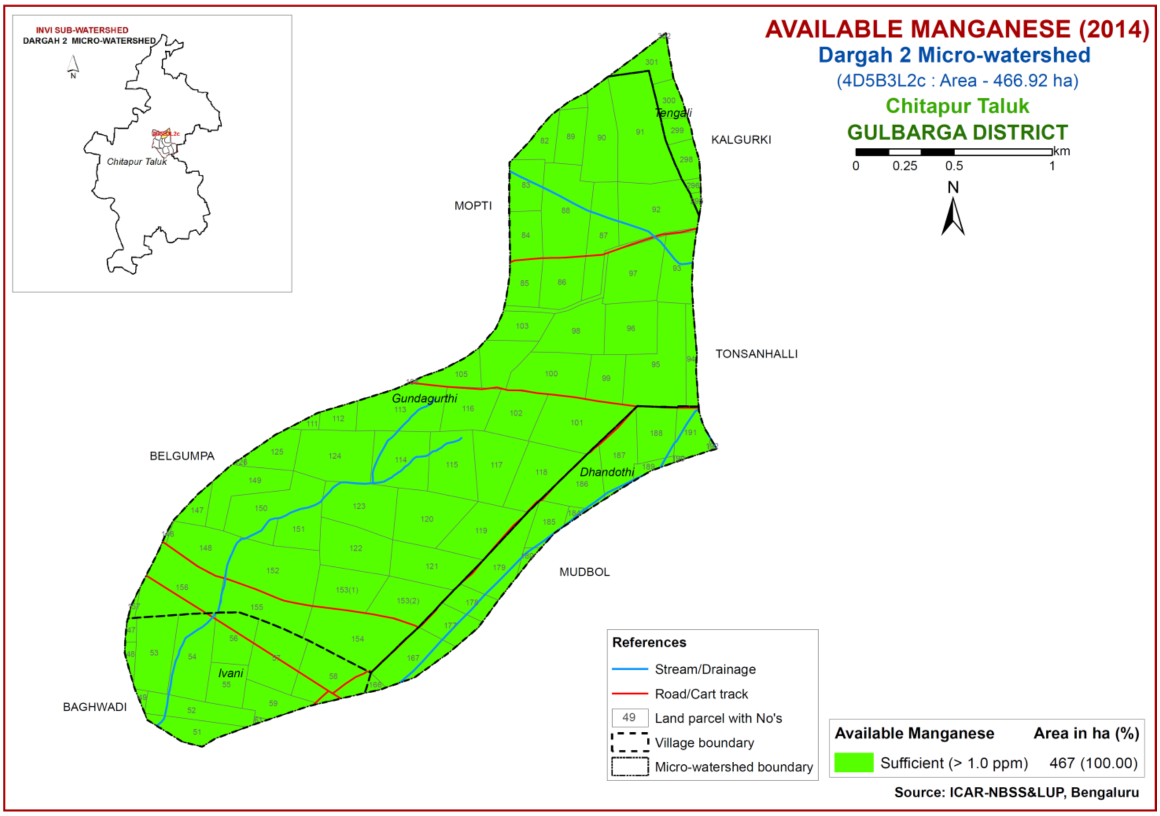

Fig.6.9 Soil available Manganese map of Dargah-2 Microwatershed

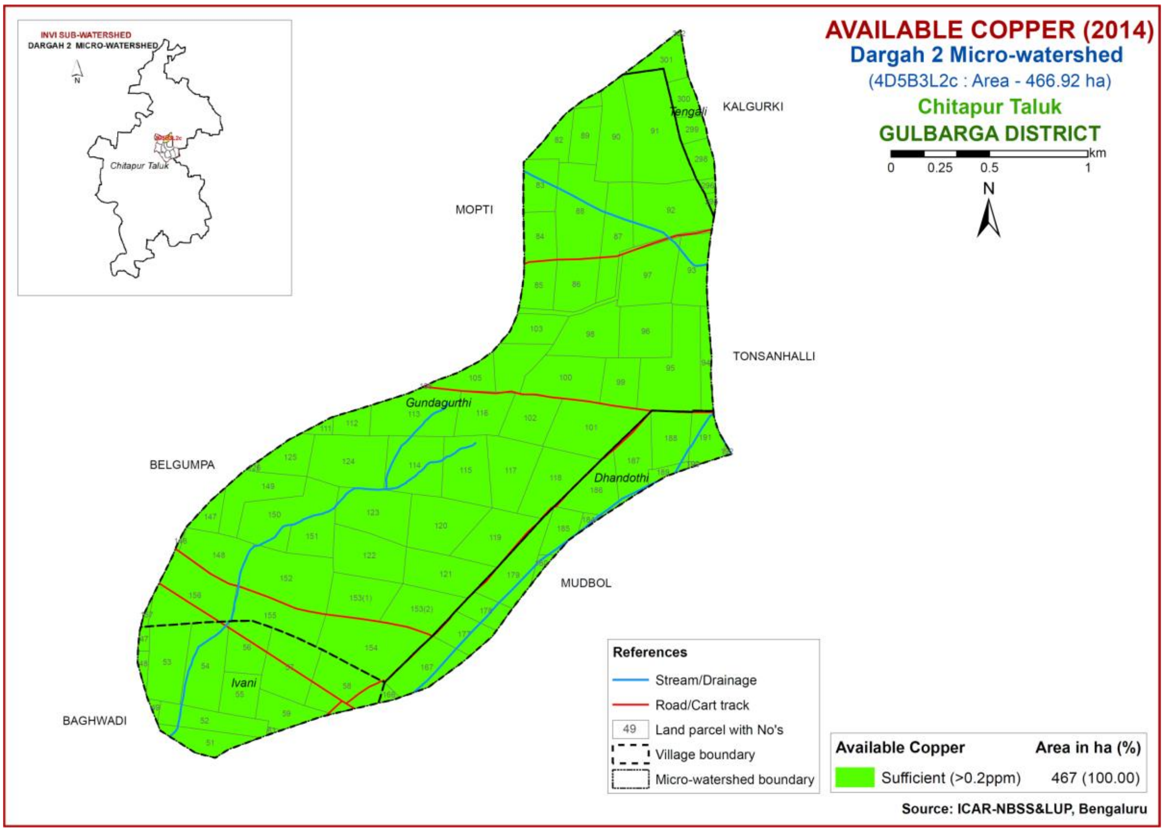

Fig.6.10 Soil available Copper map of Dargah-2 Microwatershed

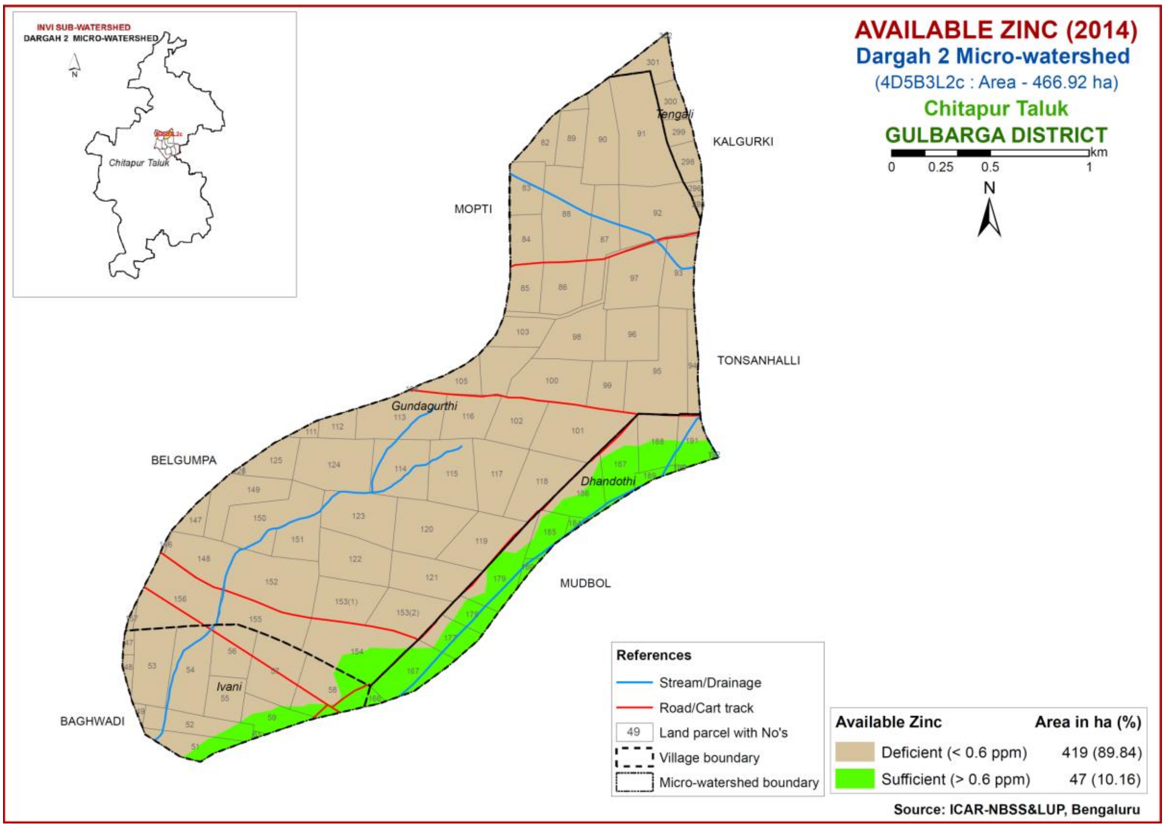

Fig.6.11 Soil available Zinc map of Dargah-2 Microwatershed

Chapter 7

LAND SUITABILITY FOR MAJOR CROPS

The soil and land resource units (soil phases) of Dargah-2 microwatershed were assessed for their suitability for growing food, fibre, fodder and other horticulture crops by following the procedure as outlined in FAO, 1976 and 1983. Crop requirements were developed for each of the crop from the available research data, and also by referring to Naidu *et. al.* (2006) and Natarajan *et. al* (2015). The crop requirements were matched with the soil and land characteristics (Table 7.1) to arrive at the crop suitability. In FAO land suitability classification, two orders are recognized. Order S-Suitable and Order N-Not suitable. The orders have classes, subclasses and units. Order-S has three classes, Class S1-Highly Suitable, Class S2-Moderately Suitable and Class S3-Marginally Suitable. Order N has two classes, N1-Currently not Suitable and N2-Permanently not Suitable. There are no subclasses within the class S1 as they will have very minor or no limitations for crop growth. Classes S2 and S3 are divided into subclasses based on the kinds of limitations encountered. The limitations that affect crop production are 'c' for erratic rainfall and its distribution and length of growing period (LGP), 'e' for erosion hazard, 'r' for rooting condition, 't' for lighter or heavy texture, 'g' for gravelliness or stoniness, 'n' for nutrient availability, 'l' for topography, 'm' for moisture availability, 'z' calcareous and 'w' for drainage. These limitations are indicated as lower case letters to the class symbol. For example, moderately suitable land with the limitations of soil depth and erosion is designated as S2re. For the microwatershed, the soil mapping units were evaluated and classified up to subclass level.

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

7.1 Land Suitability for Sorghum (*Sorghum bicolor*)

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

An area of about 234 ha (50%) in the microwatershed has soils that are highly suitable (Class S1) for growing sorghum crop. They have minor or no limitations for growing sorghum and are distributed mainly in the central, southeastern, eastern, northern and northeastern part of the microwatershed.

Table 7.1 Soil-Site Characteristics of Dargah-2 Microwatershed

Soil Map Units	Climate (P) (mm)	Growing period (Days)	Drainage class	Soil depth (cm)	Soil texture		Gravelliness		AWC (mm/m)	Slope (%)	Erosion	pH	EC (dS m^{-1})	ESP (%)	CEC [Cmol (p^+) kg^{-1}]	BS (%)
					Surface	Subsurface	Surface (%)	Subsurface (%)								
DDTmB1	762	150	MWD	>150	c	c	-	<15	>200	1-3	Slight	8.27	0.13	0.47	68.85	100
DDTmB2	762	150	MWD	>150	c	c	-	<15	>200	1-3	moderately	8.27	0.13	0.47	68.85	100
DRGmB1	762	150	MWD	100-150	c	c	-	<15	>200	1-3	Slight	8.12	0.15	0.27	73.0	100
DRGmB2	762	150	MWD	100-150	c	c	-	<15	>200	1-3	moderately	8.12	0.15	0.27	73.0	100
MTMmB2	762	150	MWD	75-100	c	c	-	<15	51-100	1-3	moderately	8.34	0.15	0.08	74.44	100
MTMmC2	762	150	MWD	75-100	c	c	-	<15	51-100	3-5	moderately	8.34	0.15	0.08	74.44	100

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

An area of about 232 ha (50%) is moderately suitable (Class S2) for growing sorghum and are distributed in the central, southeastern, eastern and northeastern part of the microwatershed. They have moderate limitations of erosion.

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. drained	imperfect	Poorly/excessively	V. poorly
Soil reaction	pH	6.0-8.0	5.5-5.9 8.1-8.5	<5.5 8.6-9.0	>9.0
Surface soil texture	Class	C, cl, sicl, sc	l, sil, sic	Sl, ls	S, fragmental skeletal
Soil depth	Cm	100-75	50-75	30-50	<30
Gravel content	% vol.	5-15	15-30	30-60	>60
Salinity (EC)	dSm^{-1}	2-4	4-8	8-10	>10
Sodicity (ESP)	%	5-8	8-10	10-15	>15

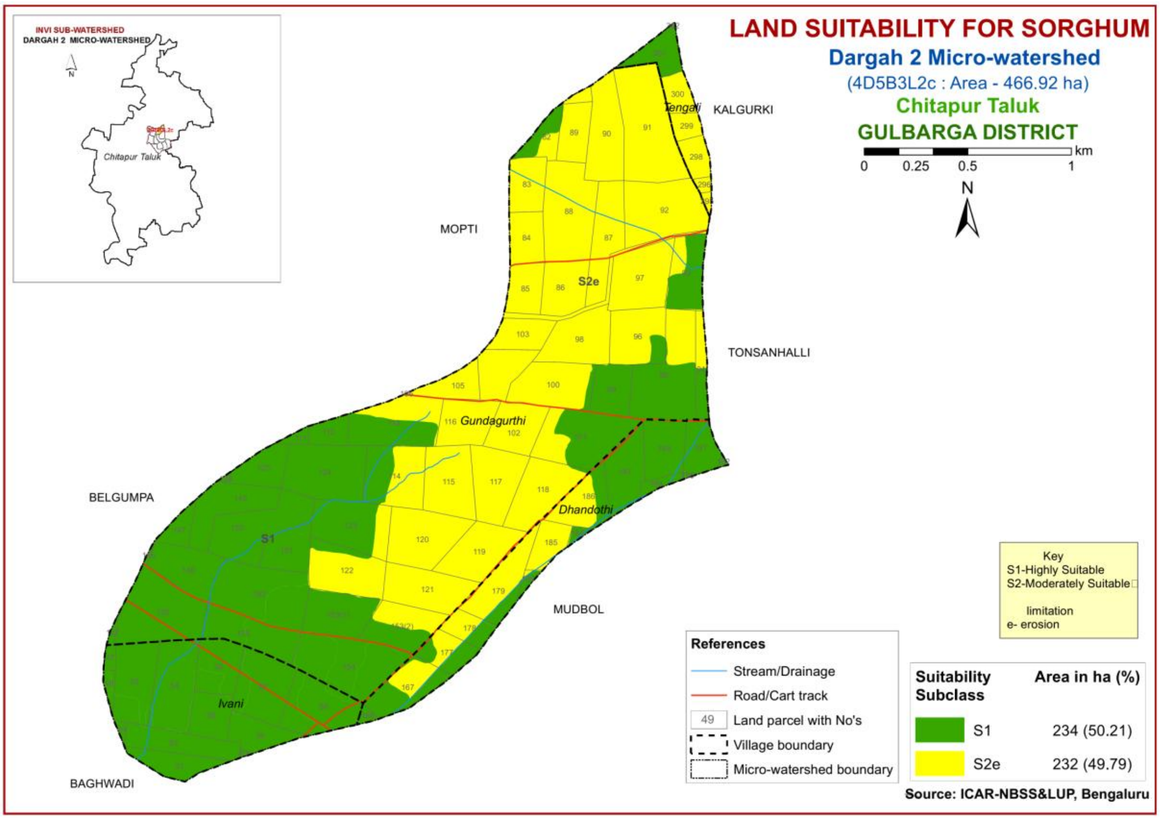

Fig. 7.1 Land Suitability map of Sorghum

7.2 Land Suitability for Maize (*Zea mays*)

Maize is the most important food crop grown in an area of 13.37 lakh ha in all the district 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.

In Dargah-2 microwatershed, there are no lands that are highly (Class S1) and moderately (Class S2) suitable for growing maize. The marginally suitable (Class S3) lands cover an entire area and occur in all parts of the microwatershed. They have severe limitations of 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	

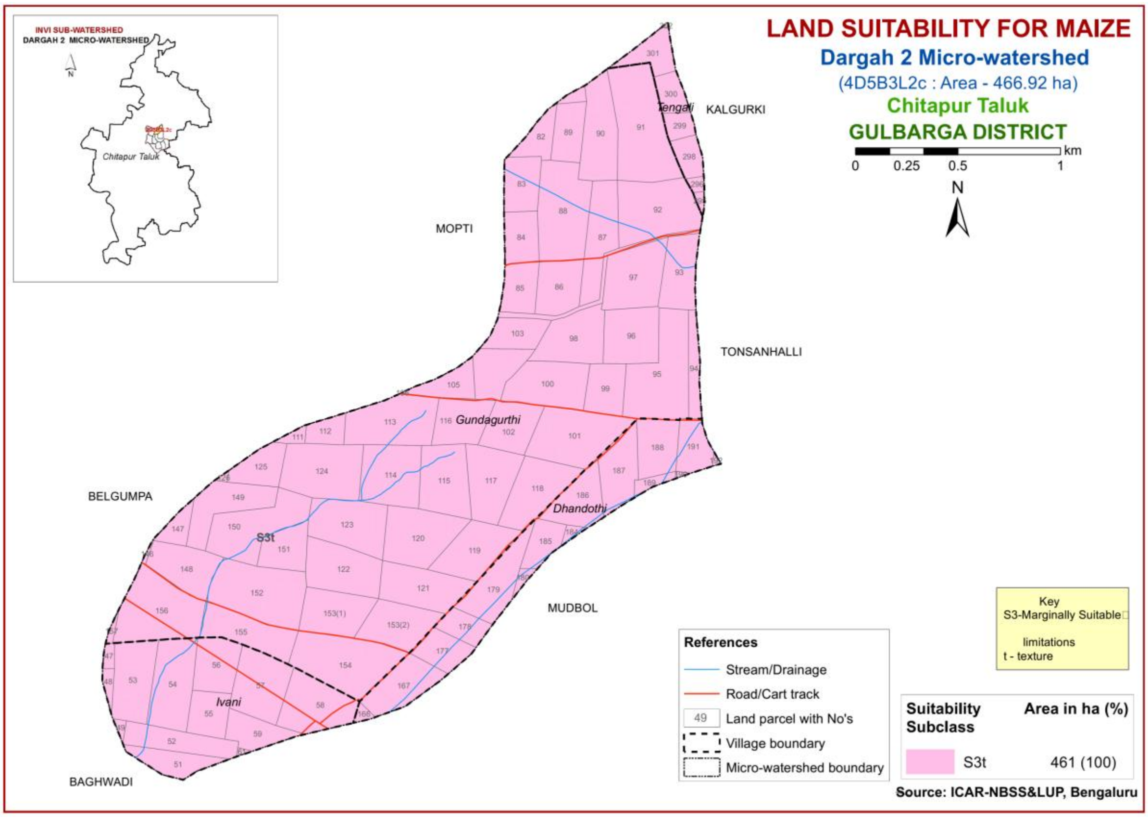

Fig. 7.2 Land Suitability map of Maize

7.3 Land Suitability for Red gram (*Cajanus cajan*)

Red gram is one of the major pulse crop grown in an area of 7.28 lakh ha mainly in northern Karnataka in Bijapur, Kalaburgi, Raichur, Bidar, Belgaum, Dharwad and Bellary districts. The crop requirements for growing red gram (Table 7.4) were matched with the soil-site characteristics (Table 7.1) of the soils of the microwatershed and a land suitability map for growing red gram was generated. The area extent and their geographic distribution of different suitability subclasses in the microwatershed is given in Figure 7.3.

In Dargah-2 microwatershed, there are no lands that are highly (Class S1) suitable for growing redgram. Entire area of 467 ha (100%) is moderately suitable (Class S2) for red gram and is distributed all parts of the microwatershed. They have moderate limitations of texture and erosion.

Table 7.4 Crop 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. to 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
Surface soil texture	Class	l, scl, sil, cl, sl	sicl, sic, c(m)	ls	S, fragmental
Soil depth	Cm	>100	85-100	40-85	<40
Gravel content	% vol.	<20	20-35	35-60	>60
Salinity (EC)	dSm^{-1}	<1.0	1.0-2.0	>2.0	
Sodicity (ESP)	%	<10	10-15	>15	

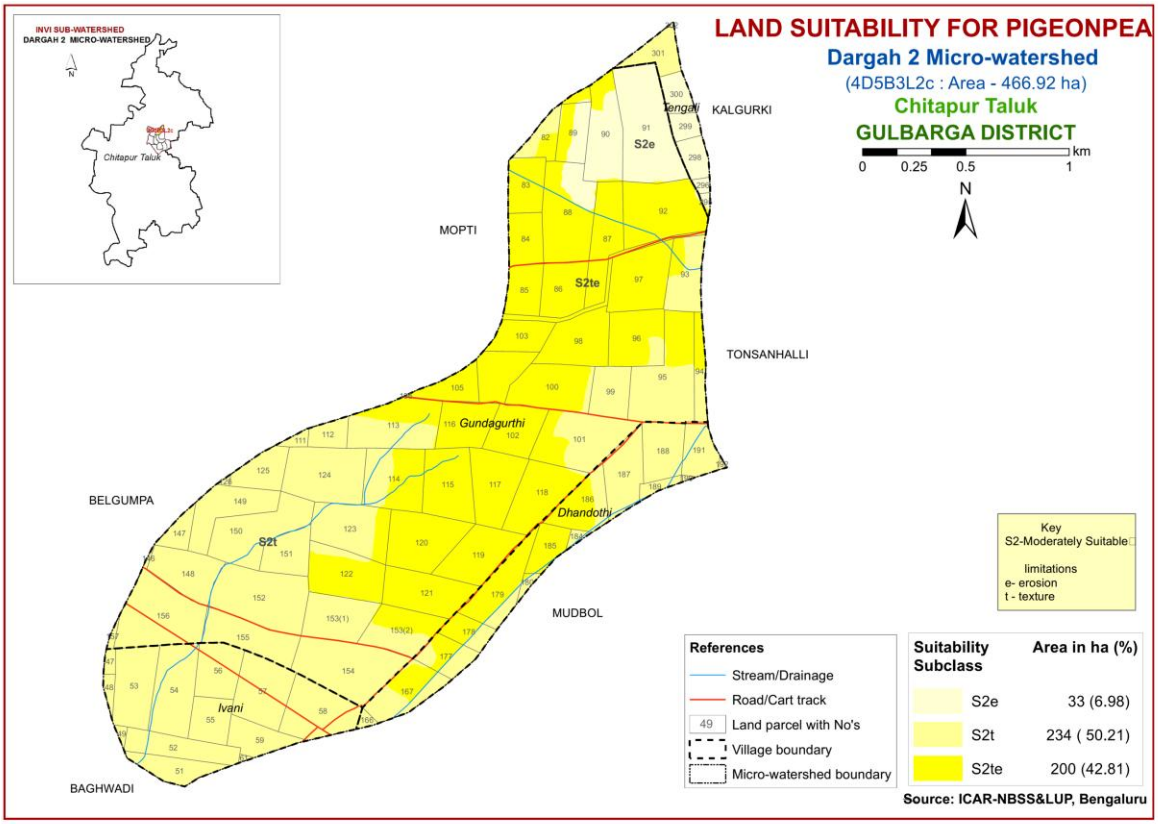

Fig. 7.3 Land Suitability map of Red gram

7.4 Land Suitability for Sunflower (*Helianthus annus*)

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

Highly suitable (Class S1) lands are found to occur in an area of 234 ha (50%) and are distributed in all parts of the microwatershed. They have minor or no limitations for growing sunflower. Moderately suitable (Class S2) lands are found to occur in an area of about 232 ha (50%). The soils have moderate limitations of erosion. They are distributed the central, southeastern, eastern, southeastern and northeastern part of the microwatershed.

