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

GUDIGERI-5 (4D4A2N2e) MICRO WATERSHED

Alavandi Hobli, Koppal Taluk and District, Karnataka

Karnataka Watershed Development Project – II

SUJALA – III

World Bank funded Project

The World Bank

ICAR – NATIONAL BUREAU OF SOIL SURVEY AND LAND USE PLANNING

ICAR - NBSS & LUP

WATERSHED DEVELOPMENT DEPARTMENT
GOVT. OF KARNATAKA, BANGALORE

About ICAR - NBSS&LUP

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

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

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PREFACE

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

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

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

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

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

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

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

Nagpur
Date: 14.01.2019

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PART-A

LAND RESOURCE INVENTORY

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EXECUTIVE SUMMARY

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

The present study covers an area of 355 ha in Koppal taluk and district, Karnataka. The climate is semiarid and categorized as drought - prone with an average annual rainfall of 662 mm, of which about 424 mm is received during south –west monsoon, 161 mm during north-east and the remaining 77 mm during the rest of the year. An area of about 96 per cent is covered by soils, four per cent by waterbodies, settlements and others. The salient findings from the land resource inventory are summarized briefly below.

- *The soils belong to 8 soil series and 18 soil phases (management units) and 4 land use classes.*
- *The length of crop growing period is <90 days and starts from 2nd week of August to 2nd week of November.*
- *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 24 major agricultural and horticultural crops were assessed and maps showing the degree of suitability along with constraints were generated.*
- *Entire area is suitable for agriculture.*
- *About 50 per cent of the soils are very shallow (<25 cm) to moderately shallow (50-75 cm) and about 47 per cent are moderately deep to very deep soils (75->150 cm).*
- *Entire area has clayey soils at the surface.*
- *About 25 per cent of the area has non-gravelly soils, 53 per cent gravelly soils (15-35 % gravel) and 19 per cent very gravelly to extremely gravelly (35- 80% gravel) soils.*
- *About 50per cent of the area has very low (<50mm/m) to low (51-100 mm/m), 33 per cent medium (101-150 mm/m) and 13 per cent area very high (>200mm/m) available water capacity.*
- *An area of about 5 per cent has nearly level (0-1%) slopes and maximum area of about 92 per cent has very gently sloping (1-3%) lands.*

- *An area of about 11 per cent is slightly eroded (e1) and 83 per cent has moderately eroded (e2) lands and an area of about 2 per cent has severely eroded (e3)lands.*
- *An area of about 4 per cent has soils that are moderately alkaline (pH 7.8 to 8.4),38 per cent strongly alkaline (pH 8.4 to 9.0) and 54 per cent soils very strongly alkaline (pH>9.0).*
- *The Electrical Conductivity (EC) of the soils are dominantly <2 dsm^{-1}indicating that the soils are non-saline.*
- *Organic carbon is low (<0.5%) in about 23 per cent, 45 per cent of the soils are medium (0.5-0.75%) and 29 per cent of the soils are high (>0.75%) in organic carbon.*
- *Available phosphorus is low (<23 kg/ha) in the entire area of the microwatershed.*
- *About 13 per cent area has soils that are medium (145-337 kg/ha) and 83 per cent high (>337 kg/ha) in available potassium.*
- *Available sulphur is low (<10 ppm) in 55 per cent area, medium (10-20 ppm) in about 18 per cent area and about 24 per cent area is high (>10 ppm).*
- *Available boron is low (0.5 ppm) in about 53 per cent area and medium (0.5-1.0 ppm) in 44 per cent area.*
- *Available iron is sufficient (>4.5 ppm) in the entire area.*
- *Available zinc is deficient (<0.6 ppm) in 88 per cent and sufficient in 8 per cent area.*
- *Available manganese and copper are sufficient in all the soils.*
- *The land suitability for 24 major crops grown in the microwatershed was assessed and the areas that are highly suitable (S1) and moderately suitable (S2) are given below. It is however to be noted that a given soil may be suitable for various crops but what specific crop to be grown may be decided by the farmer looking to his capacity to invest on various inputs, marketing infrastructure, market price, and finally the demand and supply position.*

Land suitability for various crops in the microwatershed

Crop	Suitability Area in ha (%)			Crop	Suitability Area in ha (%)	
	Highly suitable (S1)	Moderately suitable (S2)			Highly suitable (S1)	Moderately suitable (S2)
Sorghum	*26(7)*	*226(64)*		*Sapota*	-	-
Maize	-	-		*Jackfruit*	-	-
Bajra	-	-		*Jamun*	-	*80 (23)*
Groundnut	-	*85 (24)*		*Musambi*	*14 (4)*	*152 (43)*
Sunflower	*14(4)*	*152(43)*		*Lime*	*14 (4)*	*152 (43)*
Chilli	-	-		*Cashew*	-	-
Tomato	-	-		*Custard apple*	*26 (7)*	*225 (64)*
Drumstick	-	*166(47)*		*Amla*		*252(71)*
Mulbery		*252 (71)*		*Tamarind*	-	*80 (23)*
Pomegranate	-	*166 (46)*		*Marigold*	-	*252 (71)*
Guava	-	-		*Chrysanthemum*	-	*252 (71)*
Mango	-	*34 (9)*		*Jasmine*	-	*85 (24)*

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

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

Chapter 1

INTRODUCTION

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

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

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

The continued neglect and unscientific use of the resources for a long time has led to the situation observed at present in the state. It is a known fact and established beyond doubt by many studies in the past that the cause for all kinds of degradation is the neglect and irrational use of the land resources. Hence, there is urgent need to generate a detailed site-specific farm level database on various land resources for all the villages/watersheds in a time bound manner that would help to protect the valuable soil and land resources and also to stabilize the farm production.

Therefore, the land resource inventory required for farm level planning is the one which investigates not only the surface but also consider the other parameters which are critical for productivity *viz.*, soils, climate, water, minerals and rocks, topography, geology, hydrology, vegetation, crops, land use pattern, animal population, socio-

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

The Land Resource Inventory is basically done for identifying 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 was made to upscale the soil resource information from 1:250000 and 1:50000 scale to the LEU map in Goa and other states.

The land resource inventory aims to provide site specific database for Gudigeri -5 microwatershed in Koppal Taluk, Koppal District, Karnataka state for the Karnataka Watershed Development Department. The database was generated by using cadastral map of the village as a base along with high resolution IRS LISS IV and Cartosat-1 merged satellite imagery. Later, an attempt will be made to uplink this LRI data generated at 1:7920 scale under Sujala-III Project to the proposed Landscape Ecological Units (LEUs) map.

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

Chapter 2

GEOGRAPHICAL SETTING

2.1 Location and Extent

The Gudigeri-5 micro-watershed (Koppal taluk, Koppal district) is located in between $15^0$17' – $15^0$18' North latitudes and $75^0$55' – $75^0$57' East longitudes, covering an area of about 355 ha, It is about 66 km southwest of Koppal town and is surrounded by bounded by Kavalura village on all the sides.

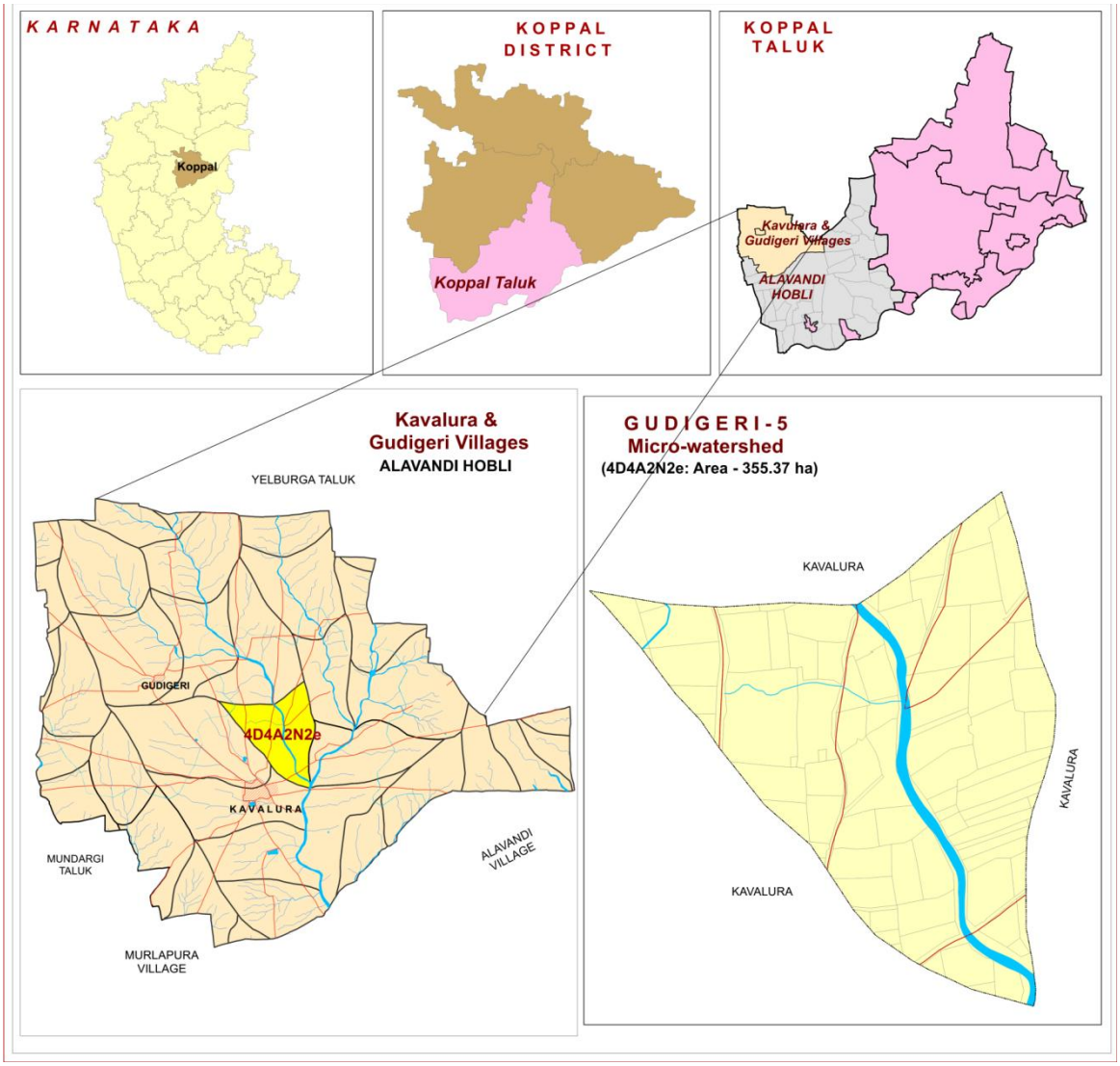


Fig.2.1 Location map of Gudigeri-5 Microwatershed

2.2 Geology

Major rock formations observed in the microwatershed are granite gneiss and alluvium (Figs.2.2a and b). Granite gneisses are essentially pink to gray and are coarse to medium grained. They consist primarily of quartz, feldspar, biotite and hornblende. The gray granite gneisses are highly weathered, fractured and fissured upto a depth of about 10 m. Dolerite dykes and quartz veins are common with variable width and found to

occur in Gudigeri-5 village. The soil thickness of the alluvium generally is limited to less than a meter, except in river valleys where it is very deep extending to tens of meters. Such soils are transported and represent palaeo black soils originally formed at higher elevation, but now occupying river valleys.

Fig.2.2 a Granite and granite gneiss rocks

Fig.2.2 b Alluvium

2.3 Physiography

Physiographically, the area has been identified as Granite gneiss and Alluvial landscapes based on geology. The microwatershed area has been further divided into mounds/ridges, summits, side slopes and very gently sloping uplands and nearly level plains based on slope and its relief features. The elevation ranges from 540 to 566 m in the gently sloping uplands. The mounds and ridges are mostly covered by rock outcrops.

2.4 Drainage

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

2.5 Climate

The district falls under semiarid tract of the state and is categorized as drought - prone with total annual rainfall of 662 mm (Table 2.1). Maximum of 424 mm precipitation is received during south–west monsoon period from June to September, north-east monsoon contributes about 161 mm and prevails from October to early December and the remaining 77 mm takes place during the rest of the year. The winter season is from December to February. During April and May, the temperatures reach up to 45°C and in December and January, the temperatures will go down to 16°C. Rainfall distribution is shown in Figure 2.3. The average Potential Evapo Transpiration (PET) is 145 mm and varies from a low of 101 mm in December to 193 mm in the month of May. The PET is always higher than precipitation in all the months except in the month of September. Generally, the Length of crop Growing Period (LGP) is <90 days and starts from 2nd week of August to 2nd week of November.

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

Sl.No.	Months	Rainfall	PET	1/2 PET
1	January	1.60	116.70	58.35
2	February	1.50	129.20	64.60
3	March	14.10	169.80	84.90
4	April	18.10	180.60	90.30
5	May	41.60	193.50	96.75
6	June	85.80	167.90	83.95
7	July	72.10	156.20	78.10
8	August	110.50	152.50	76.25
9	September	155.60	138.50	69.25
10	October	116.30	122.30	61.15
11	November	36.00	106.40	53.20
12	December	9.10	101.00	50.50
TOTAL		**662.30**	**144.55**	

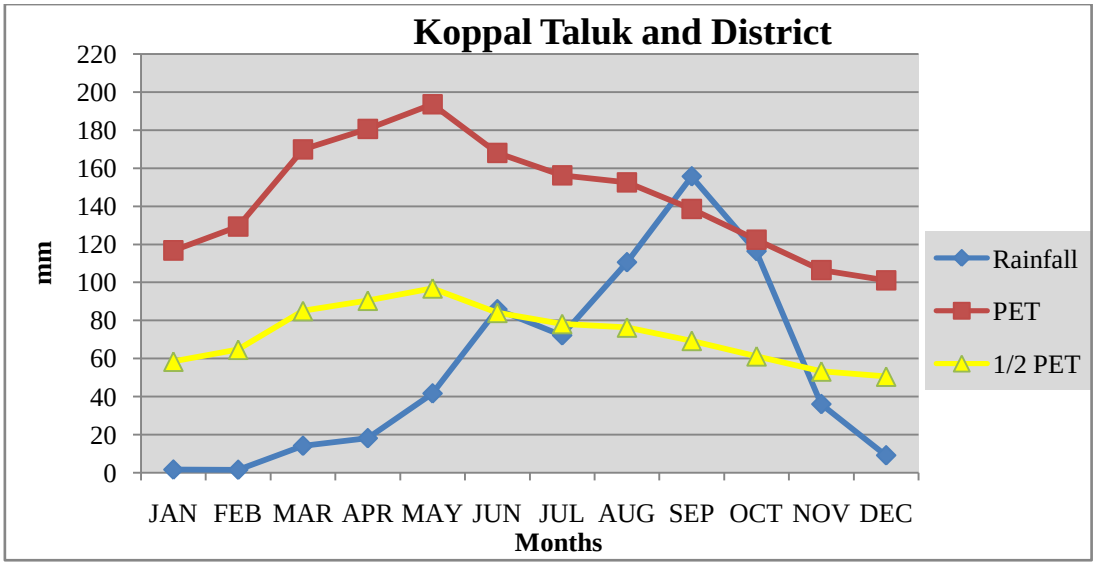


Fig. 2.3 Rainfall distribution in Koppal Taluk and District

2.6 Natural Vegetation

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

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

Fig 2.4 Natural vegetation of Gudigeri-5 microwatershed

2.7 Land Utilization

About 91 per cent area (Table 2.2) in Koppal district is cultivated at present and about 16 per cent of the area is sown more than once. An area of about 3 per cent is currently barren. Forests occupy a small area of about 5 per cent and the tree cover is in a very poor state. Most of the mounds, ridges and boulder areas have very poor vegetative cover. Major crops grown in the area are sorghum, maize, bajra, cotton, safflower, sunflower, red gram, horse gram, onion, mulberry, pomegranate, sugarcane, bengalgram and groundnut (Fig 2.6). 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 Gudigeri-5 microwatershed is presented in Fig.2.5.

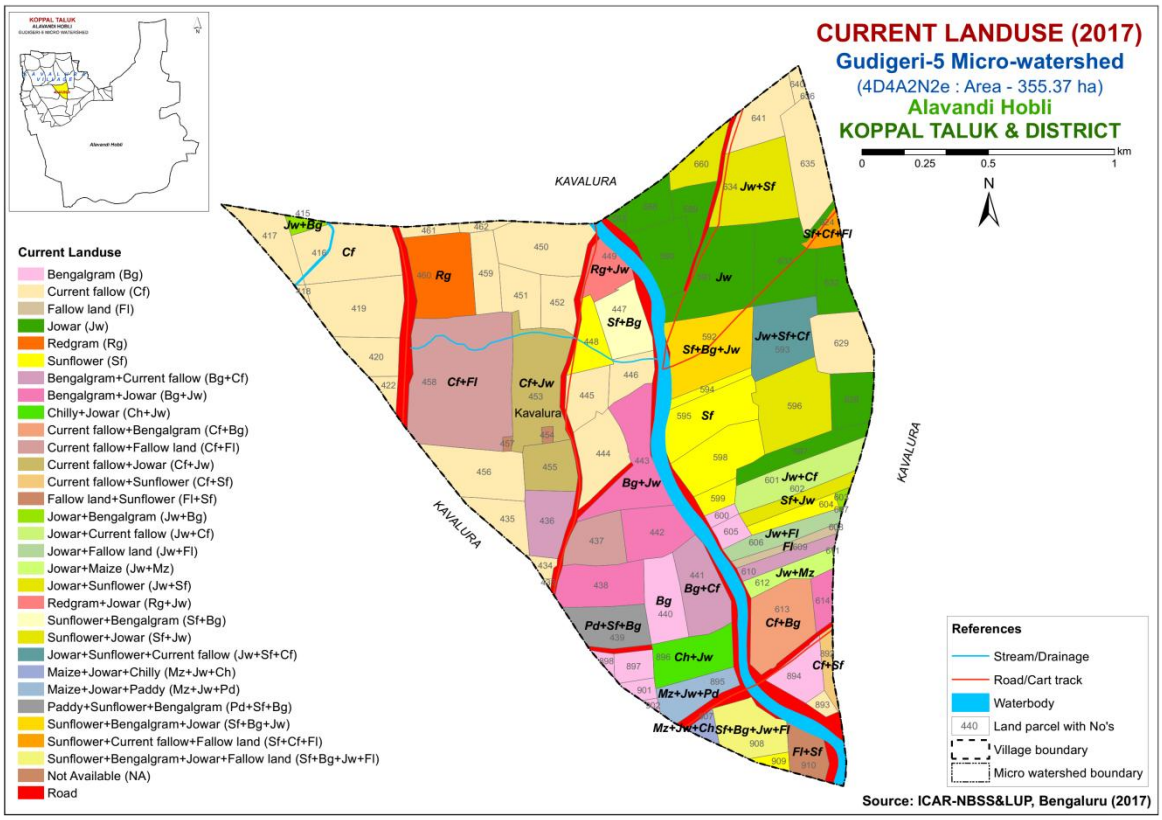


Fig.2.5 Current Land Use – Gudigeri-5 Microwatershed

Table 2.2 Land Utilization in Koppal District

Sl.No.	Agricultural land use	Area (ha)	Per cent
1	Total geographical area	552495	
2	Total cultivated area	500542	90.6
3	Area sown more than once	92696	16.8
4	Trees and groves	210	0.04
5	Cropping intensity	-	118
6	Forest	29451	5.33
7	Cultivable wasteland	2568	0.46
8	Permanent Pasture land	14675	2.66
9	Barren land	16627	3.01
10	Non agricultural land	40591	7.35
11	Current fallow	19660	3.56

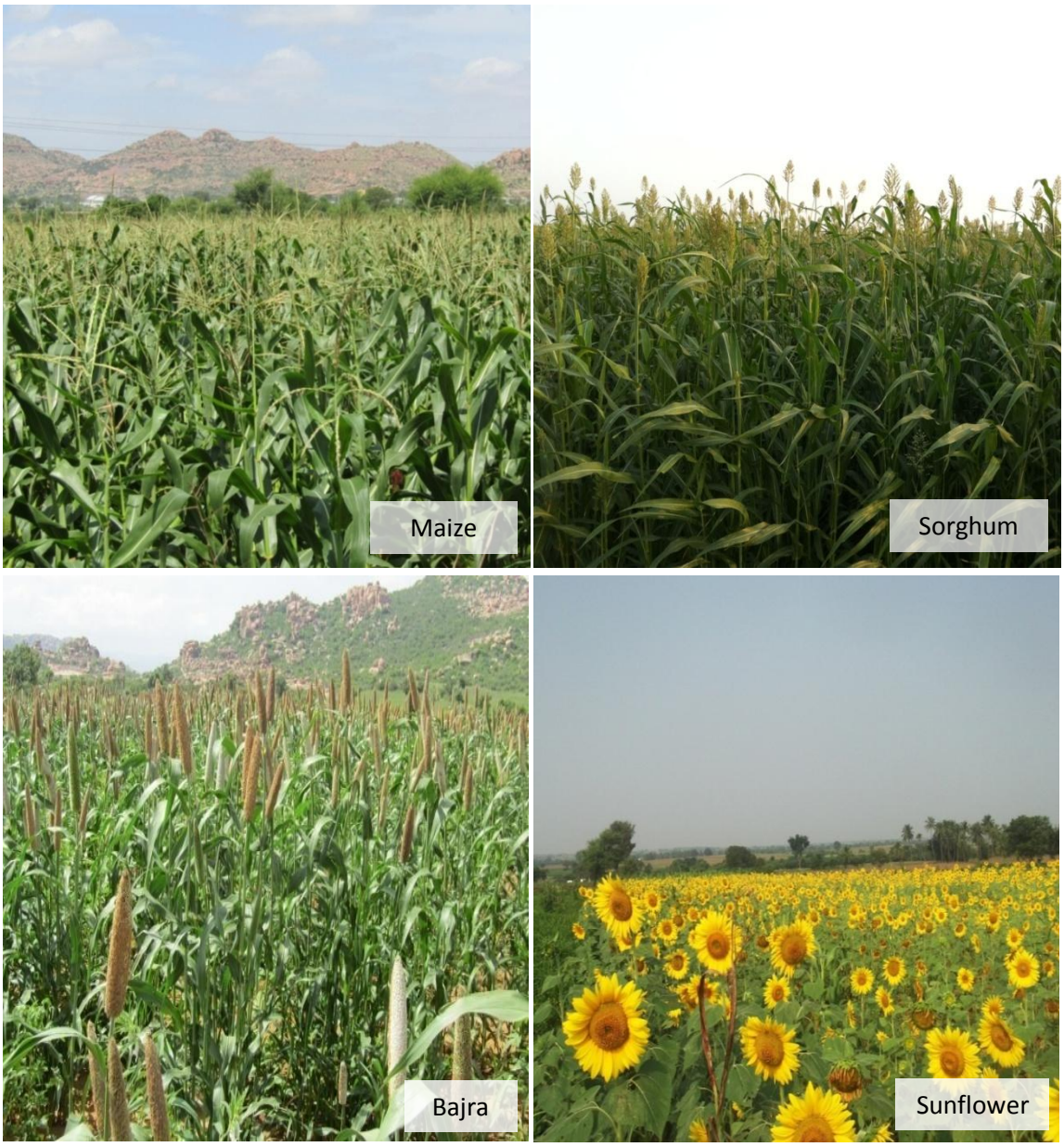


Fig.2.6 (a) Different crops and cropping systems in Gudigeri-5 Microwatershed

Fig.2.6 (b) Different crops and cropping systems in Gudigeri-5 Microwatershed

Chapter 3

SURVEY METHODOLOGY

The purpose of land resource inventory is to delineate similar areas (soil series and phases), which respond or expected to respond similarly to a given level of management. This was achieved in Gudigeri-5 microwatershed by the detailed study of all the soil characteristics (depth, texture, colour, structure, consistence, coarse fragments, porosity, soil reaction, soil horizons etc.) and site (slope, erosion, drainage, occurrence of rock fragments etc.) and followed by grouping of similar areas based on soil-site characteristics into homogeneous (management units) units and showing their area extent and geographic distribution on the microwatershed cadastral map. The detailed soil survey at 1:7920 scale was carried out in 355.37 haarea. The methodology followed for carrying out land resource inventory was as per the guidelines given in Soil Survey Manual (IARI, 1971; Soil Survey Staff, 2006; Natarajan *et al.,* 2015) which is briefly described below.

3.1 Base Maps

The detailed survey of the land resources occurring in the microwatershed was carried out by using digitized cadastral map as a base. The cadastral map shows field boundaries with their survey numbers, location of tanks, streams and other permanent features of the area (Fig. 3.1). Apart from the cadastral map, remote sensing data products from Cartosat-1 and LISS IV merged at the scale of 1:7920 were used in conjunction with the cadastral map to identify the geology, landscapes, landforms and other surface features. The imagery helped in the identification and delineation of boundaries between hills, uplands and lowlands, water bodies, forest and vegetated areas, roads, habitations and other cultural features of the area (Fig.3.2).The cadastral map was overlaid on the satellite imagery (Fig.3.3) that helps to identify the parcel boundaries and other permanent features. Apart from cadastral maps and images, toposheets of the area (1:50,000 scale) were used for initial traversing, identification of geology, landscapes 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 (FCC) of Cartosat-I and LISS-IV merged satellite data covering the microwatershed area was visually interpreted using image interpretation elements and all the available collateral data with local knowledge. The delineated physiographic boundaries were transferred on to a cadastral map overlaid on satellite imagery. Physiographically, the area has been identified as granite gneiss and alluvial landscapes and is divided into landforms such as ridges, mounds and uplands based on slope. They were further subdivided into physiographic/ image interpretation units based on image characteristics. The image interpretation legend for physiography is given below.

Image Interpretation Legend for Physiography

G- Granite gneiss landscape

G1 Hills/ Ridges/ Mounds
- G11 Summits
- G12 Side slopes
  - G121 Side slopes with dark grey tones

G2 Uplands
- G21 Summits
- G22 Gently sloping uplands
  - G221 Gently sloping uplands, yellowish green (eroded)
  - G222 Gently sloping uplands, yellowish white (severely eroded)
- G23 Very gently sloping uplands
  - G231 Very gently sloping uplands, yellowish green
  - G232 Very gently sloping uplands, medium green and pink
  - G233 Very gently sloping uplands, pink and green (scrub land)
  - G234 Very gently sloping uplands, medium greenish grey
  - G235 Very gently sloping uplands, yellowish white (eroded)
  - G236 Very gently sloping uplands, dark green
  - G237 Very gently sloping uplands, medium pink (coconut garden)
  - G238 Very gently sloping uplands, pink and bluish white (eroded)

DSe Alluvial landscape

DSe 1 Summit
- DSe 11 Nearly level Summit with dark grey tone
- DSe 12 Nearly level Summit with medium grey tone
- DSe 13 Nearly level Summit with whitish grey tone
- DSe 14 Nearly level Summit with whitish tone (Calcareousness)
- DSe 15 Nearly level Summit with pinkish grey tone
- DSe 16 Nearly level Summit with medium pink tone
- DSe 17 Nearly level Summit with bluish white tone
- DSe 18 Nearly level Summit with greenish grey tone

DSe 2 Very genetly sloping
- DSe 21 Very gently sloping, whitish tone
- DSe 22 Very gently sloping, greyish pink tone
- DSe 23 Very gently sloping, whitish grey tone
- DSe 24 Very gently sloping, medium grey tone
- DSe 25 Very gently sloping, medium pink tone
- DSe 26 Very gently sloping, dark grey tone
- DSe 27 Very gently sloping, bluish grey tone
- DSe 28 Very gently sloping, greenish grey tone
- DSe 29 Very gently sloping, Pinkish grey

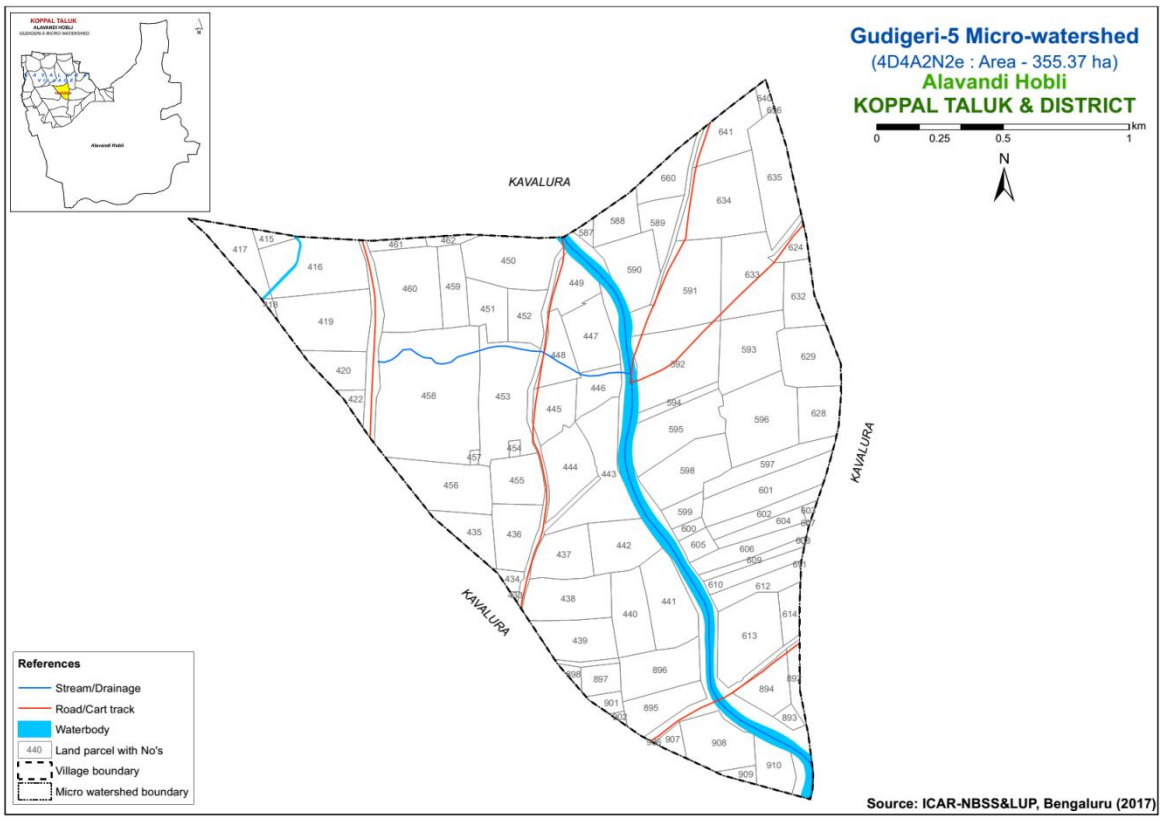


Fig 3.1 Scanned and Digitized Cadastral map of Gudigeri-5 Microwatershed

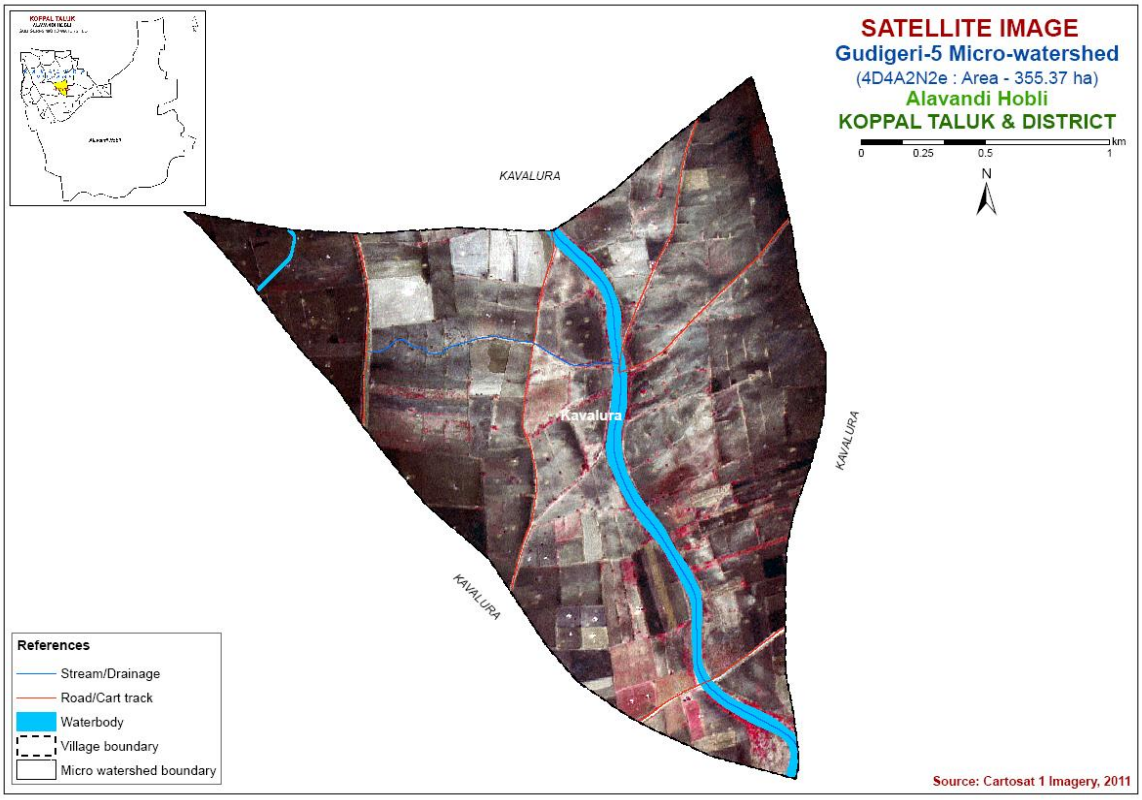


Fig.3.2 Satellite Image of Gudigeri-5 Microwatershed

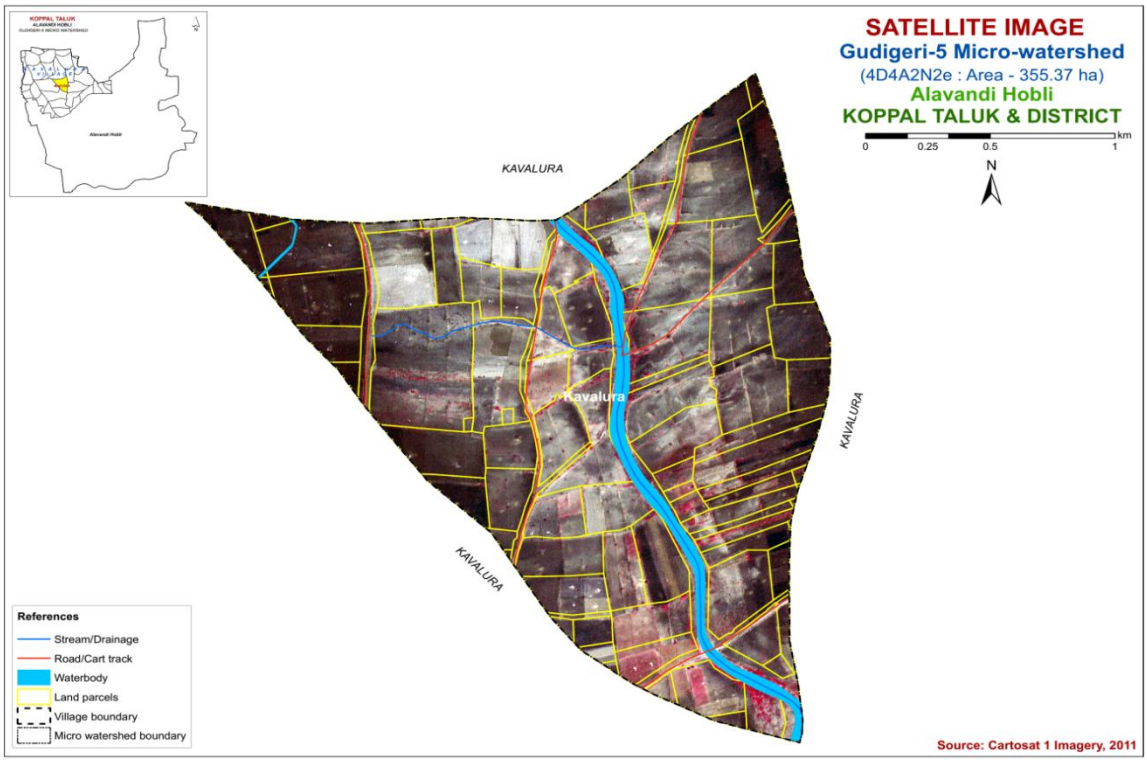


Fig.3.3 Cadastral map overlaid on IRS PAN+LISS IV merged imagery of Gudigeri-5 Microwatershed

3.3 Field Investigation

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

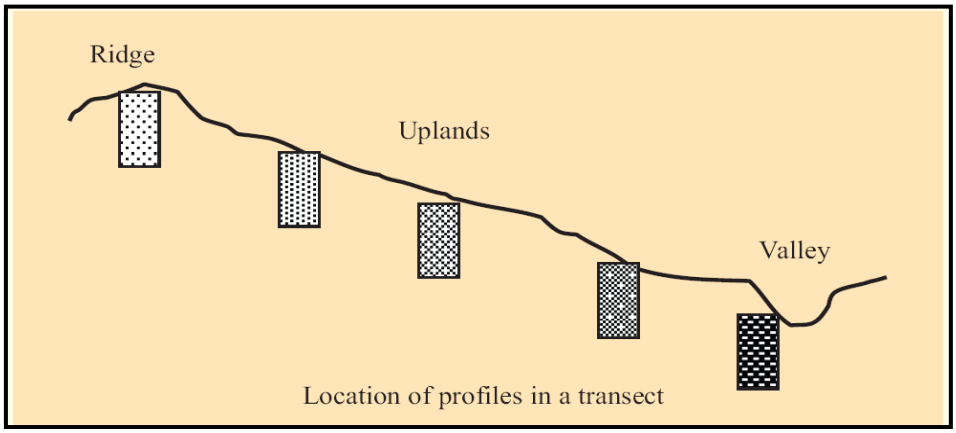


Fig: 3.4. Location of profiles in a transect

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

Based on the soil characteristics, the soils were grouped into different soil series. Soil series is the most homogeneous unit having similar horizons and properties and behaves similarly for a given level of management. Soil depth, texture, colour, kind of horizon and horizon sequence, amount and nature of gravel present, calcareousness, nature of substratum etc, were used as the major differentiating characteristics for identifying soil series occurring in the area. The differentiating characteristics used for identifying the soil series are given in Table 3.1. Based on the above characteristics, 8 soil series were identified in Gudigeri-5 Microwatershed.

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

Soils of Granite Gneiss Landscape							
Sl. No	**Soil Series**	**Depth (cm)**	**Colour (moist)**	**Texture**	**Gravel (%)**	**Horizon sequence**	**Calcareo-usness**
1	Belagatti (BGT)	<25	10 YR3/1,3/2,4/2	gc	>35	Ap-Crk	es
Soils of Alluvial Landscape							
2	Muttal(MTL)	25-50	10YR 3/2,3/3,4/2 7.5 YR 3/2,3/3,6/4	c	15-35%	Ap-Bw-Ck	e-ev
3	Ravanaki (RNK)	50-75	7.5YR3/2,3/3,5/2,5/3 10YR3/1,3/2,4/1, 4/2, 5/1,6/1	c	<15	Ap-Bw-Cr	e-ev
4	Dambarahalli (DRL)	75-100	10YR 2/1, 3/1, 4/3	c	<15	Ap-Bw-Ck	e-es
5	Narsapura (NSP)	75-100	10YR 3/1,3/2,4/2	c	-	Ap-Bw-Cr	e-es
6	Handrala (HDL)	100-150	10 YR 2/1, 3/1,4/1,	c	-	Ap-Bss-Ck	es
7	Kavalur (KVR)	100-150	10 YR2/2,3/1,3/2, 3/3,4/4	c	-	AP-Bss--Cr	es-ev
8	Budagumpa (BGP)	>150	7.5YR 3/2,5/1 10YR4/1,4/4	c	<15	Ap-Bw	es

3.4 Soil Mapping

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

The soil mapping units are shown on the map (Fig.3.5) in the form of symbols. During the survey about 9 soil profile pits, few minipits and a few auger bores representing different landforms occurring in the microwatershed were studied. In addition to the profile study, spot observations in the form of minipits, road cuts, terrace cuts etc., were studied to validate the soil boundaries on the soil map.

The soil map shows the geographic distribution of 18 mapping units representing 8 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 18 phases mapped in the microwatershed. Each mapping unit (soil phase) delineated on the map has similar soil and site characteristics. In other words, all the farms or survey numbers included in one soil phase will have similar management needs and have to be treated accordingly.

The 18 soil phases identified and mapped in the microwatershed were regrouped into six 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 (LUC's) based on the management needs. One or more than one soil site characteristic having influence on the management have been chosen for identification and delineation of LUCs. For Gudigeri-5 Microwatershed, five soil and site characteristics, namely soil depth, soil texture, slope, erosion and gravel content have been considered for defining LUCs. The land use classes are expected to behave similarly for a given level of management.

3.5 Laboratory Characterization

Soil samples for each series 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 in the year 2017 from farmer's fields in Gudigeri-5 microwatershed (36 samples) for fertility status (major and micronutrients) at 250 m grid interval were analyzed in the laboratory (Katyal and Rattan, 2003). By linking the soil fertility data to the survey numbers through GIS, soil fertility maps were generated using Kriging method for the microwatershed.

Table 3.2 Soil map unit description of Gudigeri-5 Microwatershed

Soil map unit no*	Soil Series	Soil Phase Symbol	Mapping Unit Description	Area in ha (%)
Soils of Granite gneiss				
	BGT	Belagatti soils are very shallow (<25 cm), well drained, have very dark gray to very dark grayish brown, calcareous gravelly clay black soils occurring on very gently sloping uplands under cultivation		**2 (0.46)**
3		BGTmB2g2	Clay surface, slope 1-3%, moderate erosion, very gravelly (35-60%)	2(0.46)
Alluvial landscape				
	MTL	Muttal soils are shallow (25-50 cm), well drained, have very dark grayish brown to dark brown, calcareous black gravelly clay soils occurring on gently to very gently sloping uplands under cultivation		**70 (19.77)**
6		MTLmB2g1	Clay surface, slope 1-3%, moderate erosion, gravelly (15-35%)	51 (14.36)
7		MTLmB2g2	Clay surface, slope 1-3%, moderate erosion, very gravelly (35-60%)	11 (3.08)
8		MTLmB3g3	Clay surface, slope 1-3%, severe erosion, extremely gravelly (60-80%)	8 (2.33)
	RNK	Ravanaki soils are moderately shallow (50-75 cm), moderately well drained, have dark brown to very dark grayish brown and dark gray, calcareous gravelly sandy clay to clay black soils occurring on very gently sloping uplands under cultivation		**104 (29.42)**
10		RNKmB2	Clay surface, slope 1-3%, moderate erosion	15(4.21)
11		RNKmB2g1	Clay surface, slope 1-3%, moderate erosion, gravelly (15-35%)	57 (16.15)
12		RNKmB2g2	Clay surface, slope 1-3%, moderate erosion, very gravelly (35-60%)	13 (3.58)
13		RNKmB2g3	Clay surface, slope 1-3%, moderate erosion, extremely gravelly (60-80%)	19 (5.48)
	DRL	Dambarahalli soils are moderately deep (75-100 cm), moderately well drained, have dark brown to very dark gray, calcareous black cracking clay soils occurring on nearly level to very gently sloping uplands under cultivation		**74 (20.98)**
28		DRLmB1g1	Clay surface, slope 1-3%, slight erosion, gravelly (15-35%)	7 (2.03)
29		DRLmB2	Clay surface, slope 1-3%, moderate erosion	26 (7.32)
30		DRLmB2g1	Clay surface, slope 1-3%, moderate erosion, gravelly (15-35%)	26 (7.40)
31		DRLmB2g2	Clay surface, slope 1-3%, moderate erosion, very gravelly (35-60%)	15 (4.23)
	NSP	Narasapura soils are moderately deep (75-100 cm), moderately well drained, have dark grayish brown to very dark grayish brown and very dark gray black cracking clay soils occurring on very gently sloping uplands under cultivation		**11 (3.13)**
34		NSPmB2g1	Clay surface, slope 1-3%, moderate erosion, gravelly (15-35%)	11 (3.13)

	HDL	Handrala soils are deep (100-150 cm), moderately well drained, have dark gray to very dark gray, black cracking clay soils occurring on very gently sloping uplands under cultivation		**14 (4.05)**
46		HDLmB2	Clay surface, slope 1-3%, moderate erosion	14 (4.05)
	KVR	Kavalur soils are deep (100-150 cm), moderately well drained, have dark yellowish brown to very dark brown and very dark gray, calcareous black cracking clay soils occurring on very gently sloping uplands under cultivation		**34 (9.45)**
50		KVRiB2g1	Sand clay surface, slope 1-3%, moderate erosion, gravelly (15-35%)	2(0.48)
51		KVRmA1	Clay surface, slope 0-1%, slight erosion	17(4.84)
53		KVRmB1	Clay surface, slope 1-3%, slight erosion	15 (4.13)
	BGP	Budagumpa soils are very deep (>150 cm), moderately well drained, have gray to dark gray and dark brown to dark yellowish brown, calcareous black cracking clay soils occurring on nearly level to very gently sloping uplands under cultivation		**32 (9.12)**
72		BGPmB2g1	Clay surface, slope 1-3%, moderate erosion, gravelly (15 35%)	32 (9.12)
90		Others	Habitation & Waterbody	13 (3.62)

*Soil map unit numbers are continuous for the taluk, not for the Microwatershed

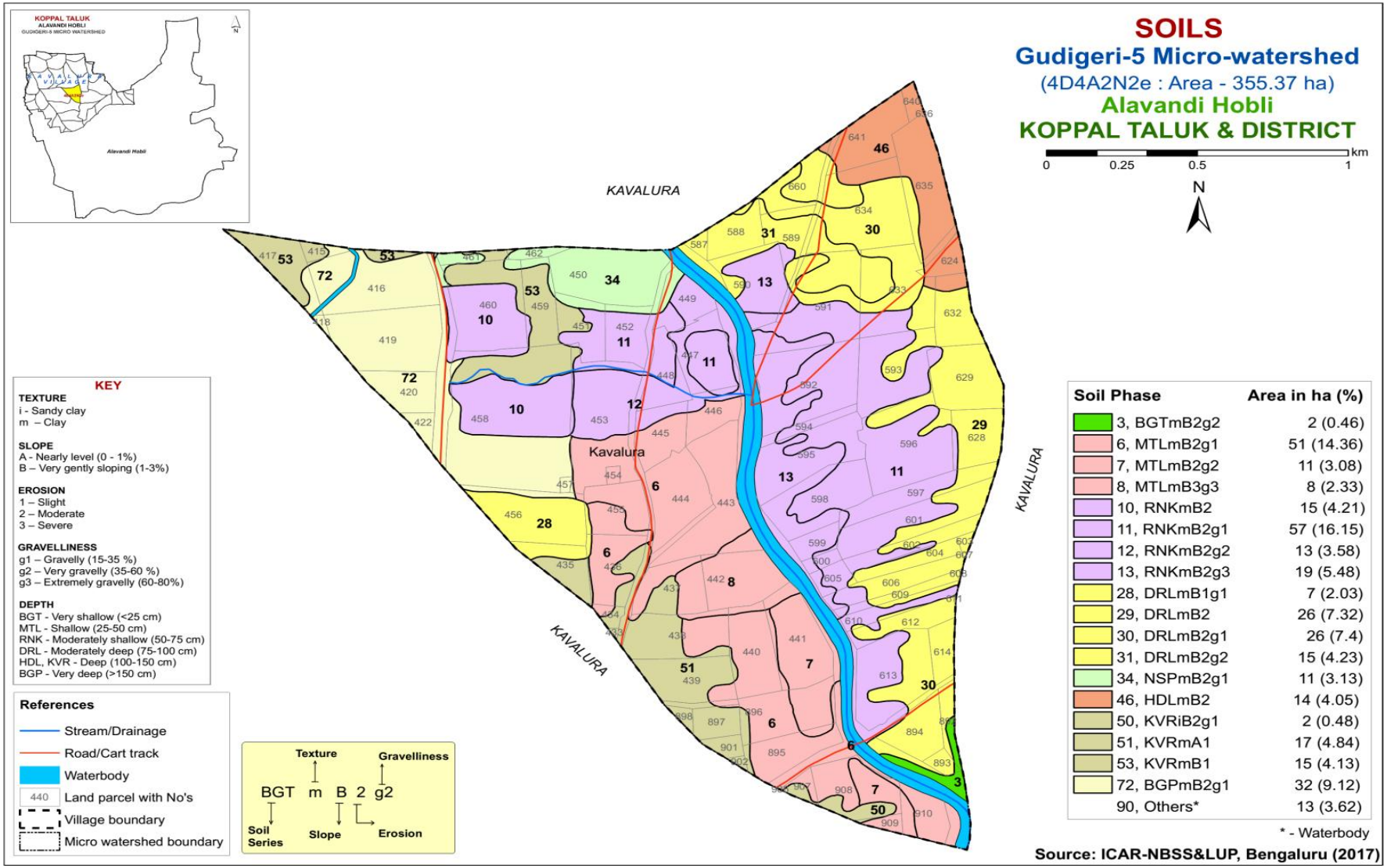


Fig 3.5 Soil Phase or Management Units- Gudigeri-5 Microwatershed

Chapter 4

THE SOILS

Detailed information pertaining to the nature, extent and distribution of different kinds of soils occurring in Gudigeri-5 Microwatershed is provided in this chapter. The microwatershed area has been identified as Granite gneiss and Alluvial landscapes based on geology. In all, 8 soil series are identified. Soil formation is the result of the combined effect of environmental and terrain factors that are reflected in soil morphology. The soil formation is dominantly influenced by the parent material, climate and relief.

A brief description of each of the 8 soil series identified followed by 18 soil phases (management units) mapped under each series (Fig. 3.5) are furnished below. The physical and chemical characteristics of soil series identified in Gudigeri-5 microwatershed are given in Table 4.1. The soils in any one map unit differ from place to place in their depth, texture, slope, gravelliness, erosion or any other site characteristic that affect management. The soil phase map can be used for identifying the suitability of areas for growing specific crops or for other alternative uses and also for deciding the type of conservation structures needed. The detailed information on soil and site-characteristics like soil depth, surface soil texture, slope, erosion, gravelliness, AWC, LCC etc, with respect to each of the soil phase identified is given village/survey number wise for the microwatershed in Appendix-I.

4.1 Soils of Granite and Granite gneiss landscape

In this landscape, only one soil series is identified and mapped. The brief description of the soil series and phases identified in the microwatershed are given below.

4.1.1 Belagatti (BGT) Series: Belagatti soils are very shallow (< 25 cm), well drained, have dark gray to dark grayish brown calcareous gravelly clay soils. They have developed from granite gneiss and occur on very gently sloping uplands. Belagatti series has been classified as a member of the clayey mixed, isohyperthermic (calcareous) family of Lithic Ustorthents.

The thickness of the soil is less than 25 cm. Its colour is in 10 YR hue with value 3 to 4 and chroma 1 to 2. The texture is clay with more than 35 per cent gravel and the available water capacity is low (50-100 mm/m). One phase was identified and mapped.

Landscape and soil profile characteristics of Belagatti (BGT) Series

4.2 Soils of Alluvial Landscape

In this landscape, 7 soil series were identified and mapped. Of these, Ravanaki (RNK) series occupies maximum area of 104 ha (29 %) followed by Dambarahalli (DRL) and muttal (MTL) series. The brief description of each soil series along with the soil phases identified and mapped is given below.

4.2.1 Ravanaki (RNK) Series: Ravanaki soils are moderately shallow (50-75 cm), well drained, have dark brown to very dark grayish brown, calcareous clayey soils. They have developed from granite gneiss and occur on nearly level to very gently sloping uplands. The Ravanaki series has been classified as a member of the very fine, smectitic, isohyperthermic (calc) family of Typic Haplustepts.

The thickness of the solum ranges from 50 to 75 cm. The thickness of A horizon ranges from 15 to 20 cm. Its colour is in 7.5 YR and 10 YR hue with value 2 to 3 and chroma 2.5 to 4. The texture varies from sandy clay to clay with 10 to 15 per cent gravel. The thickness of B horizon ranges from 35 to 60 cm. Its colour is in 10 YR and 7.5 YR hue with value 2 to 6 and chroma 2 to 4. Its texture is dominantly to clay, calcareous with gravel content of < 15 per cent. The available water capacity is low (51-100 mm/m). Four phases were identified and mapped.

Landscape and Soil Profile Characteristics of Ravanaki (RNK) Series

4.2.2 Dambarahalli (DRL) Series: Dambarahalli soils are moderately deep (75-100 cm), moderately well drained, have black and very dark gray to dark brown calcareous cracking clay soils. They have developed from weathered granite gneiss and occur on very gently to gently sloping uplands under cultivation.

The thickness of the solum ranges from 75 to 99 cm. The thickness of A horizon ranges from 13 to 24 cm. Its colour is in 10 YR hue with value 3 to 4 and chroma 1 to 2. The texture is clay. The thickness of B horizon ranges from 54 to 85 cm. Its colour is in 10 YR hue with value 2 to 4 and chroma 1 to 3. Its texture is clay and is calcareous. The available water capacity is high (150-200 mm/m). Four soil phases are identified and mapped.

Landscape and soil profile characteristics of Dambarahalli (DRL) Series

4.2.3 Handrala (HDL) Series: Handrala soils are deep (100-150 cm), moderately well drained, have black, very dark brown and dark gray calcareous cracking clay soils. They have developed from weathered granite gneiss and occur on very gently to gently sloping uplands. Handrala series has been classified as a member of the very fine, smectitic, isohyperthermic (calc) family of Typic Haplusterts.

The thickness of the solum ranges from 102 to 149 cm. The thickness of A horizon ranges from 14 to 26 cm. Its colour is in 10 YR hue with value 3 and chroma 1. The texture is clay. The thickness of B horizon ranges from 103 to 127 cm. Its colour is in 10 YR hue with value 2 to 4 and chroma 1 to 2. Texture is dominantly clay. The available water capacity is very high (>200 mm/m). Only one soil phase was identified and mapped.

` Landscape and soil profile characteristics of Handrala (HDL) Series

Narsapura (NSP) series: Narasapura soils are moderately deep (75-100 cm), moderately well drained, have dark grayish brown to very dark grayish brown and very dark gray, black cracking clay soils They have developed from alluvium and occur on very gently sloping uplands. The Narsapura series has been classified as a member of the very fine, smectitic, isohyperthermic (Calc) family of Typic Haplustepts.

The thickness of the solum is 76 to 98 cm. The thickness of A horizon ranges from 15 to 19 cm. Its colour is in 10 YR hue with value 3 and chroma 1 to 2.The texture is clay with no gravel. The thickness of B horizon ranges from 57 to 83 cm. Its colour is in 10 YR hue with value 3 to 5 and chroma 1 to 3. Its texture is clay. The available water capacity is medium (101-150 mm/m).

Landscape and soil profile characteristics of Narsapura (NSP) series

Kavalur (KVR) Series: Kavalur soils are deep (100-150 cm), moderately well drained, have dark yellowish brown to very dark brown and very dark gray, calcareous black cracking clay soils They have developed from alluvium and occur on very gently sloping uplands. The Kavalur series has been classified as a member of the fine, smectitic, isohyperthermic (calc) family of Typic Haplusterts.

The thickness of the solum is 113 to 143 cm. The thickness of A horizon ranges from 9 to 24 cm. Its colour is in 10 YR hue with value 3 and chroma 1. The texture is clay with no gravel. The thickness of B horizon ranges from 89 to 134 cm. Its colour is in 10 YR hue with value 3 and chroma 1. Its texture is clay. The available water capacity is very high (>200 mm/m).

Landscape and soil profile characteristics of Kavalur (KVR) series

Muttal (MTL) Series: Muttal soils are shallow (25-50 cm), well drained, have dark brown to very dark grayish brown, calcareous clay soils. They have developed from alluvium and occur on nearly level to very gently sloping uplands. The Muttal series has been classified as a member of the clayey, mixed, isohyperthermic (calc) family of (Paralithic) Haplustepts.

The thickness of the solum ranges from 30 to 50 cm. The thickness of A horizon ranges from 15 to 18 cm. Its colour is in 7.5 YR and 10 YR hue with value 2 to 3 and chroma 2.5 to 4. The texture varies from sandy clay to clay with 10 to 15 per cent gravel. The thickness of B horizon ranges from 18 to 32 cm. Its colour is in 10 YR and 7.5 YR hue with value 2 to 6 and chroma 2 to 4. Its texture is sandy clay to clay. The available water capacity is low (50-100 mm/m).

Landscape and soil profile characteristics of Muttal (MTL) Series

Budagumpa (BGP) Series: Budagumpa soils are very deep (>150 cm), well drained, have dark brown to very dark grayish brownblack calcareous sandy clay to clay soils. They have developed from alluvium and occur on very gently sloping uplands under cultivation.

The thickness of the solum is more than 150 cm. The thickness of A horizon ranges from 16 to 26 cm. Its colour is in 7.5 YR and 10 YR hue with value 2 to 3 and chroma 2 to 4. The texture varies from sandy clay to clay with 5 to 10 per cent gravel. The thickness of B horizon ranges from 130 to 160 cm. Its colour is in 10 YR and 7.5 YR hue with value 3 to 5 and chroma 1 to 4. Its texture is clay with gravel content of <15 per cent. These soils are calcareous that increase with depth. The available water capacity is very high (>200 mm/m).

Landscape and soil profile characteristics of Budagumpa (BGP) Series

Table: 4.1 Physical and Chemical Characteristics of Soil Series identified in Gudigeri-5 microwatershed

Series Name: Belagatti (BGT), Pedon: A2/RM-5

Location: $15^0$19'10.8"N, $75^0$57'48.1"E, Kavalura village, Koppal Taluk and District

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

Depth (cm)	Horizon	Size class and particle diameter (mm)								Coarse fragments w/w (%)	Texture Class (USDA)	% Moisture	
		Total			Sand								
		Sand (2.0-0.05)	Silt (0.05-0.002)	Clay (<0.002)	Very coarse (2.0-1.0)	Coarse (1.0-0.5)	Medium (0.5-0.25)	Fine (0.25-0.1)	Very fine (0.1-0.05)			1/3 Bar	15 Bar
0-23	Ap	36.14	20.34	43.52	10.87	6.93	5.97	8.42	3.94	40	c	29.53	17.97

Depth (cm)	pH (1:2.5)			E.C. (1:2.5)	O.C.	$CaCO_3$	Exchangeable bases					CEC	CEC/Clay	Base saturation	ESP
							Ca	Mg	K	Na	Total				
	Water	$CaCl_2$	M KCl	dS m^{-1}	%	%	Cmol kg^{-1}							%	%
0-23	8.4			0.157	0.12	18.24			0.73	0.50		44.84	1.03		1.11

Series Name: Muttal (MTL), Pedon: RM-13
Location: $15^0$14'30.8"N, $75^0$56'50.6"E, Gatareddihalla village, Koppal Taluk and District
Analysis at: NBSS&LUP, Regional Centre, Bangalore **Classification:** Clayey, mixed, isohyperthermic (calc) (Paralithic) Haplustepts

Depth (cm)	Horizon	Size class and particle diameter (mm)								Coarse fragments w/w (%)	Texture Class (USDA)	% Moisture	
		Total			Sand								
		Sand (2.0-0.05)	Silt (0.05-0.002)	Clay (<0.002)	Very coarse (2.0-1.0)	Coarse (1.0-0.5)	Medium (0.5-0.25)	Fine (0.25-0.1)	Very fine (0.1-0.05)			1/3 Bar	15 Bar
0-20	Ap	39.05	13.74	47.21	3.05	5.05	8.21	14.63	8.11	15-30	c	29.95	17.94
20-34	Bwk	28.77	19.57	51.66	4.81	4.71	4.92	9.09	5.24	10	c	33.44	21.56

Depth (cm)	pH (1:2.5)			E.C. (1:2.5)	O.C.	$CaCO_3$	Exchangeable bases					CEC	CEC/ Clay	Base saturation	ESP
							Ca	Mg	K	Na	Total				
	Water	$CaCl_2$	M KCl	dS m^{-1}	%	%	cmol kg^{-1}							%	%
0-20	8.27			0.202	0.79	6.10			0.62	0.25		36.64	0.78	-	0.69
20-34	8.36			0.177	0.99	23.04			0.29	0.38		39.60	0.77	-	0.96

Series Name: Ravanaki (RNK), Pedon: RM-20

Location: $15^0$14'22.7"N, $75^0$57'45.8"E, Gatareddihalla village, Koppal taluk and district

Analysis at: NBSS&LUP, Regional Centre, Bangalore **Classification:** Very fine, smectitic, isohyperthermic (calc) Typic Haplustepts

Depth (cm)	Horizon	Size class and particle diameter (mm)								Coarse fragments w/w (%)	Texture Class (USDA)	% Moisture	
		Total			Sand								
		Sand (2.0-0.05)	Silt (0.05-0.002)	Clay (<0.002)	Very coarse (2.0-1.0)	Coarse (1.0-0.5)	Medium (0.5-0.25)	Fine (0.25-0.1)	Very fine (0.1-0.05)			1/3 Bar	15 Bar
0-28	Ap	24.43	17.76	57.81	5.30	3.89	3.78	7.14	4.32	20	c	41.40	29.60
28-55	Bw	18.77	15.59	65.64	2.74	3.73	2.85	4.83	4.61	10	c	46.71	35.18
55-80	Bc	12.53	15.43	72.04	2.60	1.92	1.47	3.16	3.39	10	c	56.82	43.73

Depth (cm)	pH (1:2.5)			E.C. (1:2.5)	O.C.	$CaCO_3$	Exchangeable bases					CEC	CEC/Clay	Base saturation	ESP
							Ca	Mg	K	Na	Total				
	Water	$CaCl_2$	M KCl	dS m^{-1}	%	%	cmol kg^{-1}							%	%
0-28	8.86			0.483	0.63	15.48			0.86	6.27		37.00	0.64		16.94
28-55	8.61			1.4	0.23	13.68			0.68	12.27		53.20	0.81		23.06
55-80	8.35			4.53	0.91	11.40			0.75	28.97		54.80	0.76		52.86

Series Name: Handrala (HDL), Pedon: A2/RM-1

Location: $15^0$19'69.8"N, $75^0$58'00"E, Kavalura village, Koppal taluk and district

Analysis at: NBSS&LUP, Regional Centre, Bangalore **Classification:** Very fine, smectitic, isohyperthermic (calc) Typic Haplusterts

Depth (cm)	Horizon	Size class and particle diameter (mm)								Coarse fragments w/w (%)	Texture Class (USDA)	% Moisture	
		Total			Sand								
		Sand (2.0-0.05)	Silt (0.05-0.002)	Clay (<0.002)	Very coarse (2.0-1.0)	Coarse (1.0-0.5)	Medium (0.5-0.25)	Fine (0.25-0.1)	Very fine (0.1-0.05)			1/3 Bar	15 Bar
0-25	Ap	21.68	16.62	61.70	4.42	3.98	3.43	5.64	4.20	10	c	41.36	31.27
25-50	Bss1	14.93	15.76	69.32	2.64	2.53	2.99	3.33	3.44	05	c	48.92	39.19
50-82	Bss2	23.11	16.60	60.29	4.51	3.61	6.31	4.74	3.95	05	c	42.46	33.85
82-117	Bss3	10.50	18.38	71.12	1.98	1.98	1.63	2.57	2.33	05	c	52.95	42.82

Depth (cm)	pH (1:2.5)			E.C. (1:2.5)	O.C.	$CaCO_3$	Exchangeable bases					CEC	CEC/Clay	Base saturation	ESP
							Ca	Mg	K	Na	Total				
	Water	$CaCl_2$	M KCl	dS m^{-1}	%	%	cmol kg^{-1}							%	%
0-25	9.06			0.371	0.16	4.80			0.80	7.93		62.33	1.01		12.72
25-50	9.09			0.719	0.2	7.20			0.42	14.94		67.10	0.97		22.26
50-82	9.28			0.47	0.19	9.36			0.47	11.59		60.21	1.00		19.26
82-117	8.76			1.55	0.36	8.64			0.11	2.28		25.33	0.36		9.02

Series Name: Kavalura (KVR), Pedon:A2/RM-9
Location: $15^0$18'86.8"N, $75^0$56'56.3"E, Kavalura village, Koppal taluk and district
Analysis at: NBSS&LUP, Regional Centre, Bangalore **Classification:** Fine, smectitic, isohyperthermic (calc) Typic Haplusterts

Depth (cm)	Horizon	Size class and particle diameter (mm)								Coarse fragments w/w (%)	Texture Class (USDA)	% Moisture	
		Total			Sand								
		Sand (2.0-0.05)	Silt (0.05-0.002)	Clay (<0.002)	Very coarse (2.0-1.0)	Coarse (1.0-0.5)	Medium (0.5-0.25)	Fine (0.25-0.1)	Very fine (0.1-0.05)			1/3 Bar	15 Bar
0-24	Ap	36.18	17.80	46.02	7.04	7.47	6.62	9.28	5.76	10	c	28.20	18.75
24-50	Bss1	38.79	15.36	45.85	6.25	6.25	9.70	10.67	5.93	05	c	27.16	18.81
50-85	Bss2	36.80	14.66	48.54	9.63	8.23	7.03	7.58	4.33	<5	c	30.16	22.17
85-124	Bss3	22.66	17.24	60.09	4.18	3.85	5.28	5.06	4.29	<5	c	40.34	31.42

Depth (cm)	pH (1:2.5)			E.C. (1:2.5)	O.C.	$CaCO_3$	Exchangeable bases					CEC	CEC/ Clay	Base saturation	ESP
							Ca	Mg	K	Na	Total				
	Water	$CaCl_2$	M KCl	dS m^{-1}	%	%	cmol kg^{-1}							%	%
0-24	8.4	-	-	0.265	0.2	8.04	-	-	0.97	0.65		43.25	0.94		1.50
24-50	9.27	-	-	0.23	0.37	8.04	-	-	0.31	3.21		41.66	0.91		7.70
50-85	9.44	-	-	0.297	0.41	8.64	-	-	0.35	6.43		43.99	0.91		14.63
85-124	9.37	-	-	0.46	0.41	11.40	-	-	0.42	7.99		51.09	0.85		15.65

Series Name: Narsapura (NSP), Pedon: A2/RM-2

Location: $15^0$19'86.9"N, $75^0$57'86.1"E, Kavalura village, Koppal Taluk and District

Analysis at: NBSS&LUP, Regional Centre, Bangalore. **Classification:** Very fine, smectitic, isohyperthermic (calc) Typic Haplustepts

Depth (cm)	Horizon	Size class and particle diameter (mm)								Coarse fragments w/w (%)	Texture Class (USDA)	% Moisture	
		Total			Sand								
		Sand (2.0-0.05)	Silt (0.05-0.002)	Clay (<0.002)	Very coarse (2.0-1.0)	Coarse (1.0-0.5)	Medium (0.5-0.25)	Fine (0.25-0.1)	Very fine (0.1-0.05)			1/3 Bar	15 Bar
0-29	Ap	31.32	16.52	52.16	5.51	5.40	5.51	9.83	5.08	10	c	38.86	27.64
29-52	Bw1	13.30	22.08	64.62	2.52	2.41	2.41	3.67	2.29	05	c	49.88	40.05
52-77	BW2	13.22	17.39	69.40	3.56	2.41	1.95	2.76	2.53	05	c	51.33	41.55

Depth (cm)	pH (1:2.5)			E.C. (1:2.5)	O.C.	$CaCO_3$	Exchangeable bases					CEC	CEC/ Clay	Base saturation	ESP
							Ca	Mg	K	Na	Total				
	Water	$CaCl_2$	M KCl	dS m^{-1}	%	%	cmol kg^{-1}							%	%
0-29	9.16			0.615	0.23	9.36			0.72	10.98		51.09	0.98		21.49
29-52	8.69			2.01	0.5	8.64			0.55	24.42		60.63	0.94		40.27
52-77	8.52			2.68	0.46	7.68			0.50	25.65		60.74	0.88		42.24

Chapter 5

INTERPRETATION FOR LAND RESOURCE MANAGEMENT

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

5.1 Land Capability Classification

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

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

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

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

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

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

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

Class III: They are moderately good lands that have severe 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 18 soil map units identified in the Gudigeri-5 microwatershed are grouped under three land capability classes and four land capability subclasses (Fig. 5.1).