Table 7.5 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 drained	imperfectly drained	Poorly drained
Soil reaction	pH	6.5-8.0	8.1-8.5 5.5-6.4	8.6-9.0; 4.5-5.4	>9.0 <4.5
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	

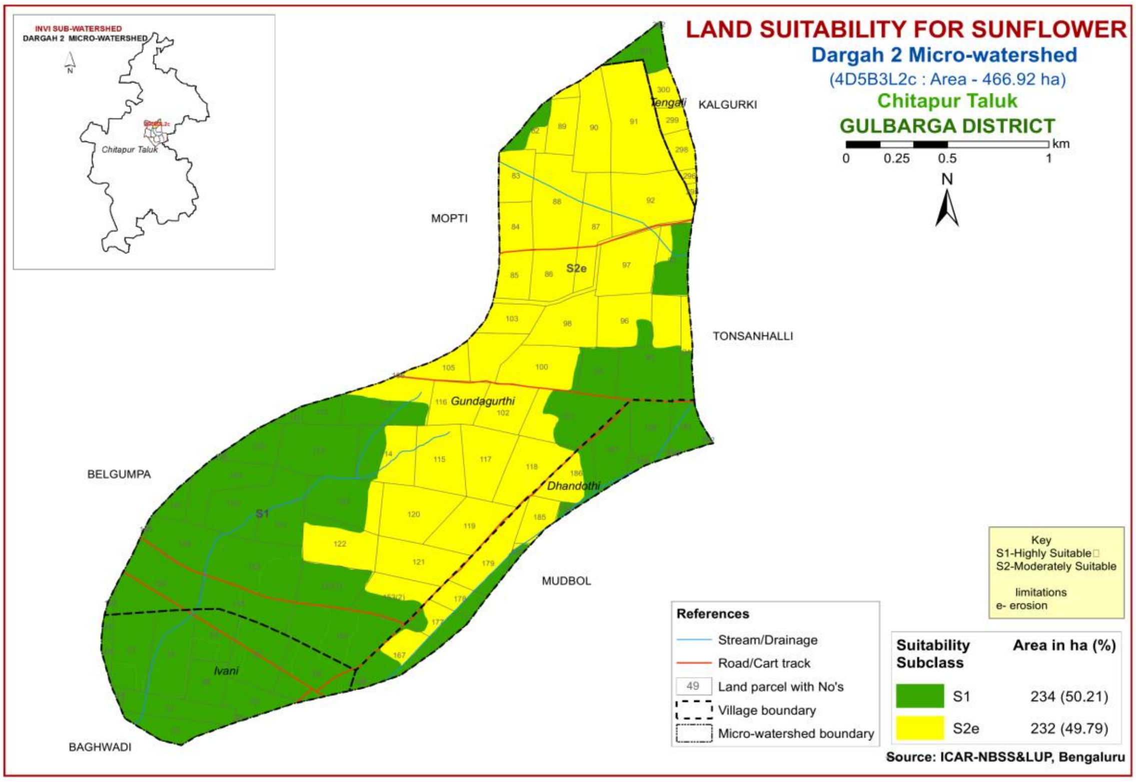

Fig. 7.4 Land Suitability map of Sunflower

7.5 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, Kalaburgi, Bijapur, Bidar, Bellary, Chitradurga and Chamarajnagar districts. The crop requirements for growing cotton (Table 7.6) were matched with the soil-site characteristics (Table 7.1) and a land suitability map for growing cotton was generated. The area extent and their geographical distribution of different suitability subclasses in the microwatershed is given in Figure 7.5.

An area of about 234 ha (50%) in the microwatershed has soils that are highly suitable (Class S1) for growing cotton crop. They have minor or no limitations for growing cotton and are distributed in all parts of the microwatershed. Moderately suitable (Class S2) lands are found to occur in an area of about 232 ha (50%). The soils have moderate limitations of erosion. They are distributed in the southern, central, northern, eastern and northeastern part of the microwatershed.

Table 7.6 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

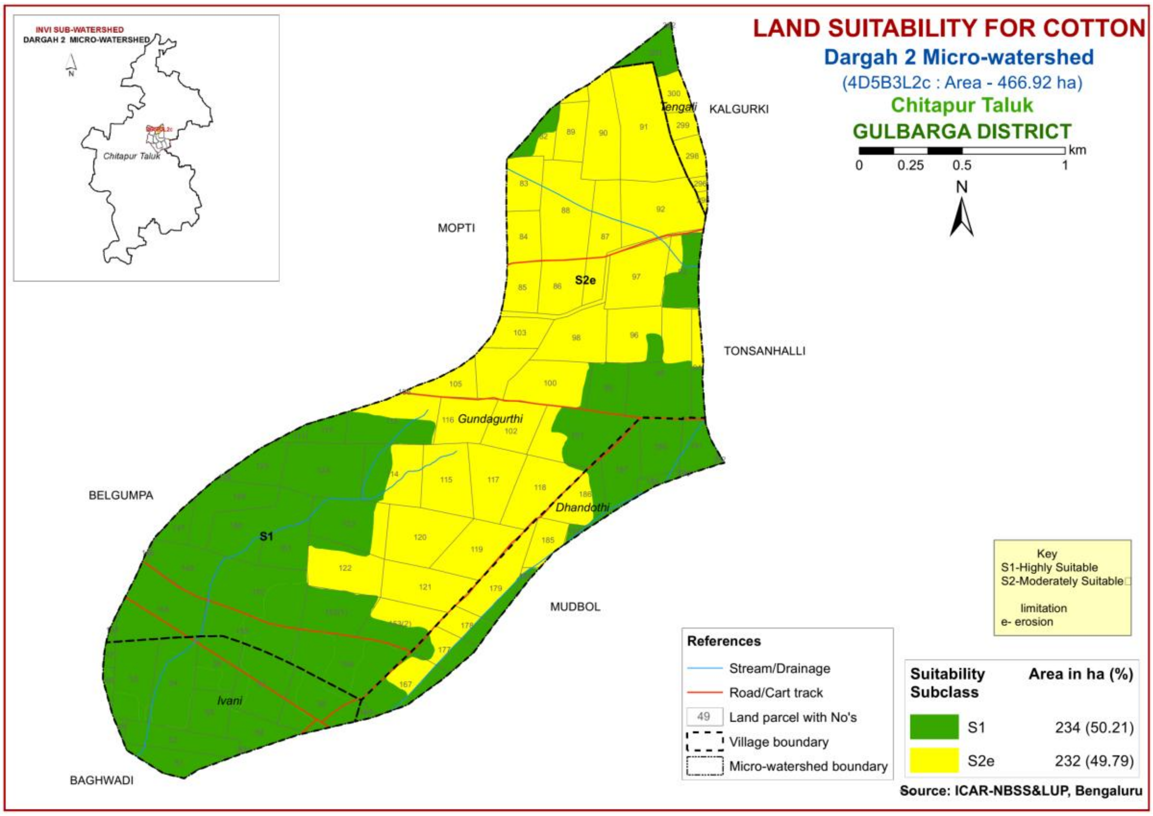

Fig. 7.5 Land Suitability map of Cotton

7.6 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 under irrigated conditions. The crop requirements for growing sugarcane (Table 7.7) were matched with the soil-site characteristics (Table 7.1) and a land suitability map for growing sugarcane was generated. The area extent and their geographical distribution of different suitability subclasses in the microwatershed is given in Figure 7.6.

Highly (Class S1) and moderately suitable (Class S2) lands are not available for growing sugarcane in Dargah-2 microwatershed. The marginally suitable (Class S3) lands cover an entire area and are distributed in all parts of the microwatershed. They have severe limitations of texture.

Table 7.7 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

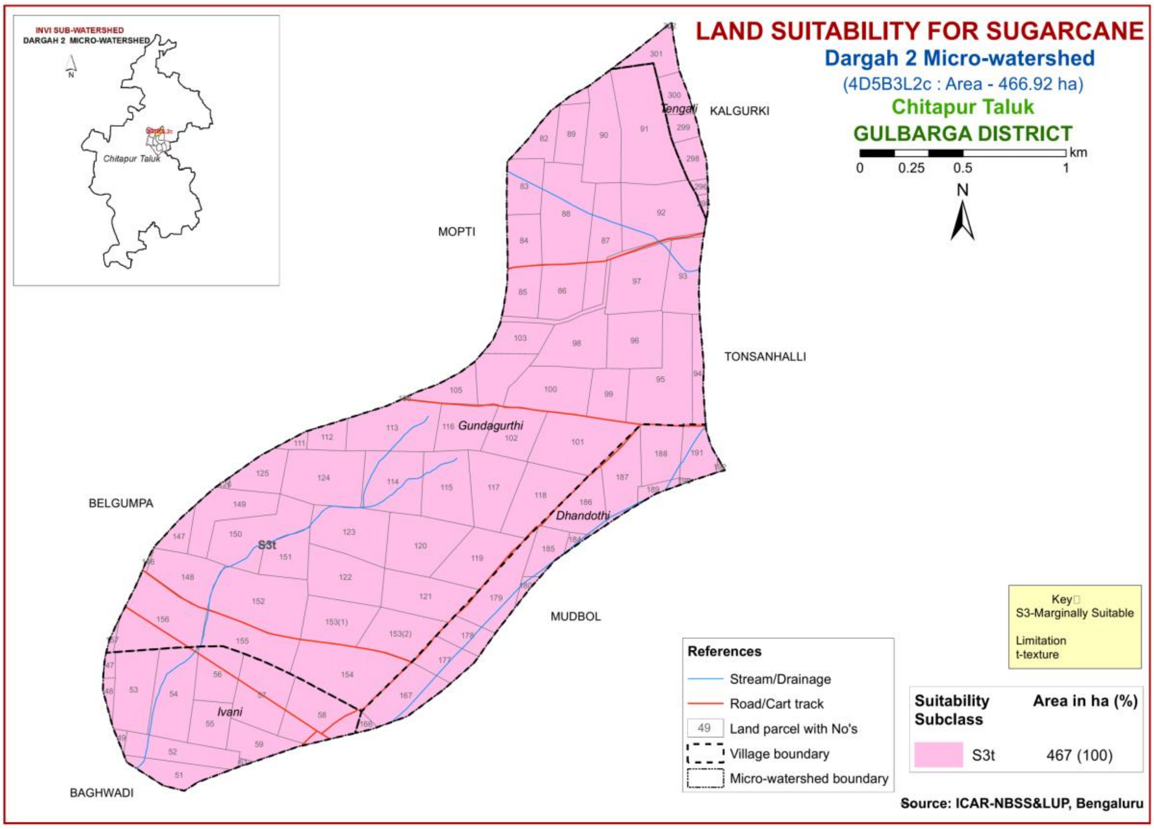

Fig. 7.6 Land Suitability map of Sugarcane

7.7 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 7.7.

Highly suitable (Class S1) lands are found to occur in an area of 234 ha (50%). They have minor or no limitations for growing soybean and are distributed in all parts of the microwatershed. Moderately suitable (Class S2) lands are found to occur in an area of about 232 ha (50%). The soils have moderate limitations of erosion. They are distributed in the southern, central, northern, eastern and northeastern part of the microwatershed.

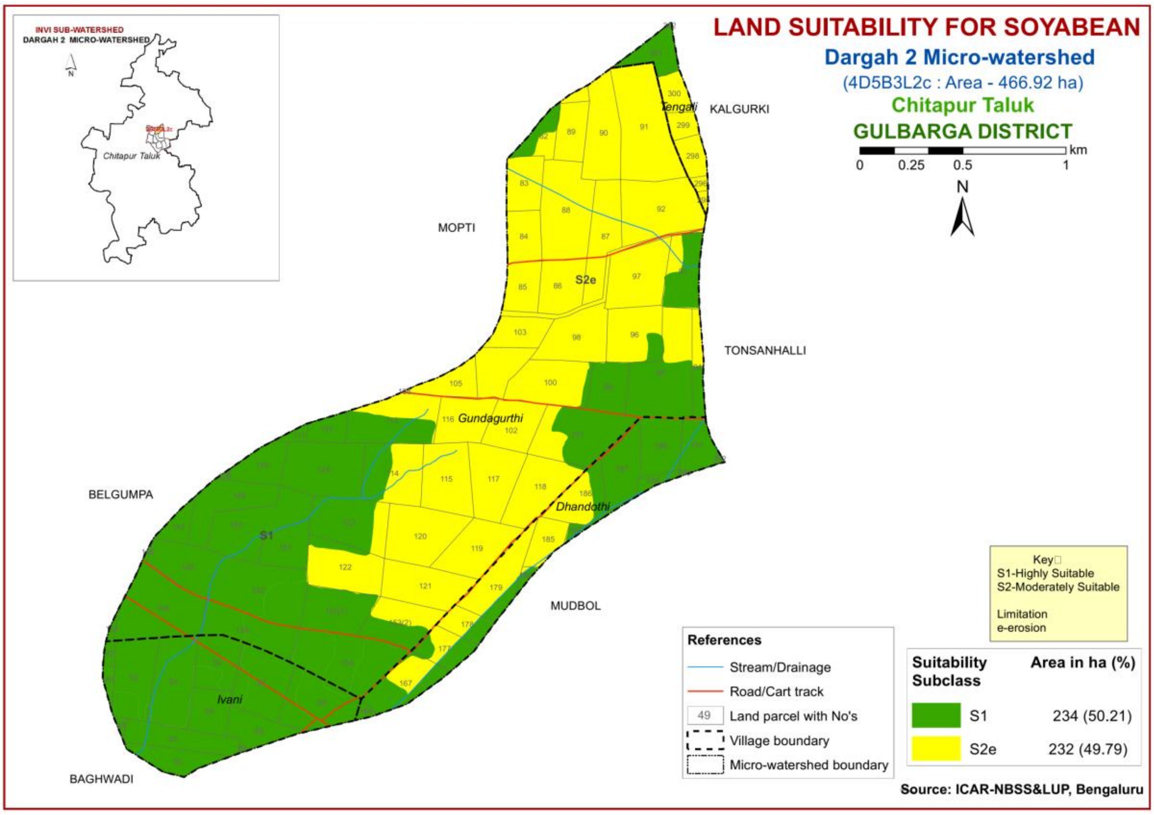

Fig. 7.7 Land Suitability map of Soybean

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

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

Highly suitable (Class S1) lands are found to occur in an entire area of 467 ha (100%). They have minor or no limitations for growing Bengal gram and are distributed in all parts of the microwatershed.

7.8 Land suitability criteria for Bengal gram

Crop requirement		Rating			
Soil –site characteristics	**Unit**	**Highly suitable (S1)**	**Moderately Suitable (S2)**	**Marginally suitable (S3)**	**Not suitable (N)**
Slope	%	<3	3-5	5-10	>10
LGP	Days	>100	90-100	70-90	<70
Soil drainage	class	Well drained	Mod. to well drained; imperfectly drained	Poorly drained; excessively drained	Very Poorly drained
Soil reaction	pH	6.0-7.5	5.5-5.7 7.6-8.0	8.1-9.0;4.5-5.4	>9.0
Surface soil texture	Class	l, scl, sil, cl,	sicl, sic, c	Sl, c>60%	
Soil depth	Cm	>75	51-75	25-50	<25
Gravel content	% vol.	<15	15-35	>35	
Salinity (ECe)	dsm^{-1}	<1.0	1.0-2.0	>2.0	
Sodicity (ESP)	%	<10	10-15	>15	

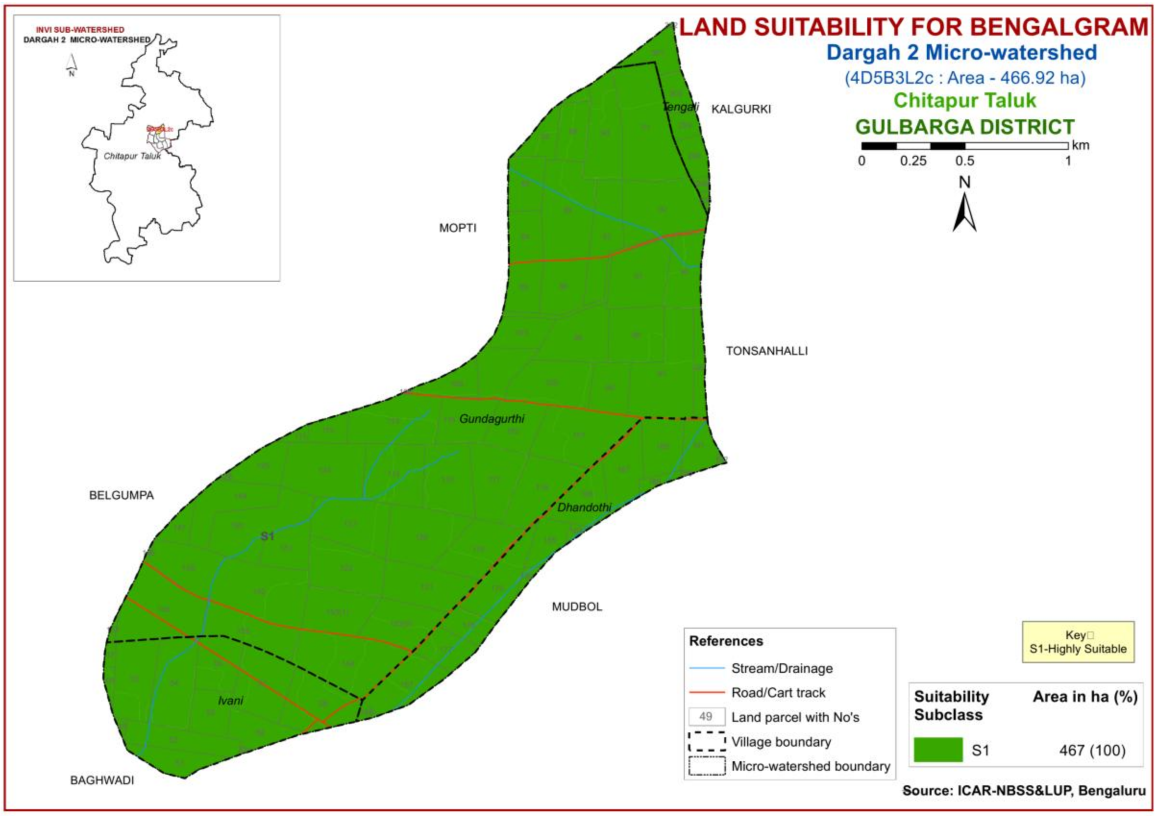

Fig. 7.8 Land Suitability map of Bengal gram

7.9 Land Suitability for Guava (*Psidium guajava*)

Guava is the most important fruit crop grown in about 6558 ha area in Raichur, Dharwad, Belgaum, Kalaburgi, Bijapur, Bidar, Bellary, Chitradurga, Bangalore and

Chamarajnagar districts. The crop requirements for growing guava (Table 7.8) were matched with the soil-site characteristics (Table 7.1) and a land suitability map for growing guava was generated. The area extent and their geographical distribution of different suitability subclasses in the microwatershed is given in Figure 7.9.

In Dargah-2 microwatershed, there are no highly (Class S1) suitable lands available for growing guava. Moderately suitable (Class S2) lands are found to occur in maximum area of about 446 ha (96%). The soils have moderate limitations of texture, erosion and rooting depth. They are dominantly distributed in all parts of the microwatershed. The marginally suitable (Class S3) lands cover a small area of about 20 ha (4%) and mainly distributed in the northeastern part of the microwatershed. They have severe limitations of topography and rooting depth.

Table 7.9 Crop suitability criteria for Guava

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

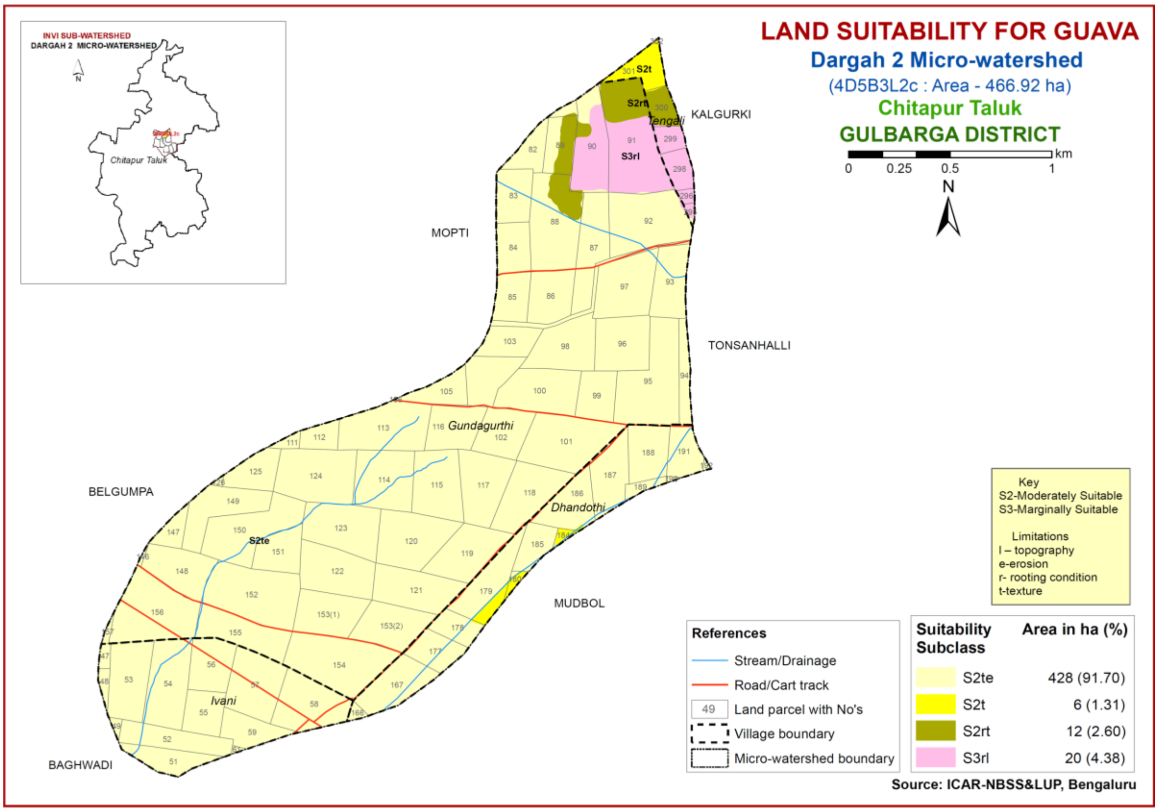

Fig 7.9 Land Suitability map of Guava

7.10 Land Suitability for Mango (*Mangifera indica*)

Mango is the most important fruit crop grown in about 1.73 lakh ha area in all the districts of the State. The crop requirements for growing mango (Table 7.9) 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 is given in Figure 7.10.