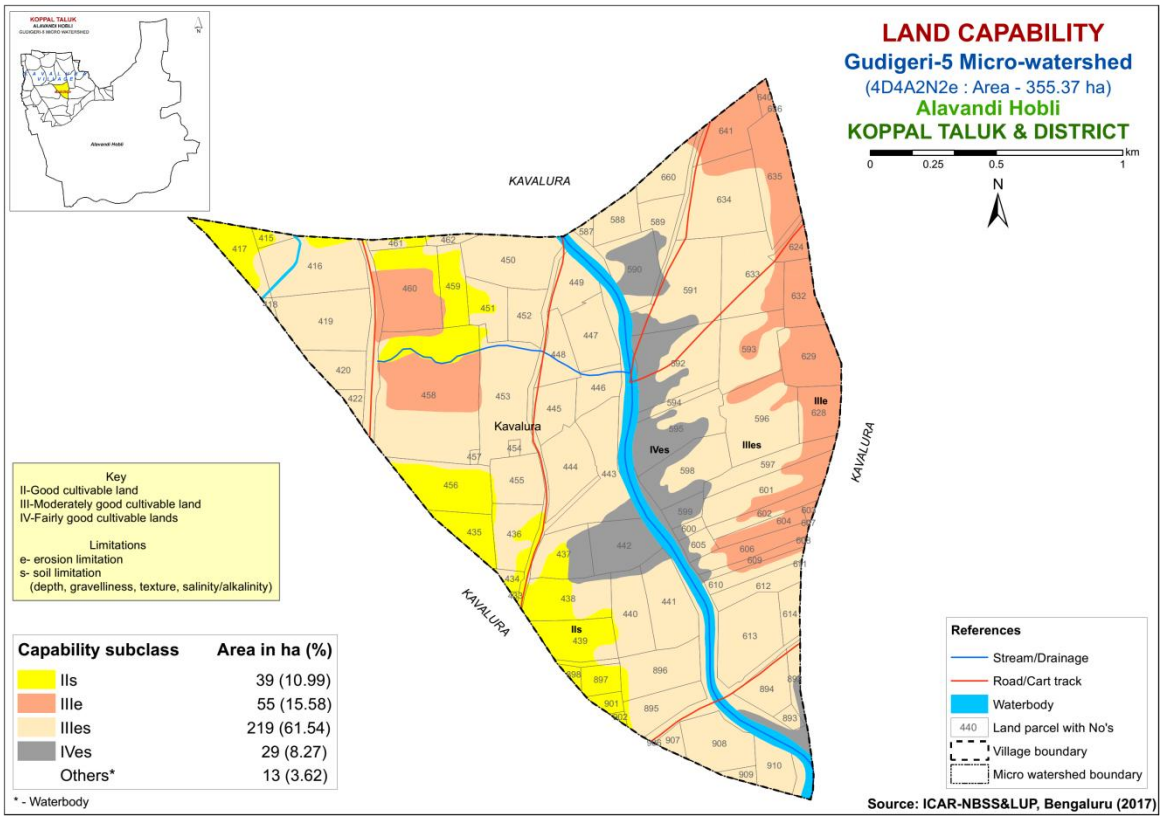


Fig. 5.1 Land Capability map of Gudigeri-5 Microwatershed

Entire area in the microwatershed is suitable for agriculture. Good cultivable lands (Class II) cover an area of about 39 ha (11%) and are distributed in western, north western and northern part of the microwatershed. Moderately good cultivable lands covers maximum area of about 274 ha (77%) with moderate problems of erosion and shallow depth. Fairly good lands (Class IV) cover an area of about 29 ha (8%) and are distributed in the central and southeastern part of the microwatershed with severe limitations of erosion and shallow depth.

5.2 Soil Depth

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

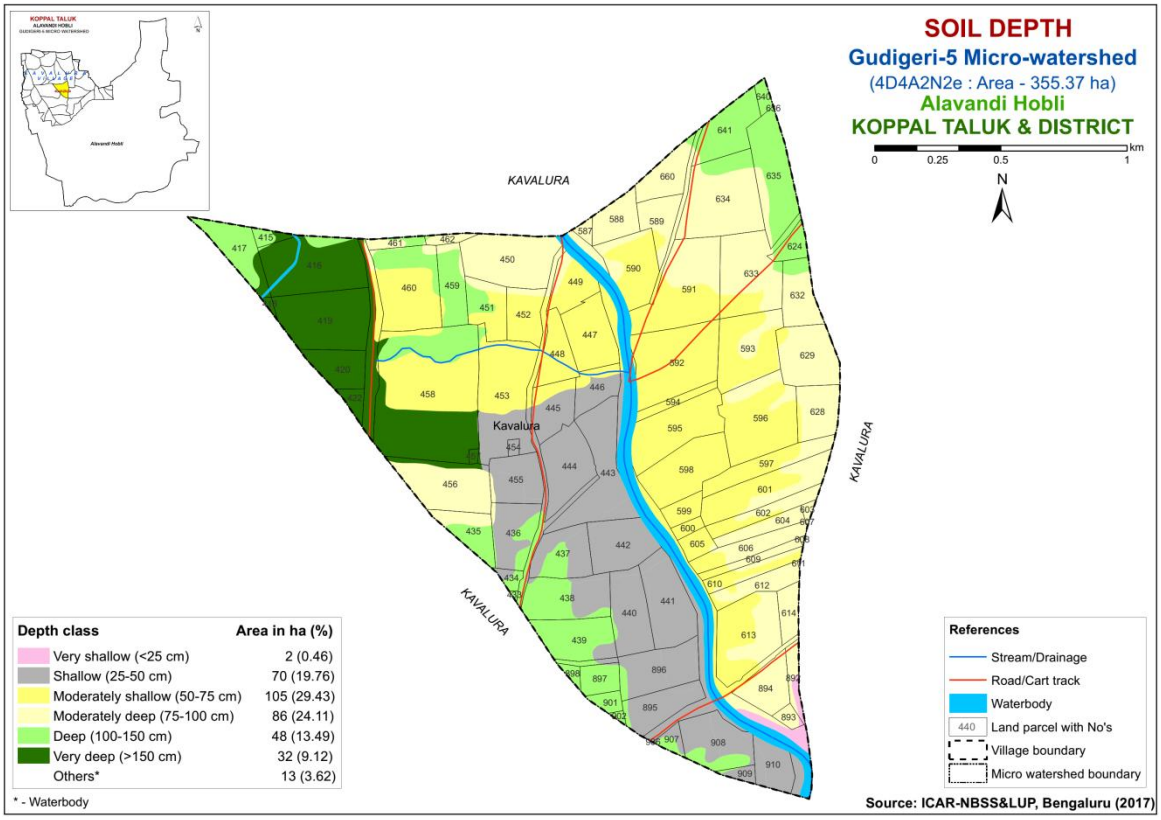


Fig. 5.2 Soil Depth map of Gudigeri-5 Microwatershed

Very shallow (<25 cm) and shallow (50-75 cm) soils occupy an area of about 2 ha (<1%) and 70 ha(20%) respectively and are distributed in the southeastern, central and southern part microwatershed. Moderately shallow (75-100 cm) and moderately deep (75-

100cm) soils occupy an area of about 191ha (53%) and distributed in the major part of the Microwatershed. Deep (100-150 cm) and very deep (>150cm) soils occupy an area of about 80ha (23%) and occur in the eastern, western and northwestern part of the microwatershed.

The most problem lands cover a small area of about 2 ha (<1%) having very shallow (<25 cm) rooting depth and are not suitable for growing agricultural crops but well suited for pasture, forestry or other recreational purposes. Occasionally, short duration crops may be grown if rainfall is normal. The most productive lands cover about 80 ha (23%) where all climatically adopted long duration crops be grown.

5.3 Surface Soil Texture

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

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

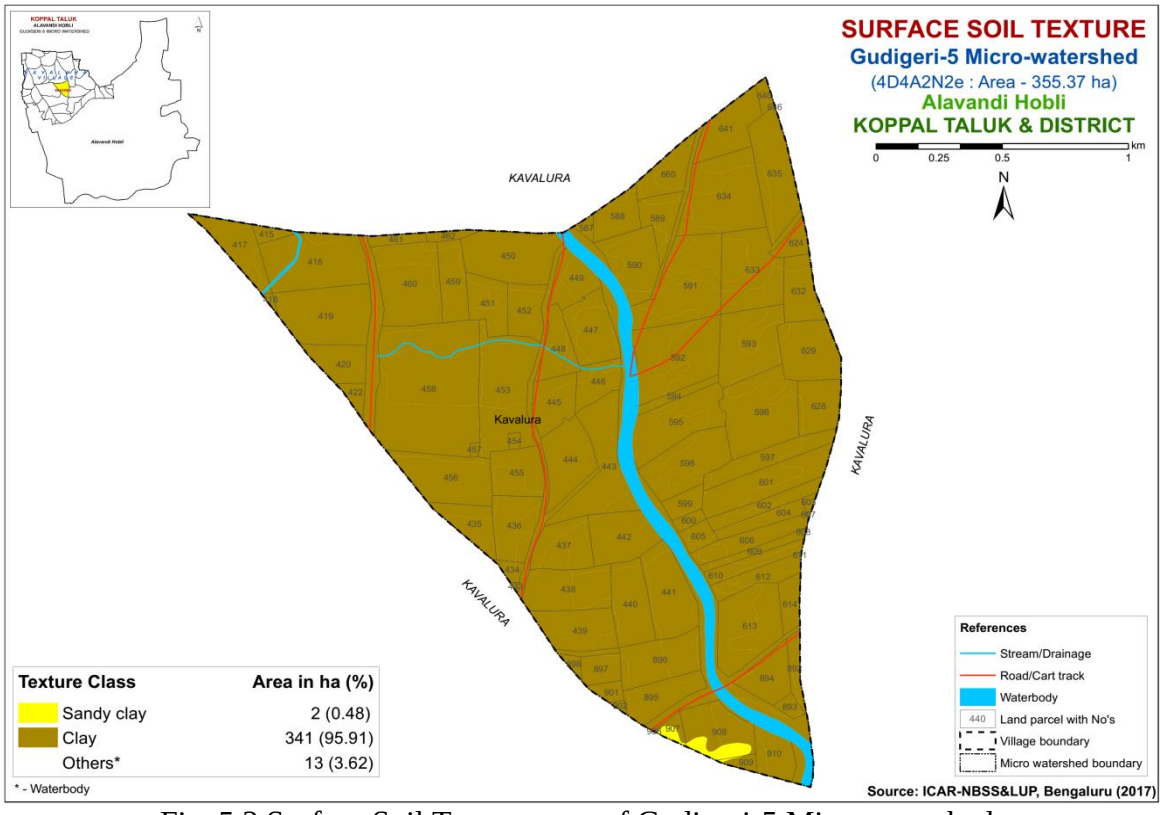


Fig. 5.3 Surface Soil Texture map of Gudigeri-5 Microwatershed

5.4 Soil Gravelliness

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

The soils that are non-gravelly (<15% gravel) cover an area of about 87 ha (25%) and are distributed in the western, eastern and northern part of the microwatershed. An area of 187 ha (53%) is covered by gravelly (15-35% gravel) soils and are distributed in the major part of the microwatershed. Very gravelly(35-60%) soils covers an area of about 40 ha (11.35%) and are distributed in the southern, central and northern part of the microwatershed and an area of about 28 ha (8%) has extremely gravelly (60-80%) soils and are distributed in the central part of the microwatershed (Fig. 5.4).

The most productive lands with respect to gravelliness are found to be 25%. They are non-gravelly with less than 15 per cent gravel and have potential for growing both annual and perennial crops. The problem soils that are very gravelly (35-60%) and extremely gravelly (60-80%) where only short duration crops can be grown cover about 19 per cent.

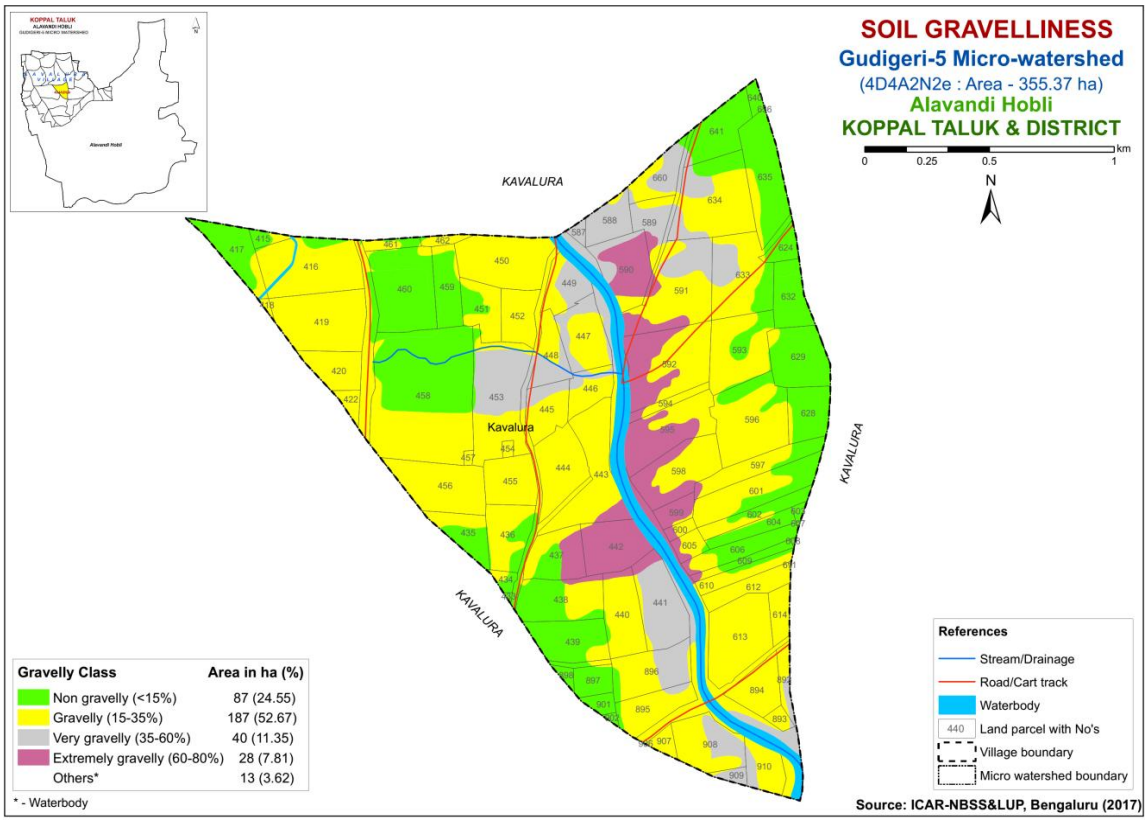


Fig. 5.4 Soil Gravelliness map of Gudigeri-5 Microwatershed

5.5 Available Water Capacity

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

A very small area of about 2 ha (0.4%) in the microwatershed has soils that are very low (<50 mm/m) in available water capacity and distributed in the southern part of the microwatershed. An area with low available water capacity (51-100 mm/m) comprises an area of about 175 ha (49%) and are distributed in the major part of the microwatershed. Medium (101-150mm/m) and very high (>200mm/m) available water capacity classes summates an area of about 166 ha (47 %) and are distributed in the outer corners of the microwatershed.

Problematic soils with regard to available water capacity comprises of very small area of 2ha (<1%). Here only short duration crops can be grown and the probability of crop failure is very high. These areas are best put to other alternative uses. An area of about 48 ha (13%) has soils that have high potential (>200 mm/m) with regard to available water capacity where all climatically adapted long duration crops can be grown successfully.

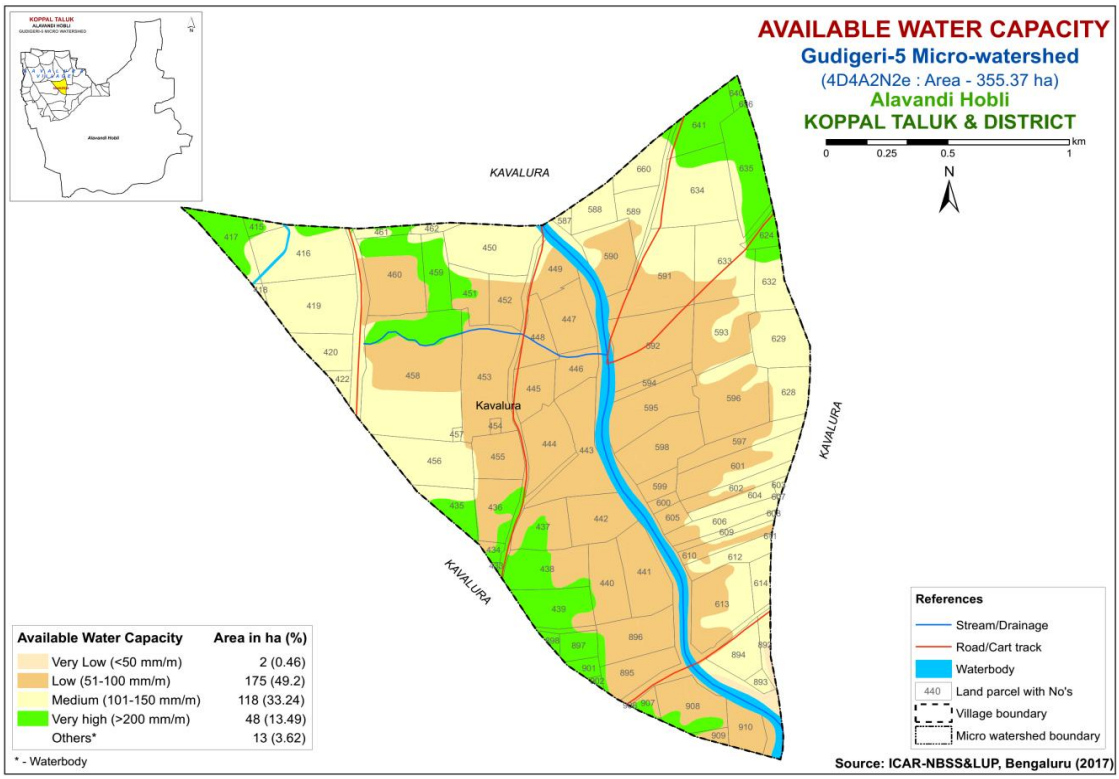


Fig. 5.5 Soil Available Water Capacity map of Gudigeri-5 Microwatershed

5.6 Soil Slope

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

In the Gudigeri-5 microwatershed nearly level (0-1% slope) lands account to about 17 ha (5%) and distributed in the southwestern part of the microwatershed. While the major area of about 325ha (92%) falls under very gently sloping (1-3% slope) lands. In all these areas, all climatically adapted annual and perennial crops can be grown without much soil and water conservation and other land development measures.

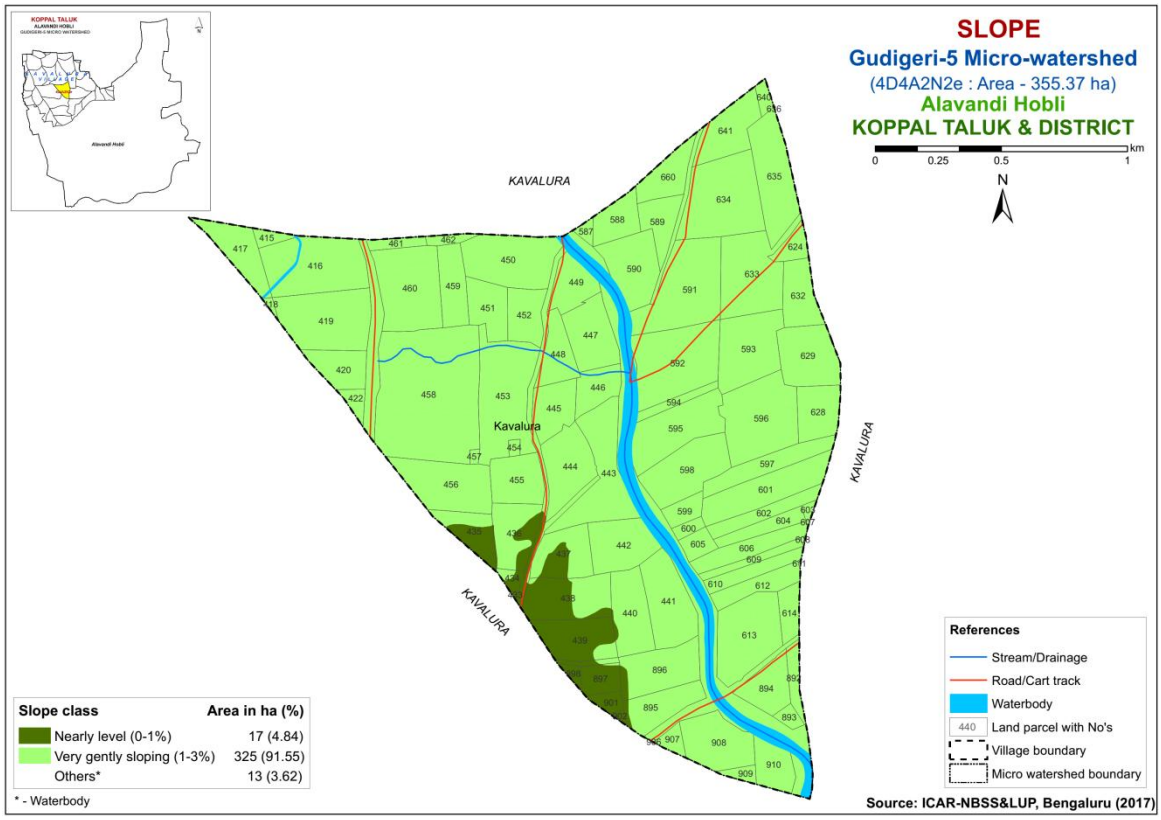


Fig. 5.6 Soil Slope map of Gudigeri-5 Microwatershed

5.7 Soil Erosion

Soil erosion refers to the wearing away of the earth's surface by the forces of water, wind and ice involving detachment and transport of soil by raindrop impact. It is used for accelerated soil erosion resulting from disturbance of the natural landscape by burning, excessive grazing and indiscriminate felling of forest trees and tillage, all usually by man. The erosion classes showing an estimate of the current erosion status as judged from field observations in the form of rills, gullies or a carpet of gravel on the surface are

recorded. Four erosion classes, viz, slight erosion (e1), moderate erosion (e2), severe erosion (e3) and very severe erosion (e4) are recognized. The soil map units were grouped into different erosion classes and a soil erosion map generated. The area extent and their spatial distribution in the microwatershed is given in Figure 5.7.

In the Gudigeri-5 microwatershed slightly eroded lands covers an area of about 11%) and distributed in the northwestern and western part, while the major area of about 295 ha (83%) were moderately eroded (e2 class). Severe eroded lands cover in very small area of about 8 ha (2%) and distributed in the central part of the microwatershed. The moderately and severly eroded lands are problematic and need appropriate soil and water conservation and other land development measures.

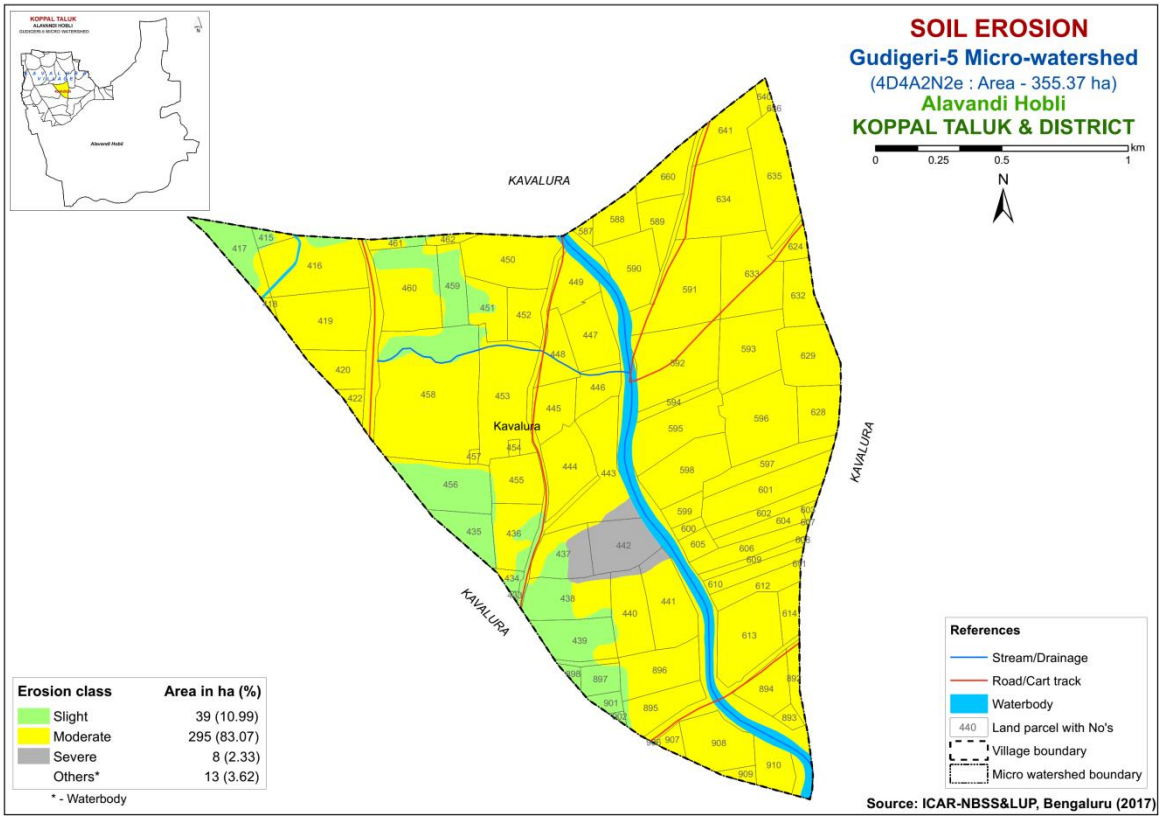


Fig. 5.7 Soil Erosion map of Gudigeri-5 Microwatershed

Chapter 6

FERTILITY STATUS

Soil fertility plays an important role in increasing crop yield. The adoption of high yielding varieties that require high amounts of nutrients has resulted in deficiency symptoms in crops and plants due to imbalanced fertilization and poor inherent fertility status, as these areas are characterised by low rainfall and high temperatures. Hence, it is necessary to know the fertility (macro and micro nutrients) status of the soils of the watersheds for assessing the kind and amount of fertilizers required for each of the crop intended to be grown. For this purpose, the surface soil samples collected from the grid points (one soil sample at every 250 m grid interval) all over the microwatershed through land resource inventory in the year 2017 were analysed for pH, EC, organic carbon, available phosphorus and potassium, and for micronutrients like zinc, boron, copper, iron and manganese, and secondary nutrient sulphur.

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

6.1 Soil Reaction (pH)

The soil analysis of the Gudigeri-5 microwatershed for soil reaction (pH) showed that an area of about 16 ha (4%) is moderately alkaline (pH 7.8 - 8.4) and is distributed in the southwestern part of the microwatershed. An area of about 136 ha (38%) is under strongly alkaline (pH 8.4-9.0) and is distributed in the southern, central and north eastern part of the microwatershed. An area of about 191 ha (53.77%) is very strongly alkaline (pH > 9.0) and are distributed in the northwestern, western and eastern parts of the microwatershed (Fig.6.1).Thus all the soils in the microwatershed are alkaline in reaction.

6.2 Electrical Conductivity (EC)

With respect to electrical conductivity, major part (88%) of the Microwatershed is nonsaline (<2 dSm^{-1}) in nature. An area of about 28 ha is categorized into low, medium and high saline classes and distributed in the southwestern part of the microwatershed.

6.3 Organic Carbon

An area of about 80 ha (23%) is low(<0.5%) in organic carbon content and distributed in the northern, northwestern and northeastern part of the microwatershed, an area of about 160 ha (45%) is medium in (0.5-0.75%) organic carbon content and distributed in the central, northern and north eastern parts. An area of about 103 ha (29%) is high (>0.75%) in organic carbon content and occur in the southern, western and northern part of the microwatershed (Fig.6.3).

6.4 Available Phosphorus

Entire area is low (<23 kg/ha) in available phosphorus. 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. (Fig 6.4).

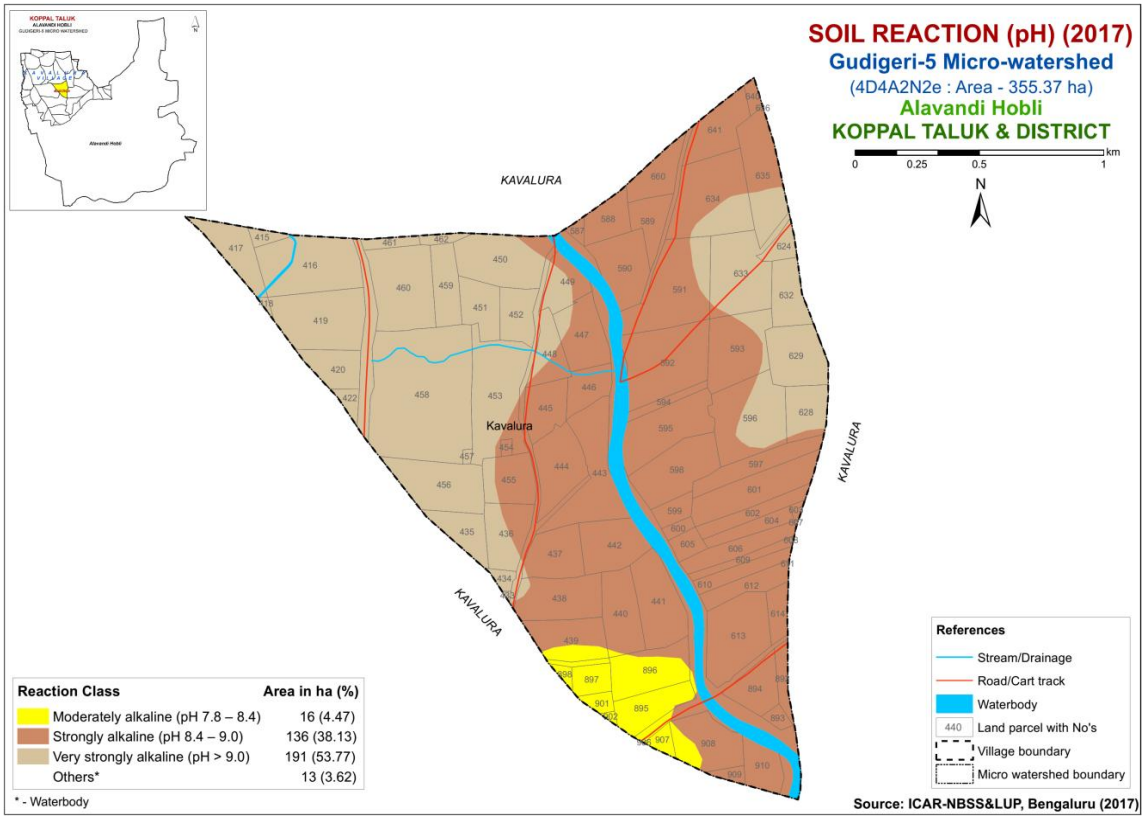


Fig.6.1 Soil Reaction (pH) map of Gudigeri-5 Microwatershed

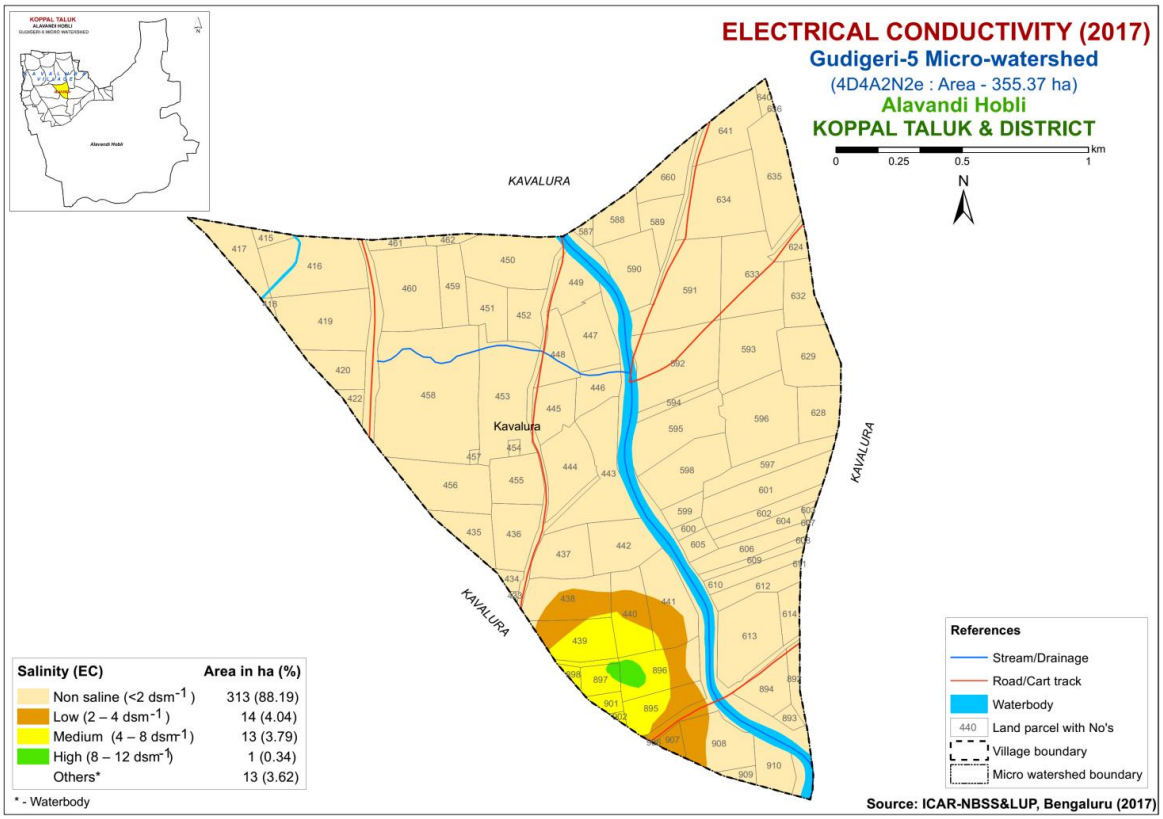


Fig.6.2 Electrical Conductivity (EC) map of Gudigeri-5 Microwatershed

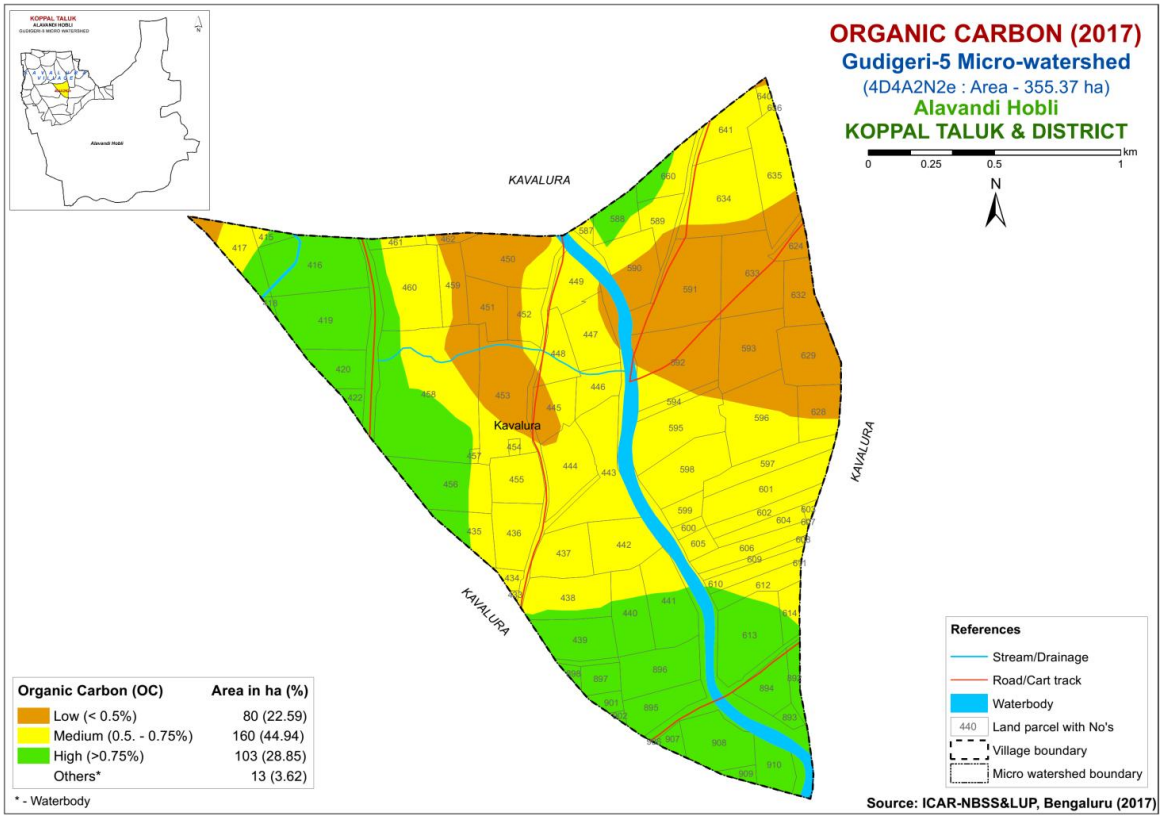


Fig.6.3 Soil Organic Carbon map of Gudigeri-5 Microwatershed

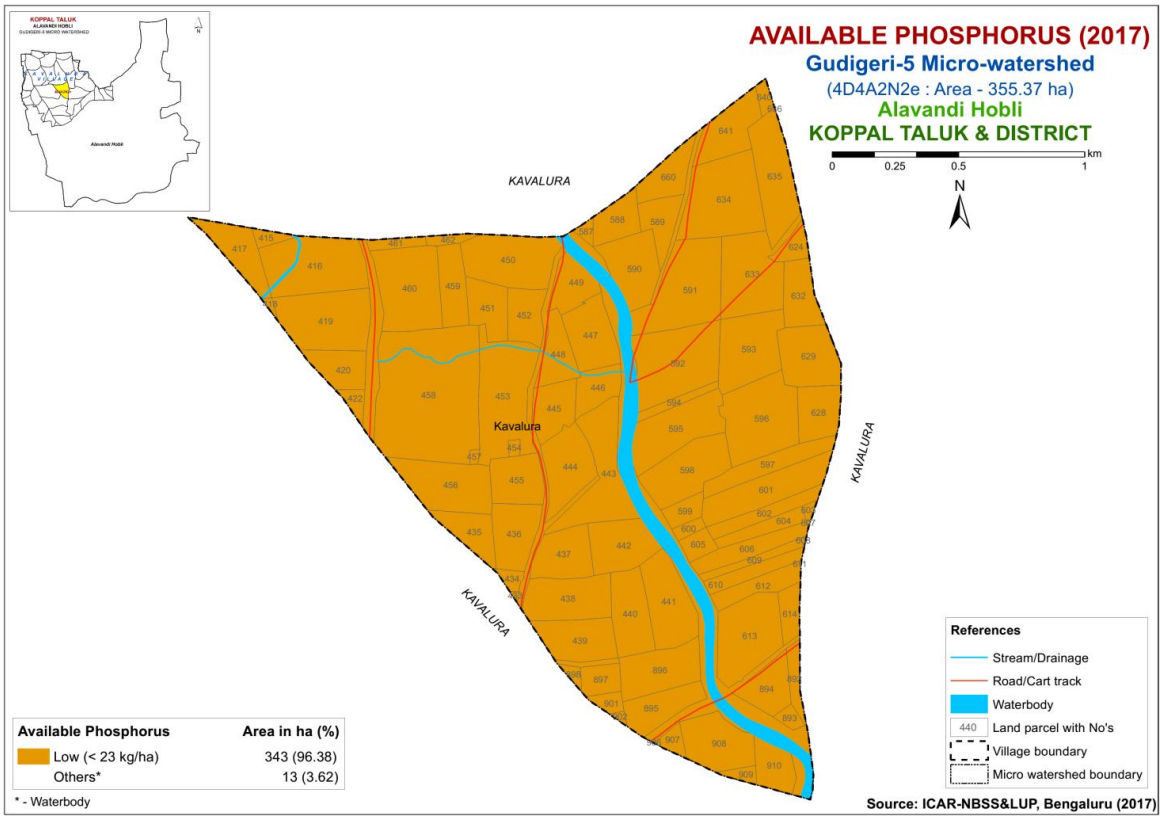


Fig.6.4 Soil Available Phosphorus map of Gudigeri-5 Microwatershed

6.5 Available Potassium

High available potassium content can be observed in major part of the microwatershed with an area of about 295 ha (83%). An area of about 48 ha (13%) is medium in available potassium and distributed in the southern part of the microwatershed (Fig 6.4).

6.6 Available Sulphur

A major area of about 194ha (55%) is low in available sulphur and distributed in the central and northern part of the microwatershed (Fig.6.6). An area of about 64 ha (18%) is medium in available sulphur and distributed in the central and eastern parts. High sulphur content were found in southern and western parts of the microwatershed with an area of about 84ha (24%). The areas that are low and medium in sulphur content need to be applied with magnesium sulphate or gypsum or factomphos (p) fertilizer (13% sulphur) for 2-3 years for the deficiency to be corrected.

6.7 Available Boron

Available boron content is low (<0.5 ppm) in an area of about 187 ha (53%) and distributed in all the parts of the microwatershed. An area of about 155 ha (44%) with medium (0.5-1.0 ppm) boron content is distributed in the northern, eastern, western and southwestern part of the microwatershed (Fig.6.7).

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 the major part of the microwatershed with an area of about 314 ha (88%). An area (28ha) with sufficient zinc content can be noticed in the southern and northwestern part of the microwatershed (Fig 6.11).

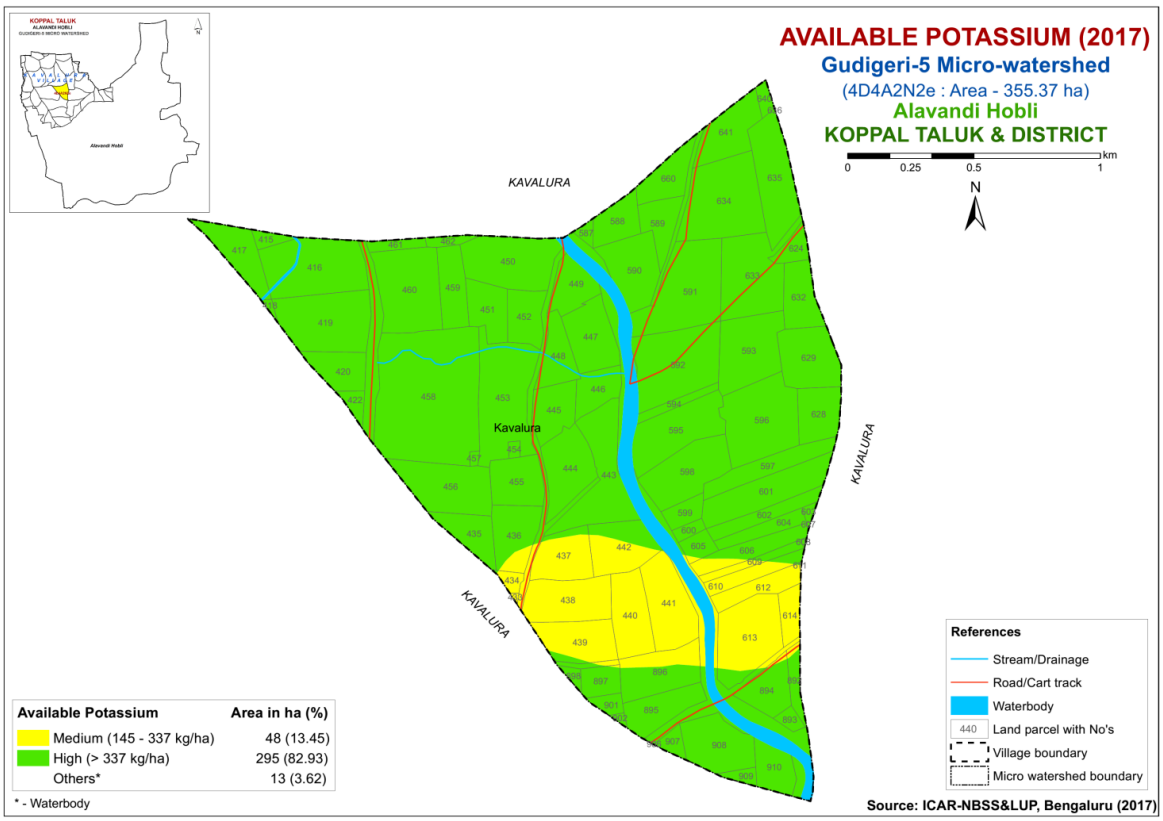


Fig.6.5 Soil Available Potassium map of Gudigeri-5 Microwatershed

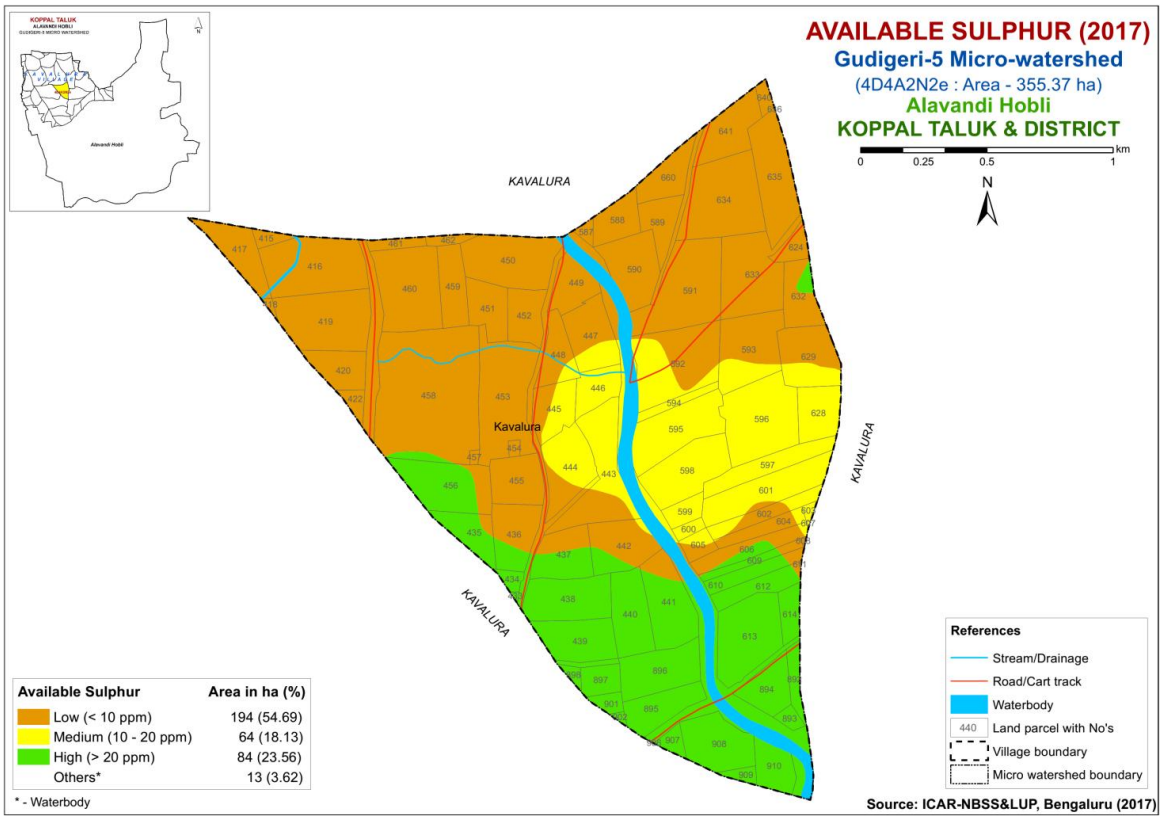


Fig.6.6 Soil Available Sulphur map of Gudigeri-5 Microwatershed

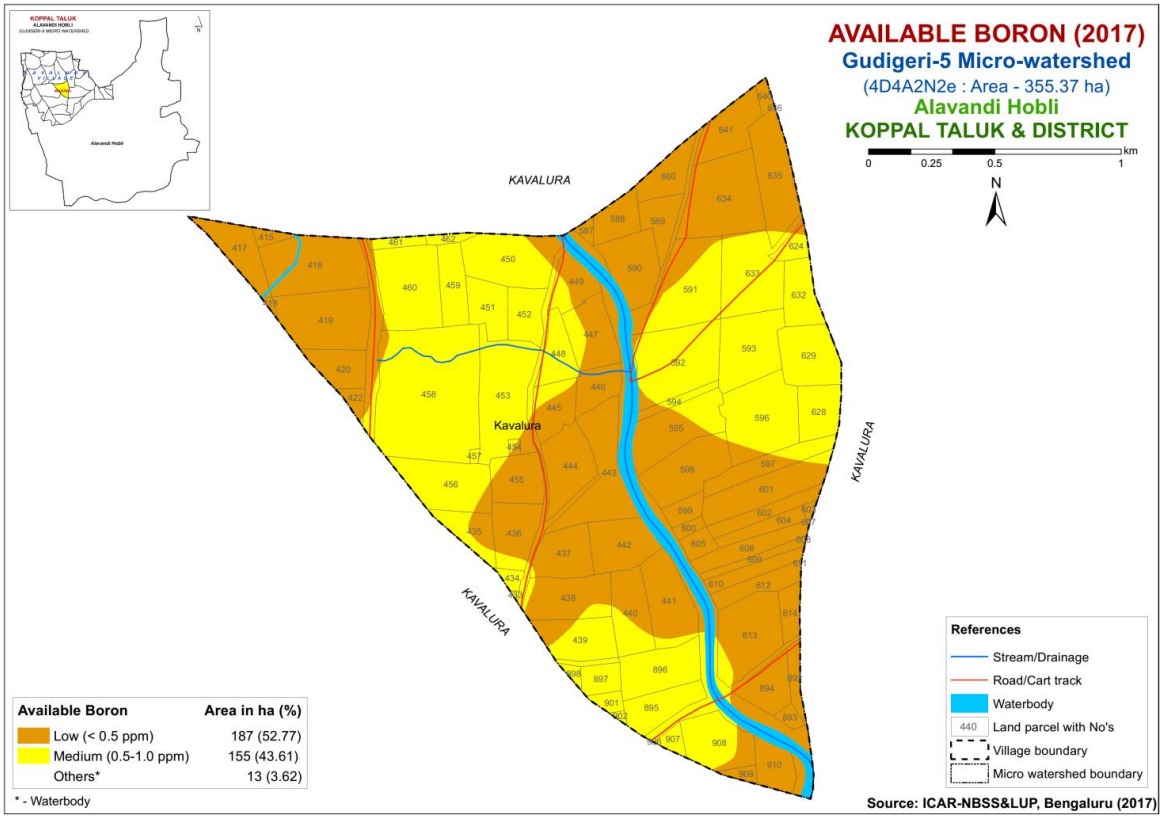


Fig.6.7 Soil Available Boron map of Gudigeri-5 Microwatershed

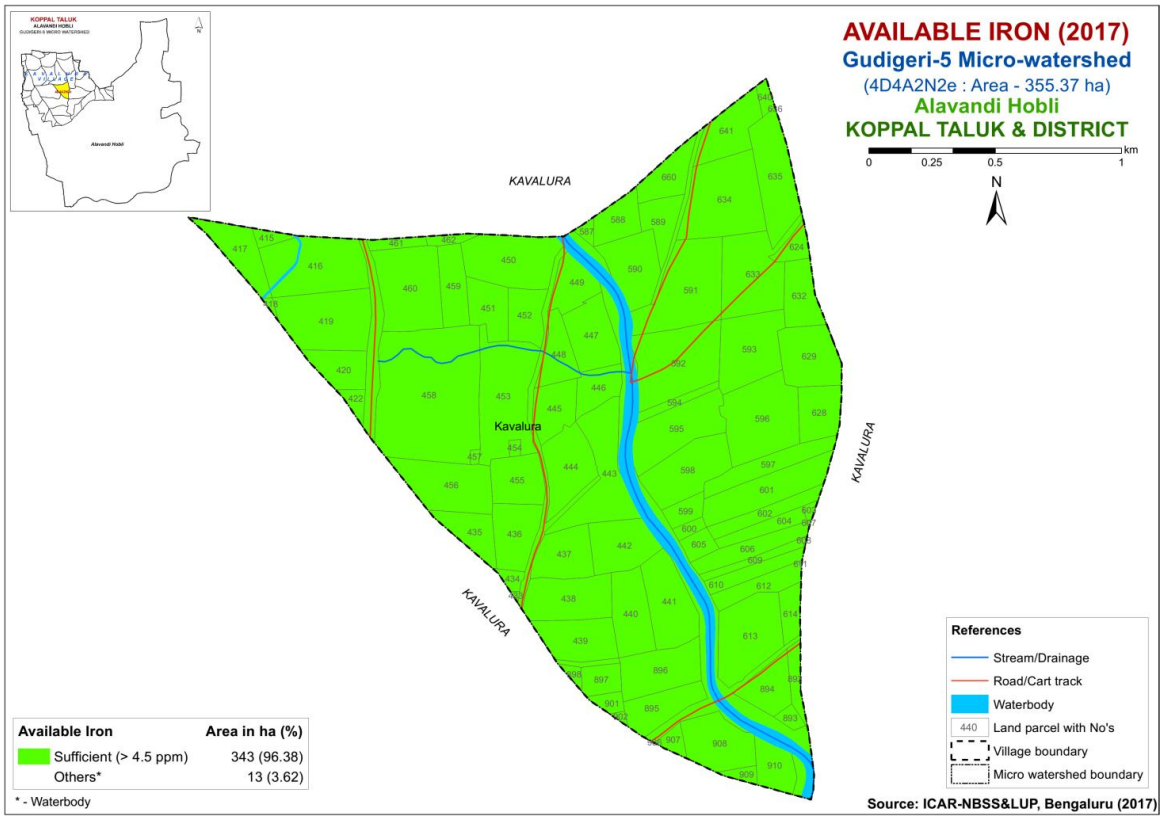


Fig.6.8 Soil Available Iron map of Gudigeri-5 Microwatershed

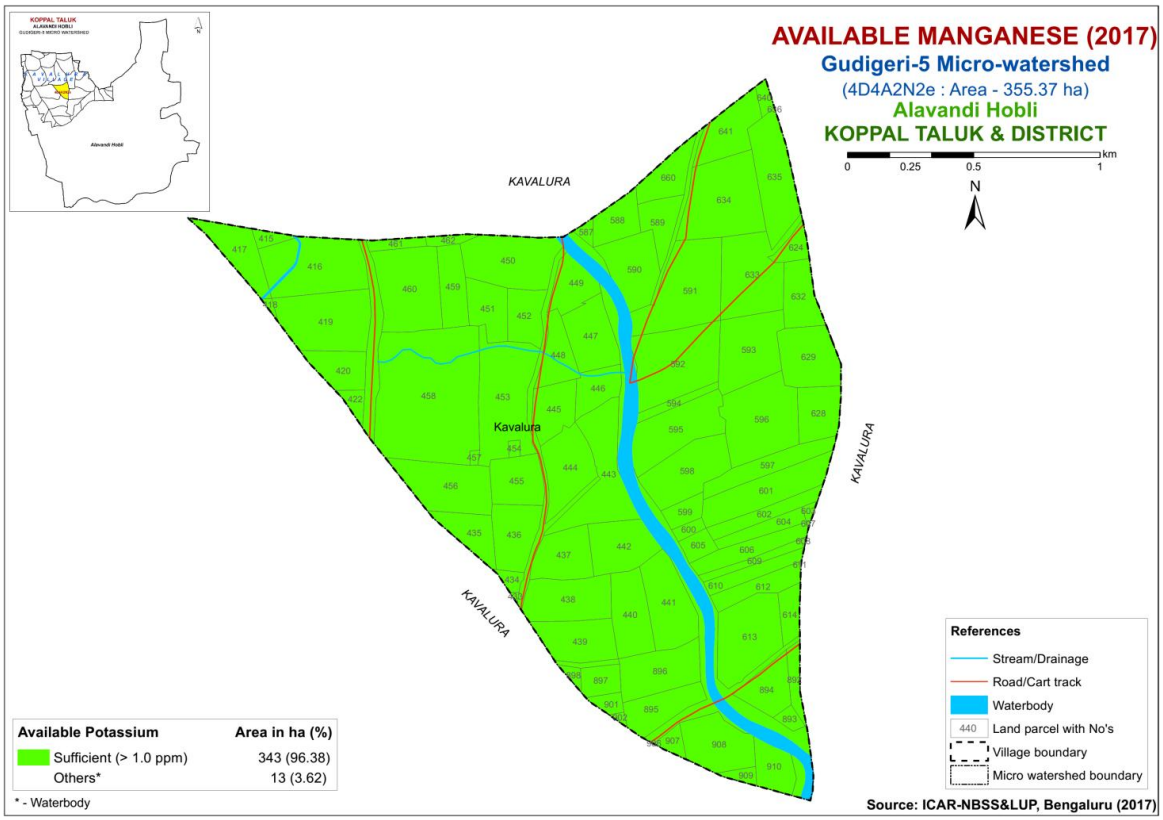


Fig.6.9 Soil Available Manganese map of Gudigeri-5 Microwatershed

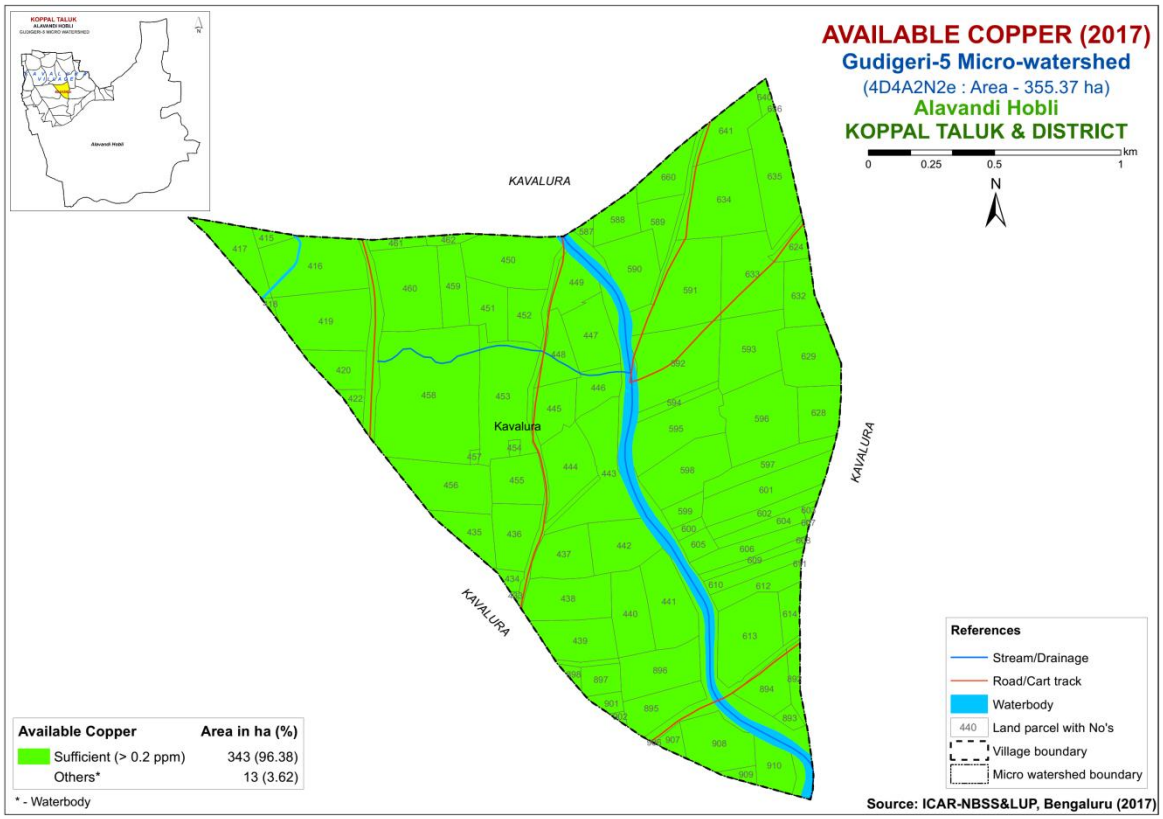


Fig.6.10 Soil Available Copper map of Gudigeri-5 Microwatershed

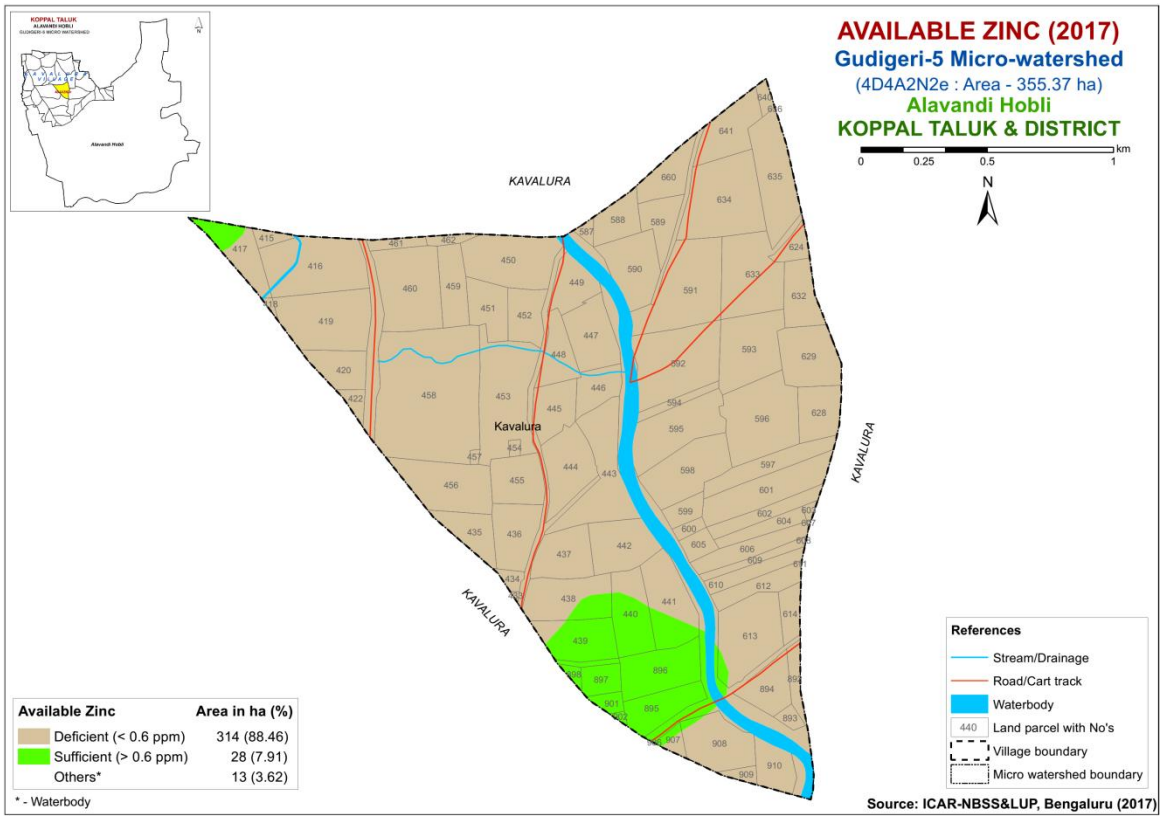


Fig.6.11 Soil Available Zinc map of Gudigeri-5 Microwatershed

Chapter 7

LAND SUITABILITY FOR MAJOR CROPS

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

Using the above criteria, the soil map units of the microwatershed were evaluated and land suitability maps for 24 major annual and perennial crops were generated. The detailed information on the kind of suitability of each of the soil phase for the crops assessed are given village/ survey number wise for the microwatershed in Appendix-III.