No highly (Class S1) and moderately suitable (Class S2) lands are available for growing mango in the Dargah-2 microwatershed. The marginally suitable (class S3) lands cover maximum area of about 446 ha (96%) and mainly occur in all parts of the microwatershed. They have severe limitations of rooting depth, texture and erosion. Small area of about 20 ha (4%) is not suitable (Class N) for growing mango and occur in the northeastern part of the microwatershed.

Table 7.10 Crop suitability criteria for Mango

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

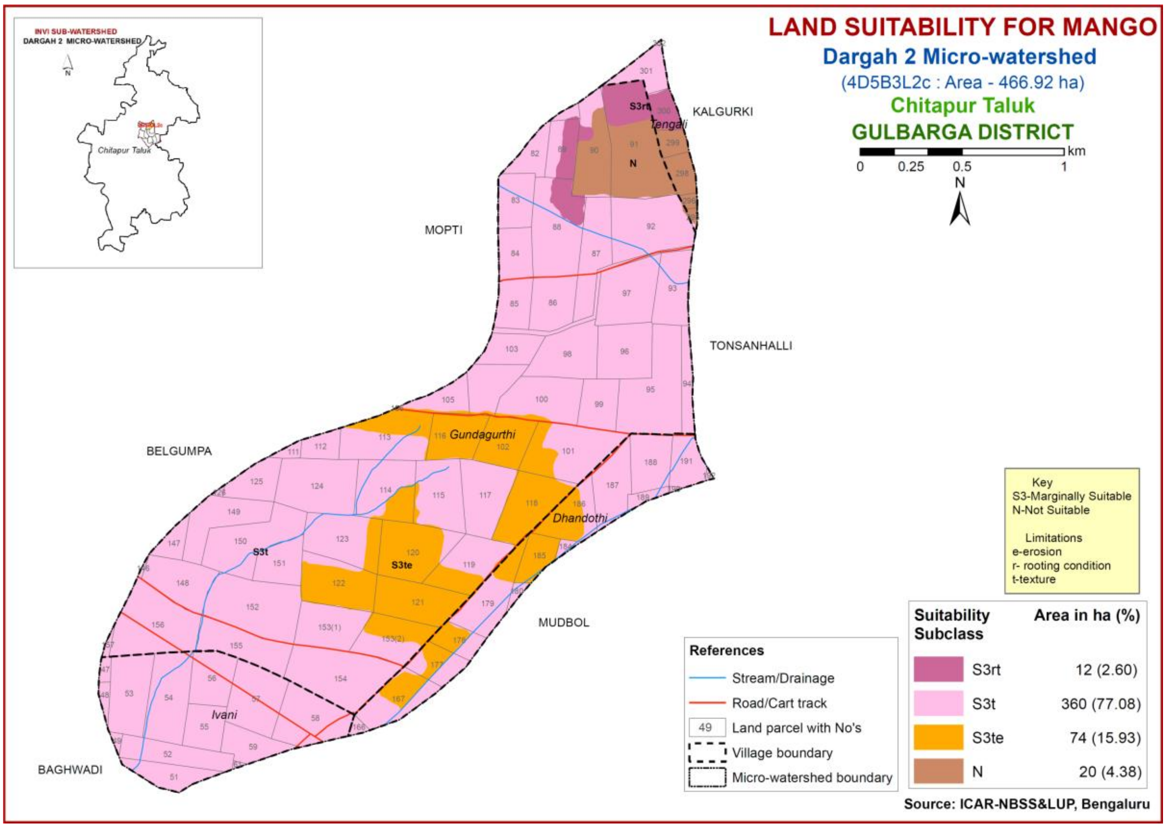

Fig. 7.10 Land Suitability map of Mango

7.11 Land Suitability for Sapota (*Manilkara zapota*)

Sapota is the most important fruit crop grown in about 0.29 lakh ha area in almost all the districts of the state. The crop requirements for growing sapota (Table 7.10) 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 7.11.

In Dargah-2 microwatershed, there are no lands that are highly (Class S1) suitable for growing sapota. Moderately suitable (Class S2) lands are found to occur in maximum area of about 446 ha (96%). The soils have moderate limitations of texture, erosion and rooting depth and are distributed in all parts of the microwatershed. The marginally suitable (Class S3) lands cover an area of about 20 ha (4%) and mainly occur in the northeastern part of the microwatershed. They have severe limitations of rooting depth and topography.

Table 7.11 Crop suitability criteria for Sapota

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

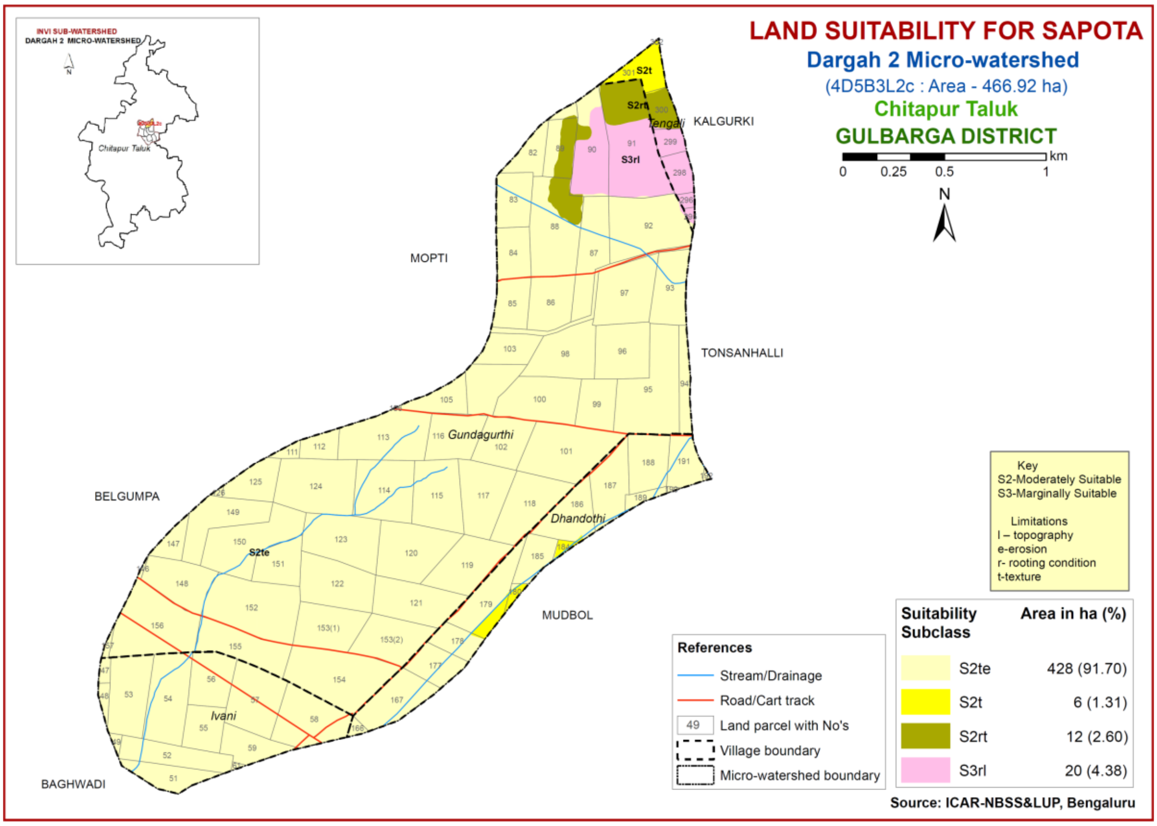

Fig. 7.11 Land Suitability map of Sapota

7.12 Land Suitability for Jackfruit (*Artocarpus heterophyllus*)

Jackfruit is the most important fruit crop grown in about 5368 ha area in 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 geographical distribution of different suitability subclasses in the microwatershed is given in Figure 7.12.

No highly (Class S1) and moderately suitable (Class S2) lands are available for growing jackfruit in the microwatershed. The marginally suitable (Class S3) lands cover an area of about 446 ha (96%) and occur in all parts of the microwatershed. They have severe limitations of texture and rooting depth. Small area of about 20 ha (4%) is not suitable (Class N) for growing jackfruit and occur in mainly in the northeastern part of the microwatershed.

7.12 Land suitability criteria for Jackfruit

Crop requirement			Rating			
Soil –site characteristics		Unit	Highly suitable (S1)	Moderately Suitable (S2)	Marginally suitable (S3)	Not suitable (N)
Soil aeration	Soil drainage	class	well	Mod. well	Poorly	V. Poorly
Nutrient availability	Texture	Class	Scl, cl, sc, c (red)	-	Sl, ls, c (black)	-
	pH	1:2.5	5.5-7.3	5.0-5.5 7.3-7.8	7.8-8.4	>8.4
Rooting conditions	Soil depth	Cm	>100	75-100	50-75	<50
	Gravel content	% vol.	<15	15-35	35-60	>60
Erosion	Slope	%	0-3	3-5	>5	-

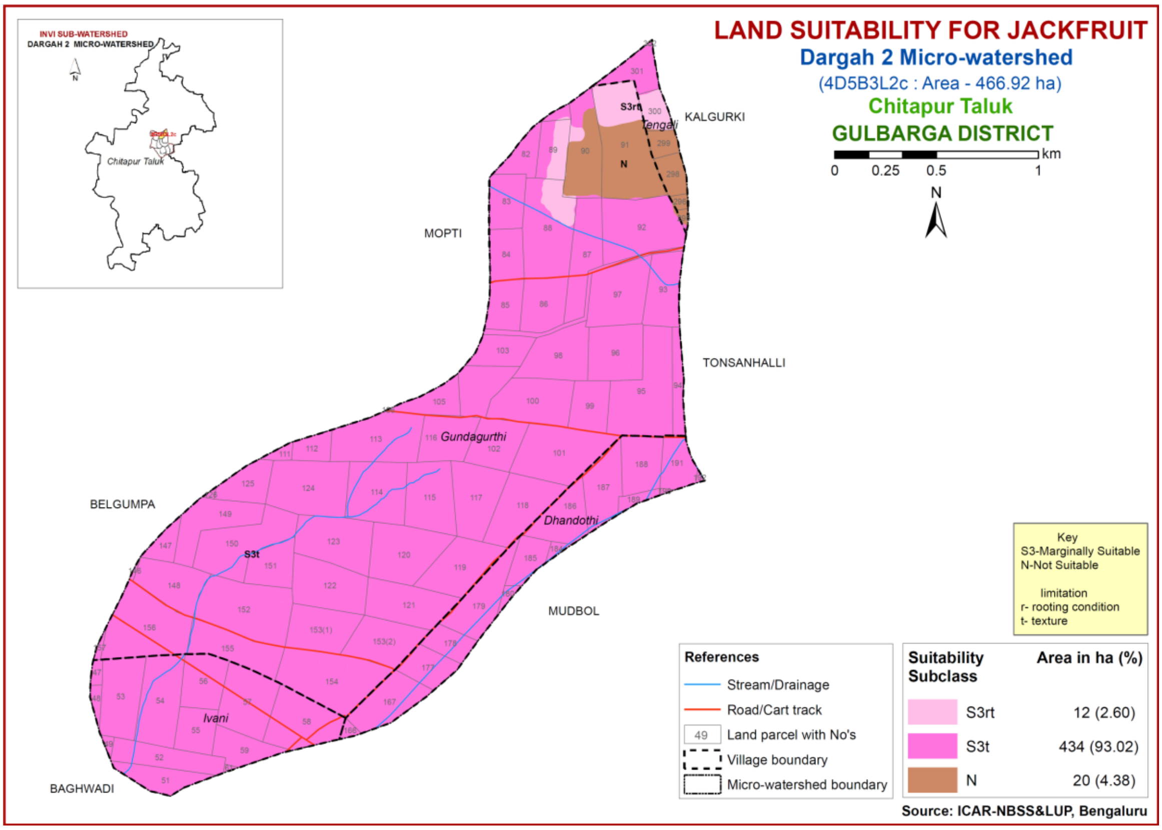

Fig 7.12 Land Suitability map of Jackfruit

7.13 Land Suitability for Jamun (*Syzygium cumini*)

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

No highly (Class S1) lands are available for growing jamun in the microwatershed. The moderately suitable (Class S2) lands are found to occur in an area of about 446 ha (96%). The soils have moderate limitations of texture, erosion and rooting depth. They are distributed in all parts of the microwatershed. The marginally suitable (Class S3) lands cover about a small area of 20 ha (4%) and mainly occur in the northeastern part of the microwatershed. They have severe limitations of rooting depth and topography.

7.13 Land suitability criteria for Jamun

Crop requirement			Rating			
Soil –site characteristics		**Unit**	**Highly suitable (S1)**	**Moderately suitable (S2)**	**Marginally suitable (S3)**	**Not suitable (N)**
Soil aeration	Soil drainage	Class	Well	Mod. well	Poorly	V.Poorly
Nutrient availability	Texture	Class	Scl, cl, sc, C (red)	Sl, C (black)	ls	-
	pH	1:2.5	6.0-7.8	5.0-6.0	7.8-8.4	>8.4
Rooting conditions	Soil depth	Cm	>150	100-150	50-100	<50
	Gravel content	% vol.	<15	15-35	35-60	>60
Erosion	Slope	%	0-3	3-5	5-10	>10

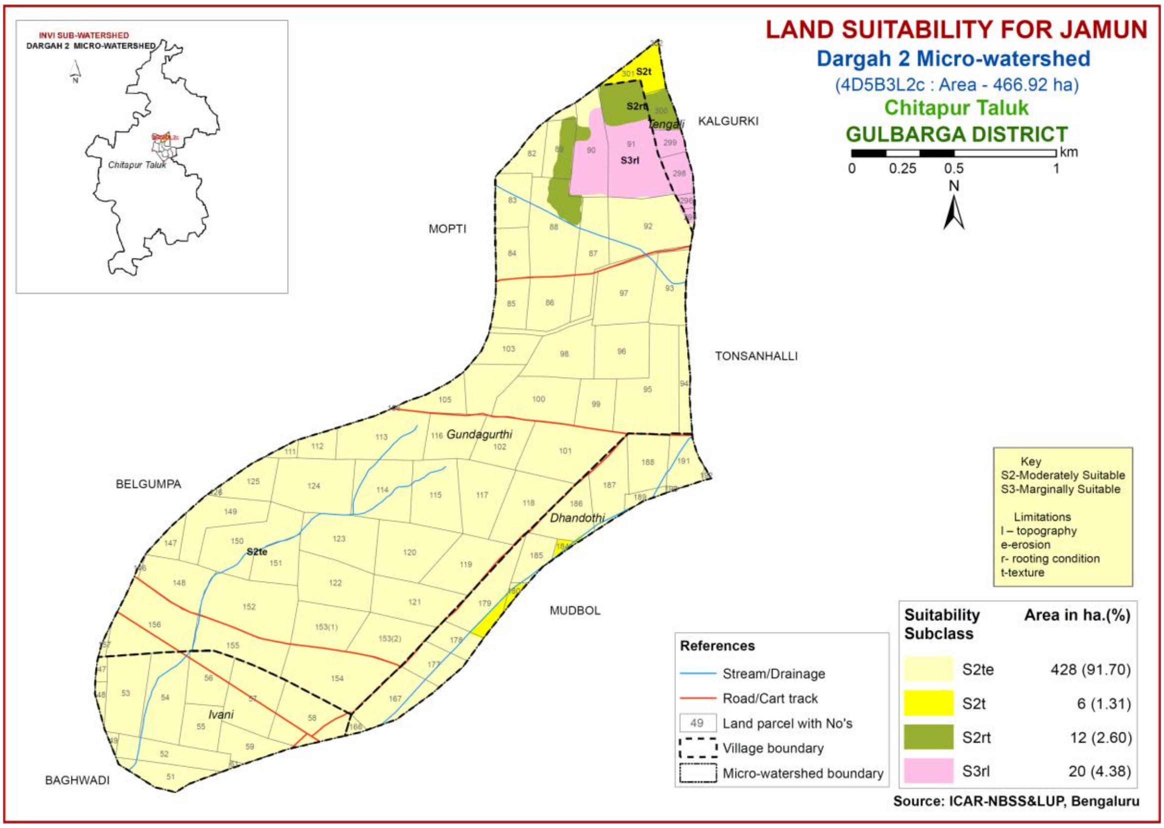

Fig 7.13 Land Suitability map of Jamun

7.14 Land Suitability for Musambi (*Citrus limetta*)

Musambi is the most important fruit crop grown in about 5446 ha area in almost all the districts of the state. The crop requirements for growing musambi were matched with the soil-site characteristics and a land suitability map for growing musambi was generated. The area extent and their geographical distribution of different suitability subclasses in the microwatershed is given in Figure 7.14.

Highly suitable (Class S1) lands are found to occur in a maximum area of about 434 ha (93%) and are distributed in all parts of the microwatershed. They have minor or no limitations for growing musambi. The moderately suitable (Class S2) lands occur in very small area of about 12 ha (3%). The soils have moderate limitations of texture and rooting depth. They are distributed in the northeastern part of the microwatershed. The marginally suitable (Class S3) lands also cover a very small area of about 20 ha (4%) in the microwatershed and mainly occur in the northeastern part of the microwatershed. They have severe limitations of rooting depth and topography.

Table 7.14 Crop suitability criteria for Musambi

Crop requirement			Rating			
Soil –site characteristics		Unit	Highly suitable (S1)	Moderately suitable (S2)	Marginally suitable (S3)	Not suitable (N)
Climate	Temp in growing season	^0C	28-30	31-35 24-27	36-40 20-23	>40 <20
Soil moisture	Growing period	Days	240-265	180-240	150-180	<150
Soil aeration	Soil drainage	class	Well drained	Mod. to imperfectly drained	poorly	Very poorly
Nutrient availability	Texture	Class	Scl, l, sicl, cl, s	Sc, sc, c	C (>70%)	S, ls
	pH	1:2.5	6.0-7.5	5.5-6.4/ 7.6-8.0	4.0-5.4 8.1-8.5	<4.0 >8.5
	$CaCO_3$ in root zone	%	Non calcareous	Upto 5	5-10	>10
Rooting condition	Soil depth	cm	>150	100-150	50-100	<50
	Gravel content	% vol.	Non gravelly	15-35	35-55	>55
Soil toxicity	Salinity	dS/m	Non saline	Upto 1.0	1.0-2.5	>2.5
	Sodicity	%	Non sodic	5-10	10-15	>15
Erosion	Slope	%	<3	3-5	5-10	

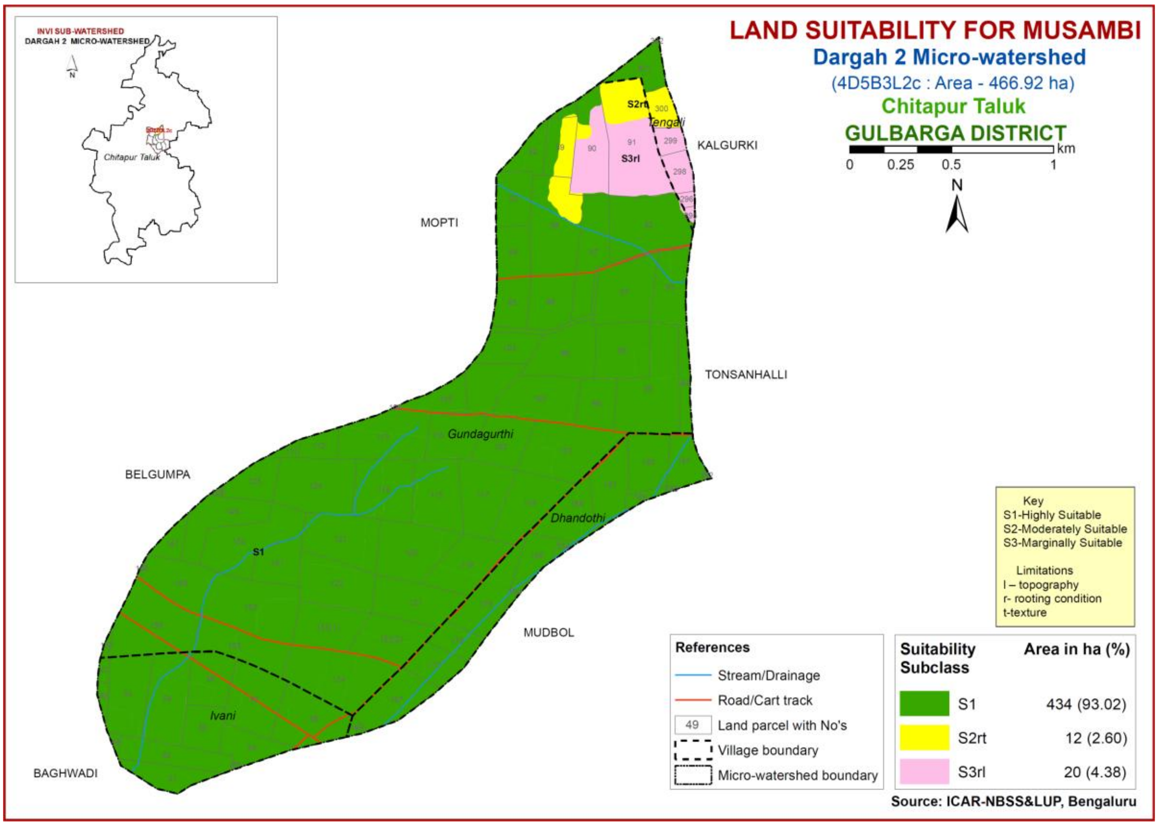

Fig 7.14 Land Suitability map of Musambi

7.15 Land Suitability for Lime (*Citrus sp*)

Lime is the most important fruit crop grown in about 0.11 lakh in almost all the districts of the state. The crop requirements for growing lime (Table 7.11) 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 is given in Figure 7.15.

Highly suitable (Class S1) lands are found to occur in an area of about 434 ha (93%) and are distributed in all parts of the microwatershed. They have minor or no limitations for growing lime. The moderately suitable (Class S2) lands occur in an area of about 12 ha (3%). The soils have moderate limitations of texture and rooting depth. They are dominantly distributed in the northeastern part of the microwatershed. The marginally suitable (Class S3) lands cover an area of about 20 ha (4%) and are distributed in the northeastern part of the microwatershed. They have severe limitations of rooting depth and topography.