7.1 Land Suitability for Sorghum (*Sorghum bicolor*)

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

Highly suitable (Class S1) lands occupy an area of about 26 ha (7%) for growing sorghum and occur in the northern and northeastern part of the microwatershed. Maximum area of about 226 ha (64%) is moderately suitable (Class S2) for growing sorghum with minor limitations of rooting depth, nutrient availability, calcareousness and

Table 7.1 Soil-Site Characteristics of Gudigeri-5 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								
BGTmB2g2	662	<90	WD	<25	c	c	35-60	>35	50-100	1-3	Moderate	8.4	0.15	1.11	44.84	-
MTLmB2g1	662	<90	WD	25-50	c	c	15-35	15-35	50-100	1-3	Moderate	8.27	0.20	0.69	36.64	-
MTLmB2g2	662	<90	WD	25-50	c	c	35-60	15-35	50-100	1-3	Moderate	8.27	0.20	0.69	36.64	-
MTLmB3g3	662	<90	WD	25-50	c	c	60-80	15-35	50-100	1-3	Moderate	8.27	0.20	0.69	36.64	-
RNKmB2	662	<90	MWD	50-75	c	c	-	<15	50-100	1-3	moderate	8.86	0.48	37.0	16.94	-
RNKmB2g1	662	<90	MWD	50-75	c	c		<15	50-100	1-3	moderate	8.86	0.48	37.0	16.94	-
RNKmB2g2	662	<90	MWD	50-75	c	c	35-60	<15	50-100	1-3	moderate	8.86	0.48	37.0	16.94	-
RNKmB2g3	662	<90	MWD	50-75	c	c	60-80	<15	50-100	1-3	moderate	8.86	0.48	37.0	16.94	-
DRLmB1g1	662	<90	MWD	75-100	c	c	15-35	<15	150-200	1-3	moderate	-	-	-	-	-
DRLmB2	662	<90	MWD	75-100	c	c	-	<15	150-200	1-3	moderate	-	-	-	-	-
DRLmB2g1	662	<90	MWD	75-100	c	c	15-35	<15	150-200	1-3	moderate	-	-	-	-	-
DRLmB2g2	662	<90	MWD	75-100	c	c	35-60	<15	150-200	1-3	moderate	-	-	-	-	-
NSPmB2g1	662	<90	MWD	75-100	c	c	-	-	100-150	1-3	moderate	9.16	0.61	21.49	51.09	-
HDLmB2	662	<90	MWD	100-150	c	c	-	-	>200	1-3	moderate	9.06	0.37	12.72	62.33	-
KVRiB2g1	662	<90	MWD	100-150	sc	c	15-35	-	>200	1-3	moderate	8.4	0.26	1.50	43.25	-
KVRmA1	662	<90	MWD	100-150	c	c	-	-	>200	0-1	Slight	8.4	0.26	1.50	43.25	-
KVRmB1	662	<90	MWD	100-150	c	c	-	-	>200	1-3	moderate	8.4	0.26	1.50	43.25	-
BGPmB2g1	662	<90	MWD	100-150	c	c	15-35	<15	>200	-	-	-	-	-	-	-

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

gravelliness. An area of about 62 ha (17%) is marginally suitable for growing sorghum and is distributed in the central and southern parts, they have moderate limitations of rooting depth, calcareousness and gravelliness. An area of about 30 ha (8%) is not suitable (Class N1) for growing sorghum and occur in the central and southern part of the microwatershed.

Table 7.2 Crop suitability criteria for Sorghum

Crop requirement		Rating			
Soil –site characteristics	**Unit**	**Highly suitable (S1)**	**Moderately suitable(S2)**	**Marginally suitable (S3)**	**Not suitable (N)**
Slope	%	2-3	3-8	8-15	>15
LGP	Days	120-150	120-90	<90	
Soil drainage	Class	Well to mod. Well drained	imperfect	Poorly/excessi vely	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	30-6	>60
Salinity (EC)	dSm^{-1}	2-4	4-8	8-10	>10
Sodicity (ESP)	%	5-8	8-10	10-15	>15

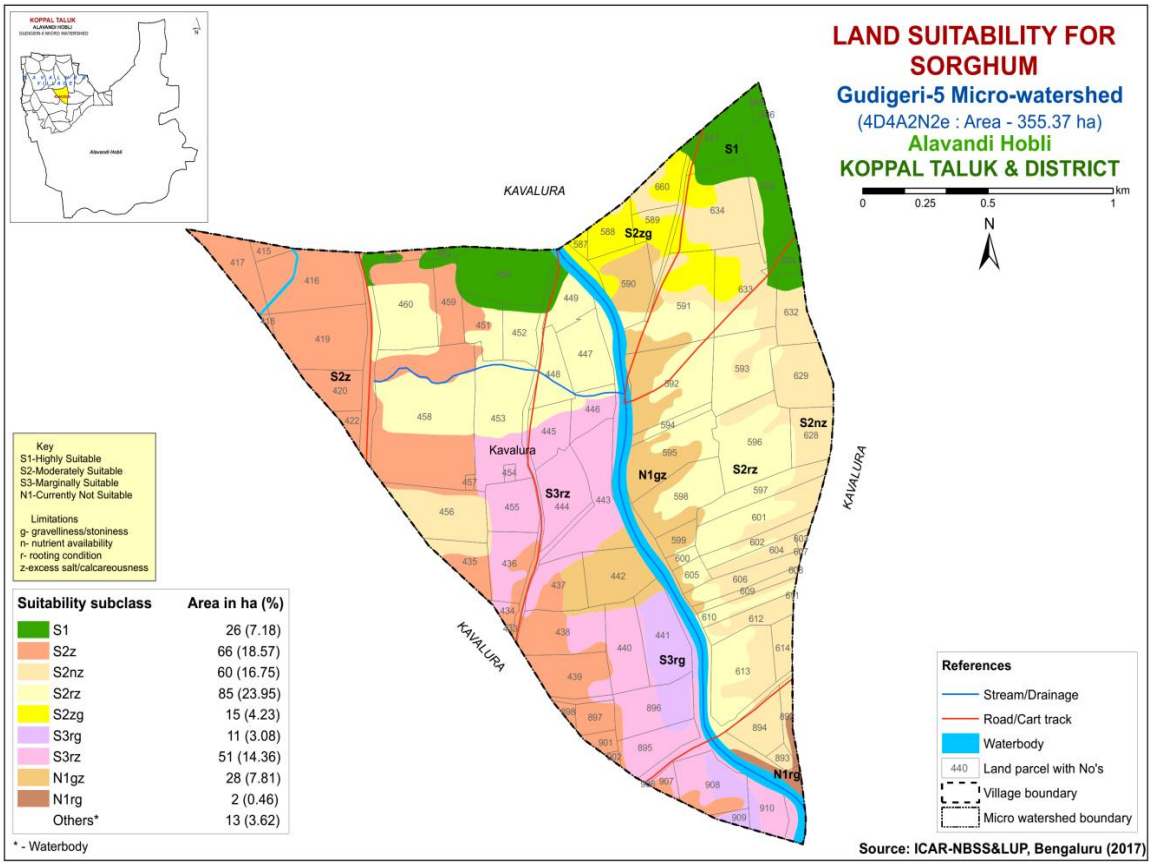


Fig. 7.1 Land Suitability map of Sorghum

7.2 Land Suitability for Maize (*Zea mays*)

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

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	

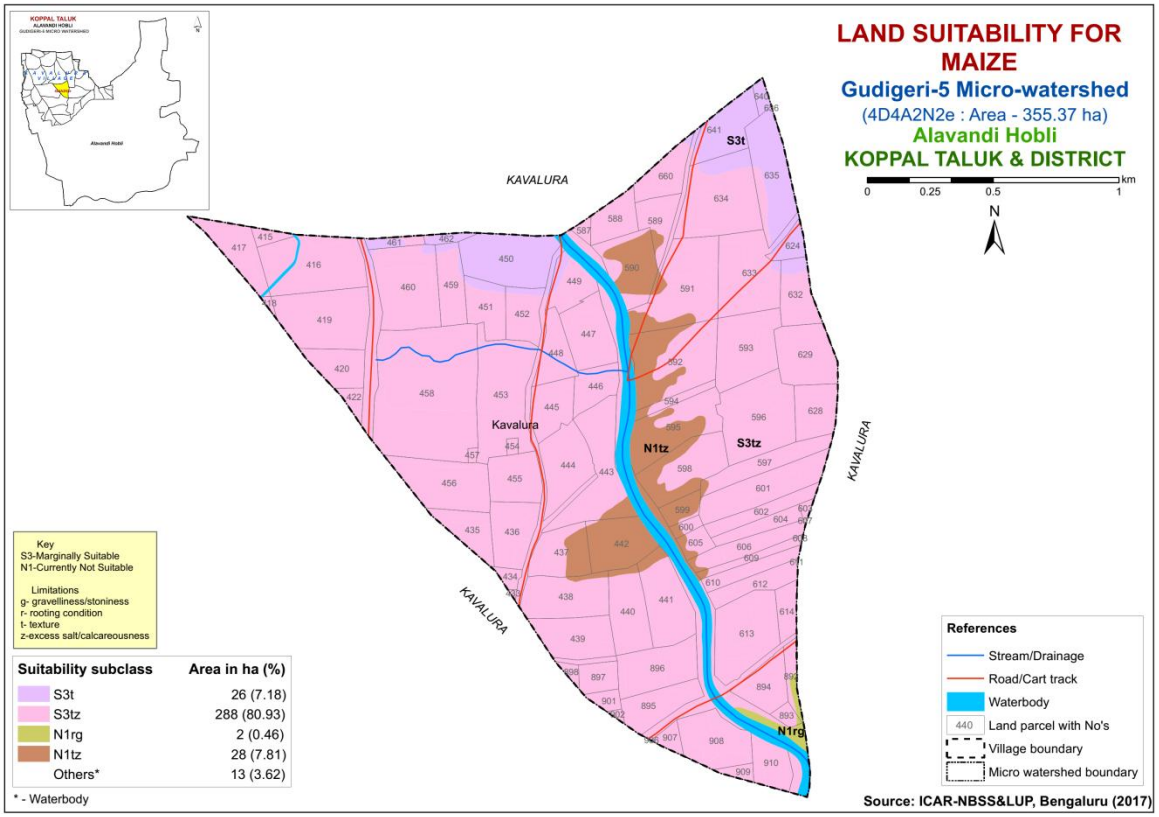


Fig. 7.2 Land Suitability map of Maize

There are no highly (S1) and moderately suitable (S2) lands for growing maize. Marginally suitable (Class S3) lands cover a maximum area of about 314 ha (88%) and occur in the major parts of the microwatershed with moderate limitations of texture and calcareousness. A small area of about 30 ha (8%) is not suitable (Class N1) for growing maize and occur in the central and northern part of the microwatershed with severe limitations of gravelliness, rooting depth, texture and calcareousness.

7.3 Land Suitability for Bajra (*Pennisetum glaucum)*

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

There are no highly (S1) and moderately suitable (S2) lands for growing Bajra. Marginally suitable (Class S3) lands cover a maximum area of about 314 ha (88%) and occur in the major part of the microwatershed with moderate limitations of texture, rooting depth and calcareousness. An area of about 30 ha (8%) is not suitable for growing bajra and occur in the central and northern part of the Microwatershed with severe limitations of gravelliness, rooting depth and calcareousness.

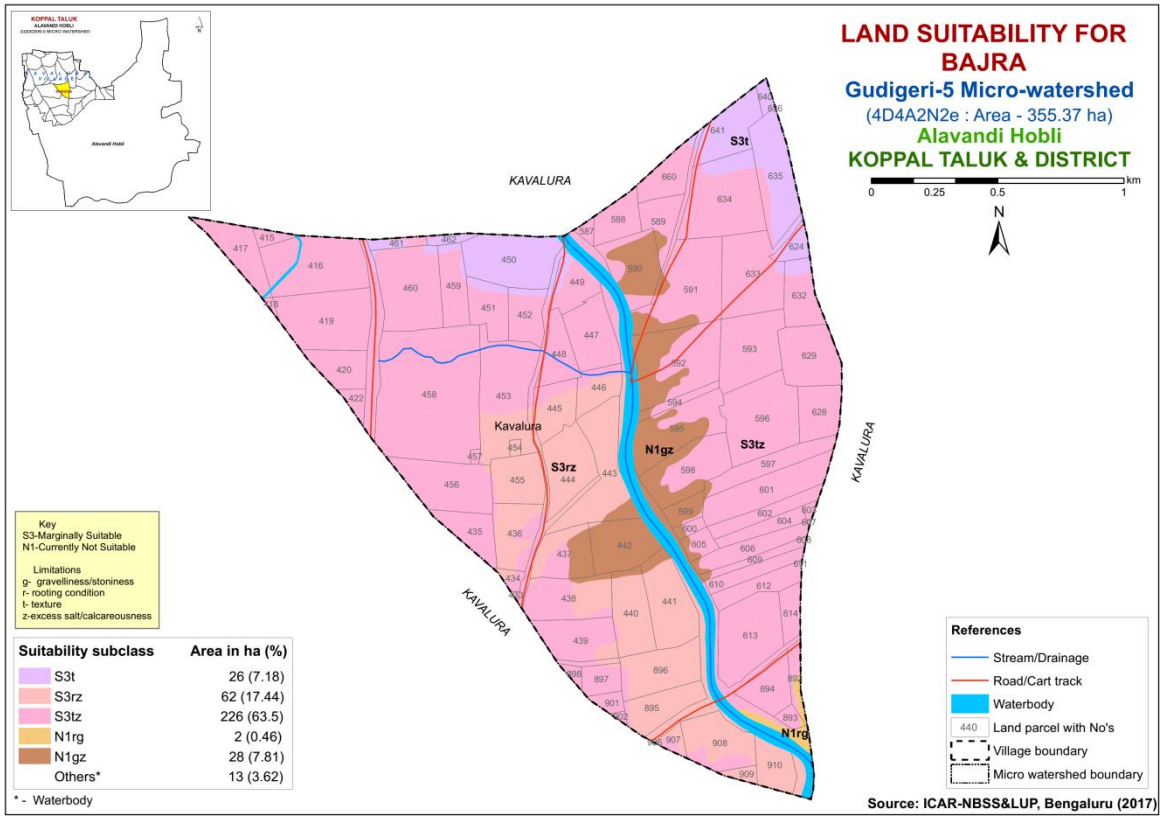


Fig. 7.3 Land Suitability map of Bajra

7.4 Land Suitability for Groundnut (*Arachis hypogaea*)

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

Table 7.4 Crop suitability criteria for Groundnut

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

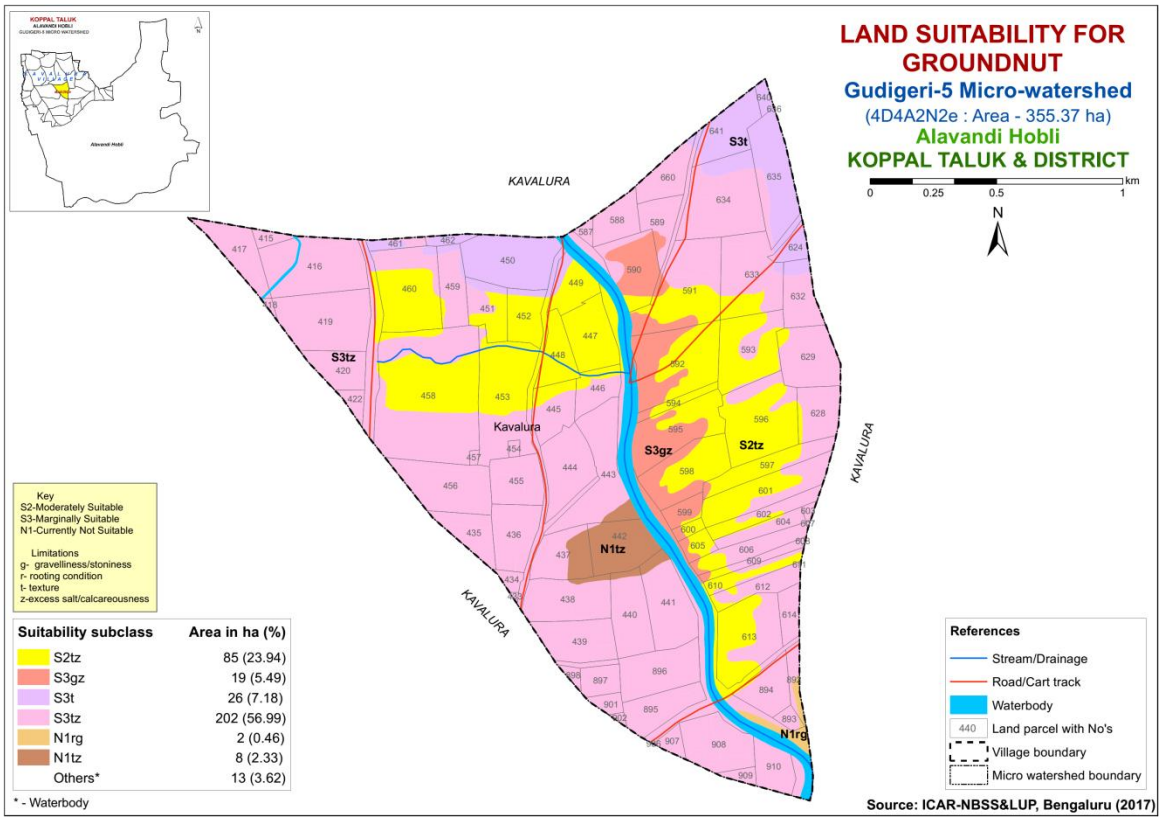


Fig. 7.4 Land Suitability map of Groundnut

An area of about 85 ha (24%) is moderately suitable (Class S2) for groundnut and are distributed in the northern,central and southern parts of the microwatershed. They have minor limitations of gravelliness, texture and calcareousness. Marginally suitable (Class S3) lands occupy major area of about 247 ha (43%) in the microwatershed with moderate limitation of texture. An area of about 10 ha (3%) area is not suitable (Class N1) for growing groundnut and occur in the central and southern part of the microwatershed with severe limitations of gravelliness, texture ,calcareousness and rooting depth.

7.5 Land Suitability for Sunflower (*Helianthus annus*)

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

An area of about 14 ha (4%) is highly suitable (Class S1) for growing sunflower and are distributed in the northeastern part of the microwatershed. An area of about 152 ha (43%) is moderately suitable (Class S2) for sunflower and are distributed in the outer corners of the microwatershed. They have minor limitations of rooting depth and calcareousness. Marginally suitable (Class S3) lands occupy an area of about 85 ha (24%) and are distributed in the central, northern and southern part of the microwatershed with moderate limitations of rooting depth and calcareousness and a an area of about 91 ha (26%) is not suitable (Class N1) for growing sunflower and occur in the central, northern and southern part of the microwatershed with severe limitations of gravelliness, calcareousness and rooting depth.

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	

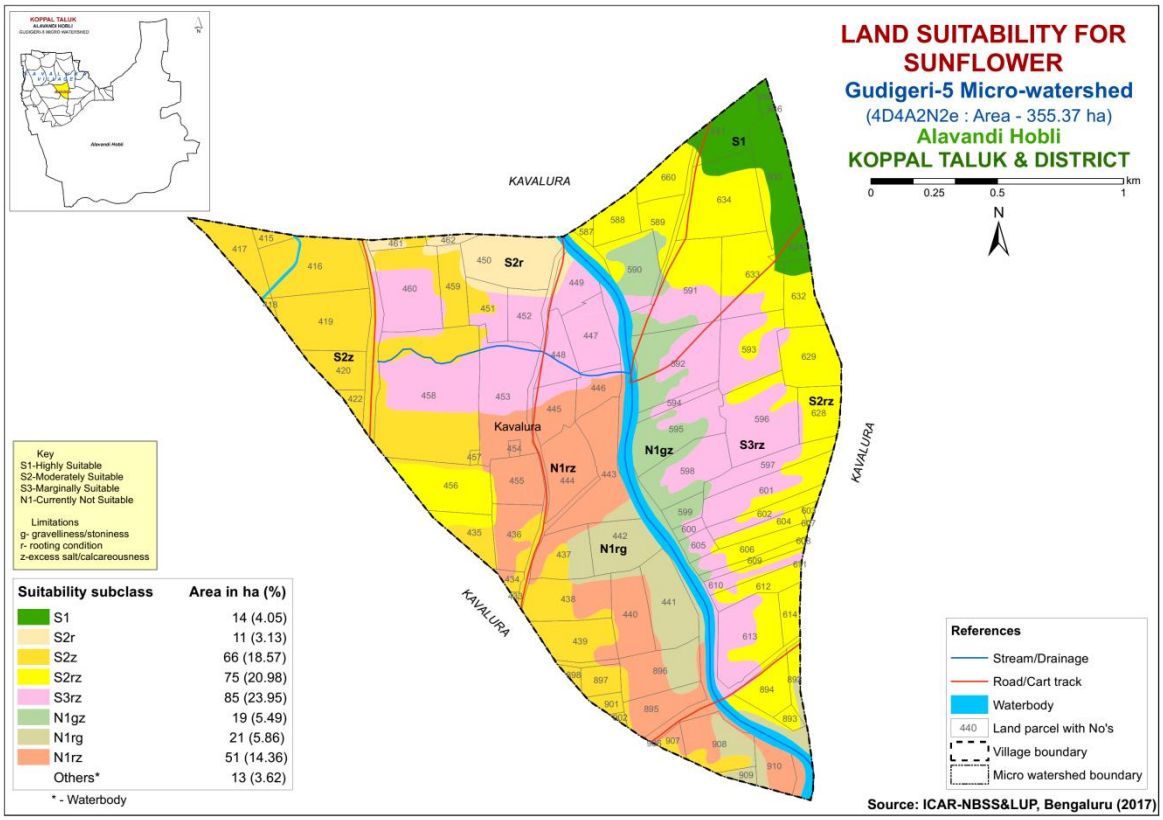


Fig. 7.5 Land Suitability map of Sunflower

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

Chilli is one of the major fruit and spice crop grown in an area of 0.42 lakh ha in Karnataka State. The crop requirements for growing chilli (Table 7.6) were matched with the soil-site characteristics (Table 7.1) of the soils of the microwatershed and a land suitability map for growing chilli was generated. The area extent and their geographic distribution of different suitability subclasses in the microwatershed are given in Figure 7.6.

Table 7.6 Crop suitability criteria for Chilli

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

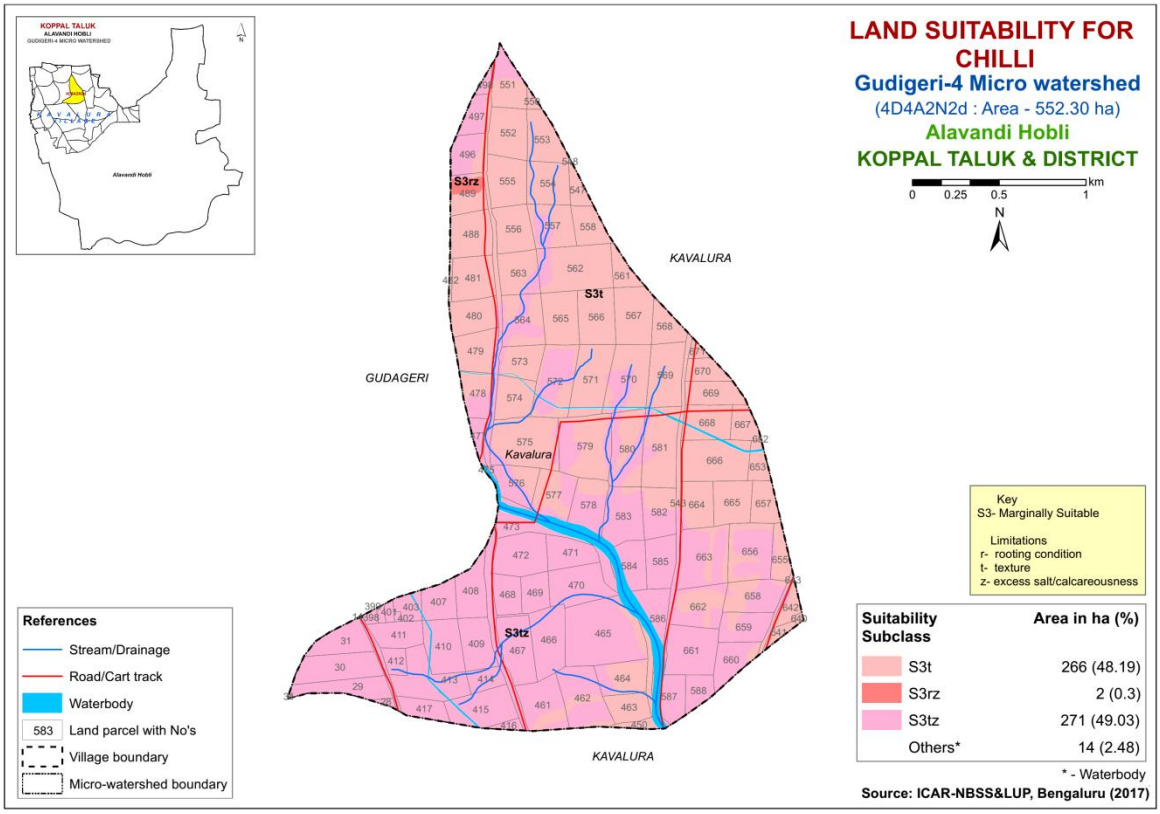


Fig. 7.6 Land Suitability map of Chilli

There are no highly (S1) and moderately suitable (S2) lands for growing chilli. Marginally suitable (Class S3) lands cover an entire area of about 314 ha (88%) and occur in major part of the microwatershed. They have moderate limitations of texture, rooting and calcareousness. They have moderate limitations texture, rooting depth and calcareousness. An area of about 29 ha(8%) is not suitable (Class N1) for growing chilli and occur in the central, northern and southern part of the microwatershed with severe limitations of gravelliness, calcareousness and rooting depth.

7.7 Land Suitability for Tomato (*Solanum lycopersicum*)

Tomato is the most important vegetable and fruit crop grown in an area of 0.65 lakh ha in almost all the districts of the State. The crop requirements (Table 7.9) for growing tomato were matched with the soil-site characteristics (Table 7.1) and a land suitability map for growing tomato was generated. The area extent and their geographic distribution of different suitability subclasses in the microwatershed are given in Figure 7.7.

There are no highly (S1) and moderately suitable (S2) lands for growing tomato. Marginally suitable (Class S3) lands cover maximum area of about 314 ha (88%) and occur in the major part of the microwatershed with moderate limitations of texture, rooting depth and calcareousness. Area not suitable (class N1) for growing tomato are distributed in the southern, central and northern parts covering an area of about 29 ha (8%) with severe limitations of rooting depth, gravelliness, calcareousness and texture.

Table 7.7 Crop suitability criteria for Tomato

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

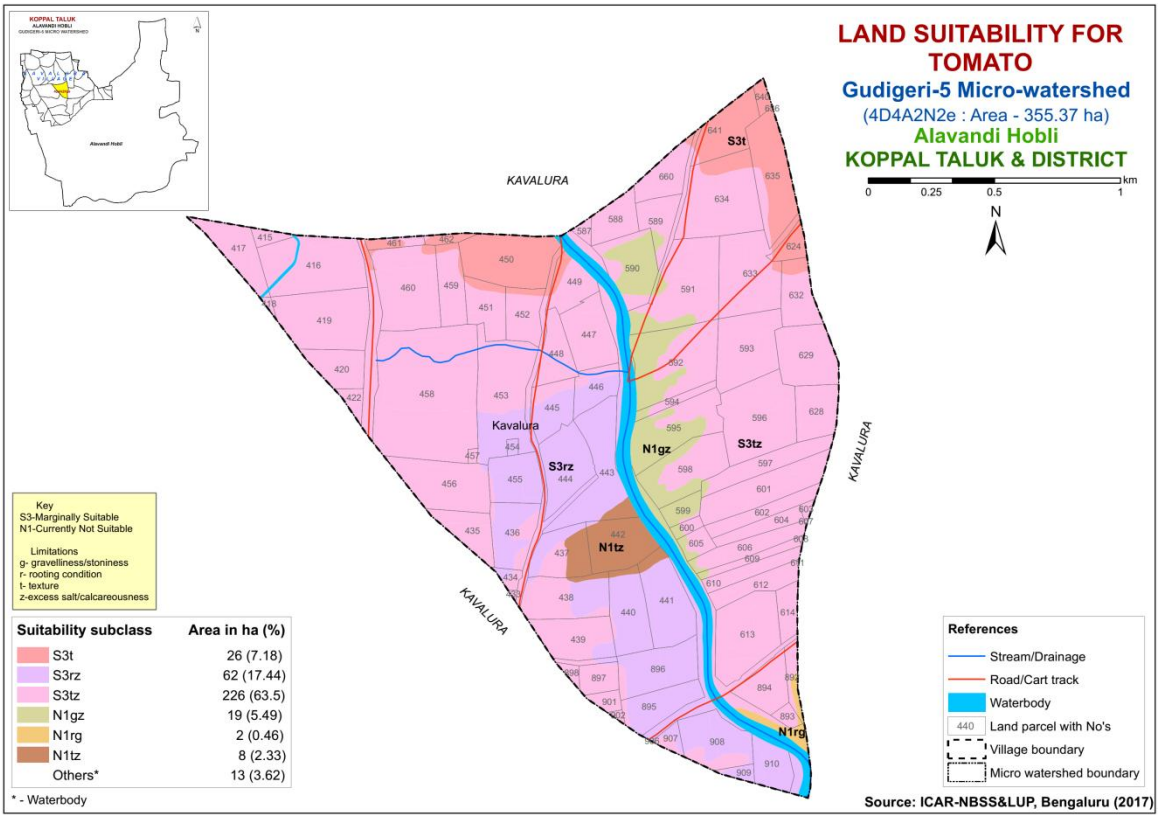


Fig. 7.7 Land Suitability map of Tomato

7.8 Land Suitability for Drumstick (*Moringa oleifera)*

Drumstick is one of the most important vegetable crop grown in 2403 ha area in the state. The crop requirements for growing drumstick (Table 7.8) were matched with the soil-site characteristics (Table 7.1) and a land suitability map for growing drumstick

was generated. The area extent and their geographical distribution of different suitability subclasses in the microwatershed is given in Figure 7.8.

Table 7.8 Land suitability criteria for Drumstick

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	Moderately well drained	Poorly drained	V. Poorly drained
Nutrient availability	Texture	Class	Sc,scl,cl,c(red)	Sl, c (black)	ls	S
	pH	1:2.5	5.5-6.5	5-5.5:6.5-7.3	7.8-8.4	>8.4
Rooting conditions	Soil depth	cm	>100	75-100	50-75	<50
	Gravel content	% vol.	0-35	35-60	60-80	>80
Erosion	Slope	%	0-3	3-10	-	>10

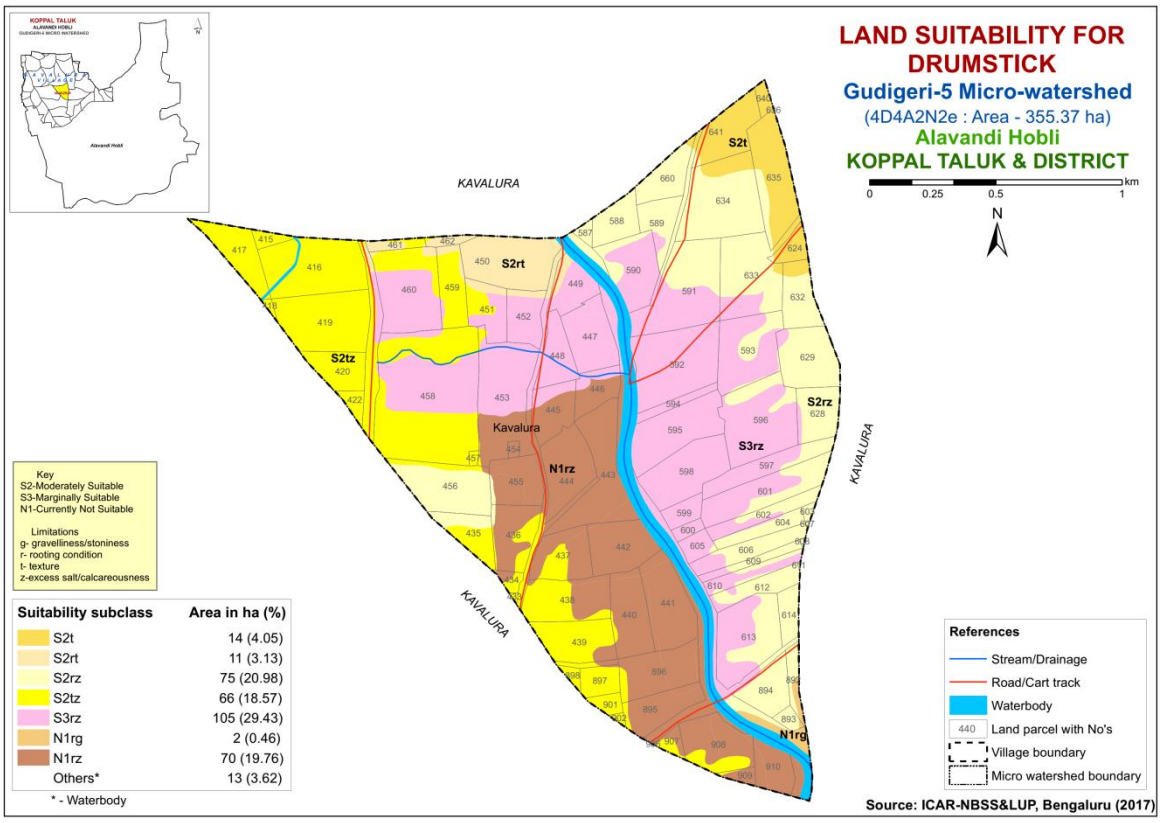


Fig. 7.8 Land Suitability map of Drumstick

Moderately suitable (Class S2) lands occupy an area of about 166 ha (47%) and occur in the outer corners of the microwatershed with minor limitations of rooting depth and texture. Marginally suitable lands cover an area of about 105 ha (29%) and occur in the central, northern and southern part of the microwatershed. They have moderate limitations of rooting depth and calcareousness. An area of about 72 ha (20%) is not suitable (Class N1) for growing drumstick and occur in the central and southern part of the microwatershed and have severe limitations of rooting depth, gravelliness and calcareousness.

7.9 Land Suitability for Mulbery (*Morus nigra*)

Mulbery is the most important leaf crop grown for rearing silkworms in about 1.66 lakh ha in all the districts of the state. The crop requirements for growing mulbery (Table 7.9) were matched with the soil-site characteristics (Table 7.1) and a land suitability map for growing mulbery was generated. The area extent and their geographical distribution of different suitability subclasses in the microwatershed is given in Figure 7.9.

Table 7.9 Land suitability criteria for Mulberry

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	Moderately well drained	Poorly drained	V. Poorly drained
Nutrient availability	Texture	Class	Sc, cl, scl	C (red)	C(black),sl, ls	-
	pH	1:2.5				
Rooting conditions	Soil depth	cm	>100	75-100	50-75	<50
	Gravel content	% vol.	0-35	35-60	60-80	>80
Erosion	Slope	%	0-3	3-5	5-10	>10

Note: Suitability evaluation only for Mulberry leaf not for Silk worm rearing

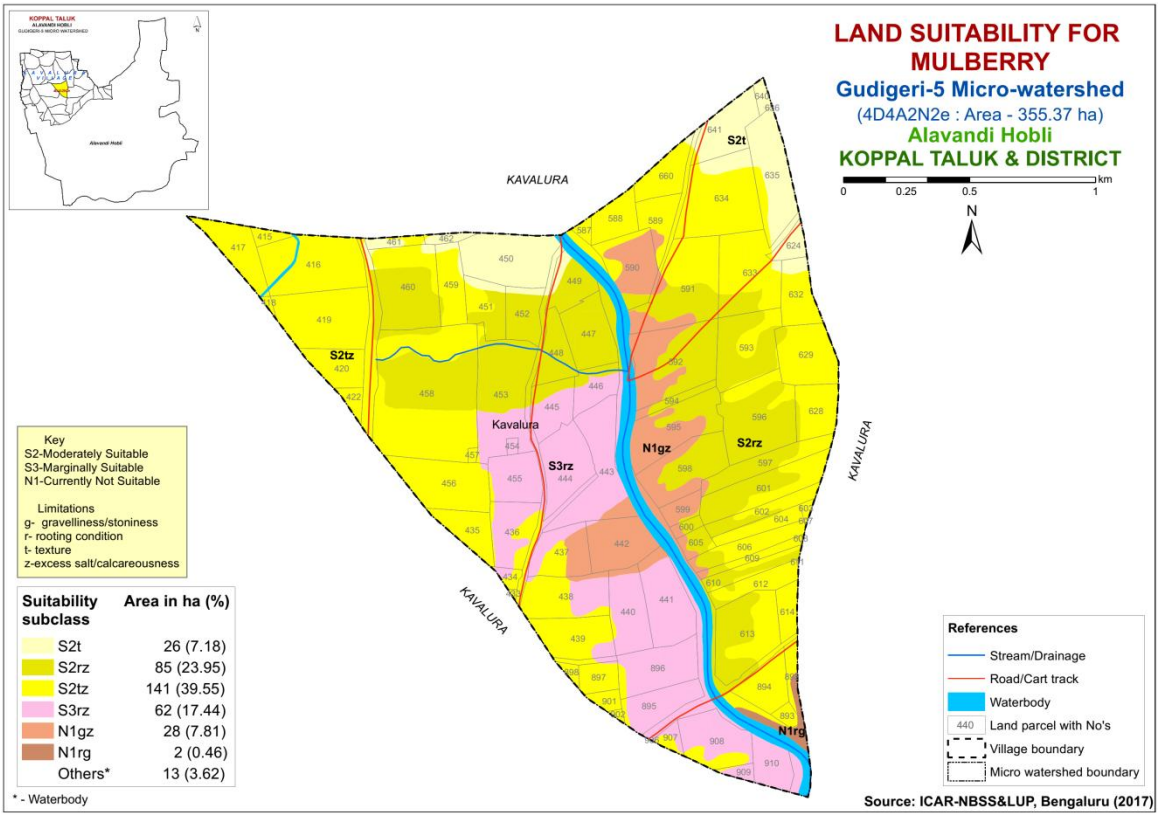


Fig. 7.9 Land Suitability map of Mulberry

Moderately suitable (Class S2) lands occupy maximum area of about 252 ha (71%) and occur in the northern and northeastern part of the microwatershed. They have minor limitations of texture and calcareousness. Marginally suitable lands cover an area

of about 62 ha (17%) and occur in the central and southern part of the microwatershed. They have moderate limitations of rooting depth and calcareousness. Not suitable (class N1) lands cover an area of about 30 ha (8%) and are distributed in the central, northern and southeastern part of the microwatershed.

7.10 Land suitability for Mango (*Mangifera indica*)

Mango is one of the most important fruit crop grown in about 1.73 lakh ha in almost all the districts of the State. The crop requirements (Table 7.10) for growing mango were matched with the soil-site characteristics (Table 7.1) and a land suitability map for growing mango was generated. The area extent and their geographic distribution of different suitability subclasses in the microwatershed are given in Figure 7.10.

There are no highly (S1) lands for growing mango, moderately suitable (S2) lands covers an area of about 34 ha (9%) and are distributed in the southwestern and northwestern part of the microwatershed. Marginally suitable (Class S3) lands cover an area of about 132 ha (37%) and occur in the eastern, northern and northwestern part of the microwatershed. They have moderate limitations of rooting depth, texture and calcareousness. Not suitable lands (Class N1) for growing mango occur in an area of about 177 ha (50%) and are distributed in the central, northern and southern parts of the microwatershed with severe limitations of rooting depth, texture and calcareousness.

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 imp. drained	Poor drained	V. poorly drained
	Water table	M	>3	2.50-3.0	2.5-1.5	<1.5
Nutrient availability	Texture	Class	Sc,l, sil, cl	Sl, sc, sic,l,c	C (<60%)	C(>60%),
	pH	1:2.5	5.5-7.5	7.6-8.5:5.0-5.4	8.6-9.0:4.0-4.9	>9.0<4.0
	OC	%	High	medium	low	
	$CaCO_3$ in root zone	%	Non calcareous	<5	5-10	>10
Rooting conditions	Soil depth	cm	>200	125-200	75-125	<75
	Gravel content	%vol	Non-gravelly	<15	15-35	>35
Soil toxicity	Salinity	dS/m	Nonsaline	<2.0	2.0-3.0	>3.0
	Sodicity	%	Non sodic	<10	10-15	>15
Erosion	Slope	%	<3	3-5	5-10	

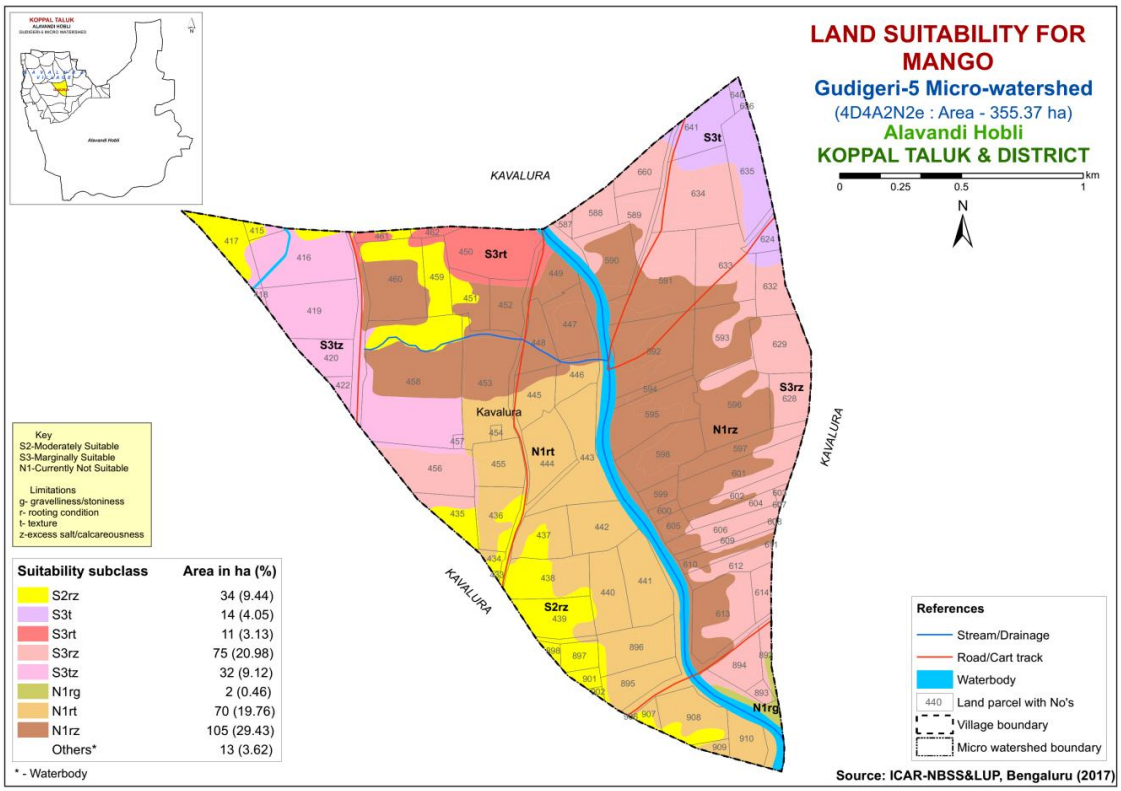


Fig. 7.10 Land Suitability map of Mango

7.11 Land suitability for Sapota (*Manilkara zapota*)

Sapota is one of the most important fruit crop grown in an area of about 29373 ha in almost all the districts of the state. The crop requirements (Table 7.11) for growing sapota were matched with the soil-site characteristics (Table 7.1) and a land suitability map for growing sapota was generated. The area extent and their geographic distribution of different suitability subclasses in the microwatershed are given in Figure 7.11.

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 availability	Texture	Class	Scl, l, cl, sil	Sl, sicl, sc	C (<60%)	ls,s,C(>60%)
	pH	1:2.5	6.0-7.5	7.6-8.0:5.0-5.9	8.1-9.0:4.5-4.9	>9.0:<4.5
	$CaCO_3$ in root zone	%	Non calcareous	<10	10-15	>15
Rooting conditions	Soil depth	Cm	>150	75-150	50-75	<50
	Gravel content	%vol.	Non gravelly	<15	15-35	<35
Soil toxicity	Salinity	dS/m	Non saline	Up to 1.0	1.0-2.0	2.0-4.0
	Sodicity	%	Non sodic	10-15	15-25	>25
Erosion	Slope	%	<3	3-5	5-10	>10

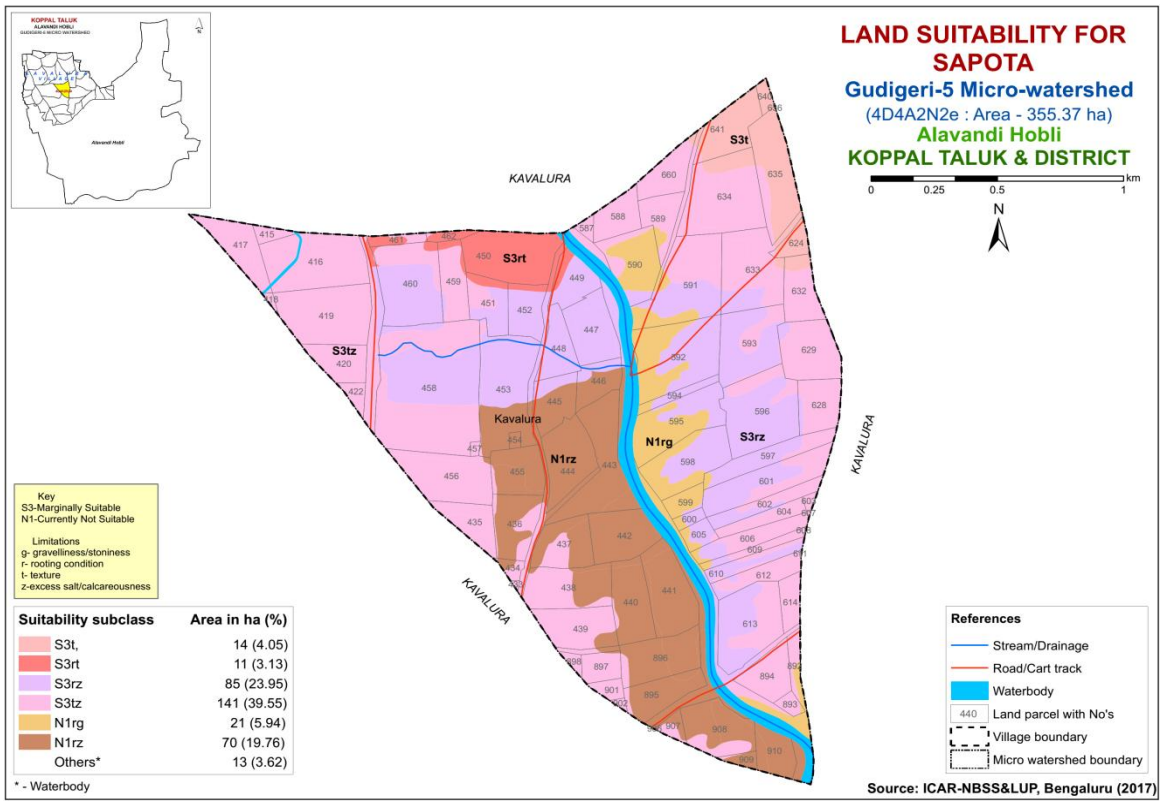


Fig. 7.11 Land Suitability map of Sapota

There are no highly (S1) and moderately suitable (S2) lands for growing sapota. Marginally suitable (Class S3) lands cover a maximum area of about 251 ha (71%) and occur in the major parts of the microwatershed. They have moderate limitations of rooting depth, texture and calcareousness. An area of about 91 ha (26%) is not suitable (Class N1) for growing sapota and occur in the southern and central part of the microwatershed with severe limitations of gravelliness, rooting depth and calcareousness.

7.12 Land Suitability for Pomegranate (*Punica granatum*)

Pomegranate is one of the commercially grown fruit crop in about 18488 ha in Karnataka mainly in Bijapur, Bagalkot, Koppal, Gadag and Chitradurga districts. The crop requirements for growing pomegranate (Table 7.12) were matched with the soil-site characteristics (Table 7.1) of the soils of the microwatershed and a land suitability map for growing pomegranate was generated. The area extent and their geographic distribution of different suitability subclasses in the microwatershed are given in Figure 7.12.

Moderately suitable (Class S2) lands occupy an area of about 166 ha (46%) and are distributed in the major part of the microwatershed. They have minor limitations of rooting depth, texture and calcareousness. Marginally suitable (Class S3) lands for growing pomegranate occupy an area of about 106 ha (29%) and are distributed in the northern, southern and central part of the microwatershed with moderate limitations of gravelliness, rooting depth and calcareousness. An area of about 72 ha (20%) is not suitable (Class N1) for growing pomegranate and occur in the central and southern part of

the microwatershed and have severe limitations of gravelliness, rooting depth and calcareousness

Table 7.12 Crop suitability criteria for Pomegranate

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

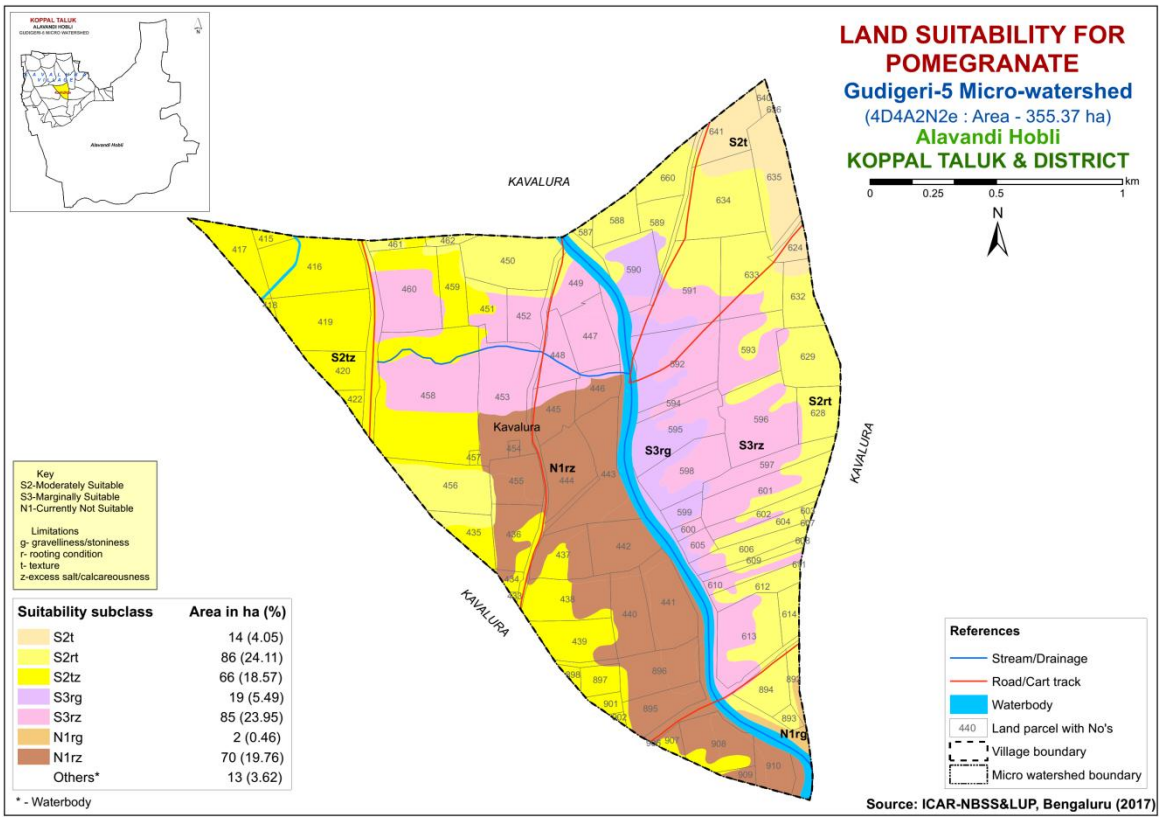


Fig. 7.12 Land Suitability map of Pomegranate

7.13 Land suitability for Guava (*Psidium guajava*)

Guava is one of the most important fruit crop grown in an area of about 6558 ha in almost all the districts of the state. The crop requirements (Table 7.13) for growing guava

were matched with the soil-site characteristics (Table 7.1) and a land suitability map for growing guava was generated. The area extent and their geographic distribution of different suitability subclasses in the microwatershed are given in Figure 7.13.

Table 7.13 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 imp.	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

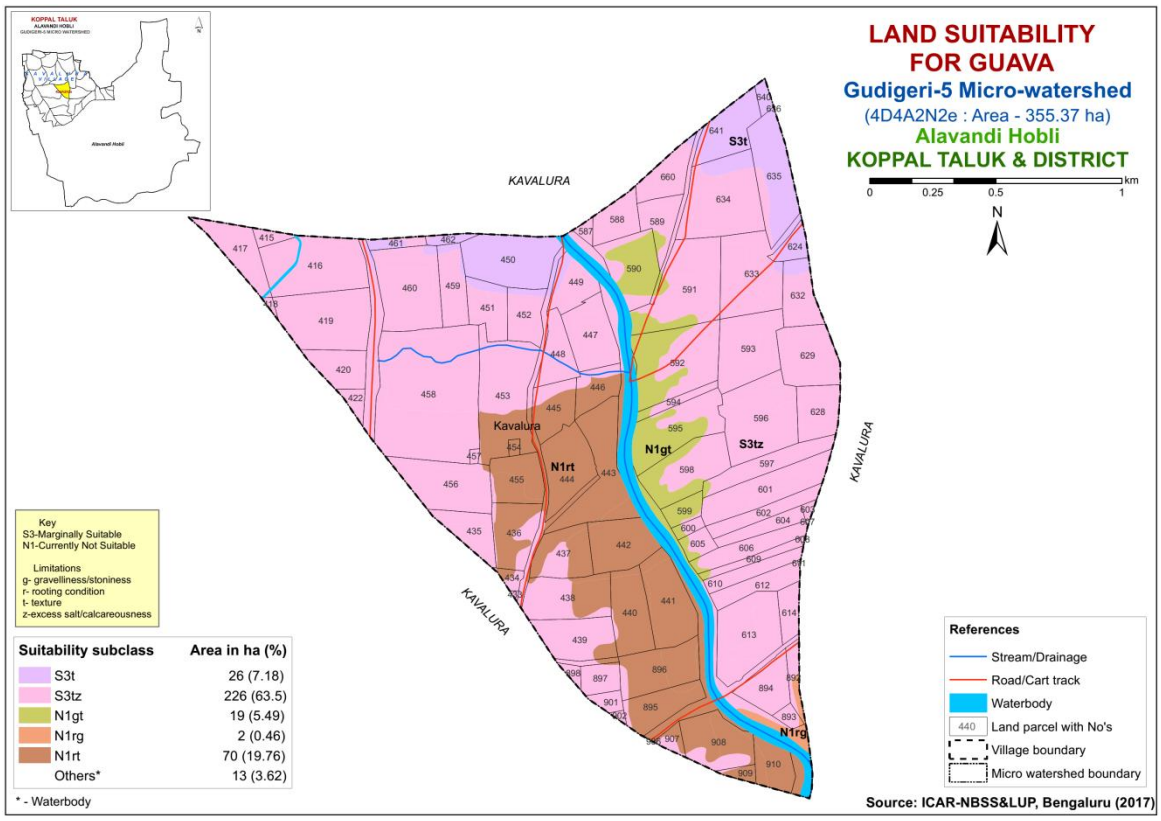


Fig. 7.13 Land Suitability map of Guava

There are no highly (Class S1) and moderately suitable (Class S2) lands for growing guava. Marginally suitable (Class S3) lands cover a maximum area of about 252 ha (71 %) and occur in major part of the microwatershed. They have moderate limitations of texture and calcareousness. An area of about 91 ha (26%) is not suitable (Class N1) for growing guava and occur in the southern and central part of the microwatershed with severe limitations of gravelliness, rooting depth and texture.

7.14 Land Suitability for Jackfruit (*Artocarpus heterophyllus*)

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

There are no highly (Class S1) and moderately suitable (Class S2) lands for growing jackfruit. Marginally suitable (Class S3) lands cover a maximum area of about 252 ha (71 %) and occur in the major part of the microwatershed. They have moderate limitations of texture and calcareousness. An area of about 91 ha (26%) is not suitable (Class N1) for growing jackfruit and occur in the southern and central part of the microwatershed with severe limitations of gravelliness, rooting depth and texture.

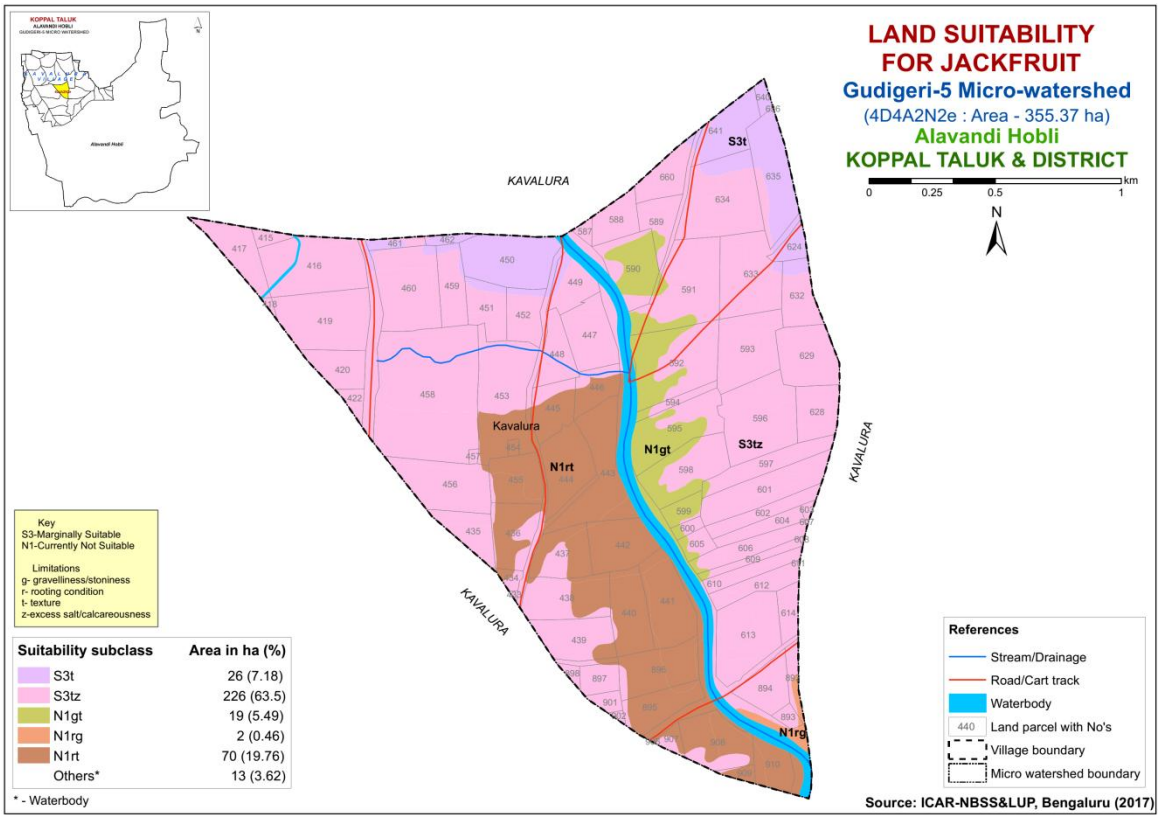


Fig. 7.14 Land Suitability map of Jackfruit

7.15 Land Suitability for Jamun (*Syzygium cumini*)

Jamun is an important fruit crop grown in almost all the districts of the state. The crop requirements for growing jamun were matched with the soil-site characteristics and a land suitability map for growing jamun was generated. The area extent and their geographic distribution of different suitability subclasses in the microwatershed are given in Figure 7.15.

There are no highly suitable (Class S1) lands for growing jamun. An area of about 80 ha (23%) is moderately suitable (Class S2) and occur in the northwestern, northeastern and western part of the microwatershed. They have minor limitations of rooting depth, texture and calcareousness. The marginally suitable (Class S3) lands cover an area of about 171 ha (48%) and are distributed in the northern, eastern and southern part of the microwatershed with moderate limitations of rooting depth, calcareousness and texture. An area of about 91 ha (26%) is not suitable for growing jamun and are distributed in the southern and central parts of the microwatershed.