Table 7.15 Crop suitability criteria for Lime

Crop requirement			Rating			
Soil –site characteristics		**Unit**	**Highly suitable (S1)**	**Moderately suitable (S2)**	**Marginally suitable (S3)**	**Not suitable (N)**
Climate	Temp in growing season	^{0}C	28-30	31-35 24-27	36-40 20-23	>40 <20
Soil moisture	Growing period	Days	240-265	180-240	150-180	<150
Soil aeration	Soil drainage	class	Well drained	Mod. to imperfectly drained	poorly	Very poorly
Nutrient availability	Texture	Class	Scl, l, sicl, cl, s	Sc, sc, c	C (>70%)	S, ls
	pH	1:2.5	6.0-7.5	5.5-6.4/ 7.6-8.0	4.0-5.4 8.1-8.5	<4.0 >8.5
	$CaCO_3$ in root zone	%	Non calcareous	Upto 5	5-10	>10
Rooting condition	Soil depth	cm	>150	100-150	50-100	<50
	Gravel content	% vol.	Non gravelly	15-35	35-55	>55
Soil toxicity	Salinity	dS/m	Non saline	Upto 1.0	1.0-2.5	>2.5
	Sodicity	%	Non sodic	5-10	10-15	>15
Erosion	Slope	%	<3	3-5	5-10	

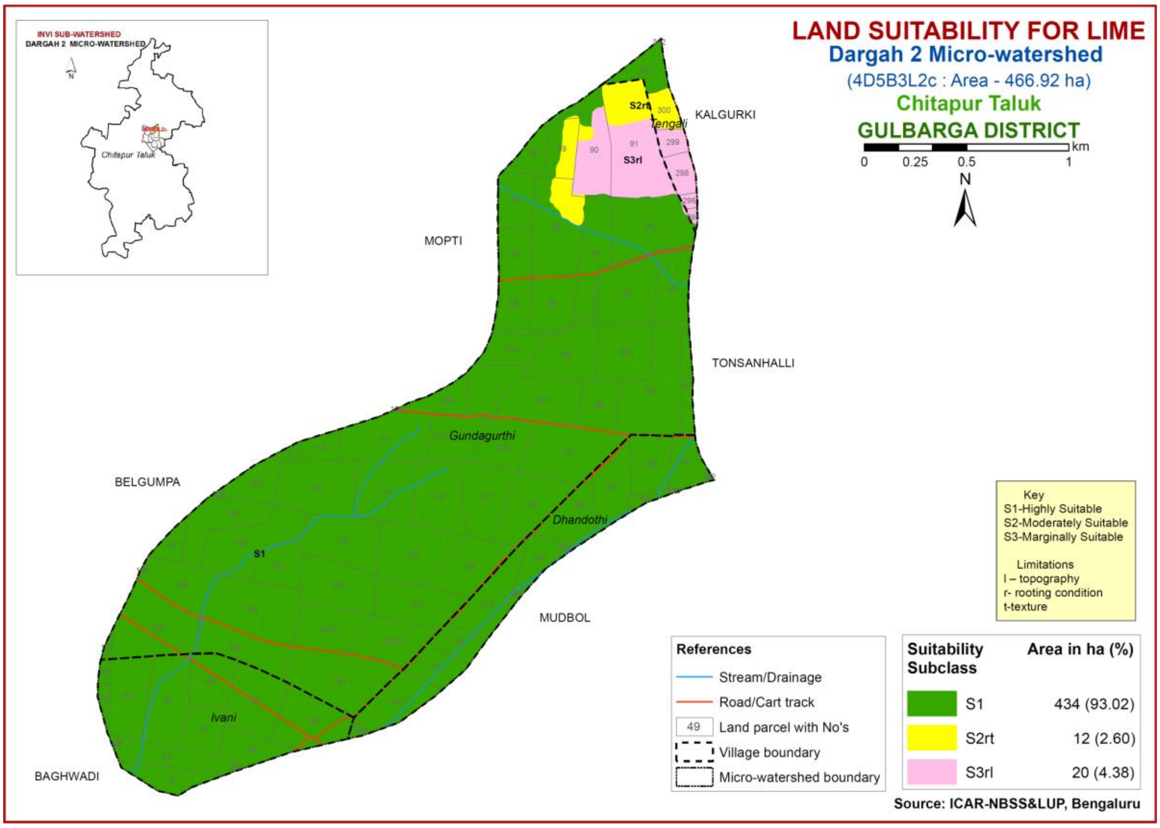

Fig 7.15 Land Suitability map of Lime

7.16 Land Suitability for Cashew (*Anacardium occidentale)*

Cashew is the most important plantation crop grown in about 0.70 lakh ha area in almost all the districts. 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 is given in Figure 7.16.

There are no suitable lands for growing cashew in the entire area. And all the lands are not suitable (Class N) lands for growing cashew and occur in all parts of the microwatershed.

7.16 Land suitability criteria for cashew

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

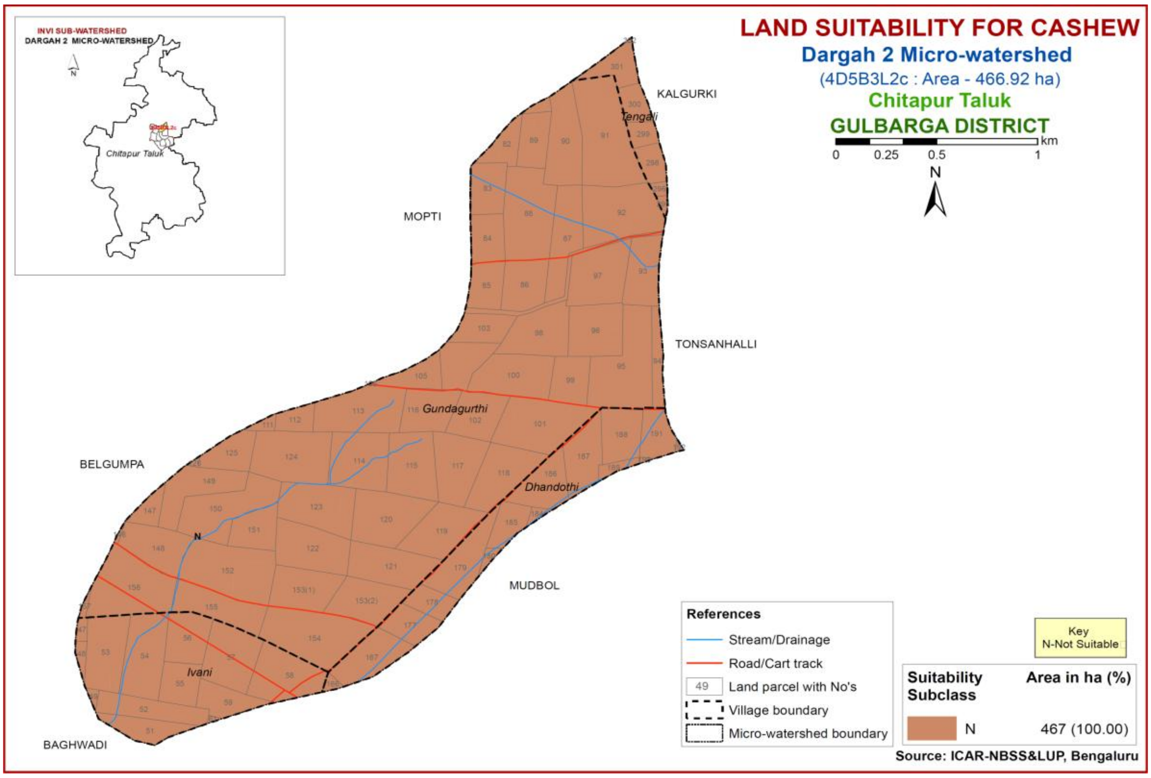

Fig 7.16 Land Suitability map of Cashew

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

Custard apple is the most important fruit crop grown in about 1426 ha area in 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 is given in Figure 7.17.

Highly suitable (Class S1) lands are found to occur in an area of 446 ha (96%) and are distributed all parts of the microwatershed. They have minor or no limitations for growing custard apple. Moderately suitable (Class S2) lands are found to occur in an area of about 20 ha (4%). The soils have moderate limitations of topography and rooting depth. They are distributed in the northeastern part of the microwatershed

7.17 Land suitability criteria for Custard apple

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

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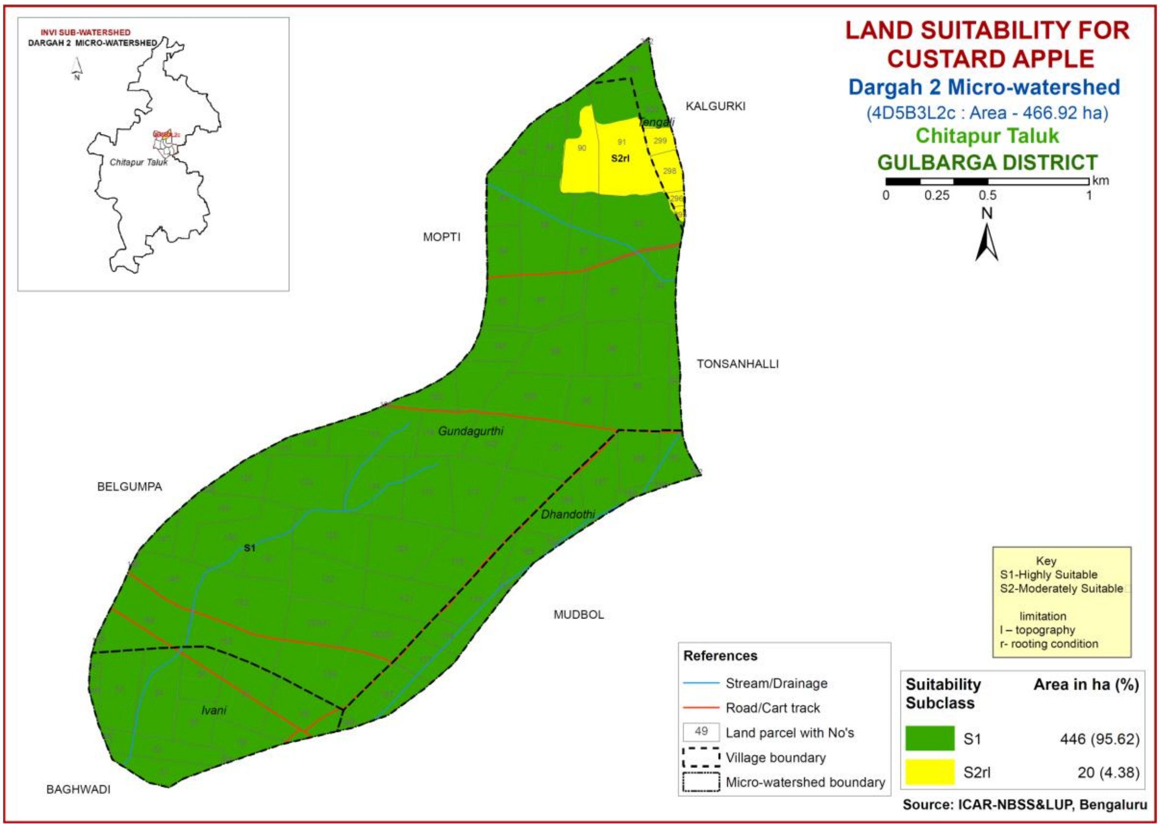


Fig 7.17 Land Suitability map of Custard Apple

7.18 Land Suitability for Amla (*Phyllanthus emblica*)

Amla is the most important fruit crop grown in about 151 ha area in 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 geographical distribution of different suitability subclasses in the microwatershed is given in Figure 7.18.

Highly suitable (Class S1) lands are found to occur in an area of 446 ha (96%). They have minor or no limitations for growing amla and are distributed in all parts of the microwatershed. Moderately suitable (Class S2) lands are found to occur in an area of about 20 ha (4%). The soils have moderate limitations of topography and rooting depth. They are dominantly distributed in the northeastern part of the microwatershed.

7.18 Land suitability criteria for Amla

Crop requirement			Rating			
Soil –site characteristics		**Unit**	**Highly suitable (S1)**	**Moderately suitable (S2)**	**Marginally suitable (S3)**	**Not suitable (N)**
Soil aeration	Soil drainage	Class	Well drained	Mod.well drained	Poorly drained	V. Poorly drained
Nutrient availability	Texture	Class	Scl, cl, sc, c (red)	C (black)	ls, sl	-
	pH	1:2.5	5.5-7.3	5.0-5.5	7.8-8.4	>8.4
Rooting conditions	Soil depth	Cm	>75	50-75	25-50	<25
	Gravel content	% vol.	<15-35	35-60	60-80	
Erosion	Slope	%	0-3	3-5	5-10	>10

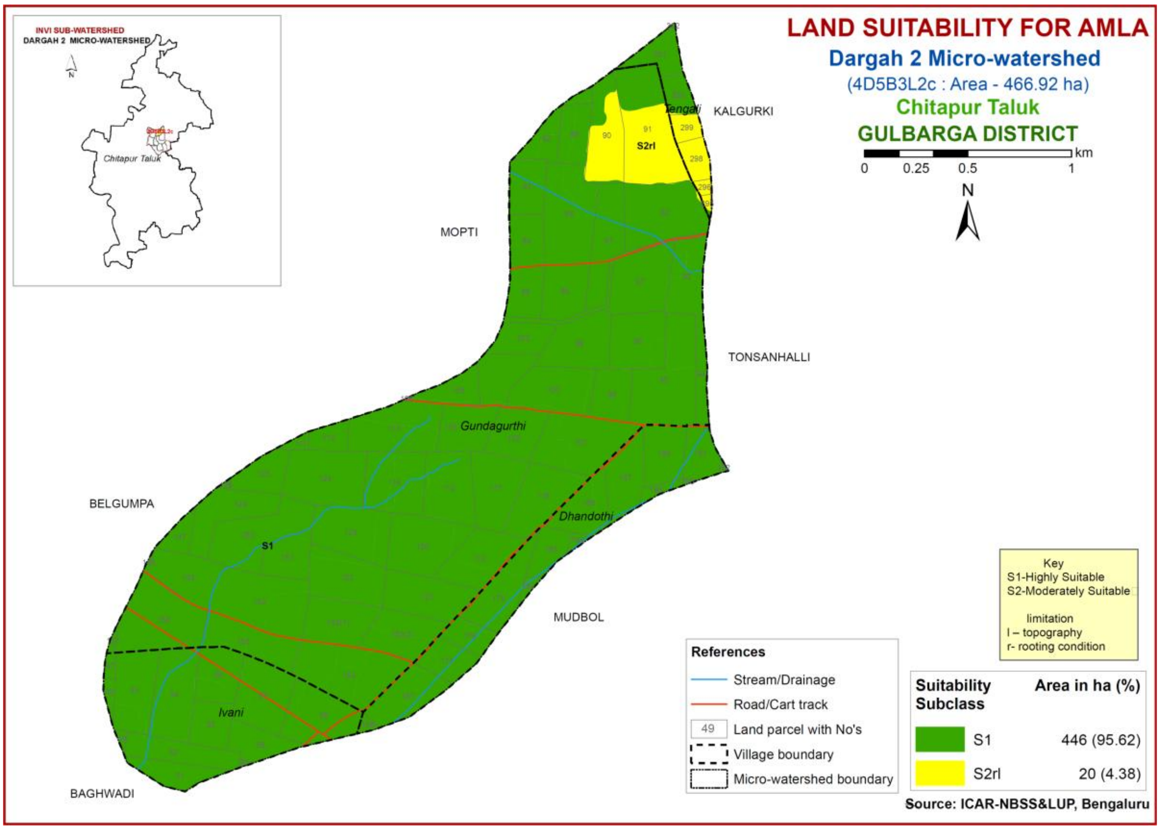


Fig 7.18 Land Suitability map of Amla

7.19 Land Suitability for Tamarind (*Tamarindus indica*)

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

No highly (Class S1) suitable lands are available for growing tamarind in the Dargah-2 microwatershed. Moderately suitable (Class S2) lands are found to occur in a maximum area of about 446 ha (96%). The soils have moderate limitation of texture, erosion and rooting depth. They are distributed in all parts of the microwatershed. The marginally suitable (Class S3) lands cover about 20 ha (4%) area and mainly occur in the northeastern part of the microwatershed. The soils have severe limitations of topography and rooting depth.

7.19 Land suitability criteria for Tamarind

Crop requirement			Rating			
Soil –site characteristics		Unit	Highly suitable (S1)	Moderately Suitable (S2)	Marginally suitable (S3)	Not suitable (N)
Soil aeration	Soil drainage	Class	Well drained	Mod.well drained	Poorly drained	V.Poorly drained
Nutrient availability	Texture	Class	Scl, cl,sc, c (red)	Sl, c (black)	ls	-
	pH	1:2.5	6.0-7.3	5.0-6.0 7.3-7.8	7.8-8.4	>8.4
Rooting conditions	Soil depth	Cm	>150	100-150	75-100	<75
	Gravel content	% vol.	<15	15-35	35-60	60-80
Erosion	Slope	%	0-3	3-5	5-10	>10

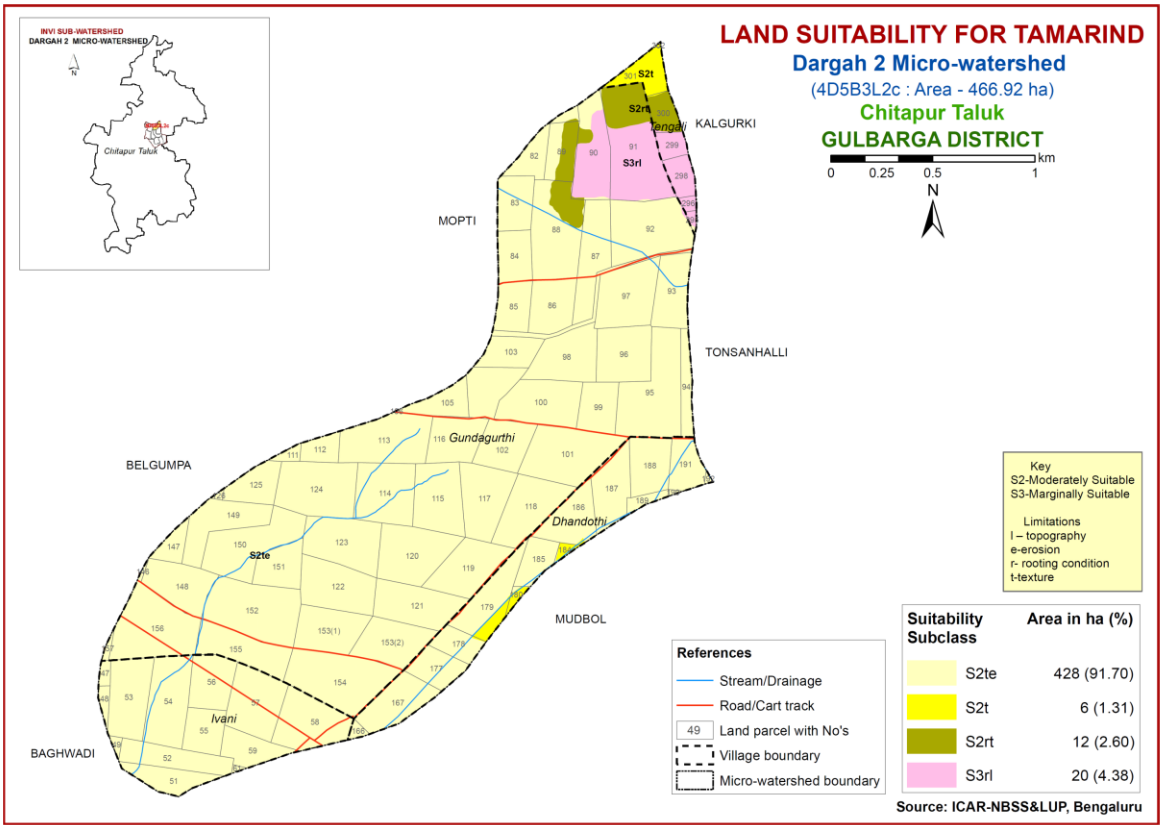


Fig 7.19 Land Suitability map of Tamarind

7.20 Land Use Classes (LUCs)

The 6 soil map units identified in Dargah-2 microwatershed have been regrouped into 2 Land Use Classes (LUC's) for the purpose of preparing a Proposed Crop Plan. Land Use Classes are grouped based on the similarities in respect of the type of soil, the depth of the soil, the surface soil texture, gravel content, AWC, slope, erosion etc. and a Land 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 2 Land Use Classes along with brief description of soil and site characteristics are given below.

LUCs	Soil map units	Soil and site characteristics
1	5 MTMmB2 6 MTMmC2	Moderately deep black soils (75-100 cm), 1-3 % slope, moderately eroded.
2	1 DDTmB2 2 DDTmC2 3 DRGmB1 4 DRGmB2	Deep to very deep Black soils (100-150 & >150 cm), 1-5 % slope, slight to moderate erosion

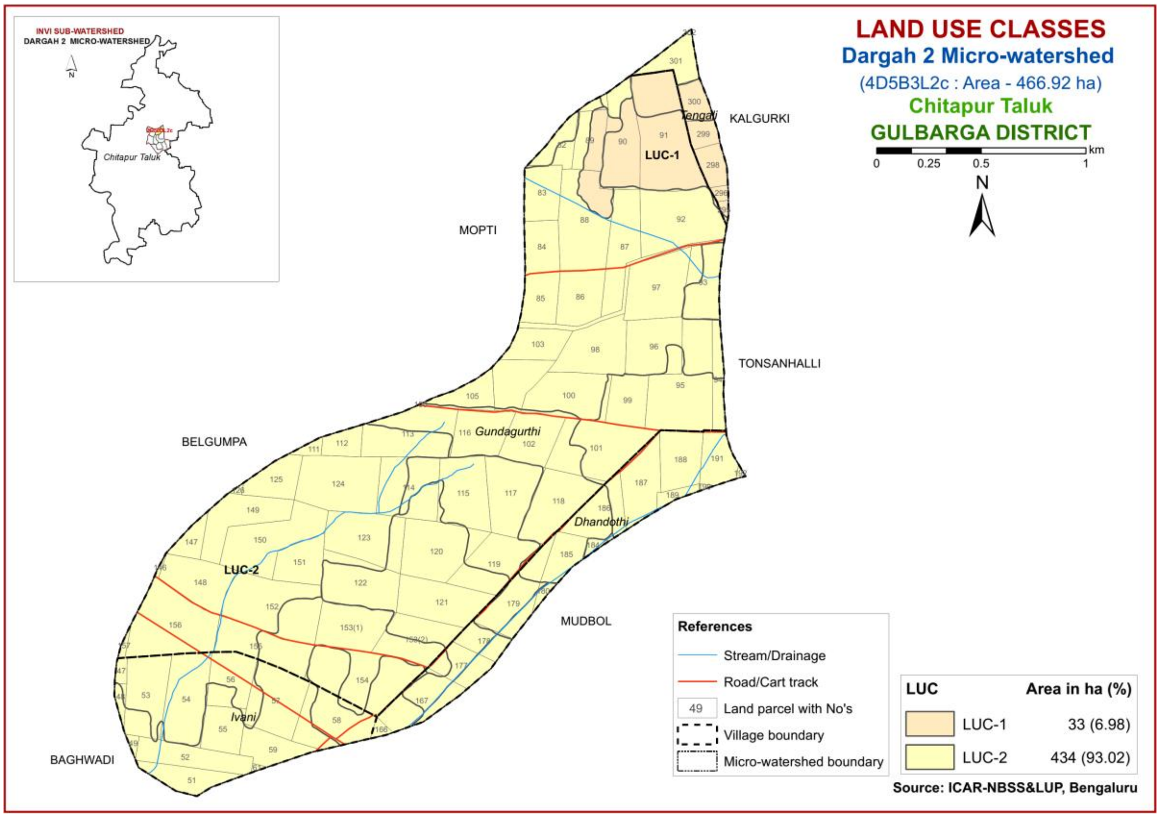


Fig. 7.20 Land Use Classes map of Dargah-2 Microwatershed

7.21 Proposed Crop Plan for Dargah-2 Microwatershed

After assessing the land suitability for the 19 crops, a proposed crop plan has been prepared for the 2 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 7.12.

Table 7.20 Proposed Crop Plan for Dargah-2 Microwatershed

LUC	Mapping unit	Survey No	Soil Characteristics	Crops proposed				Suitable Intervention
				Field crops	Forestry Crop/Grasses	Horticulture crops (Rainfed Condition)	Horticulture crops with suitable intervention	
LUC-1	5 MTMmB2 6 MTMmC2	Gundagurthi: 89,90,91 Tengali : 295,296,298,299, 300	Moderately deep black soils (75-100 cm), 1-3 % slope, moderately eroded.	Sorghum, Cotton, Red Gram, Black gram, Green gram, Soybean, Sesame, Sunflower, Safflower **Rabi**: Sorghum, Chickpea **Mixed cropping**: Red gram-cotton	Subabhul, Neem, Teak	Custard apple, Charoli, Ber, Amla **Vegetables:** Ladies finger, Brinjal, Cowpea, **Flowers:** Marigold, Chrysanthemum	Custard apple, Charoli, Ber, Amla, Papaya, Banana, Lime, Citrus, sugarcane **Vegetables:** Onion, Tomato, Brinjal, Chillies, Bhendi **Flowers:** Marigold, Chrysanthemum	Graded bunds, Strengthening of field bunds
LUC-2	1 DDTmB2 2 DDTmC2 3 DRGmB1 4 DRGmB2	Dhandothi: 166,167,177,178,179,180,184,185,186,187,188,189,190,191,192 Gundagurthi: 82,83,84,85,86,87,88,92,93,94,95,96,97,98,99, 100,101,102,103,105,106,111,112,113,114, 115,116,117,118,119,120,121,122,123,124,125,126,146,147,148,149, 150,151,152,153(1),153(2),154,155,156,157 Ivani: 47,48,49,51,52,53,54,55,56,57,58,59, 61 Tengali: 301,302	Deep to very deep Black soils (100-150 & >150 cm), 1-5 % slope, slight to moderate erosion	Sorghum, Cotton, Red Gram, Black gram, Green gram, Soybean, Sunflower, Safflower, Sesame, **Rabi:** Sorghum, wheat, Chickpea **Mixed cropping:** Red gram-cotton Pulses + sorghum	-	**Vegetable:** Ladies finger, Brinjal, Cowpea, Coriander **Field crops:** Sorghum, Cotton, Red Gram, Sunflower, Safflower, **Perennial component:** Guava, Tamarind, Sapota, Lime, Musambi **Flowers:** Marigold, Chrysanthemum	Banana, Papaya, Lime, Musambi, Guava, Tamarind sugarcane **Vegetables:** Onion, Tomato, Brinjal, Chillies, Bhendi **Flowers:** Marigold, Chrysanthemum	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 characteristics of a healthy soil are

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

Characteristics of Dargah-2 Microwatershed

- The soil phases with sizeable area identified in the microwatershed belonged to the soil series of DDT (303 ha), DRG (132 ha) and MTM (33 ha).
- As per land capability classification, entire area comes under arable land category (Class II and III) and the major limitations identified in the arable lands were soil and erosion.
- On the basis of soil reaction, small area of about 44 ha (10%) is strongly alkaline (pH 8.4-9.0). Maximum area of about 422 ha (90%) is moderately alkaline (pH 7.8-8.4) in reaction. Thus, soils in the entire area of the soils in the microwatershed are strongly to moderately alkaline in soil reaction.

Soil Health Management

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

Alkaline soils

(Slightly alkaline to moderately alkaline soils)

1. Regular addition of organic manure, green manuring, green leaf manuring, crop residue incorporation and mulching needs to be taken up to improve the soil organic matter status.
2. Application of biofertilizers (Azospirullum, Azatobacter, Rhizobium).
3. Application of 25% extra N and P (125 % RDN&P).
4. Application of $ZnSO_4$ – 12.5 kg/ha (once in three years).
5. Application of Boron – 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 area of 467 ha in the microwatershed, major area of 461 ha is suffering from moderate erosion. These areas need immediate soil and water conservation and other land husbandry practices for restoring soil health.

Disseminate information and communicate benefits

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

Inputs for Net Planning (Satural 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 below.

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

- **Surface soil texture:** Lighter soil texture in the top soil means, better rain water infiltration, less run-off and soil moisture conservation, less capillary rise and less evaporation losses. Lighter surface textured soils are amenable to good soil tilth and are highly suitable for crops like groundnut, root vegetables (carrot, raddish, potato etc) but not ideal for crops that need stagnant water like lowland paddy. Heavy textured soils are poor in water infiltration and percolation. They are prone for sheet erosion; such soils can be improved by sand mulching. The technology that is developed by the AICRP-Dryland Agriculture, Vijayapura, Karnataka may 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 Dargah-2 microwatershed.

- **Organic Carbon:** In about 7 ha (1%) area the OC content is low (<0.5%), in about 253 ha (54%) area, the OC content is medium (0.5-0.75%) and in about 207 ha (44%) area it is high (>0.75%). 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 cost 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 260 ha area where OC is less than 0.5-0.75%. 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 461 ha (99%) area, the available phosphorus is low and about 5ha (1%) area it is medium in available phosphorus in the microwatershed. Hence for all the crops, 25% additional P-needs to be applied where available P is low and medium.

- **Available Potassium:** Available potassium is medium in 387 ha (83%) area of the microwatershed, low in 79 ha (17%) area of the microwatershed. Hence, in all these plots, for all crops, an additional 25 % potassium may be applied.

- **Available Sulphur:** Available sulphur is a very critical nutrient for oilseed crops. It is low in maximum area of 342 ha (73%) of the microwatershed and medium in 122 ha (26%).These areas need to be applied with magnesium sulphate or gypsum or Factamphos (p) fertitilizer (13% sulphur) for 2-3 years for the deficiency to be corrected. Only 3 ha (1%) area has soils that are high in available sulphur.

- **Available iron:** It is sufficient in the entire area of the microwatershed.

- **Available Zinc:** It is deficient in 419 ha (90%) area of the microwatershed. Application of zinc sulphate @25kg/ha is to be applied. It is sufficient in 47 ha (10%) area in the microwatershed.

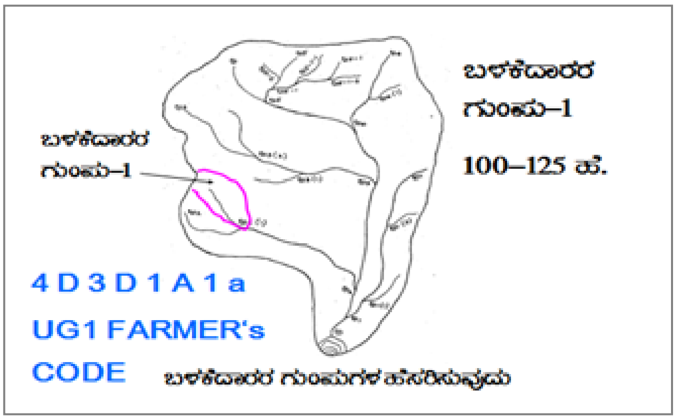
Soil alkalinity: The microwatershed has 466 ha area with soils that are moderately to strongly alkaline. These areas need application of gypsum and wherever calcium is in excess, iron pyrites and element sulphur can be recommended. Management practices like treating repeatedly with good quality water to drain out the excess salts and, provision of subsurface drainage and growing of salt tolerant crops like Casuarina, Acasia, Neem, Ber etc., are recommended.

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

SOIL AND WATER CONSERVATION TREATMENT PLAN

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

- Soil depth
- Surface soil texture
- Available water capacity
- Soil slope
- Soil gravelliness
- Land capability
- Present land use and land cover
- Crop suitability
- Rainfall
- Hydrology
- Water Resources
- Socio-economic data
- Contour plan with existing features- Network of waterways, pothissa boundaries, cut up/ minor terraces etc.
- Cadastral map (1:7920 scale)
- Satellite imagery (1:7920 scale)



Apart from these, Hand Level/ Hydro Marker/ Dumpy Level/ Total Station and Kathedars' List 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

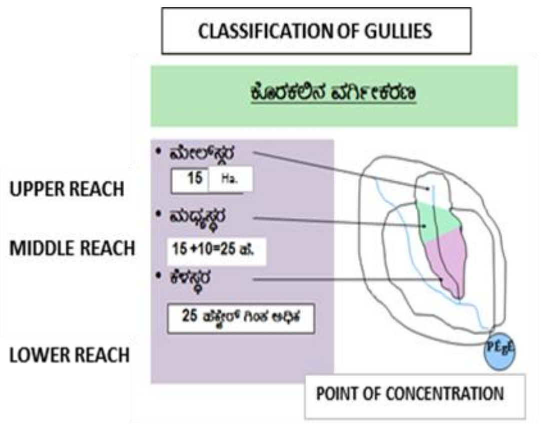
The treatment plan recommended for arable lands is briefly described below

9.1.1 Arable Land Treatment

A. BUNDING

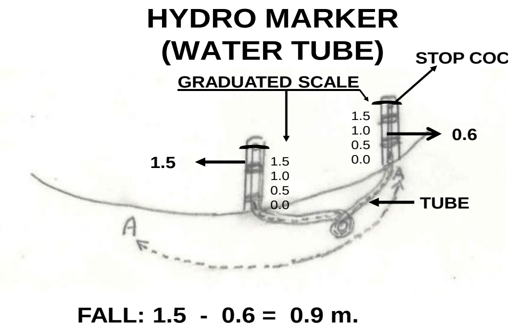
Steps for Survey and Preparation of Treatment Plan	
Cadastral map (1:7920 scale) is enlarged to a scale of 1:2500 scale Existing network of waterways, pothissa boundaries, grass belts, natural drainage lines/ watercourse, cut ups/ terraces are marked on the cadastral map to the scale Drainage lines are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

USER GROUP-1



Measurement of Land Slope

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



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

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

Note: (i) The above intervals are maximum.

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

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

Section of the Bund

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

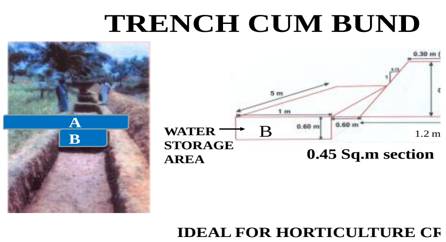
Recommended Bund Section

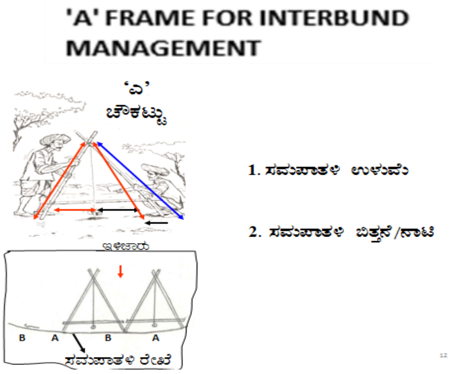
Top width (m)	Base width (m)	Height (m)	Side slope (Z:1;H:V)	Cross section (sq m)	Soil Texture	Remarks
0.3	0.9	0.3	01:01	0.18	Sandy loam	Vegetative bund
0.3	1.2	0.3	1.5:1	0.225	Sandy clay	
0.3	1.2	0.5	0.9:1	0.375	Red gravelly soils	
0.3	1.2	0.6	0.75:1	0.45		
0.3	1.5	0.6	01:01	0.54	Red sandy loam	
0.3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

Formation of Trench cum Bund

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

Details of Borrow Pit dimensions are given below:





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

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

B. Water Ways

- Existing waterways are marked on the cadastral map (1:7920 scale) and their dimensions are recorded.
- Considering the contour plan of the MWS, additional waterways/ modernization of the existing ones can be thought of.
- The design details are given in the Manual.

C. Farm Ponds

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

D. Diversion Channel

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

9.1.2 Non-Arable Land Treatment

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

9.1.3 Treatment of Natural Water Course/ Drainage Lines

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

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

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

d) Number of storage structures (Check dam/ Nala bund/ Percolation tank) will be decided considering the commitments and available runoff from water budgeting and quality of water in the wells and site suitability.

e) Detailed Levelling Survey using Dumpy Level / Total Station has to be carried out to arrive at the site-specific designs as shown in the Manual.

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

g) Rainfall intensity data of the nearest Rain gauge station is considered for Hydrologic Designs.

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

9.2 Recommended Soil and Water Conservation Measures

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

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

A map (Fig. 9.1) showing soil and water conservation plan with different kinds of structures recommended has been prepared which shows the spatial distribution and extent of area. Entire area of about 467 ha (100%) needs graded bunding / strengthening of field bunds.

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

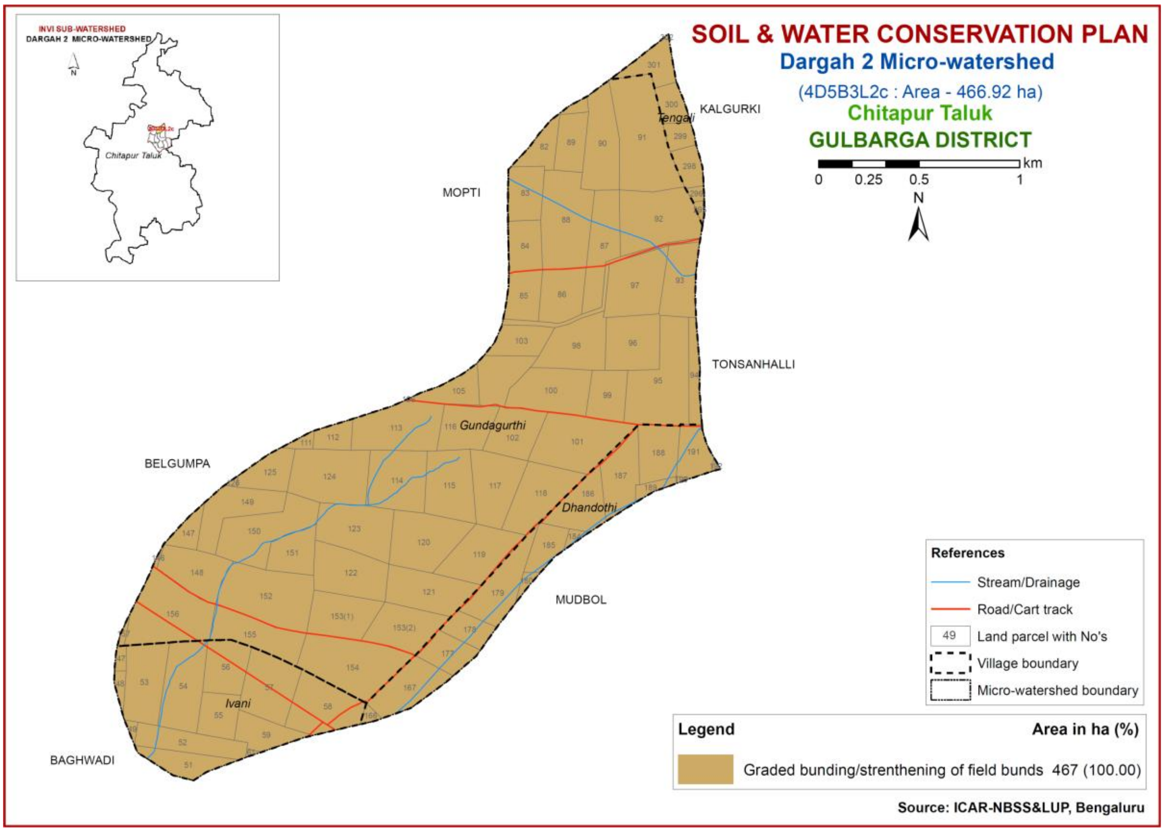


Fig. 9.1 Soil and Water Conservation Plan map of Dargah-2 Microwatershed

9.3 Greening of Microwatershed

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

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

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

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

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Appendix I

Dharga-2 Microwatershed

Soil Phase Information

Village	Survey No.	Area (ha)	Soil Phase	LUC	Soil Depth	Surface Soil Texture	Soil Gravelliness	Available Water Capacity	Slope	Soil Erosion	Current Land Use	WELLS	Land Capability	Conservation Plan
Dhandothi	166	0.53	DDTmB2	LUC -2	Very deep (>150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram (Rg)	Not Available	IIse	Graded bunding/strenthening of field bunds
Dhandothi	167	6.27	DDTmB2	LUC -2	Very deep (>150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Jowar(Jw)	Not Available	IIse	Graded bunding/strenthening of field bunds
Dhandothi	177	3.82	DDTmB2	LUC -2	Very deep (>150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram (Rg)	Not Available	IIse	Graded bunding/strenthening of field bunds
Dhandothi	178	2.9	DDTmC2	LUC -2	Very deep (>150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Gently sloping (3-5%)	Moderate	Redgram (Rg)	Not Available	IIse	Graded bunding/strenthening of field bunds
Dhandothi	179	6.9	DRGmB2	LUC -2	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram+Jowar (Rg+Jw)	Not Available	IIse	Graded bunding/strenthening of field bunds
Dhandothi	180	0.62	DRGmB1	LUC -2	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Slight	NA	Not Available	IIs	Graded bunding/strenthening of field bunds
Dhandothi	184	0.55	DRGmB1	LUC -2	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
Dhandothi	185	3.25	DDTmC2	LUC -2	Very deep (>150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Gently sloping (3-5%)	Moderate	Jowar(Jw)	Not Available	IIse	Graded bunding/strenthening of field bunds
Dhandothi	186	5.67	DDTmC2	LUC -2	Very deep (>150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Gently sloping (3-5%)	Moderate	Redgram (Rg)	Not Available	IIse	Graded bunding/strenthening of field bunds
Dhandothi	187	5.98	DDTmB2	LUC -2	Very deep (>150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram (Rg)	Not Available	IIse	Graded bunding/strenthening of field bunds
Dhandothi	188	5.37	DDTmB2	LUC -2	Very deep (>150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram (Rg)	Not Available	IIse	Graded bunding/strenthening of field bunds
Dhandothi	189	1.06	DDTmB2	LUC -2	Very deep (>150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	NA	Not Available	IIse	Graded bunding/strenthening of field bunds
Dhandothi	190	0.13	DDTmB2	LUC -2	Very deep (>150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	NA	Not Available	IIse	Graded bunding/strenthening of field bunds
Dhandothi	191	3.73	DDTmB2	LUC -2	Very deep (>150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram (Rg)	Not Available	IIse	Graded bunding/strenthening of field bunds
Dhandothi	192	0.14	DDTmB2	LUC -2	Very deep (>150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	NA	Not Available	IIse	Graded bunding/strenthening of field bunds
Gundagurthi	153(1)	6.66	DDTmB2	LUC -2	Very deep (>150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram (Rg)	Not Available	IIse	Graded bunding/strenthening of field bunds
Gundagurthi	153(2)	6.69	DDTmC2	LUC -2	Very deep (>150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Gently sloping (3-5%)	Moderate	Redgram (Rg)	Not Available	IIse	Graded bunding/strenthening of field bunds
Gundagurthi	82	3.66	DDTmB2	LUC -2	Very deep (>150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Jowar(Jw)	Not Available	IIse	Graded bunding/strenthening of field bunds
Gundagurthi	83	4.56	DRGmB2	LUC -2	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram+Jowar (Rg+Jw)	Not Available	IIse	Graded bunding/strenthening of field bunds
Gundagurthi	84	4.1	DRGmB2	LUC -2	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram (Rg)	Not Available	IIse	Graded bunding/strenthening of field bunds
Gundagurthi	85	4.02	DRGmB2	LUC -2	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Jowar(Jw)	Not Available	IIse	Graded bunding/strenthening of field bunds
Gundagurthi	86	5.5	DRGmB2	LUC -2	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Jowar(Jw)	Not Available	IIse	Graded bunding/strenthening of field bunds

Village	Survey No.	Area (ha)	Soil Phase	LUC	Soil Depth	Surface Soil Texture	Soil Gravelliness	Available Water Capacity	Slope	Soil Erosion	Current Land Use	WELLS	Land Capability	Conservation Plan
Gundagurthi	87	7.27	DRGmB2	LUC -2	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram+Jowar (Rg+Jw)	Not Available	IIse	Graded bunding/strenthening of field bunds
Gundagurthi	88	11.13	DRGmB2	LUC -2	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram+Jowar (Rg+Jw)	Not Available	IIse	Graded bunding/strenthening of field bunds
Gundagurthi	89	4.09	MTMmB2	LUC -1	Moderately deep (75-100 cm)	Clay	Non gravelly (<15%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram (Rg)	Not Available	IIIse	Graded bunding/strenthening of field bunds
Gundagurthi	90	7.87	MTMmC2	LUC -1	Moderately deep (75-100 cm)	Clay	Non gravelly (<15%)	Medium (101-150 mm/m)	Gently sloping (3-5%)	Moderate	Jowar(Jw)	Not Available	IIIse	Graded bunding/strenthening of field bunds
Gundagurthi	91	13.9	MTMmC2	LUC -1	Moderately deep (75-100 cm)	Clay	Non gravelly (<15%)	Medium (101-150 mm/m)	Gently sloping (3-5%)	Moderate	Redgram (Rg)	Not Available	IIIse	Graded bunding/strenthening of field bunds
Gundagurthi	92	10.6	DRGmB2	LUC -2	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram (Rg)	Not Available	IIse	Graded bunding/strenthening of field bunds
Gundagurthi	93	5.81	DDTmB2	LUC -2	Very deep (>150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram (Rg)	Not Available	IIse	Graded bunding/strenthening of field bunds
Gundagurthi	94	2.72	DDTmB2	LUC -2	Very deep (>150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram (Rg)	Not Available	IIse	Graded bunding/strenthening of field bunds
Gundagurthi	95	12.22	DDTmB2	LUC -2	Very deep (>150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram (Rg)	Not Available	IIse	Graded bunding/strenthening of field bunds
Gundagurthi	96	7.15	DRGmB2	LUC -2	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram (Rg)	Not Available	IIse	Graded bunding/strenthening of field bunds
Gundagurthi	97	8.35	DRGmB2	LUC -2	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Jowar(Jw)	Not Available	IIse	Graded bunding/strenthening of field bunds
Gundagurthi	98	7.37	DRGmB2	LUC -2	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Jowar(Jw)	Not Available	IIse	Graded bunding/strenthening of field bunds
Gundagurthi	99	4.46	DDTmB2	LUC -2	Very deep (>150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram (Rg)	Not Available	IIse	Graded bunding/strenthening of field bunds
Gundagurthi	100	8.12	DRGmB2	LUC -2	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram (Rg)	Not Available	IIse	Graded bunding/strenthening of field bunds
Gundagurthi	101	10.28	DDTmB2	LUC -2	Very deep (>150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram (Rg)	Not Available	IIse	Graded bunding/strenthening of field bunds
Gundagurthi	102	10.57	DDTmC2	LUC -2	Very deep (>150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Gently sloping (3-5%)	Moderate	Redgram+Jowar (Rg+Jw)	Not Available	IIse	Graded bunding/strenthening of field bunds
Gundagurthi	103	3.92	DRGmB2	LUC -2	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram (Rg)	Not Available	IIse	Graded bunding/strenthening of field bunds
Gundagurthi	105	3.49	DRGmB2	LUC -2	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Jowar(Jw)	Not Available	IIse	Graded bunding/strenthening of field bunds
Gundagurthi	106	0	DDTmC2	LUC -2	Very deep (>150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Gently sloping (3-5%)	Moderate	NA	Not Available	IIse	Graded bunding/strenthening of field bunds
Gundagurthi	111	0.76	DDTmB2	LUC -2	Very deep (>150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	NA	Not Available	IIse	Graded bunding/strenthening of field bunds
Gundagurthi	112	2.31	DDTmB2	LUC -2	Very deep (>150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram (Rg)	Not Available	IIse	Graded bunding/strenthening of field bunds
Gundagurthi	113	9.5	DDTmB2	LUC -2	Very deep (>150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram (Rg)	Not Available	IIse	Graded bunding/strenthening of field bunds
Gundagurthi	114	8.37	DDTmB2	LUC -2	Very deep (>150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram (Rg)	Not Available	IIse	Graded bunding/strenthening of field bunds