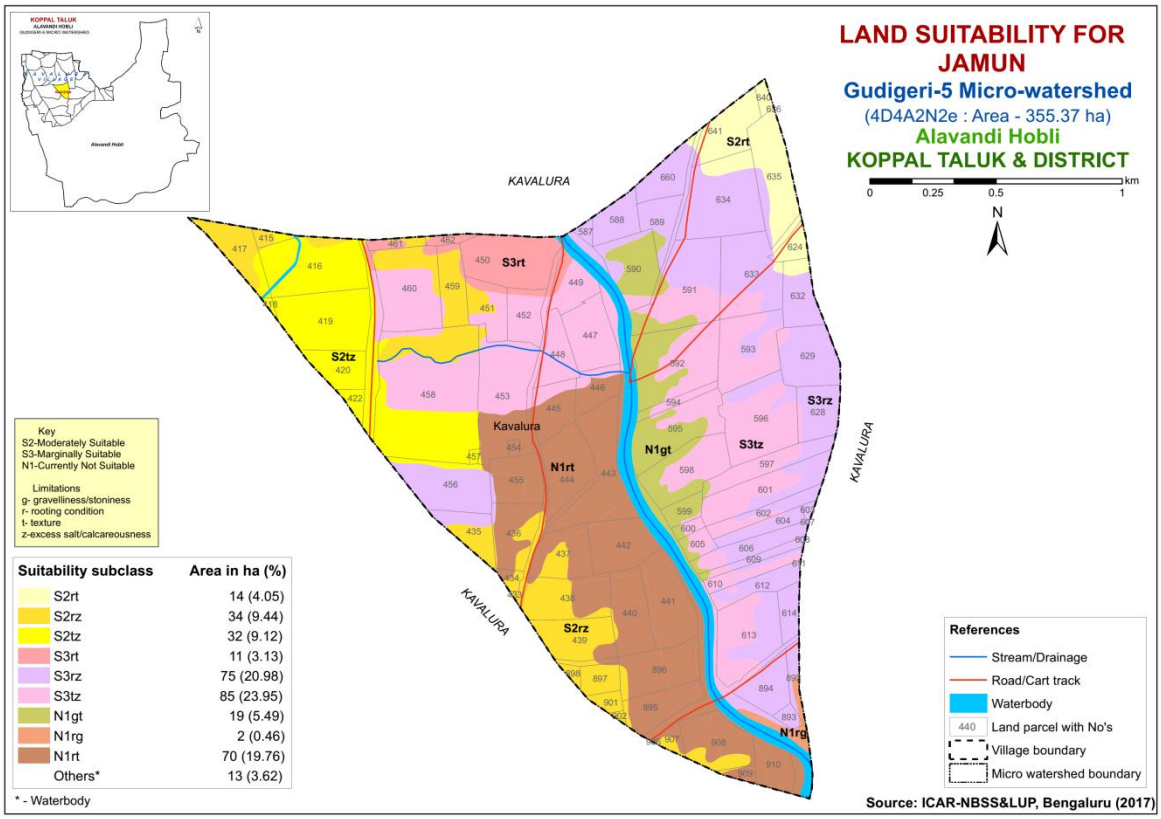


Fig. 7.15 Land Suitability map of Jamun

7.16 Land Suitability for Musambi (*Citrus limetta*)

Musambi is one of the most important fruit crop grown in an area of 5446 ha in almost all the districts of the state. The crop requirements for growing musambi were matched with the soil-site characteristics (Table 7.14) and a land suitability map for growing musambi was generated. The area extent and their geographic distribution of different suitability subclasses in the microwatershed are given in Figure 7.16.

Table 7.14 Crop suitability criteria for Musambi

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

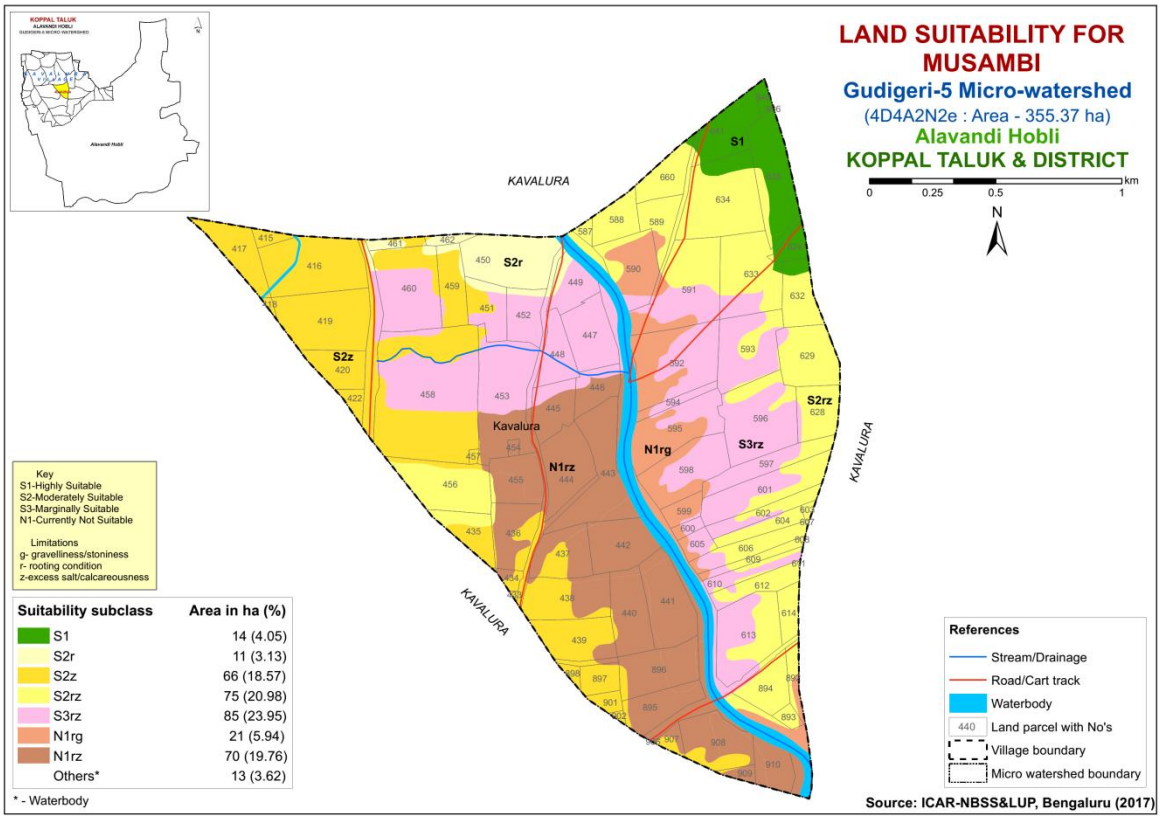


Fig. 7.16 Land Suitability map of Musambi

An area of about 14 ha (4%) is highly suitable (Class S1) for growing musmabi and are distributed in the northeastern part of the microwatershed. An area of about 152 ha (43%) is moderately suitable (Class S2) and occurs in the major of the microwatershed. They have minor limitations of rooting depth and calcareousness. An

area of about 85 ha (24%) is marginally suitable (Class S3) for growing musambi and are distributed in the northern and central part of the microwatershed with moderate limitations of calcareousness and rooting depth. An area of about 91 ha (26%) is not suitable (Class N1) for growing musambi with severe limitations of rooting depth, calcareousness and gravelliness and are distributed in the southern and central part of the microwatershed.

7.17 Land Suitability for Lime (*Citrus sp*)

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

Table 7.15 Crop suitability criteria for Lime

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

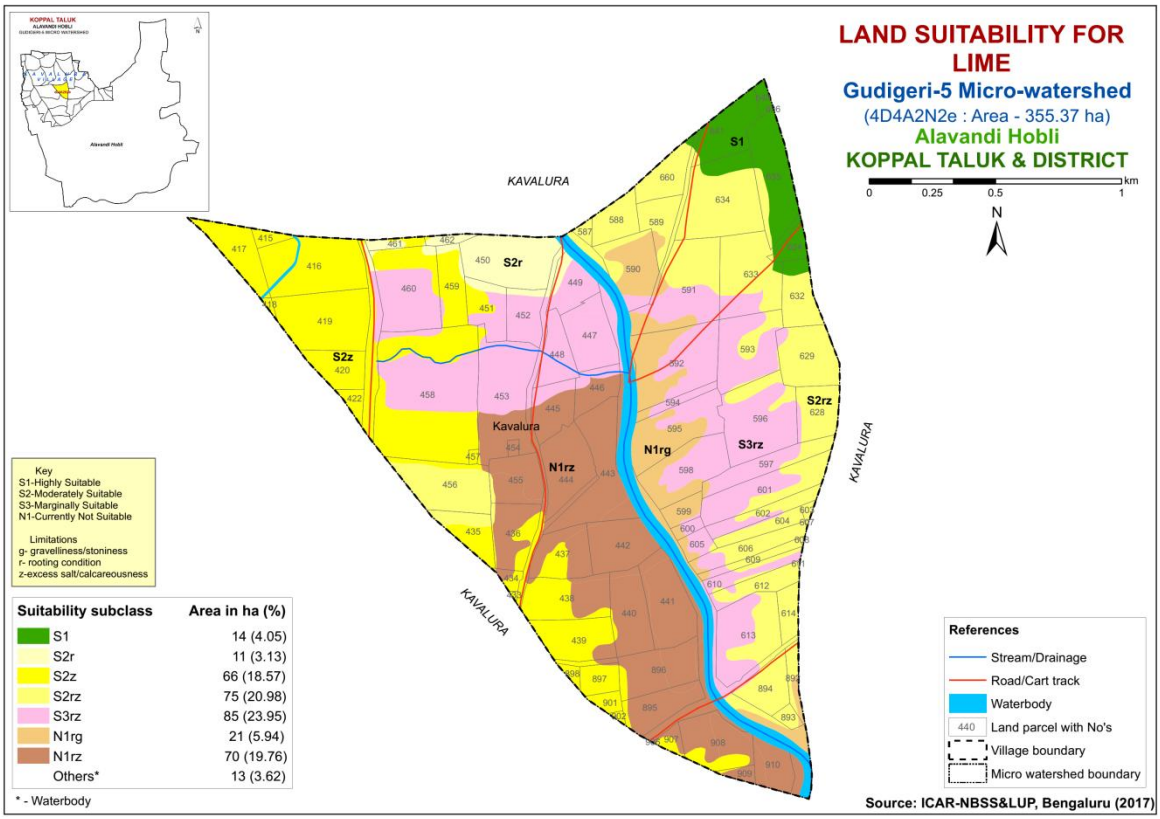


Fig. 7.17 Land Suitability map of Lime

An area of about 14 ha (4%) is highly suitable (Class S1) for growing lime and are distributed in the northeastern part of the microwatershed. An area of about 152 ha (43%) is moderately suitable (Class S2) and occur in the major part of the microwatershed. They have minor limitations of rooting depth and calcareousness. An area of about 85ha (24%) is marginally suitable (Class S3) for growing lime and are distributed in the northern and central part of the microwatershed with moderate limitations of calcareousness and rooting depth. An area of about 91 ha (26%) is not suitable (Class N1) for growing lime with severe limitations of rooting depth, calcareousness and gravelliness and are distributed in the southern and central part of the microwatershed.

7.18 Land Suitability for Cashew (*Anacardium occidentale)*

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

Entire area is not suitable (Class N1) for growing cashew in the microwatershed with limitations of texture, gravelliness, rooting depth and calcareousness.

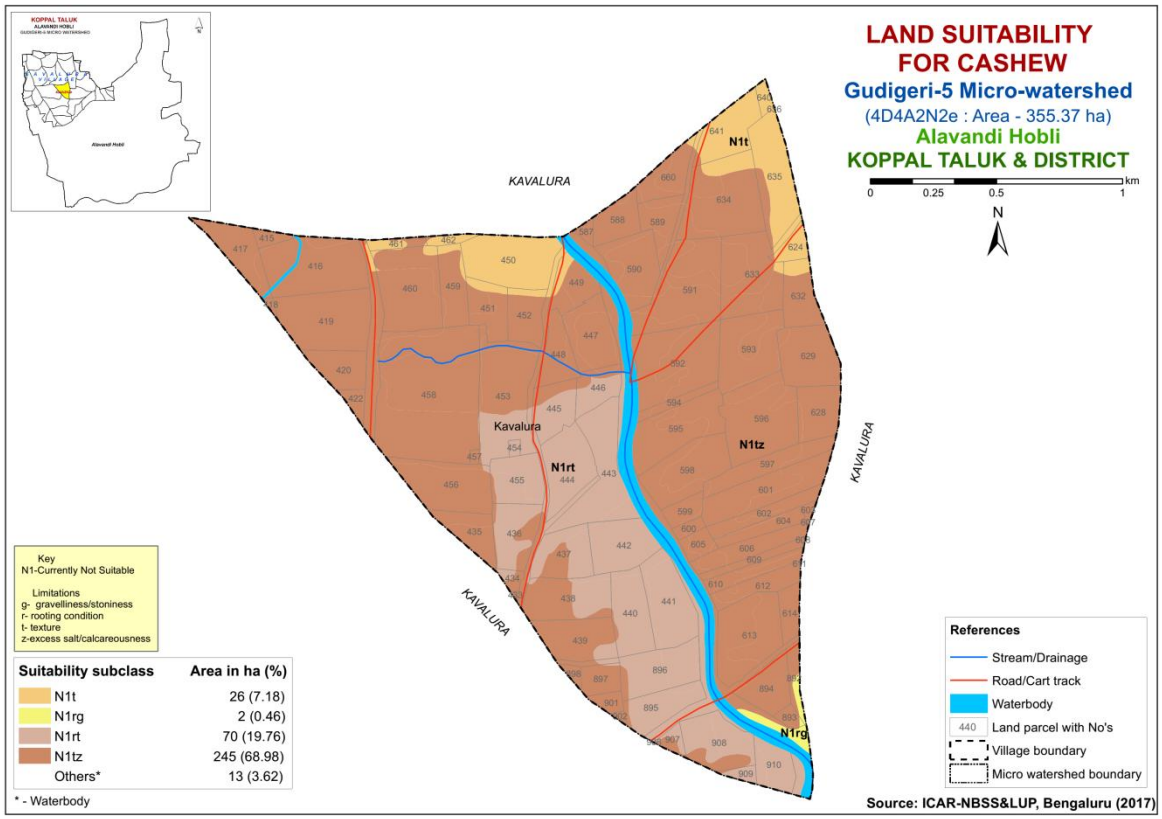


Fig. 7.18 Land Suitability map of Cashew

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

Custard apple is one of the most important fruit crop grown in 1426 ha in almost all the districts of the State. The crop requirements for growing custard apple were matched with the soil-site characteristics (Table 7.1) and a land suitability map for growing custard apple was generated .The area extent and their geographic distribution of different suitability subclasses in the microwatershed are given in Figure 7.19.

An area of about 26 ha (7%) is highly suitable (Class S1) for growing custard apple and are distributed in the northern and northeastern part of the microwatershed. An area of about 225 ha (64%) is moderately suitable (Class S2) and occur in the major part of the microwatershed. They have minor limitations of rooting depth, calcareousness and gravelliness. An area of about 89 ha (25%) is marginally suitable (Class S3) for growing custard apple and are distributed in the southern and central part of the microwatershed with moderate limitations of calcareousness and gravelliness. About 2 ha (<%) is not suitable (Class N1) for growing custard apple with severe limitations of rooting depth and gravelliness and is distributed in the southern part of the microwatershed.

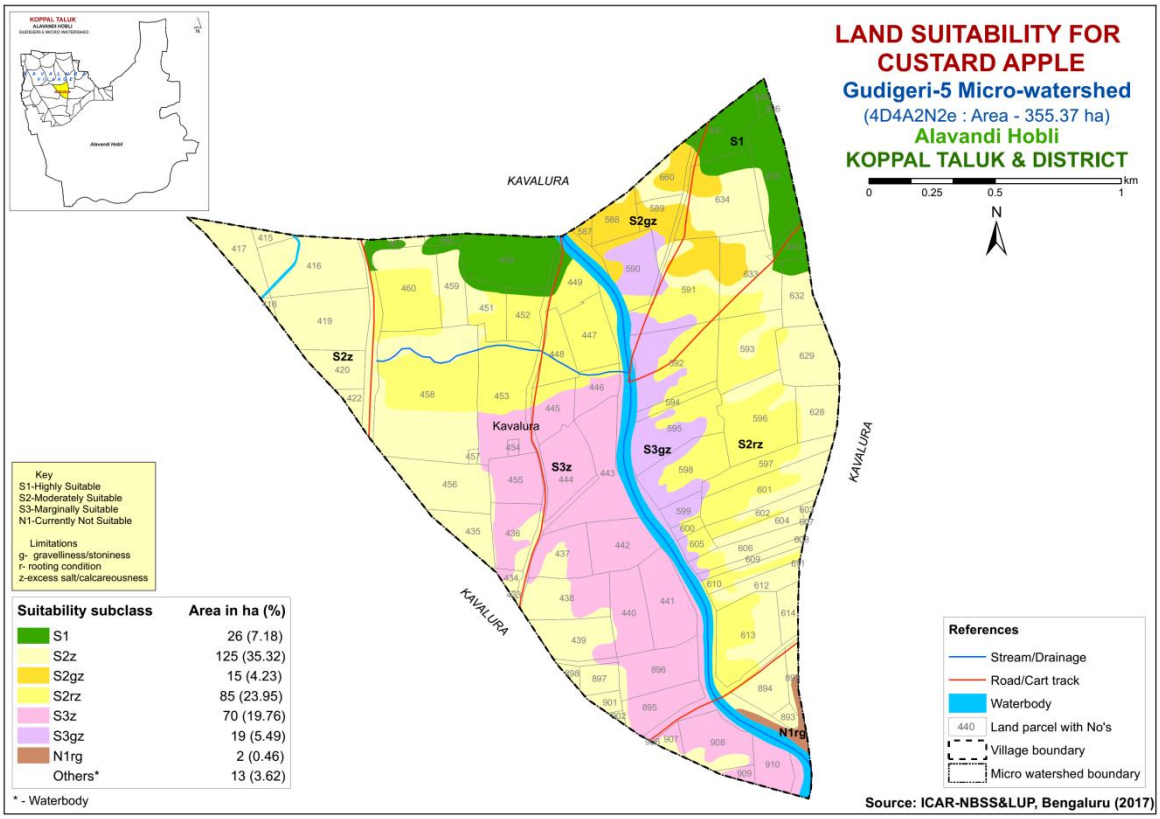


Fig. 7.19 Land Suitability map of Custard Apple

7.20 Land Suitability for Amla (*Phyllanthus emblica*)

Amla is one of the most important fruit and medicinal crop grown in an area of 151 ha and distributed 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 geographic distribution of different suitability subclasses in the microwatershed are given in Figure 7.20.

Maximum area of about 252 ha (71 %) has soils that are moderately suitable (Class S2) and are distributed in major parts of the microwatershed. They have minor limitations of rooting depth, texture and calcareousness. The marginally suitable (Class S3) lands cover an area of about 89 ha (25%) and occur in the central and southern part of the microwatershed with moderate problems of rooting depth, gravelliness, texture and calcareousness. Not suitable (Class N1) for growing amla occur in an area of about 2 ha (<1%) with severe limitations of rooting depth and gravelliness and distributed in the southern part of the microwatershed.

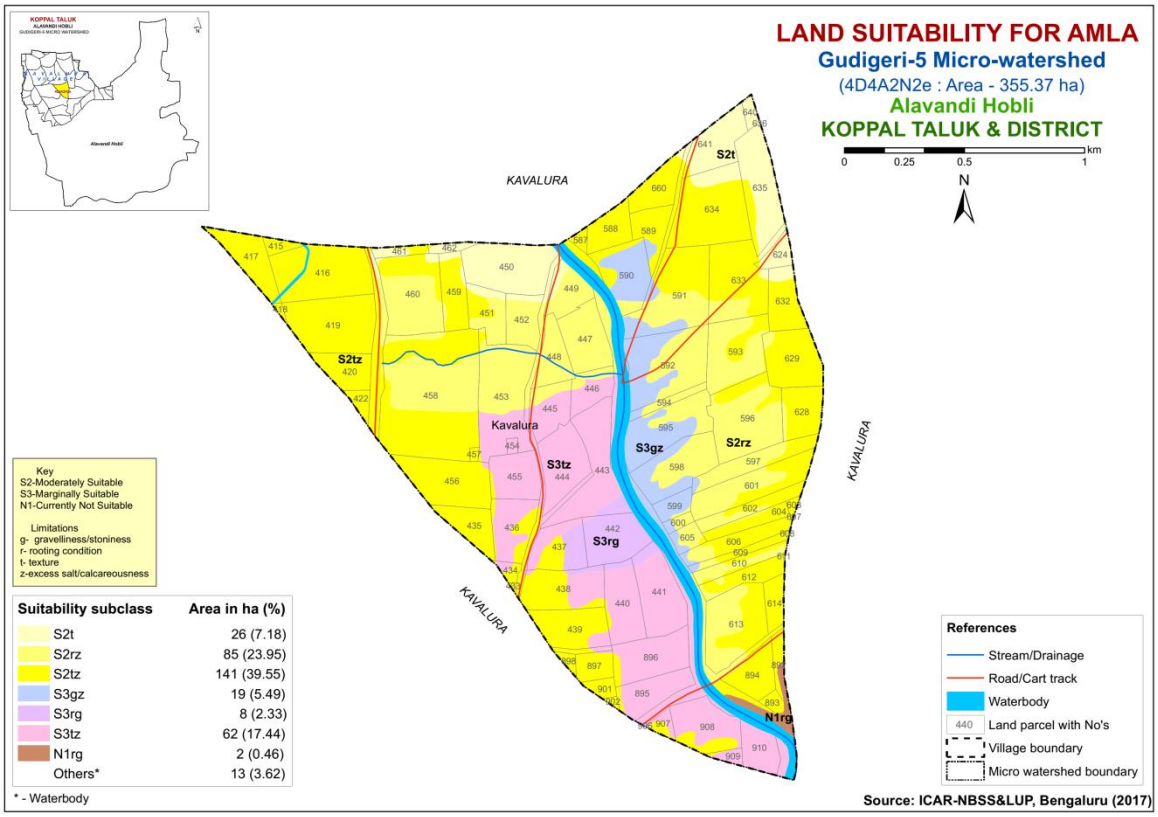


Fig. 7.20 Land Suitability map of Amla

7.21 Land Suitability for Tamarind (*Tamarindus indica*)

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

There are no highly suitable lands (Class S1) for growing tamarind. An area of about 80 ha (23%) is moderately suitable (Class S2) and occur in the northeastern, north western and western part of the microwatershed. They have minor limitations of texture rooting depth and calcareousness. An area of about 86 ha (24%) is marginally suitable (Class S3) and occur in the northern, southern and eastern part of the microwatershed. They have moderate limitations of rooting depth and calcareousness. Maximum area of about 177 ha (49%) is not suitable (Class N1) for growing tamarind and are distributed in the major area of the microwatershed. They have severe limitations of rooting depth, gravelliness and calcareousness.

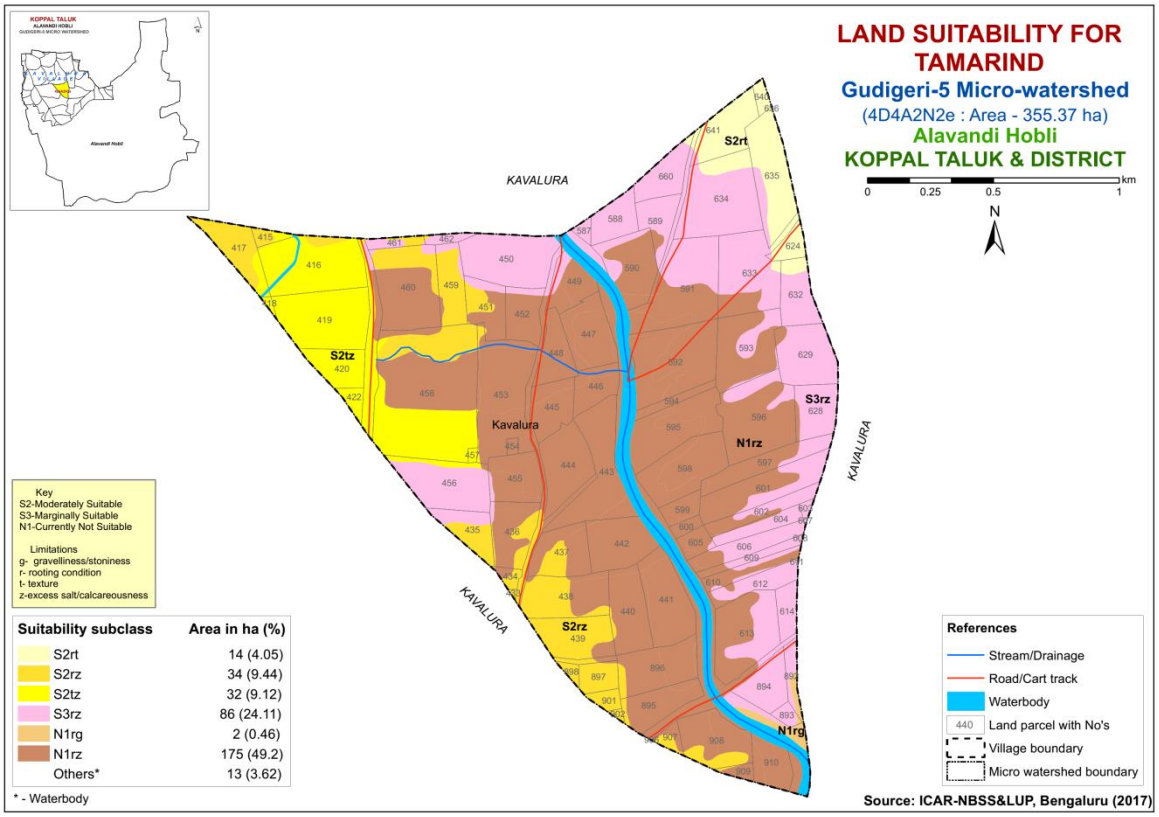


Fig. 7.21 Land Suitability map of Tamarind

7.22 Land Suitability for Marigold (*Tagetes erecta*)

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

There are no highly suitable lands (Class S1) for growing marigold. Maximum area of about 252 ha (71%) is moderately suitable (Class S2) and occur in the major part of the microwatershed. They have minor limitations of texture rooting depth and calcareousness. An area of about 62 ha (17%) is marginally suitable (Class S3) and occur in the central and southern part of the microwatershed. They have moderate limitations of rooting depth and calcareousness. An area of about 30ha (8%) is not suitable (Class N1) for growing marigold and are distributed in the central and southern part of the microwatershed. They have severe limitations of rooting depth, gravelliness and calcareousness.

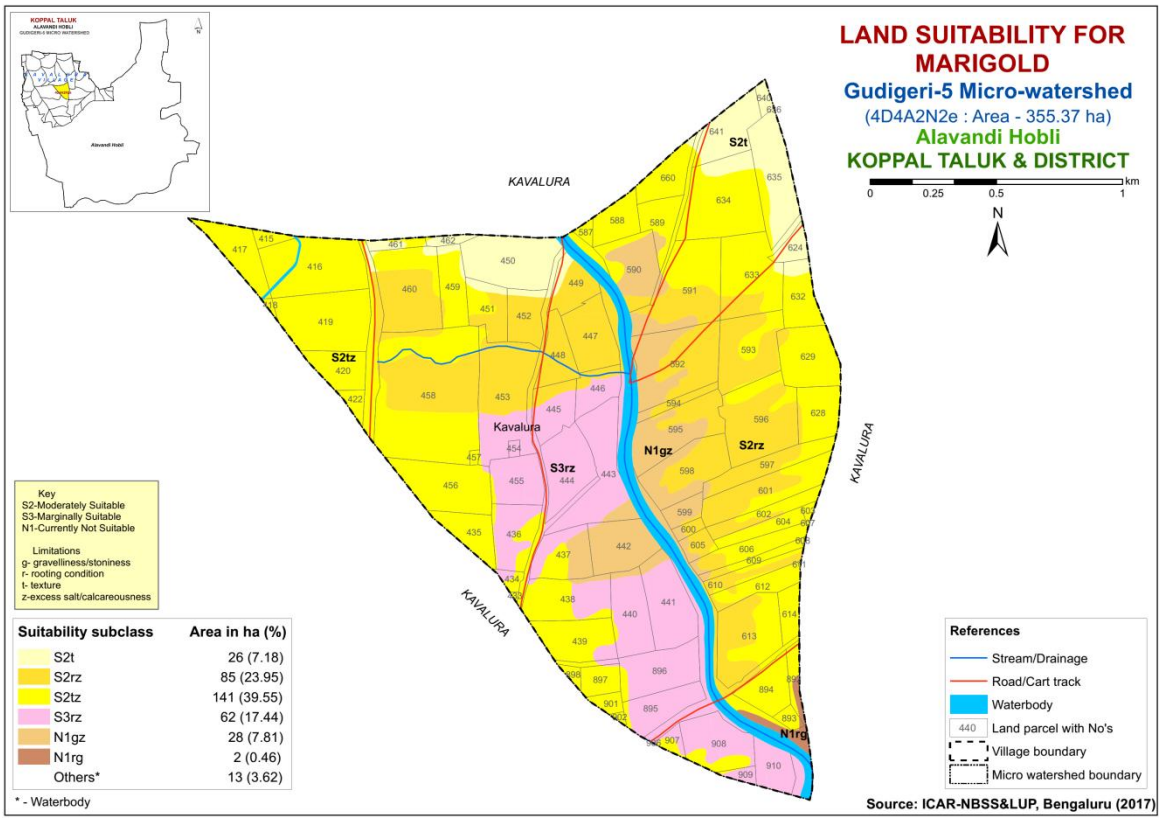


Fig. 7.22 Land Suitability map of Marigold

7.23 Land Suitability for Chrysanthemum (*Chrysanthemum indicum*)

Chrysanthemum is one of the most important flower crop grown in an area of 4978 ha in almost all the districts of the State. The crop requirements for growing chrysanthemum were matched with the soil-site characteristics and a land suitability map for growing chrysanthemum was generated. The area extent and their geographic distribution of different suitability subclasses in the microwatershed is given in Figure 7.23.

There are no highly suitable lands (Class S1) for growing Chrysanthemum. Maximum area of about 252 ha (71%) is moderately suitable (Class S2) and occur in the major part of the microwatershed. They have minor limitations of texture, rooting depth and calcareousness. An area of about 62 ha (17%) is marginally suitable (Class S3) and occur in the central and southern part of the microwatershed. They have moderate limitations of rooting depth and calcareousness. An area of about 30 ha (8%) not suitable (Class N1) for growing chrysanthemum and are distributed in the central and southern part of the microwatershed. They have severe limitations of rooting depth, gravelliness and calcareousness.

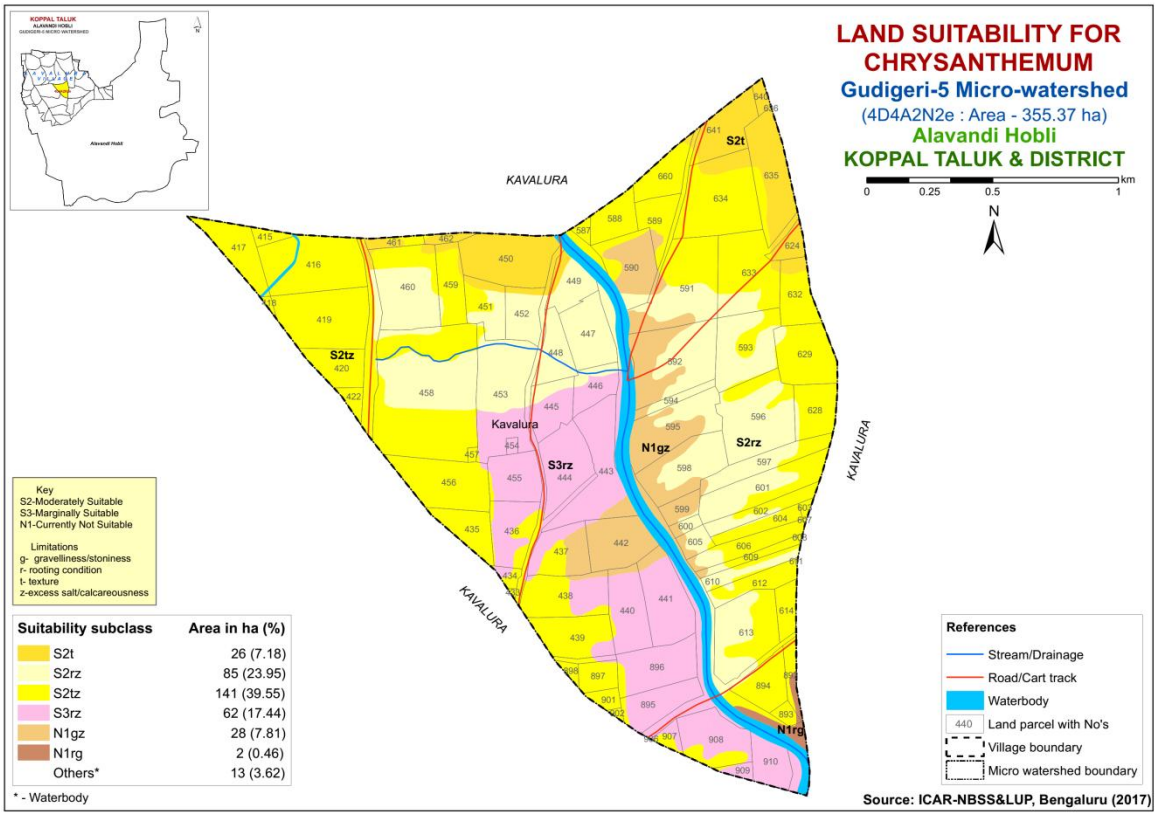


Fig. 7.23 Land Suitability map of Chrysanthemum

7. 24 Land Suitability for Jasmine *(Jasminum sp.)*

Jasmine is one of the most important flower crop grown in an area of 803 ha in almost all the districts of the State. The crop requirements (Table 7.17) for growing jasmine were matched with the soil-site characteristics (Table 7.1) and a land suitability map for growing jasmine was generated. The area extent and their geographical distribution of different suitability subclasses in the microwatershed are given in Figure 7.24.