Village	Survey No.	Area (ha)	Soil Phase	LUC	Soil Depth	Surface Soil Texture	Soil Gravelliness	Available Water Capacity	Slope	Soil Erosion	Current Land Use	WELLS	Land Capability	Conservation Plan
Gundagurthi	115	7.89	DRGmB2	LUC -2	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram (Rg)	Not Available	IIse	Graded bunding/strenthening of field bunds
Gundagurthi	116	5.6	DDTmC2	LUC -2	Very deep (>150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Gently sloping (3-5%)	Moderate	Redgram (Rg)	Not Available	IIse	Graded bunding/strenthening of field bunds
Gundagurthi	117	7.6	DRGmB2	LUC -2	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram (Rg)	Not Available	IIse	Graded bunding/strenthening of field bunds
Gundagurthi	118	7.73	DDTmC2	LUC -2	Very deep (>150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Gently sloping (3-5%)	Moderate	Redgram (Rg)	Not Available	IIse	Graded bunding/strenthening of field bunds
Gundagurthi	119	7.3	DRGmB2	LUC -2	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram (Rg)	Not Available	IIse	Graded bunding/strenthening of field bunds
Gundagurthi	120	8.84	DDTmC2	LUC -2	Very deep (>150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Gently sloping (3-5%)	Moderate	Redgram (Rg)	Not Available	IIse	Graded bunding/strenthening of field bunds
Gundagurthi	121	7.57	DDTmC2	LUC -2	Very deep (>150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Gently sloping (3-5%)	Moderate	Jowar(Jw)	Not Available	IIse	Graded bunding/strenthening of field bunds
Gundagurthi	122	8.04	DDTmC2	LUC -2	Very deep (>150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Gently sloping (3-5%)	Moderate	Jowar(Jw)	Not Available	IIse	Graded bunding/strenthening of field bunds
Gundagurthi	123	8.49	DDTmB2	LUC -2	Very deep (>150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram+Jowar (Rg+Jw)	Not Available	IIse	Graded bunding/strenthening of field bunds
Gundagurthi	124	9.84	DDTmB2	LUC -2	Very deep (>150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram (Rg)	Not Available	IIse	Graded bunding/strenthening of field bunds
Gundagurthi	125	4.08	DDTmB2	LUC -2	Very deep (>150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram (Rg)	Not Available	IIse	Graded bunding/strenthening of field bunds
Gundagurthi	126	0.18	DDTmB2	LUC -2	Very deep (>150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	NA	Not Available	IIse	Graded bunding/strenthening of field bunds
Gundagurthi	146	0.16	DDTmB2	LUC -2	Very deep (>150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	NA	Not Available	IIse	Graded bunding/strenthening of field bunds
Gundagurthi	147	2.06	DDTmB2	LUC -2	Very deep (>150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram (Rg)	Not Available	IIse	Graded bunding/strenthening of field bunds
Gundagurthi	148	6.39	DDTmB2	LUC -2	Very deep (>150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram (Rg)	Not Available	IIse	Graded bunding/strenthening of field bunds
Gundagurthi	149	6.82	DDTmB2	LUC -2	Very deep (>150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram (Rg)	Not Available	IIse	Graded bunding/strenthening of field bunds
Gundagurthi	150	9.52	DDTmB2	LUC -2	Very deep (>150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram (Rg)	Not Available	IIse	Graded bunding/strenthening of field bunds
Gundagurthi	151	4.46	DDTmB2	LUC -2	Very deep (>150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram (Rg)	Not Available	IIse	Graded bunding/strenthening of field bunds
Gundagurthi	152	11.63	DDTmB2	LUC -2	Very deep (>150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram (Rg)	Not Available	IIse	Graded bunding/strenthening of field bunds
Gundagurthi	154	11.47	DDTmB2	LUC -2	Very deep (>150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram+Jowar (Rg+Jw)	Not Available	IIse	Graded bunding/strenthening of field bunds
Gundagurthi	155	6.79	DDTmB2	LUC -2	Very deep (>150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Jowar(Jw)	Not Available	IIse	Graded bunding/strenthening of field bunds
Gundagurthi	156	11.32	DDTmB2	LUC -2	Very deep (>150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram+Jowar (Rg+Jw)	Not Available	IIse	Graded bunding/strenthening of field bunds
Gundagurthi	157	0.35	DDTmB2	LUC -2	Very deep (>150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram (Rg)	Not Available	IIse	Graded bunding/strenthening of field bunds
Ivani	47	0.65	DDTmB2	LUC -2	Very deep (>150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram (Rg)	Not Available	IIse	Graded bunding/strenthening of field bunds

Village	Survey No.	Area (ha)	Soil Phase	LUC	Soil Depth	Surface Soil Texture	Soil Gravellіness	Available Water Capacity	Slope	Soil Erosion	Current Land Use	WELLS	Land Capability	Conservation Plan
Ivani	48	0.78	DDTmB2	LUC -2	Very deep (>150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram (Rg)	Not Available	IIse	Graded bunding/strenthening of field bunds
Ivani	49	0.38	DDTmB2	LUC -2	Very deep (>150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram (Rg)	Not Available	IIse	Graded bunding/strenthening of field bunds
Ivani	51	4.06	DDTmB2	LUC -2	Very deep (>150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram (Rg)	Not Available	IIse	Graded bunding/strenthening of field bunds
Ivani	52	5.6	DDTmB2	LUC -2	Very deep (>150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram+Jowar (Rg+Jw)	Not Available	IIse	Graded bunding/strenthening of field bunds
Ivani	53	7.41	DDTmB2	LUC -2	Very deep (>150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram+Jowar (Rg+Jw)	Not Available	IIse	Graded bunding/strenthening of field bunds
Ivani	54	8.52	DDTmB2	LUC -2	Very deep (>150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram (Rg)	Not Available	IIse	Graded bunding/strenthening of field bunds
Ivani	55	4.09	DDTmB2	LUC -2	Very deep (>150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram (Rg)	Not Available	IIse	Graded bunding/strenthening of field bunds
Ivani	56	5.33	DDTmB2	LUC -2	Very deep (>150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Jowar(Jw)	Not Available	IIse	Graded bunding/strenthening of field bunds
Ivani	57	7.88	DDTmB2	LUC -2	Very deep (>150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram+Jowar (Rg+Jw)	Not Available	IIse	Graded bunding/strenthening of field bunds
Ivani	58	8.06	DDTmB2	LUC -2	Very deep (>150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram+Jowar (Rg+Jw)	Not Available	IIse	Graded bunding/strenthening of field bunds
Ivani	59	4.04	DDTmB2	LUC -2	Very deep (>150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram+Jowar (Rg+Jw)	Not Available	IIse	Graded bunding/strenthening of field bunds
Ivani	61	0.16	DDTmB2	LUC -2	Very deep (>150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	NA	Not Available	IIse	Graded bunding/strenthening of field bunds
Tengali	295	0.38	MTMmC2	LUC -1	Moderately deep (75-100 cm)	Clay	Non gravelly (<15%)	Medium (101-150 mm/m)	Gently sloping (3-5%)	Moderate	Redgram (Rg)	Not Available	IIIse	Graded bunding/strenthening of field bunds
Tengali	296	0.53	MTMmC2	LUC -1	Moderately deep (75-100 cm)	Clay	Non gravelly (<15%)	Medium (101-150 mm/m)	Gently sloping (3-5%)	Moderate	Redgram (Rg)	Not Available	IIIse	Graded bunding/strenthening of field bunds
Tengali	298	2.38	MTMmC2	LUC -1	Moderately deep (75-100 cm)	Clay	Non gravelly (<15%)	Medium (101-150 mm/m)	Gently sloping (3-5%)	Moderate	Redgram (Rg)	Not Available	IIIse	Graded bunding/strenthening of field bunds
Tengali	299	1.74	MTMmC2	LUC -1	Moderately deep (75-100 cm)	Clay	Non gravelly (<15%)	Medium (101-150 mm/m)	Gently sloping (3-5%)	Moderate	Jowar(Jw)	Not Available	IIIse	Graded bunding/strenthening of field bunds
Tengali	300	2.46	MTMmB2	LUC -1	Moderately deep (75-100 cm)	Clay	Non gravelly (<15%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram (Rg)	Not Available	IIIse	Graded bunding/strenthening of field bunds
Tengali	301	3.58	DRGmB1	LUC -2	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Slight	Jowar(Jw)	Not Available	IIs	Graded bunding/strenthening of field bunds
Tengali	302	0.04	DRGmB1	LUC -2	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Slight	NA	Not Available	IIs	Graded bunding/strenthening of field bunds

Appendix II

Dharga-2 Microwatershed

Soil Fertility Information

Village	Survey No.	Soil Reaction	Salinity (dsm-1)	Organic Carbon	Available Phosphorus	Available Potassium	Available Sulphur	Available Boron	Available Iron	Available Manganese	Available Copper	Available Zinc
Dhandothi	166	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	High (> 0.75 %)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Medium (10 - 20 ppm)	Medium (0.5 - 1.0 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Sufficient (> 0.6 ppm)
Dhandothi	167	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	High (> 0.75 %)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Low (< 10 ppm)	Medium (0.5 - 1.0 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Sufficient (> 0.6 ppm)
Dhandothi	177	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	Medium (0.5 - 0.75%)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Low (< 10 ppm)	Medium (0.5 - 1.0 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Sufficient (> 0.6 ppm)
Dhandothi	178	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	High (> 0.75 %)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Sufficient (> 0.6 ppm)
Dhandothi	179	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	High (> 0.75 %)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Sufficient (> 0.6 ppm)
Dhandothi	180	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	Medium (0.5 - 0.75%)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Sufficient (> 0.6 ppm)
Dhandothi	184	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	Medium (0.5 - 0.75%)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Sufficient (> 0.6 ppm)
Dhandothi	185	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	Medium (0.5 - 0.75%)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Sufficient (> 0.6 ppm)
Dhandothi	186	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	High (> 0.75 %)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Sufficient (> 0.6 ppm)
Dhandothi	187	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	Medium (0.5 - 0.75%)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Sufficient (> 0.6 ppm)
Dhandothi	188	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	Medium (0.5 - 0.75%)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Dhandothi	189	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	Medium (0.5 - 0.75%)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Sufficient (> 0.6 ppm)
Dhandothi	190	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	Medium (0.5 - 0.75%)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Sufficient (> 0.6 ppm)
Dhandothi	191	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	Medium (0.5 - 0.75%)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Sufficient (> 0.6 ppm)
Dhandothi	192	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	High (> 0.75 %)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Medium (10 - 20 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Sufficient (> 0.6 ppm)
Gundagurthi	153(1)	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	Medium (0.5 - 0.75%)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Gundagurthi	153(2)	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	Medium (0.5 - 0.75%)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Gundagurthi	82	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	Medium (0.5 - 0.75%)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Medium (10 - 20 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Gundagurthi	83	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	High (> 0.75 %)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Medium (10 - 20 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Gundagurthi	84	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	Medium (0.5 - 0.75%)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Gundagurthi	85	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	Medium (0.5 - 0.75%)	Low (< 23 kg/ha)	Low (< 145 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Gundagurthi	86	Strongly alkaline (pH 8.4 - 9.0)	Non saline (< 2 dsm)	Medium (0.5 - 0.75%)	Low (< 23 kg/ha)	Low (< 145 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)

Village	Survey No.	Soil Reaction	Salinity (dsm-1)	Organic Carbon	Available Phosphorus	Available Potassium	Available Sulphur	Available Boron	Available Iron	Available Manganese	Available Copper	Available Zinc
Gundagurthi	87	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	High (> 0.75 %)	Low (< 23 kg/ha)	Low (< 145 kg/ha)	Medium (10 - 20 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Gundagurthi	88	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	High (> 0.75 %)	Low (< 23 kg/ha)	Low (< 145 kg/ha)	Medium (10 - 20 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Gundagurthi	89	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	Medium (0.5 - 0.75%)	Low (< 23 kg/ha)	Low (< 145 kg/ha)	Medium (10 - 20 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Gundagurthi	90	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	Medium (0.5 - 0.75%)	Low (< 23 kg/ha)	Low (< 145 kg/ha)	Medium (10 - 20 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Gundagurthi	91	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	Medium (0.5 - 0.75%)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Medium (10 - 20 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Gundagurthi	92	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	High (> 0.75 %)	Low (< 23 kg/ha)	Low (< 145 kg/ha)	Medium (10 - 20 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Gundagurthi	93	Strongly alkaline (pH 8.4 - 9.0)	Non saline (< 2 dsm)	High (> 0.75 %)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Medium (10 - 20 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Gundagurthi	94	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	Medium (0.5 - 0.75%)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Gundagurthi	95	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	Medium (0.5 - 0.75%)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Gundagurthi	96	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	Medium (0.5 - 0.75%)	Low (< 23 kg/ha)	Low (< 145 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Gundagurthi	97	Strongly alkaline (pH 8.4 - 9.0)	Non saline (< 2 dsm)	High (> 0.75 %)	Low (< 23 kg/ha)	Low (< 145 kg/ha)	Medium (10 - 20 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Gundagurthi	98	Strongly alkaline (pH 8.4 - 9.0)	Non saline (< 2 dsm)	High (> 0.75 %)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Gundagurthi	99	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	Medium (0.5 - 0.75%)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Gundagurthi	100	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	High (> 0.75 %)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Low (< 10 ppm)	Medium (0.5 - 1.0 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Gundagurthi	101	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	High (> 0.75 %)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Gundagurthi	102	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	High (> 0.75 %)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Gundagurthi	103	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	High (> 0.75 %)	Low (< 23 kg/ha)	Low (< 145 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Gundagurthi	105	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	Medium (0.5 - 0.75%)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Gundagurthi	106	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	Medium (0.5 - 0.75%)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Gundagurthi	111	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	High (> 0.75 %)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Gundagurthi	112	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	High (> 0.75 %)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Gundagurthi	113	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	Medium (0.5 - 0.75%)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Gundagurthi	114	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	Medium (0.5 - 0.75%)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Gundagurthi	115	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	Medium (0.5 - 0.75%)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)

Village	Survey No.	Soil Reaction	Salinity (dsm-1)	Organic Carbon	Available Phosphorus	Available Potassium	Available Sulphur	Available Boron	Available Iron	Available Manganese	Available Copper	Available Zinc
Gundagurthi	116	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	Medium (0.5 - 0.75%)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Gundagurthi	117	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	High (> 0.75 %)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Gundagurthi	118	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	High (> 0.75 %)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Gundagurthi	119	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	High (> 0.75 %)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Gundagurthi	120	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	Medium (0.5 - 0.75%)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Gundagurthi	121	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	Medium (0.5 - 0.75%)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Gundagurthi	122	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	Medium (0.5 - 0.75%)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Gundagurthi	123	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	Medium (0.5 - 0.75%)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Gundagurthi	124	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	High (> 0.75 %)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Gundagurthi	125	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	Medium (0.5 - 0.75%)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Gundagurthi	126	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	Medium (0.5 - 0.75%)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Gundagurthi	146	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	Medium (0.5 - 0.75%)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Gundagurthi	147	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	Medium (0.5 - 0.75%)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Gundagurthi	148	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	Medium (0.5 - 0.75%)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Gundagurthi	149	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	Medium (0.5 - 0.75%)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Gundagurthi	150	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	Medium (0.5 - 0.75%)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Gundagurthi	151	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	Medium (0.5 - 0.75%)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Gundagurthi	152	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	High (> 0.75 %)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Gundagurthi	154	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	High (> 0.75 %)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Low (< 10 ppm)	Medium (0.5 - 1.0 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Gundagurthi	155	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	High (> 0.75 %)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Gundagurthi	156	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	High (> 0.75 %)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Gundagurthi	157	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	Medium (0.5 - 0.75%)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Ivani	47	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	Medium (0.5 - 0.75%)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Ivani	48	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	Medium (0.5 - 0.75%)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Low (< 10 ppm)	Medium (0.5 - 1.0 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)

Village	Survey No.	Soil Reaction	Salinity (dsm^{-1})	Organic Carbon	Available Phosphorus	Available Potassium	Available Sulphur	Available Boron	Available Iron	Available Manganese	Available Copper	Available Zinc
Ivani	49	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	High (> 0.75 %)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Low (< 10 ppm)	Medium (0.5 - 1.0 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Ivani	51	Strongly alkaline (pH 8.4 - 9.0)	Non saline (< 2 dsm)	Medium (0.5 - 0.75%)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	High (> 20 ppm)	Medium (0.5 - 1.0 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Ivani	52	Strongly alkaline (pH 8.4 - 9.0)	Non saline (< 2 dsm)	High (> 0.75 %)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Low (< 10 ppm)	Medium (0.5 - 1.0 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Ivani	53	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	Medium (0.5 - 0.75%)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Low (< 10 ppm)	Medium (0.5 - 1.0 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Ivani	54	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	Medium (0.5 - 0.75%)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Ivani	55	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	Medium (0.5 - 0.75%)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Medium (10 - 20 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Ivani	56	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	High (> 0.75 %)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Ivani	57	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	High (> 0.75 %)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Medium (10 - 20 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Ivani	58	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	High (> 0.75 %)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Medium (10 - 20 ppm)	Medium (0.5 - 1.0 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Ivani	59	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	Medium (0.5 - 0.75%)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Medium (10 - 20 ppm)	Medium (0.5 - 1.0 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Sufficient (> 0.6 ppm)
Ivani	61	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	Medium (0.5 - 0.75%)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Medium (10 - 20 ppm)	Medium (0.5 - 1.0 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Sufficient (> 0.6 ppm)
Tengali	295	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	High (> 0.75 %)	Low (< 23 kg/ha)	Low (< 145 kg/ha)	Medium (10 - 20 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Tengali	296	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	High (> 0.75 %)	Low (< 23 kg/ha)	Low (< 145 kg/ha)	Medium (10 - 20 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Tengali	298	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	Medium (0.5 - 0.75%)	Low (< 23 kg/ha)	Low (< 145 kg/ha)	Medium (10 - 20 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Tengali	299	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	Medium (0.5 - 0.75%)	Low (< 23 kg/ha)	Low (< 145 kg/ha)	Medium (10 - 20 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Tengali	300	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	Low (< 0.5 %)	Low (< 23 kg/ha)	Medium (145-337 kg/ha)	Medium (10 - 20 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Tengali	301	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	Medium (0.5 - 0.75%)	Medium (23 - 57 kg/ha)	Medium (145-337 kg/ha)	Medium (10 - 20 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)
Tengali	302	Moderately alkaline (pH 7.8 - 8.4)	Non saline (< 2 dsm)	Medium (0.5 - 0.75%)	Medium (23 - 57 kg/ha)	Medium (145-337 kg/ha)	Medium (10 - 20 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (>0.2ppm)	Deficient (< 0.6 ppm)

Appendix III

Dharga-2 Microwatershed

Soil Suitability Information

Village	Survey Number	Sorgham	Maize	Sunflower	Cotton	Mango	Sapota	Guava	Jackfruit	Jamun	Musambi	Lime	Cashew	Custard-apple	Amla	Tamarind	Bengalgram	Sugarcane	Soyabean	Pigeon-Pea
Dhandothi	166	S1	S3t	S1	S1	S3t	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S1	S2t
Dhandothi	167	S1	S3t	S1	S1	S3t	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S1	S2t
Dhandothi	177	S1	S3t	S1	S1	S3t	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S1	S2t
Dhandothi	178	S2e	S3t	S2e	S2e	S3te	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S2e	S2te
Dhandothi	179	S2e	S3t	S2e	S2e	S3t	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S2e	S2te
Dhandothi	180	S1	S3t	S1	S1	S3t	S2t	S2t	S3t	S2t	S1	S1	N	S1	S1	S2t	S1	S3t	S1	S2t
Dhandothi	184	S1	S3t	S1	S1	S3t	S2t	S2t	S3t	S2t	S1	S1	N	S1	S1	S2t	S1	S3t	S1	S2t
Dhandothi	185	S2e	S3t	S2e	S2e	S3te	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S2e	S2te
Dhandothi	186	S2e	S3t	S2e	S2e	S3te	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S2e	S2te
Dhandothi	187	S1	S3t	S1	S1	S3t	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S1	S2t
Dhandothi	188	S1	S3t	S1	S1	S3t	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S1	S2t
Dhandothi	189	S1	S3t	S1	S1	S3t	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S1	S2t
Dhandothi	190	S1	S3t	S1	S1	S3t	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S1	S2t
Dhandothi	191	S1	S3t	S1	S1	S3t	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S1	S2t
Dhandothi	192	S1	S3t	S1	S1	S3t	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S1	S2t
Gundagurthi	153(1)	S1	S3t	S1	S1	S3t	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S1	S2t
Gundagurthi	153(2)	S2e	S3t	S2e	S2e	S3te	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S2e	S2te
Gundagurthi	82	S1	S3t	S1	S1	S3t	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S1	S2t
Gundagurthi	83	S2e	S3t	S2e	S2e	S3t	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S2e	S2te
Gundagurthi	84	S2e	S3t	S2e	S2e	S3t	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S2e	S2te
Gundagurthi	85	S2e	S3t	S2e	S2e	S3t	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S2e	S2te
Gundagurthi	86	S2e	S3t	S2e	S2e	S3t	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S2e	S2te
Gundagurthi	87	S2e	S3t	S2e	S2e	S3t	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S2e	S2te
Gundagurthi	88	S2e	S3t	S2e	S2e	S3t	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S2e	S2te
Gundagurthi	89	S2e	S3t	S2e	S2e	S3rt	S2rt	S2rt	S3rt	S2rt	S2rt	S2rt	N	S1	S1	S2rt	S1	S3t	S2e	S2e
Gundagurthi	90	S2e	S3t	S2e	S2e	N	S3rl	S3rl	N	S3rl	S3rl	S3rl	N	S2rl	S2rl	S3rl	S1	S3t	S2e	S2e
Gundagurthi	91	S2e	S3t	S2e	S2e	N	S3rl	S3rl	N	S3rl	S3rl	S3rl	N	S2rl	S2rl	S3rl	S1	S3t	S2e	S2e
Gundagurthi	92	S2e	S3t	S2e	S2e	S3t	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S2e	S2te
Gundagurthi	93	S1	S3t	S1	S1	S3t	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S1	S2t
Gundagurthi	94	S1	S3t	S1	S1	S3t	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S1	S2t
Gundagurthi	95	S1	S3t	S1	S1	S3t	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S1	S2t
Gundagurthi	96	S2e	S3t	S2e	S2e	S3t	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S2e	S2te
Gundagurthi	97	S2e	S3t	S2e	S2e	S3t	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S2e	S2te
Gundagurthi	98	S2e	S3t	S2e	S2e	S3t	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S2e	S2te
Gundagurthi	99	S1	S3t	S1	S1	S3t	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S1	S2t
Gundagurthi	100	S2e	S3t	S2e	S2e	S3t	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S2e	S2te
Gundagurthi	101	S1	S3t	S1	S1	S3t	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S1	S2t
Gundagurthi	102	S2e	S3t	S2e	S2e	S3te	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S2e	S2te
Gundagurthi	103	S2e	S3t	S2e	S2e	S3t	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S2e	S2te
Gundagurthi	105	S2e	S3t	S2e	S2e	S3t	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S2e	S2te
Gundagurthi	106	S2e	S3t	S2e	S2e	S3te	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S2e	S2te
Gundagurthi	111	S1	S3t	S1	S1	S3t	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S1	S2t
Gundagurthi	112	S1	S3t	S1	S1	S3t	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S1	S2t
Gundagurthi	113	S1	S3t	S1	S1	S3t	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S1	S2t

Village	Survey Number	Sorgham	Maize	Sunflower	Cotton	Mango	Sapota	Guava	Jackfruit	Jamun	Musambi	Lime	Cashew	Custard-apple	Amla	Tamarind	Bengalgram	Sugarcane	Soyabean	Pigeon-Pea
Gundagurthi	114	S1	S3t	S1	S1	S3t	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S1	S2t
Gundagurthi	115	S2e	S3t	S2e	S2e	S3t	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S2e	S2te
Gundagurthi	116	S2e	S3t	S2e	S2e	S3te	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S2e	S2te
Gundagurthi	117	S2e	S3t	S2e	S2e	S3t	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S2e	S2te
Gundagurthi	118	S2e	S3t	S2e	S2e	S3te	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S2e	S2te
Gundagurthi	119	S2e	S3t	S2e	S2e	S3t	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S2e	S2te
Gundagurthi	120	S2e	S3t	S2e	S2e	S3te	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S2e	S2te
Gundagurthi	121	S2e	S3t	S2e	S2e	S3te	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S2e	S2te
Gundagurthi	122	S2e	S3t	S2e	S2e	S3te	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S2e	S2te
Gundagurthi	123	S1	S3t	S1	S1	S3t	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S1	S2t
Gundagurthi	124	S1	S3t	S1	S1	S3t	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S1	S2t
Gundagurthi	125	S1	S3t	S1	S1	S3t	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S1	S2t
Gundagurthi	126	S1	S3t	S1	S1	S3t	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S1	S2t
Gundagurthi	146	S1	S3t	S1	S1	S3t	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S1	S2t
Gundagurthi	147	S1	S3t	S1	S1	S3t	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S1	S2t
Gundagurthi	148	S1	S3t	S1	S1	S3t	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S1	S2t
Gundagurthi	149	S1	S3t	S1	S1	S3t	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S1	S2t
Gundagurthi	150	S1	S3t	S1	S1	S3t	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S1	S2t
Gundagurthi	151	S1	S3t	S1	S1	S3t	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S1	S2t
Gundagurthi	152	S1	S3t	S1	S1	S3t	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S1	S2t
Gundagurthi	154	S1	S3t	S1	S1	S3t	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S1	S2t
Gundagurthi	155	S1	S3t	S1	S1	S3t	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S1	S2t
Gundagurthi	156	S1	S3t	S1	S1	S3t	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S1	S2t
Gundagurthi	157	S1	S3t	S1	S1	S3t	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S1	S2t
Ivani	47	S1	S3t	S1	S1	S3t	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S1	S2t
Ivani	48	S1	S3t	S1	S1	S3t	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S1	S2t
Ivani	49	S1	S3t	S1	S1	S3t	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S1	S2t
Ivani	51	S1	S3t	S1	S1	S3t	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S1	S2t
Ivani	52	S1	S3t	S1	S1	S3t	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S1	S2t
Ivani	53	S1	S3t	S1	S1	S3t	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S1	S2t
Ivani	54	S1	S3t	S1	S1	S3t	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S1	S2t
Ivani	55	S1	S3t	S1	S1	S3t	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S1	S2t
Ivani	56	S1	S3t	S1	S1	S3t	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S1	S2t
Ivani	57	S1	S3t	S1	S1	S3t	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S1	S2t
Ivani	58	S1	S3t	S1	S1	S3t	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S1	S2t
Ivani	59	S1	S3t	S1	S1	S3t	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S1	S2t
Ivani	61	S1	S3t	S1	S1	S3t	S2te	S2te	S3t	S2te	S1	S1	N	S1	S1	S2te	S1	S3t	S1	S2t
Tengali	295	S2e	S3t	S2e	S2e	N	S3rl	S3rl	N	S3rl	S3rl	S3rl	N	S2rl	S2rl	S3rl	S1	S3t	S2e	S2e
Tengali	296	S2e	S3t	S2e	S2e	N	S3rl	S3rl	N	S3rl	S3rl	S3rl	N	S2rl	S2rl	S3rl	S1	S3t	S2e	S2e
Tengali	298	S2e	S3t	S2e	S2e	N	S3rl	S3rl	N	S3rl	S3rl	S3rl	N	S2rl	S2rl	S3rl	S1	S3t	S2e	S2e
Tengali	299	S2e	S3t	S2e	S2e	N	S3rl	S3rl	N	S3rl	S3rl	S3rl	N	S2rl	S2rl	S3rl	S1	S3t	S2e	S2e
Tengali	300	S2e	S3t	S2e	S2e	S3rt	S2rt	S2rt	S3rt	S2rt	S2rt	S2rt	N	S1	S1	S2rt	S1	S3t	S2e	S2e
Tengali	301	S1	S3t	S1	S1	S3t	S2t	S2t	S3t	S2t	S1	S1	N	S1	S1	S2t	S1	S3t	S1	S2t
Tengali	302	S1	S3t	S1	S1	S3t	S2t	S2t	S3t	S2t	S1	S1	N	S1	S1	S2t	S1	S3t	S1	S2t

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: *Dargah-2 micro-watershed (Invi sub-watershed, Chitapur taluk, Gulbarga district) is located in between $17^0 13'$ – $17^0 15'$ North latitudes and $77^0 4'$ – $77^0 6'$ East longitudes, covering an area of about 467 ha, bounded by Kalgurki, Tonsanhalli, Mudbol, Baghwadi, Belgumpa and Mopti village with length of growing period (LGP) 120-150 days. We used soil resource map as basis for sampling farm households to test the hypothesis that soil quality influence crop selection, and conservation investment of farm households. The level of technology adoption and productivity gaps and livelihood patterns were analyses. The cost of soil degradation and eco system services were quantified.*

Results: *The socio-economic outputs for Dargah-2 micro-watershed (Invi sub-watershed, Chitapur taluk, Gulbarga district) are presented here.*

Social Indicators;

- *Male and female ratio is 50 to 50 Per cent to the total sample population.*
- *Younger age 18 to 50 years group of population is 64.7 around per cent to the total population.*
- *Literacy population is around 64.8 per cent.*
- *Social groups belong to other backward caste (OBC) 44.4 percent.*
- *Liquefied petroleum gas (LPG) is the source of energy for a cooking is around 77.8 per cent.*
- *About 11 per cent of households have a yashaswini health card.*
- *Farm households are having MGNREGA card only 22 per cent for rural employment.*
- *Dependence on ration cards for food grains through public distribution system is around 89 per cent.*
- *Swach bharath program providing closed toilet facilities around 78 per cent of sample households.*
- *Women participation in decisions making is around among all the households were found.*

Economic Indicators;

- *The average land holding is 2.31 ha indicates that majority of farm households are belong to small and medium farmers. The dry land is total cultivated land area among all the sample farmers.*
- *Agriculture is the main occupation among 49.0 per cent and agriculture is the main and agriculture labour is the subsidiary occupation around 39.2 percent of sample household.*
- *The average value of domestic assets is around Rs.13036 per household. Mobile and television are popular media mass communication.*
- *The average value of farm assets is around Rs. 247755 per household, about 55.5 per cent of sample farmers having plough and bullock cart.*
- *The average value of livestock is around Rs. 62500 per household; about 22.2 per cent of household are having livestock.*
- *The average per capita food consumption is around 809 grams (1719 kilo calories) against national institute of nutrition (NIN) recommendation at 827 gram. Around 60 per cent of sample households are consuming less than the NIN recommendation.*
- *The annual average income is around Rs. 56634 per household. About 55.5 per cent of farm households are below poverty line.*
- *The per capita average monthly expenditure is around Rs.1396.*

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.1864 per ha/year. The total cost of annual soil nutrients is around Rs. 919285 per year for the total area of 467 ha.*
- *The average value of ecosystem service for food grain production is around Rs. 19789/ ha/year. Per hectare food grain production services is maximum in red gram (Rs. 23834) and sorghum (Rs. 15744).*

- *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 in redgram (Rs. 62342) and sorghum (Rs. 37643).*

Economic Land Evaluation;

- *The major cropping pattern is red gram (92 %) and sorghum (7.9 %).*

- *In Dargah-2 micro-watershed, major soils series are Dhandothi soils are having very deep soil depth covers around 4.6 % of area the major crops are red gram and sorghum. Dargah soils series are having deep soil depth covers around 29.3 per cent of area the crop is red gram.*
- *The total cost of cultivation and benefit cost ratio (BCR) in study area for red gram ranges between Rs. 21607/ha in DRG soil (with BCR of 2.20) and Rs. 18883/ha in DDT soil (with BCR of 2.58).*
- *In sorghum the cost of cultivation in DDT soil is Rs.15131/ha (with BCR of 2.14).*
- *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 red gram (18.2 to 22.9 %) and sorghum (56.0 %).*

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

Dargah-2 micro-watershed is located in southern 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 represent agro ecological region (AER) – 3 having LGP 120-150 days.

Dargah-2 micro-watershed (Invi sub-watershed, Chitapur taluk, Gulbarga district) is located in between $17^0$13' – $17^0$15' North latitudes and $77^0$4' – $77^0$6' East longitudes, covering an area of about 467 ha, bounded by Kalgurki, Tonsanhalli, Mudbol, Baghwadi, Belgumpa and Mopti 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).

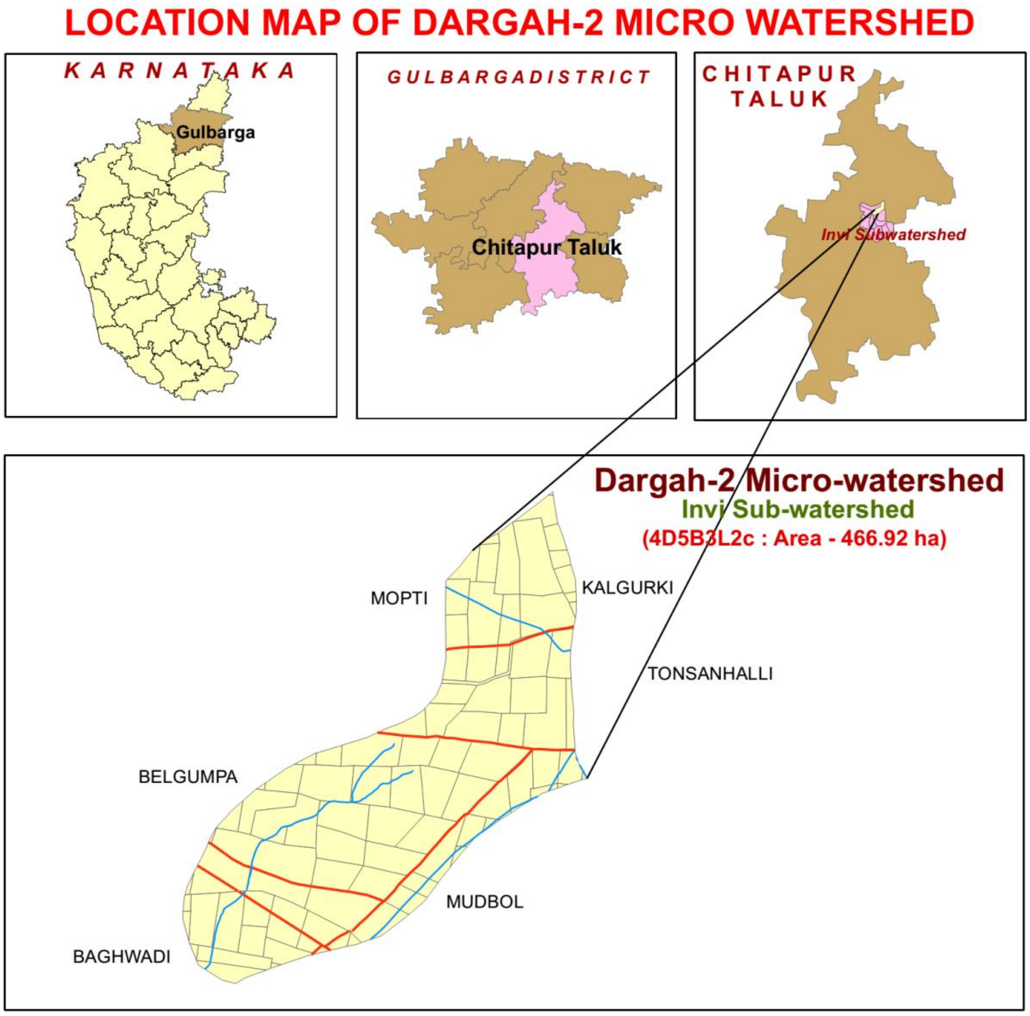

Figure 1: Location of study area

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 51, out of which 50 per cent were males and 50 per cent females. Average family size of the households is 5.6. 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 (37.3 %) followed by 30 to 50 years (27.4 %), more than 50 years (19.6 %) and 0 to18 years (15.7 %). 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 35.2 per cent of respondents were illiterate and 64.8 per cent literate (Table 1).

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

Particulars	**Units**	**Value**
Total human population in sample HHs	Number	51.0
Male	% to total Population	50.0
Female	% to total Population	50.0
Average family size	Number	5.6
Age group		
0 to 18 years	% to total Population	15.7
18 to 30 years	% to total Population	37.3
30 to 50 years	% to total Population	27.4
>50 years	% to total Population	19.6
Average age	Age in years	33.5
Education Status		
Illiterates	% to total Population	35.2
Literates	% to total Population	64.8
Primary School (<5 class)	% to total Population	15.6
Middle School (6- 8 class)	% to total Population	5.8
High School (9- 10 class)	% to total Population	17.6
Others	% to total Population	25.4

The ethnic groups among the sample farm households found to be 44.4 per cent belonging to other backward castes (OBC) followed by about 33.3 percent belonging to general caste and about 22.2 per cent belonging to scheduled caste (SC) (Table 2 and Figure 3). About 22.2 per cent of sample households are using firewood and 77.8 percent uses in liquefied petroleum gas as source of fuel for cooking. All the sample farmers are having electricity connection. About 11 per cent are sample households having health cards. About 11 percent of sample households are having MNREGA job cards for employment generation. About 89.0 per cent of farm households are having ration cards for taking food grains from public distribution system. About 78 per cent of farm households are having toilet facilities.

Table 2: Basic needs of sample households in Dargah-2 Microwatershed

Particulars	**Units**	**Value**
Social groups		
OBC	% of Households	44.4
SC	% of Households	22.2
General	% of Households	33.4
Types of fuel use for cooking		
Firewood	% of Households	22.2
Gas	% of Households	77.8
Energy supply for home		
Electricity	% of Households	100
Number of households having Health card		
Yes	% of Households	11.0
No	% of Households	89.0
MGNREGA Card		
Yes	% of Households	11.0
No	% of Households	89.0
Ration Card		
Yes	% of Households	89.0
No	% of Households	11.0
Households with toilet		
Yes	% of Households	78.0
No	% of Households	22.0
Drinking water facilities		
Tube well	% of Households	89.0
Hand pump	% of Households	11.0

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 (89 %) and hand pump (11 %).

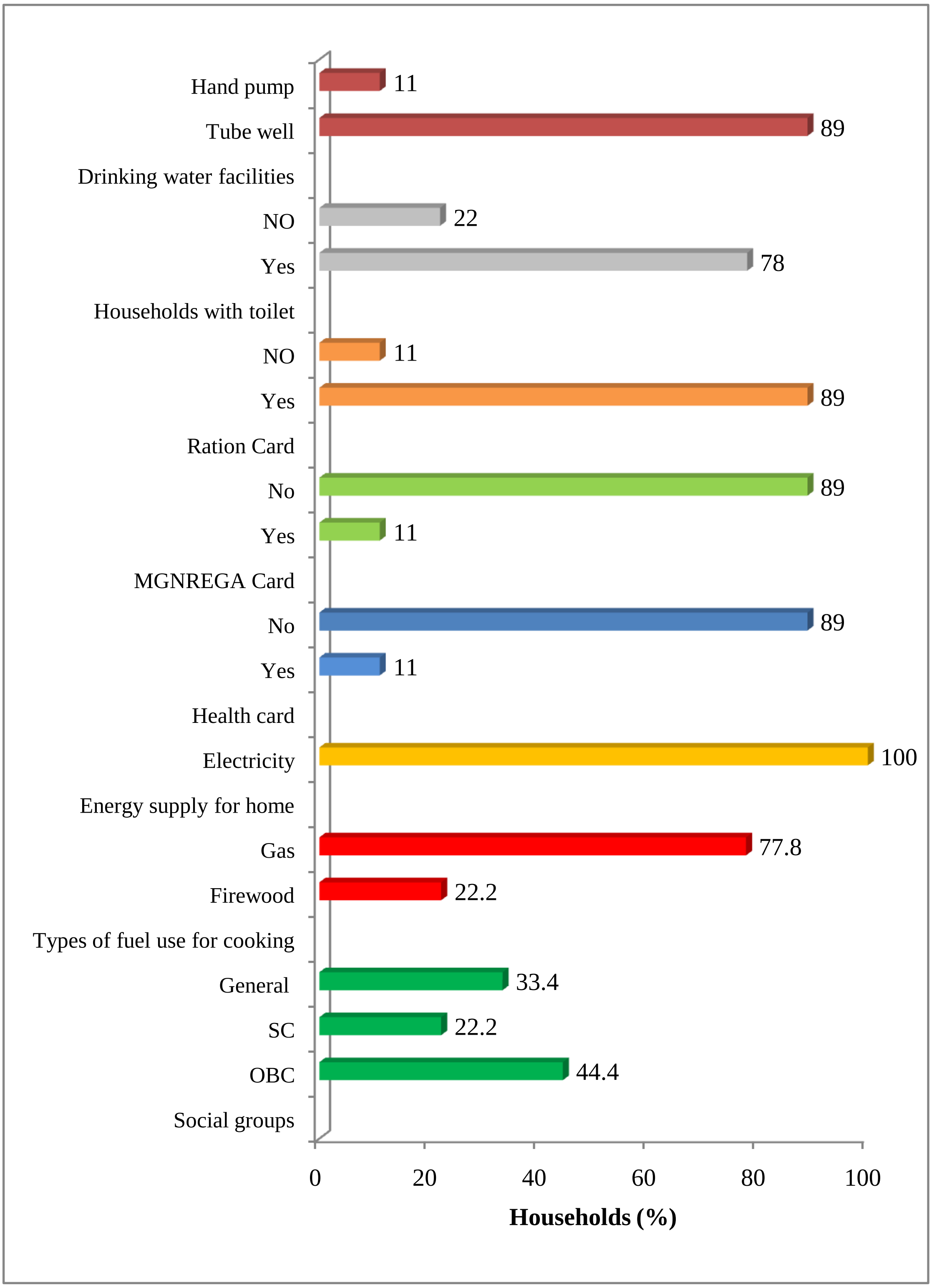

Figure 3: Basic needs of sample households in Dargah-2 Microwatershed

The data on migration in Dargah-2 Microwatershed is given in Table 3. It indicated that around 11.1 per cent of samples households were migrated. The average distance travelled for seeking employment is 250 km.

Table 3: Migration details among the sample households in Dargah-2 micro-watershed

Particulars	Value
% of households showing migration	11.1
% of persons migrating	2.0
No. of months migrated in a year	5.0
Average Distance of migration(Km)	250
Nature of job (%)	
Job wage/ work	100

The occupational pattern (Table 4) among sample households shows that agriculture is the main occupation around 49.0 per cent and agriculture is the main and subsidiary occupation like agriculture labour 39.2 per cent, govt service (2.0 %) and private service (5.9 %) of sample farmers.

Table 4: Occupational pattern in sample population in Dargah-2 Microwatershed

Occupation		% to total
Main	**Subsidiary**	
Agriculture	Agriculture	49.0
	Agriculture Labour	39.2
	Govt service	2.0
	Private service	5.9
Govt service		1.9
Private service		1.9
Grand Total		100.0
Family labour availability		**Man days/month**
Male		38.8
Female		31.2
Total		70.0

The important assets especially with reference to domestic assets were analyzed and are given in Table 5 and Figure 4. The important domestic assets possessed by all categories of farmers are mobile phone (100 %) followed by mixer/grinder (88.8 %), motor cycle (44.4 %), bicycle (11.1 %), dvd/cvd (11.1 %), computer/laptop (11.1 %), radio (11.1 %), refrigerator (11.1 %) and television (11.1 %). The average value of domestic assets is around Rs 13036 per household.

Table 5: Domestic assets among the sample households in Dargah-2 Microwatershed

Particulars	% of households	Average value in Rs
Bicycle	11.1	3000
Dvd/Cvd	11.1	4000
Computer/Laptop	11.1	30000
Mixer/grinder	33.3	2500
Mobile Phone	100	3444
Motor cycle	44.4	55000
Radio	11.1	500
Refrigerator	11.1	10000
Television	100	8888
Average value	13036	

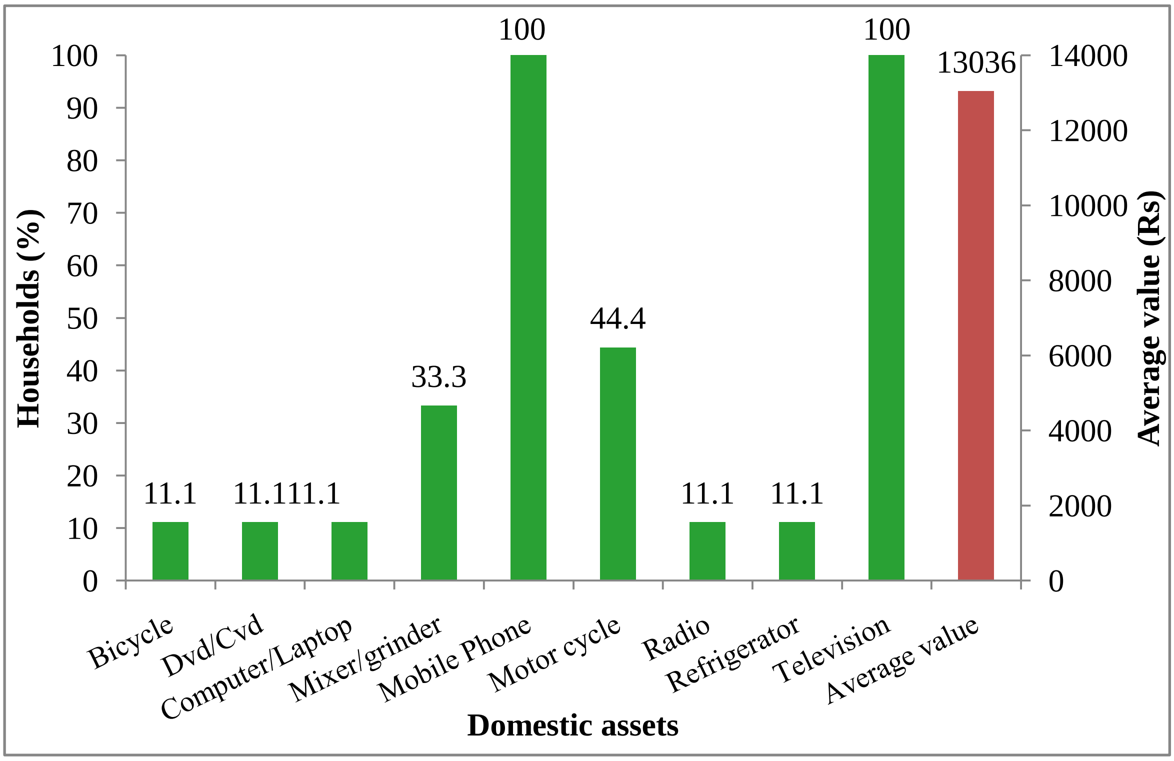

Figure 4: Domestic assets among the sample households in Dargah-2 Microwatershed

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 (55.5 %), bullock cart (44.4 %) and tractor (33.3 %). The average value of farm assets is around Rs. 247755 per households (Table 6 and Figure 5).

Table 6: Farm assets among samples households in Dargah-2 Microwatershed

Particulars	% of households	Average value in Rs
Plough	55.5	1600
Bullock cart	44.4	25000
Tractor	33.3	716666
Average value	247755	

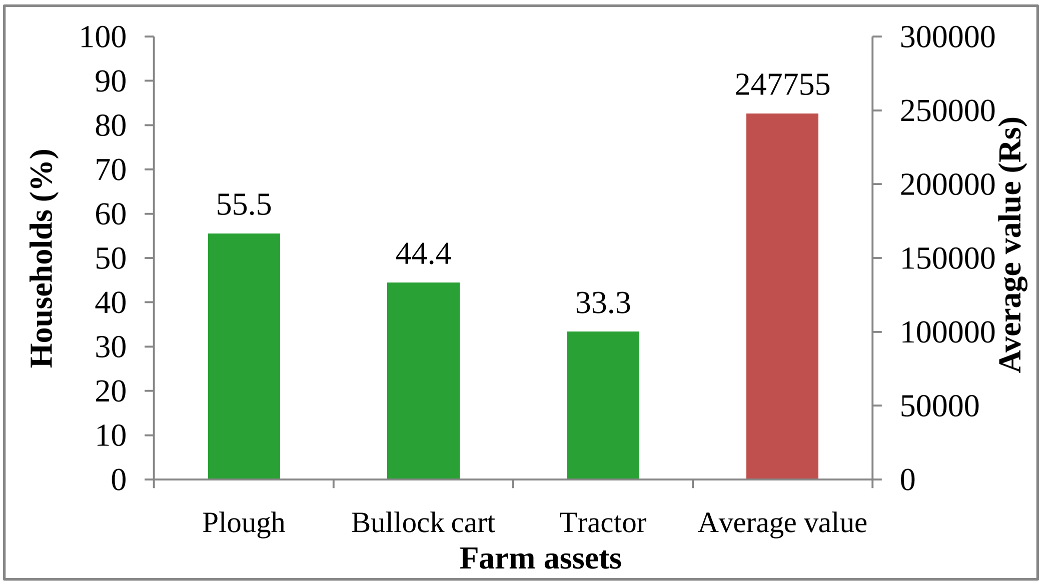

Figure 5: Farm assets among samples households in Dargah-2 Microwatershed

Livestock is an integral component of the conventional farming systems (Table 7). The highest livestock population is local dry cow were around 50.0 per cent and bullocks (50 %). The average value of livestock was Rs. 62500 per household.

Table 7: Livestock assets among sample households in Dargah-2 Microwatershed

Particulars	% of livestock population	Average value in Rs
Local dry cow	50.0	25000
Bullocks	50.0	100000
Average value	62500	

Among the farm households of fodder crops are sorghum are main crop for domestic food and fodder for animals. Livestock having population are 22.2 percent and 4 livestock population numbers in the livestock (Table 8).

Table 8: Fodder availability of sample households in Dargah-2 Microwatershed

Fodder produce	Fodder yield (kg/ha.)
Sorghum	1250
Livestock having households (%)	22.2
Livestock population (Numbers)	4

A woman participation in decision making is in Dargah-2 Microwatershed is presented in Table 9. Around 89.0 per cent the farm women earning for her family member of sample households.

Table 9: Women empowerment of sample households in Dargah-2 Microwatershed

% to Grand Total

Particulars	Yes	No
Women participation in local organization activities	0.0	100.0
Women elected as panchayat member	0.0	100.0
Women earning for her family requirement	89.0	11.0
Women taking decision in her family and agriculture related activities	0.0	100.0

The food intake in terms of kilo calorie (kcal) per person per day was calculated and presented in the Table 10 and Figure 6. More quantity of cereals is consumed by sample farmers which accounted for 992 kcal per person. The other important food items consumed was pulses 199 kcal followed by milk 93 kcal, vegetables 34 kcal, cooking oil 192 kcal, egg 186 kcal and meat 19 kcal. In the sampled households, farmers were consuming less (1719 kcal) than NIN- recommended food requirement (2250 kcal).

Table 10: Per capita daily consumption of food among the sample households in Dargah-2 Microwatershed

Particulars	NIN recommendation (gram/ per day/ person)	Present level of consumption (gram/ per day/ person)	Kilo Calories /day/person
Cereals	396.0	291	992
Pulses	43.0	58	199
Milk	200.0	143	93
Vegetables	143.0	144	34
Cooking Oil	31.0	33	192
Egg	0.5	124	186
Meat	14.2	13	19
Total	**827.7**	**809**	**1719**
Threshold of NIN recommendation		827 gram*	2250 Kcal*
% Below NIN		55.0	88.0
% Above NIN		44.0	11.0

Note: * day/person

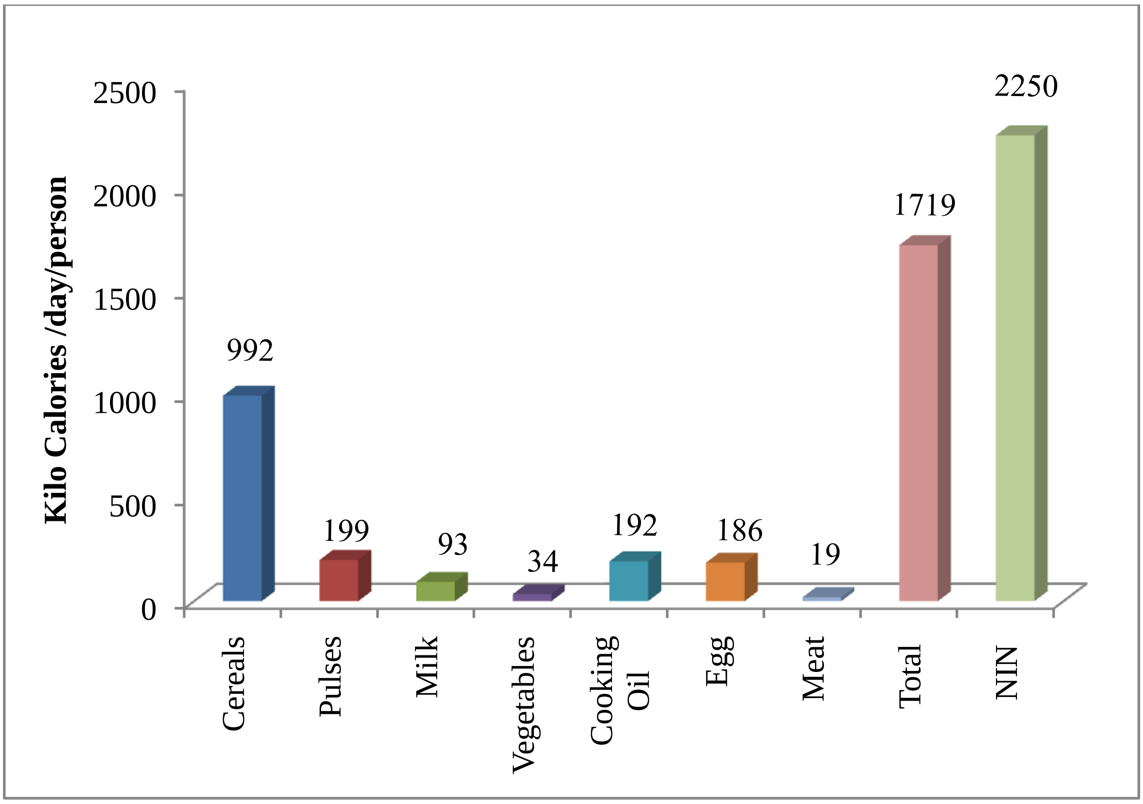

Figure 6: Per capita daily consumption of food among the sample households in Dargah-2 Microwatershed

Annual income of the sample HHs: The average annual household income is around Rs 56634. Major source of income to the farmers in the study area is from crop production (Rs 55454). The monthly per capita income is Rs.832, which is above 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 11).

Table 11: Annual average income of HHs from various sources in Dargah-2 Microwatershed

Particulars	**Income ***
Nonfarm income	1180 (11)
Livestock income (Rs)	0(0)
Crop Production (Rs)	55454(100)
Total Annual Income (Rs)	***56634***
Average monthly per capita income (Rs)	832
Threshold for Poverty level (Rs 975 per month/person)	
% of households below poverty line	55.5
% of households above poverty line	44.4

* 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. 49626) 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 1396 and about 55.5 per cent of farm households are below poverty line (Table 12 and Figure 7).

Table 12: Average annual expenditure of sample HHs in Dargah-2 Microwatershed

Particulars	Value in Rupees	Per cent
Food	49626	52.5
Education	2444	2.5
Clothing	8111	8.5
Social functions	17555	18.4
Health	17222	18.1
Total Expenditure (Rs/year)	94960	100
Monthly per capita expenditure (Rs)	1396	

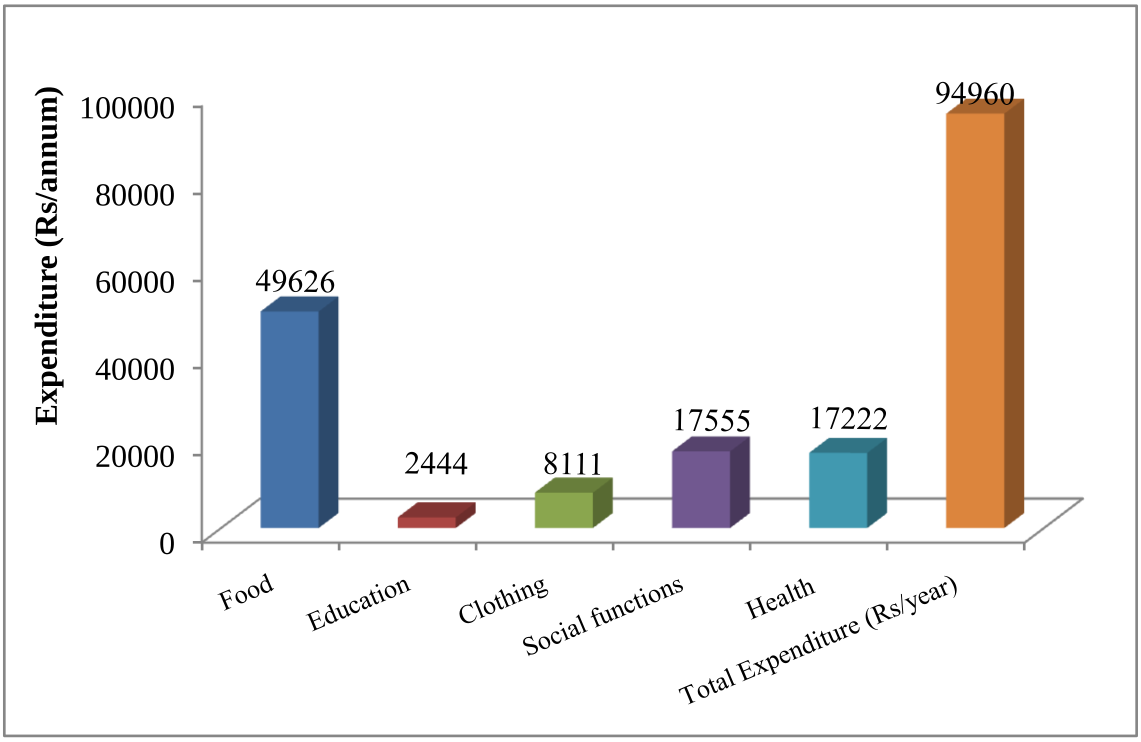

Figure 7: Average annual expenditure of sample HHs in Dargah-2 Microwatershed

Land holding: A total area cultivated by them is 20.8 ha. The average land holding of sample HHs is 2.32 ha. The large number of HHs (55.6 %) is medium size groups with an average land holding size of 3.08 ha and small farmers (44.4%) with an average land holding size of 1.36 ha (Table 13).

Table 13: Distribution of land holding among the sample households in Dargah-2 Microwatershed

Particulars	**Units**	**Values**
Small farmers		
Total land	ha	5.43
Sample size	Per cent	44.4
Average land holding	ha	1.36
Medium farmers		
Total land	ha	15.4
Sample size	Per cent	55.6
Average land holding	ha	3.08
Total farmers		
Total land	ha	20.8
Sample size	Per cent	100
Average land holding	ha	2.32

Land use: The total land holding in the Dargah-2 Microwatershed is 20.8 ha is dry land (Table 14). The average land holding per household is worked out to be 2.32 ha.

Table 14: Land use among samples households in Dargah-2 Microwatershed

Particulars	**Per cent**	**Area in ha**
Dry Land	100	20.8
Irrigated land	0.0	0.0
Fallow Land	0.0	0.0
Total land holding	100	20.8
Average land holding	2.32	

In the Microwatershed, the prevalent present land uses under perennial plants are neem tress. The land use decisions are usually based on experience of farmers, tradition, expected profit, personal preferences, resources and social requirements.

The present dominant crops grown in dry lands in the study area were by red gram (92.1%) which is taken during kharif and sorghum (7.9 %) during rabi season. The cropping intensity was 108.5 percent (Table 15).

Table 15: Present cropping pattern and cropping intensity in Dargah-2 Microwatershed

% to Grand Total

Crops	**Kharif**	**Rabi**	**Grand Total**
Redgram	92.1		92.1
Sorghum		7.9	7.9
Grand Total	***92.1***	***7.9***	***100***
Cropping intensity (%)	108.5		

Economic land evaluation

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

In Dargah-2 micro-watershed, 3 soil series are identified and mapped (Table 16). The distribution of major soil series are Dhandothi covering on area 243 (63.0 %) followed by Dargah 137.1 ha (29.3 %) and Mathumuda 32.4 ha (7.2 %).

Table 16: Distribution of soil series in Dargah-2 Microwatershed

Sl. No	Soil series	Description	Area in ha (%)
1	DDT	Very deep, black clayey soils developed from weathered basalt on very gently sloping uplands, clay surface on 1-3% slope, moderately eroded	243 0 (63.0)
2	DRG	Deep, black clayey soils developed from weathered basalt on very gently sloping uplands, clay surface on 1-3% slope, slightly eroded	137.1 (29.3)
3	MTM	Moderately deep, black clayey soils developed from weathered basalt on very gently sloping uplands, clay surface on 1-3% slope, moderately eroded	32.4 (7.02)

Present cropping pattern on different soil series are given in Table 17. Crops grown on Dhoandothi soils are redgram and sorghum. Redgram is growing on Dargah soils.

Table 17: Cropping pattern on major soil series in Dargah-2 Microwatershed

(Area in per cent)

Soil Series	Soil Depth	Crops	Dry	Grand Total
			Kharif	
DRG	Deep (100-150 cm)	Redgram	100	100
DDT	Very deep(>150 cm)	Redgram	77.8	77.8
		Sorghum	22.2	22.2

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 Microwatershed are given below (Table 18)

Table 18: Alternative land use options for different size group of farmers (Benefit Cost Ratio) in Dargah-2 Microwatershed.

Soil Series	Small farmers	Medium farmers
DDT	Redgram (1.87)	Redgram (2.93) & Sorghum (2.04).
DRG	Redgram (1.88)	Redgram (2.52)

The productivity of different crops grown in Dargah-2 Microwatershed under potential yield of the crops is given in Table 19.

Table 19: Economic land evaluation and bridging yield gap for different crops in Dargah-2 Microwatershed

Particulars	DRG(100-150 cm)	DDT(>150 cm)	
	Redgram	Redgram	Sorghum
Total cost (Rs/ha)	21607	18883	15131
Gross Return (Rs/ha)	43063	47234	30875
Net returns (Rs/ha)	21456	28351	15744
BCR	2.20	2.58	2.04
Farmers Practices (FP)			
FYM (t/ha)	2.0	1.6	1.3
Nitrogen (kg/ha)	65.5	51.2	54.1
Phosphorus (kg/ha)	61.0	57.4	57.5
Potash (kg/ha)	1.8	0.0	0.0
Grain (Qtl/ha)	11.2	12.5	12.5
Price of Yield (Rs/Qtl)	3917	3875	2500
Soil test based fertilizer Recommendation (STBR)			
FYM (t/ha)	7.4	7.4	7.4
Nitrogen (kg/ha)	20.6	18.5	61.1
Phosphorus (kg/ha)	61.8	61.8	71.0
Potash (kg/ha)	28.8	24.7	39.5
Grain (Qtl/ha)	12.4	12.4	28.4
% of Adoption/yield gap (STBR-FP) / (STBR)			
FYM (%)	72.6	78.5	83.1
Nitrogen (%)	-218.3	-176.1	11.5
Phosphorus (%)	1.1	7.1	19.0
Potash (%)	93.9	100.0	100.0
Grain (%)	9.7	-1.0	56.0
Value of yield and Fertilizer (Rs)			
Additional Cost (Rs/ha)	5411	6114	7629
Additional Benefits (Rs/ha)	4695	-491	39763
Net change Income (Rs/ha)	-716	-6605	32133

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 redgram ranges between Rs. 21607/ha in DRG soil (with BCR of 2.20) and Rs. 18883/ha in DDT soil (with BCR of 2.58) and sorghum in cultivation in DDT soil is Rs.15131/ha (with BCR of 2.14).

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 32133 in sorghum.

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 8. The average value of soil nutrient loss is around Rs 1864 per ha/year. The total cost of annual soil nutrients is around Rs 919285 per year for the total area of 467 ha.

Table 20: Estimation of onsite cost of soil erosion in Dargah-2 Microwatershed

Particulars	Quantity(kg)		Value (Rs)	
	Per ha	Total	Per ha	Total
Organic matter	260.37	128364	1640.35	808692
Phosphorus	0.37	184	16.45	8108
Potash	2.12	1045	42.41	20906
Iron	0.22	107	10.40	5128
Manganese	0.36	179	99.71	49157
Cupper	0.08	40	45.35	22357
Zinc	0.01	5	0.41	203
Sulphurs	0.18	90	7.28	3591
Boron	0.06	29	2.32	1141

Total	263.78	130042	1864	919285

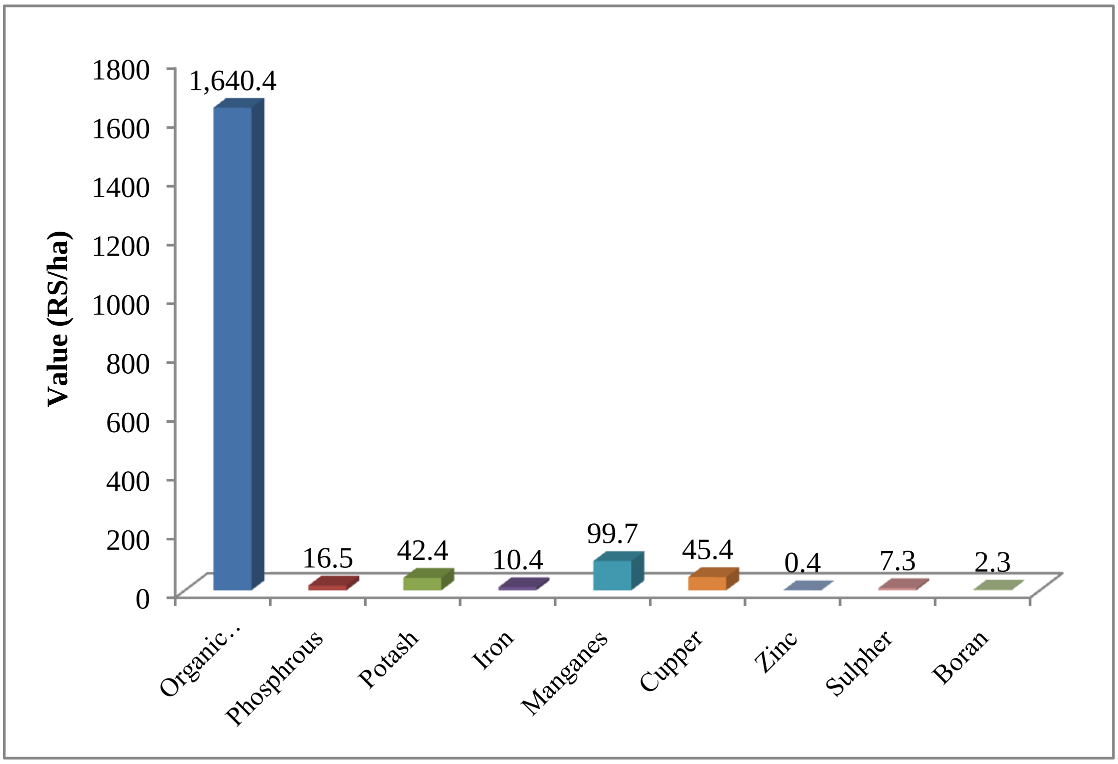

Figure 8: Estimation of onsite cost of soil erosion in Dargah-2 Microwatershed

The average value of ecosystem service for food grain production is around Rs. 19789/ ha/year (Table 21). Per hectare food grain production service is maximum in red gram (Rs. 23834) and sorghum (Rs. 15744).

Table 21: Ecosystem services of food grain production in Dargah-2 Microwatershed

Production items	Crops	Area in ha	Yield (Qtl/ha)	Price (Rs/Qtl)	Gross Returns (Rs/ha)	Cost of Cultivation (Rs/ha)	Net Returns (Rs/ha)
Cereals	Sorghum	1.6	12.0	2500	30875	15131	15744
Pulses	Redgram	18.9	10.0	3889	37378	20699	23834
Average value		20.5	11.0	3194	34126	17915	19789

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 in red gram (Rs. 62342) and sorghum (Rs. 37643) (Table 22).

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

Crops	Yield (Qtl/ha)	Virtual water (cubic meter) per ha	Value of Water (Rs/ha)	Water consumption (Cubic meters/Qtl)
Redgram	11.5	6234.2	62342	544
Sorghum	12.4	3764.3	37643	305
Average value	23.8	4999.2	49992	425

The main farming constraints in Dargah-2 micro-watershed to be found are less rainfall, non availability fertilizers, animal pests & diseases, lack of storage, lack of storage. Majority of farmers depend up on money lender and village merchants of the sources of loan for purpose of crop production. Farmers to sell the agriculture produce through village market and regulated the farmers getting the agriculture related information on newspaper. Farmers reported that they are not getting timely support/extension services from the concerned development department (Table 23).

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

<table>
<tr><th>Sl. No</th><th>Particulars</th><th>Per cent</th></tr>
<tr><td>1</td><td>Less Rainfall</td><td>88.8</td></tr>
<tr><td>2</td><td>Non availability fertilizers</td><td>66.7</td></tr>
<tr><td>3</td><td>Animal pests & Diseases</td><td>33.3</td></tr>
<tr><td>4</td><td>High crop pests & Diseases</td><td>44.4</td></tr>
<tr><td>5</td><td>Lack of storage</td><td>11.1</td></tr>
<tr><td>6</td><td>Damage of crops pests & Diseases</td><td>66.6</td></tr>
<tr><td rowspan="3">7</td><td colspan="2">Source of loan</td></tr>
<tr><td>Money Leander</td><td>77.8</td></tr>
<tr><td>Village merchants</td><td>22.2</td></tr>
<tr><td rowspan="3">8</td><td colspan="2">Market for selling</td></tr>
<tr><td>Village market</td><td>88.8</td></tr>
<tr><td>Regulated</td><td>11.2</td></tr>
<tr><td rowspan="2">9</td><td colspan="2">Sources of Agri-Technology information</td></tr>
<tr><td>Newspaper</td><td>100</td></tr>
</table>

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.