Maximum area of about 85 ha (24%) is moderately suitable (Class S2) for growing jasmine and occur in the northern, central and southern part of the microwatershed. They have minor limitations of rooting depth and calcareousness. An area of about 229 ha (64%) is marginally suitable (Class S3) for growing jasmine and occur in the major part of the microwatershed. They have moderate limitations of texture, rooting depth and calcareousness. An area about 30 ha (8%) is not suitable (Class N1) for growing jasmine with severe limitations of rooting depth, gravelliness and calcareousness and are distributed in the southern and central part of the microwatershed.

Table 7.16 Land suitability criteria for jasmine (irrigated)

Crop requirement			Rating			
Soil-site characteristics		**Unit**	**Highly suitable(S1)**	**Moderately suitable(S2)**	**Marginally suitable(S3)**	**Not suitable(N)**
Climate	Temperature in growing season		18-23	17-15 24-35	35-40 10-14	
Soil aeration	Soil drainage	Class	Well drained	Moderately drained	Imperfectly drained	Poorly drained
Nutrient availability	Texture	Class	Scl,l,scl,cl,sil	sicl,sc,sic,c(m/k)	C(ss),	ls, s
	pH	1:2.5	6.0-7.5	5.5-5.9:7.6-8.5	<5: >8.5	
	$CaCO_3$ in root zone	%	Non calcareous	Slightly calcareous	Strong calcareous	
Rooting conditions	Soil depth	Cm	>75	50-75	25-50	<25
	Gravel content	% vol.	<15	15-35	>35	
Soil toxicity	Salinity	ds/m	Non saline	Slight	Strongly	
	Sodicity	%	Non sodic	Slight	Strongly	
Erosion	Slope	%	1-3	3-5	5-10	

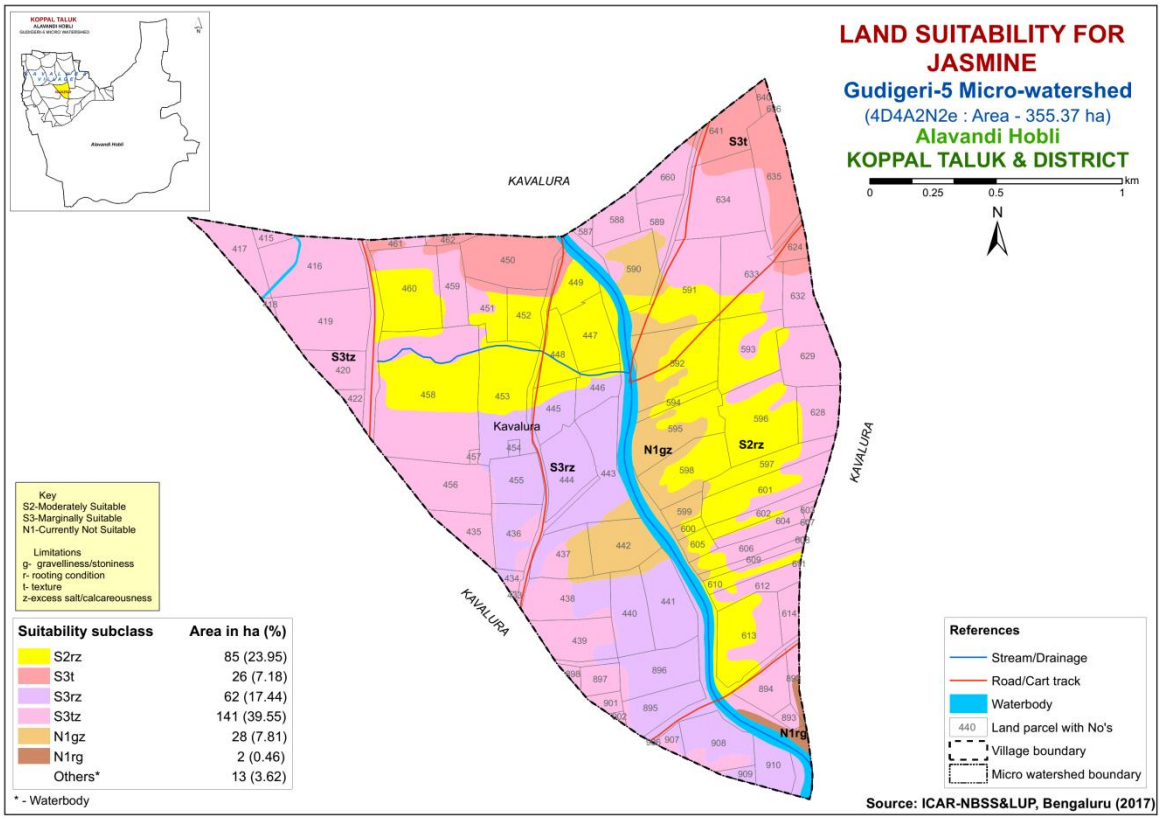


Fig. 7.24 Land Suitability map of Jasmine

7.25 Land Management Units (LMU)

The 18 soil map units identified in Gudigeri-5 microwatershed have been grouped into six Land Management Units (LMU) for the purpose of preparing a Proposed Crop Plan. Land Management Units are grouped based on the similarities in respect of the type of soil, the depth of the soil, the surface soil texture, gravel content, AWC, slope, erosion etc. and a Land Management Units map (Fig.7.25) has been generated. These Land Management Units are expected to behave similarly for a given level of management.

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

LMU	Mapping unit	Soil and site characteristics
1	KVRiB2g1, KVRmA1 KVRmB1. BGPmB2g1	Deep to Very deep, calcareous black gravelly clay soils with slopes of 0-3%, slight to moderate erosion, gravelly (15-35%)
2	NSPmB2g1, HDLmB2	Moderately deep to deep, black clayey soils with slopes of 1-3%, moderate erosion, gravelly (15-35%)
3	DRLmB1g1,DRLmB2, DRLmB2g1,DRLmB2g2	Moderately deep, calcareous black clay soils with slopes of 1-3%, slight to moderate erosion, gravelly to very gravelly (15-60%)
4	RNKmB2,RNKmB2g1, RNKmB2g2,RNKmB2g3	Very shallow to shallow calcareous black gravelly clay soils with slopes of 1-3%, moderate erosion, gravelly to extremely gravelly (15-80%)
5	MTLmB2g1,MTLmB2g2, MTLmB3g3	Shallow, calcareous black gravelly clay soils with slopes of 1-3 %, moderate to severe erosion, gravelly to extremely gravelly (15-80%)
6	BGTmB2g2	Very shallow, calcareous black gravelly clay soils with slopes of 1-3%, moderate erosion, gravelly (35-60%)

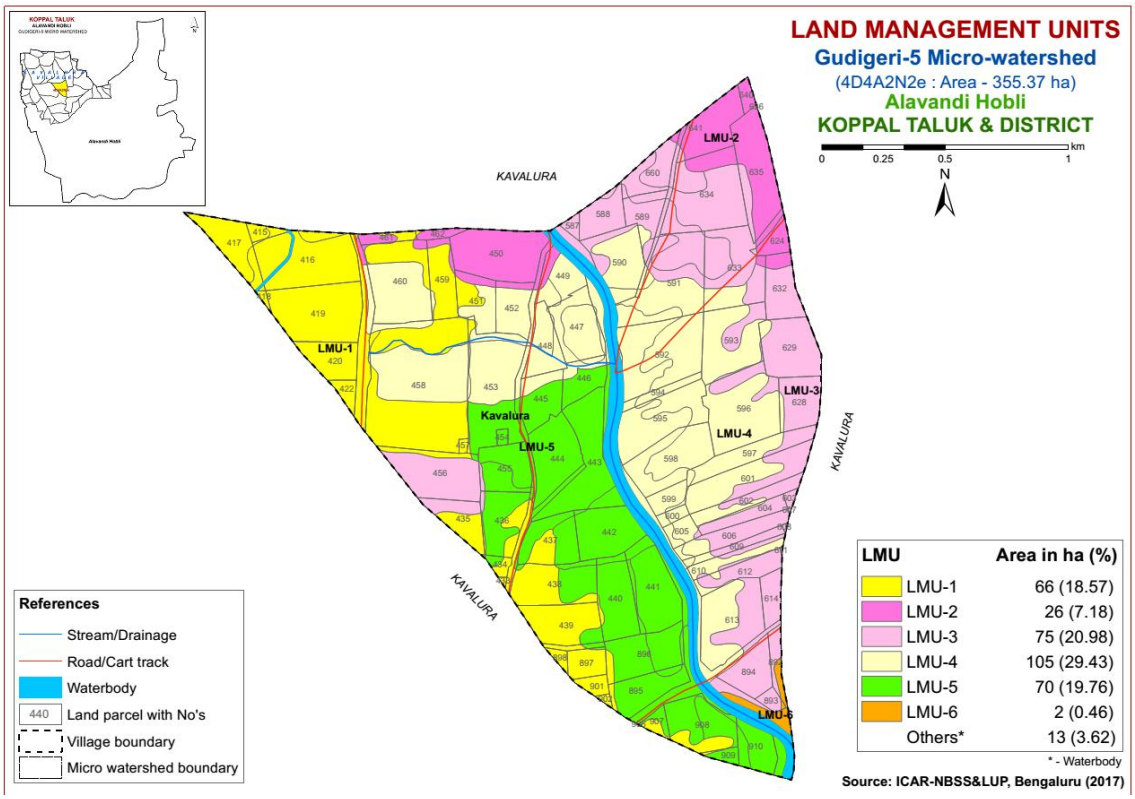


Fig 7.25 Land Management Units map of Gudigeri-5 microwatershed

7.26 Proposed Crop Plan for Gudigeri-5 Microwatershed

After assessing the land suitability for the 24 crops, the proposed crop plan has been prepared for the six identified LUCs by considering only the highly (Class S1) and moderately (Class S2) suitable lands for each of the 24 crops. The resultant proposed crop plan is presented in Table 7.17.

Table 7.17 Proposed Crop Plan for Gudigeri-5 Microwatershed

Proposed Land use Class	Soil Map Units	Survey Number	Field Crops	Horticulture Crops	Suitable Interventions
1	385. KVRiB2g1 386. KVRmA1 388.KVRmB1 392. BGPmB2g1 (Deep to Very deep, calcareous black gravelly clay soils)	Kavalura: 415,416,417,418,419, 420,422,433,434,435, 438,439,457,459,897, 898,901,902	Cotton, Sunflower, Sorghum, Bengal gram, Safflower, Linseed, Bajra	**Fruit crops**: Tamarind, Amla, Custard apple, Jamun, Lime, Musambi, Pomegranate **Vegetables:** Drumstick, Coriander **Flowers:** Marigold, Chrysanthemum	Application of FYM, Biofertilizers and micronutrients, drip irrigation, mulching, suitable conservation practices
2	363. NSPmB2g1 382. HDLmB2 (Moderately deep to deep, black clayey soils)	Kavalura: 450,461,462,624,635, 636,640,641	Bajra, Sorghum, Sunflower, Safflower	**Fruit crops:** Lime Musambi, Custardapple,Amla,Pomegranate **Vegetables:** Drumstick, Coriander **Flowers:**Marigold, Chrysanthemum	Application of FYM, Biofertilizers and micronutrients, drip irrigation, mulching, suitable conservation practices
3	349. DRLmB1g1 350. DRLmB2 351. DRLmB2g1 352. DRLmB2g2 (Moderately deep, calcareous black clay soils)	Kavalura: 456,587,588,589,602, 603,604,606,607,608, 609,611,612,614,628, 629,632,633,634,660, 892,893,894	Sunflower , Sorghum, Bengal gram	**Fruit crops:** Amla, Custard apple, Lime, Pomegranate **Vegetables:** Drumstick, Coriander **Flowers:** Marigold, Chrysanthemum, Jasmine	Application of FYM, Biofertilizers and micronutrients, drip irrigation, mulching, suitable conservation practises
4	336. RNKmB2 337. RNKmB2g1 338. RNKmB2g2 339. RNKmB2g3 (Moderately shallow calcareous black gravelly clayey soils)	Kavalura: 447,448,449,451,452, 453,458,460,590,591, 592,593,594,595,596, 597,598,599,600,601, 605,610,613	Bengal gram, Sorghum	**Fruit crops:** Amla, Custard apple **Flowers:** Marigold, Chrysanthemum, Jasmine	Application of FYM, Biofertilizers and micronutrients, drip irrigation, mulching, suitable conservation practices

5	311. MTLmB2g1 312. MTLmB2g2 316. MTLmB3g3 (Shallow, calcareous black gravelly clay soils)	Kavalura: 436,437,440,441,442, 443,444,445, 446,454,455,895,896, 906,907,908, 909,910	Bengal gram, coriander	Agri-Silvi-Pasture: Hybrid Napier, Glyricidia, *Styloxanthes hamata, Styloxanthes scabra*	Use of medium duration varieties, and deep rooted crops, sowing across the slope, drip irrigation and mulching is recommended
6	11. BGTmB2g2 (Very shallow, calcareous black gravelly clay soils)	Kavalura: 892,893	-	Agri-Silvi-Pasture: Hybrid Napier, *Styloxanthes hamata, Styloxanthes scabra*	Use of medium duration varieties, and deep rooted crops, sowing across the slope, drip irrigation and mulching is recommended

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 Gudigeri-5 Microwatershed

- The soil phases with sizeable area identified in the microwatershed belonged to the soil series of RNK (104 ha), DRL (74 ha), MTL (70 ha), KVR (34 ha) ,BGP(32ha), HDL(14ha), NSP(11ha) and BGT(2 ha).
- As per land capability classification, entire area in the microwatershed falls under arable land category (Class II, III and IV). The major limitations identified in the arable lands were soil erosion and shallow depth.
- On the basis of soil reaction, an area of about 16 ha (4%) is moderately alkaline (pH 7.8-8.4). 136 ha (38%) under strongly alkaline (pH 8.4-9.0) and 191 ha (54 %) (pH >9.0) very

strongly alkaline in reaction. Thus, all the soils in the microwatershed are alkaline in reaction.

Soil Health Management

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

Alkaline soils

(Slightly alkaline to strongly alkaline soils)

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

Neutral soils

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

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

Dissemination of Information and Communication of Benefits

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

technologies such as Cellular phones and the Internet, which can be much more effective in reaching the younger farmers.

Inputs for Net Planning (Saturation Plan) and Interventions needed

Net planning in IWMP is focusing on preparation of

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

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

- **Soil Depth:** The depth of a soil decides the amount of moisture and nutrients it can hold, what crops can be taken up or not, depending on the rooting depth and the length of growing period available for raising any crop. Deeper the soil, better for a wide variety of crops. If sufficient depth is not available for growing deep rooted crops, either choose medium or short duration crops or deeper planting pits need to be opened and additional good quality soil brought from outside has to be filled into the planting pits.
- **Surface soil texture:** Lighter soil texture in the top soil means, better rain water infiltration, less run-off and soil moisture conservation, less capillary rise and less evaporation losses. Lighter surface textured soils are amenable to good soil tilth and are highly suitable for crops like groundnut, root vegetables (carrot, raddish, potato etc) but not ideal for crops that need stagnant water like lowland paddy. Heavy textured soils are poor in water infiltration and percolation. They are prone for sheet erosion; such soils can be improved by sand mulching. The technology that is developed by the AICRP-Dryland Agriculture, Vijayapura, Karnataka can be adopted.
- **Gravelliness:** More gravel content is favorable for run-off harvesting but poor in soil moisture storage and nutrient availability. It is a significant parameter that decides the kind of crop to be raised.
- **Land Capability Classification:** The land capability map shows the areas suitable and not suitable for agriculture and the major constraints in each of the plot/survey number. Hence, one can decide what kind of enterprise is possible in each of these units. In general, erosion and soil are the major constraints in Gudigeri-5 Microwatershed.
- **Organic Carbon:** An area of about 80 ha (23%), 160 ha 45%) and 103ha (29%) is low (<0.5%), medium (0.5-0.75%) and high (>0.75%) in OC content respectively. The areas that are low and medium in OC needs to be further improved by applying farmyard manure and rotating crops with cereals and legumes or mixed cropping.
- **Promoting green manuring:** Growing of green manuring crops costs Rs. 1250/ha (green manuring seeds) and about Rs. 2000/ha towards cultivation that totals to Rs. 3250/- per ha. On the other hand, application of organic manure @ 10 tons/ha costs Rs. 5000/ha. The practice needs to be continued for 2-3 years or more. Nitrogen fertilizer needs to be

supplemented by 25% in addition to the recommended level in 240 ha area where OC is less than 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**: Entire area is low in available phosphorus. Hence for all the crops, 25% additional P-needs to be applied.
- **Available Potassium:** Available potassium is medium (145-337kg/ha) in an area of about 48 ha (13%) and high in maximum area of about 295 ha (83%). In areas with high potassium content reduce 25% from the RDF to avoid the excess application of fertilizer and apply additional 25 per cent potassium in area where it is medium or low.
- **Available Sulphur:** Available sulphur is a very critical nutrient for oilseed crops. Available sulphur is low (<10 ppm) in 194 ha (55%), medium (10-20ppm) 64 ha (18%) and high (>20ppm) in 84 ha (24%) area in the microwatershed. The areas with low and medium in available sulphur need to be applied with magnesium sulphate or gypsum or Factamphos (p) fertitilizer (13% sulphur) for 2-3 years for the deficiency to be corrected. It is high in 173 ha (35%) area of the microwatershed.
- **Available iron:** It is sufficient in the entire area of the microwatershed.
- **Available Zinc:** It is deficient (<0.6 ppm) in 88 per cent and sufficient (>0.6 ppm) in 8 per cent area of the microwatershed. Application of zinc sulphate @ 25kg/ha is to be followed in areas that are deficient in available zinc.
- **Available Boron:** An area of about 187 ha (53%) is low (<0.5 ppm) in available boron and an area of 155 ha (44%) medium (05-1.0 ppm) in available boron content. These areas need to be applied with sodium borate @ 10kg/ha as a soil application or 0.2% borax as foliar spray to correct the deficiency
- **Available manganese:** It is sufficient in the entire area of the microwatershed
- **Soil alkalinity:** The entire area in the microwatershed has soils that are moderately to very strongly alkaline. These areas need application of gypsum and wherever calcium is in excess, iron pyrites and element sulphur can be recommended. Management practices like treating repeatedly with good quality water to drain out the excess salts and provision of subsurface drainage and growing of salt tolerant crops like Casuarina, Acacia, Neem, Ber etc, are recommended.

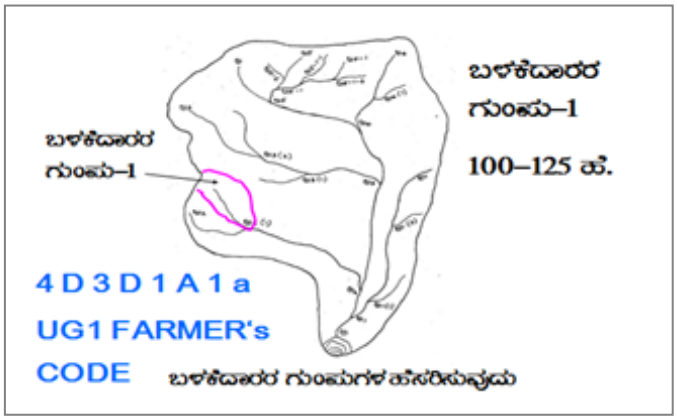
  Land Suitability for various crops: Areas that are highly, moderately and marginally suitable for growing various crops are indicated. Along with the suitability, various constraints that are limiting the productivity are also indicated. For example, in case of cotton, gravel content, rooting depth and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

Chapter 9

SOIL AND WATER CONSERVATION TREATMENT PLAN

For preparing soil and water conservation treatment plan for Gudigeri-5 Microwatershed, the land resource inventory database generated under Sujala-III project has been transformed as information through series of interpretative (thematic) maps using soil phase map as a base. The various thematic maps (1:7920 scale) generated were

- Soil depth
- Surface soil texture
- Available water capacity
- Soil slope
- Soil gravelliness
- Land capability
- Present land use and land cover
- Crop suitability maps
- Rainfall map
- 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.

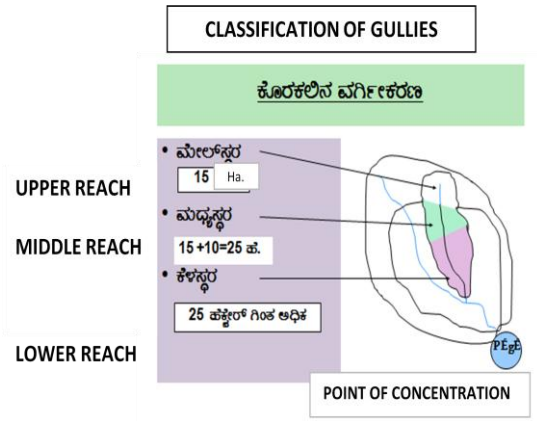
- Naming of user groups and farmers
- Identification of arable and non arable lands
- Identification of drainage lines and gullies
- Identification of non treatable areas
- Identification of priority areas in the arable lands
- Treatment plan for arable lands
- Location of water harvesting and recharge 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		**USER GROUP-1**
Cadastral map (1:7920 scale) is enlarged to a scale of 1:2500 scale Existing network of waterways, pothissa boundaries, grass belts, natural drainage lines/ watercourse, cut ups/ terraces are marked on the cadastral map to the scale Drainage lines are demarcated into		
Small gullies	(up to 5 ha catchment)	
Medium gullies	(5-15 ha catchment)	
Ravines	(15-25 ha catchment) and	
Halla/Nala	(more than 25ha catchment)	

Measurement of Land Slope

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

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

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

Note: i) The above intervals are maximum.

(ii) Considering the slope class and erosion status 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.

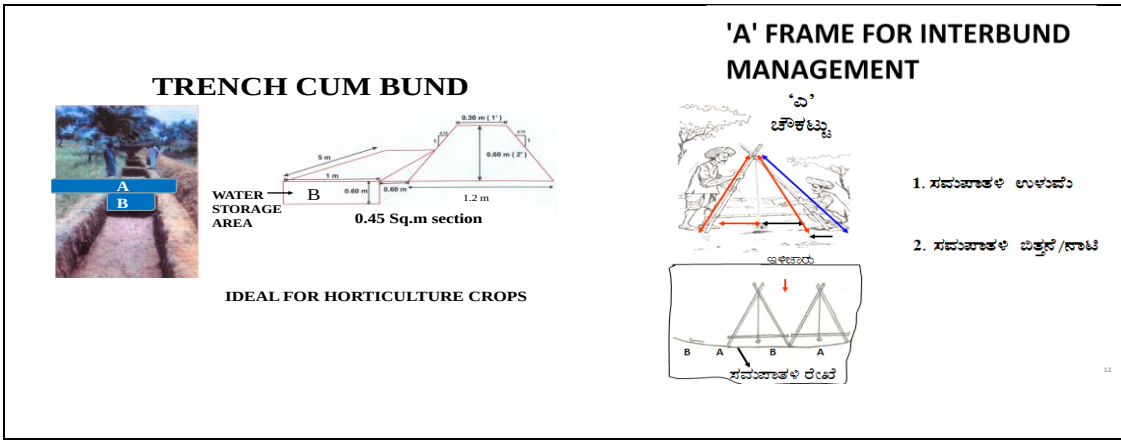
Recommended Bund Section

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 clayey black soils	
0.45	2	0.75	01:01	0.92		
0.45	2.4	0.75	1.3:1	1.07	Shallow clayey black soils	
0.6	3.1	0.7	1.78:1	1.29	Medium clayey black soils	
0.5	3	0.85	1.47:1	1.49		

Formation of Trench cum Bund

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

Details of Borrow Pit dimensions are given below



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

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

B. Waterways

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

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

c) The design details are given in the Manual.

C. Farm Ponds

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

D. Diversion Channel

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

9.1.2 Non-Arable Land Treatment

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

9.1.3 Treatment of Natural Water Course/ Drainage Lines

a) The cadastral map has to be updated as regards the network of drainge lines (gullies/ *nalas/ hallas*) and existing structures are marked to the scale and storage capacity of the existing water bodies are documented.
b) The drainage line will be demarcated into Upper Reach, Middle Reach and Lower Reach.
c) Considering the Catchment, *Nala* bed and bank conditions, suitable structures are decided.
d) Number of storage structures (Check dam/ *Nala* bund/ Percolation tank) will be decided considering the commitments and available runoff in 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 needs graded bunding. The conservation plan prepared may be presented to all the stakeholders including farmers and after considering their suggestions, the conservation plan for the microwatershed may be finalised in a participatory approach.

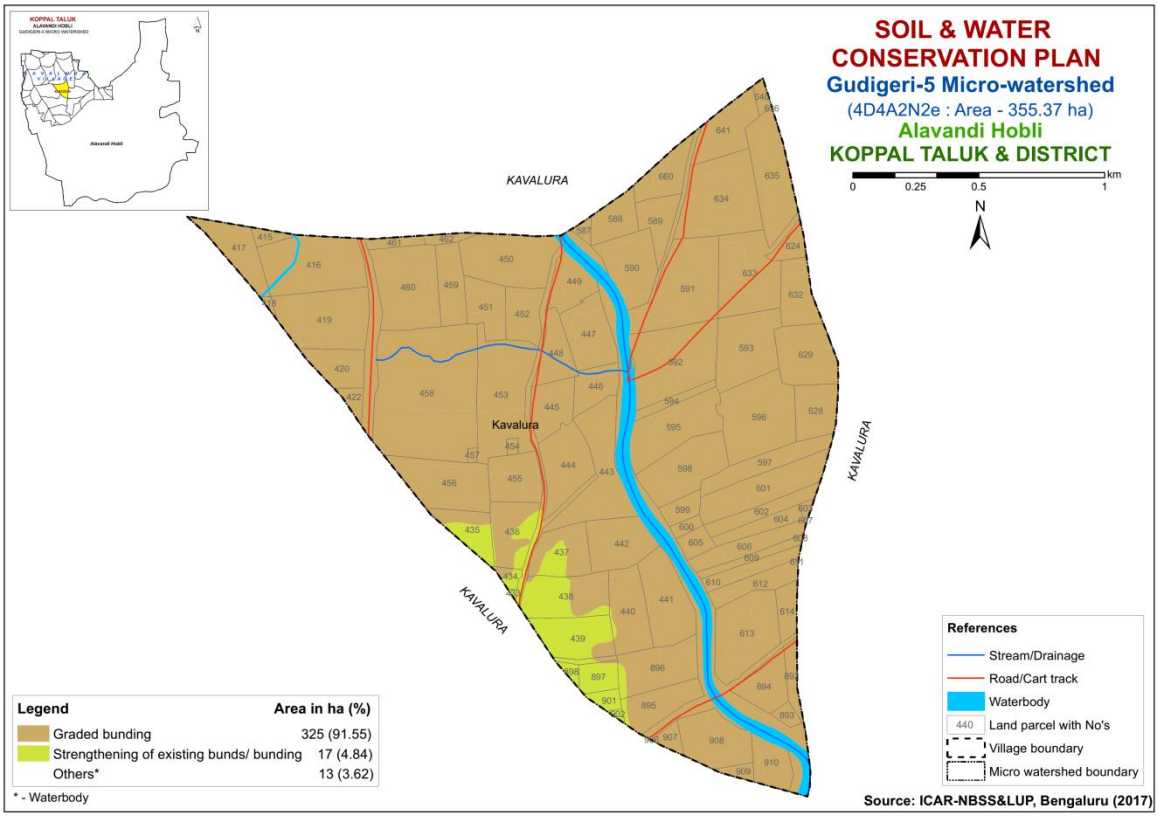


Fig. 9.1 Soil and Water Conservation Plan map of Gudigeri-5 Microwatershed

9.3 Greening of Microwatershed

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

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

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

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

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Appendix I

Gudigeri-5 Microwatershed

Soil Phase Information

Village	Survey NO.	Area (ha)	Soil Phase	LMU	Soil Depth	Surface Soil Texture	Soil Gravelliness	Available Water Capacity	Slope	Soil Erosion	Current Land Use	WELLS	Land Capability	Conservation Plan
Kavalura	415	0.74	KVRmB1	LMU-1	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Slight	Jowar+Bengalgram (Jw+Bg)	Not Available	IIs	Graded bunding
Kavalura	416	8.57	BGPmB2g1	LMU-1	Very deep (>150 cm)	Clay	Gravelly (15-35%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Moderate	Current fallow (Cf)	Not Available	IIIes	Graded bunding
Kavalura	417	3.83	KVRmB1	LMU-1	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Slight	Current fallow (Cf)	Not Available	IIs	Graded bunding
Kavalura	418	0.2	BGPmB2g1	LMU-1	Very deep (>150 cm)	Clay	Gravelly (15-35%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Moderate	Current fallow (Cf)	Not Available	IIIes	Graded bunding
Kavalura	419	7.91	BGPmB2g1	LMU-1	Very deep (>150 cm)	Clay	Gravelly (15-35%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Moderate	Current fallow (Cf)	Not Available	IIIes	Graded bunding
Kavalura	420	3.01	BGPmB2g1	LMU-1	Very deep (>150 cm)	Clay	Gravelly (15-35%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Moderate	Current fallow (Cf)	Not Available	IIIes	Graded bunding
Kavalura	422	0.83	BGPmB2g1	LMU-1	Very deep (>150 cm)	Clay	Gravelly (15-35%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Moderate	Current fallow (Cf)	Not Available	IIIes	Graded bunding
Kavalura	433	0.08	KVRmA1	LMU-1	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Nearly level (0-1%)	Slight	Current fallow (Cf)	Not Available	IIs	Field bunds
Kavalura	434	0.65	KVRmA1	LMU-1	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Nearly level (0-1%)	Slight	Current fallow (Cf)	Not Available	IIs	Field bunds
Kavalura	435	3.01	KVRmA1	LMU-1	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Nearly level (0-1%)	Slight	Current fallow (Cf)	Not Available	IIs	Field bunds
Kavalura	436	4.29	MTLmB2g1	LMU-5	Shallow (25-50 cm)	Clay	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Bengalgram+Current fallow (Bg+Cf)	Not Available	IIIes	Graded bunding
Kavalura	437	4.26	MTLmB3g3	LMU-5	Shallow (25-50 cm)	Clay	Extremely gravelly (60-80%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Severe	Current fallow+Fallow land (Cf+Fl)	Not Available	IVes	Graded bunding
Kavalura	438	5.7	KVRmA1	LMU-1	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Nearly level (0-1%)	Slight	Bengalgram+Jowar (Bg+Jw)	Not Available	IIs	Field bunds
Kavalura	439	4.72	KVRmA1	LMU-1	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Nearly level (0-1%)	Slight	Paddy+Sunflower+Bengalgram (Pd+Sf+Bg)	1 Borewell	IIs	Field bunds
Kavalura	440	4.79	MTLmB2g1	LMU-5	Shallow (25-50 cm)	Clay	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Bengalgram (Bg)	Not Available	IIIes	Graded bunding
Kavalura	441	5.92	MTLmB2g2	LMU-5	Shallow (25-50 cm)	Clay	Very gravelly (35-60%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Bengalgram+Current fallow (Bg+Cf)	1 Borewell	IIIes	Graded bunding
Kavalura	442	4.83	MTLmB3g3	LMU-5	Shallow (25-50 cm)	Clay	Extremely gravelly (60-80%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Severe	Bengalgram+Jowar (Bg+Jw)	Not Available	IVes	Graded bunding
Kavalura	443	7.58	MTLmB2g1	LMU-5	Shallow (25-50 cm)	Clay	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Bengalgram+Jowar (Bg+Jw)	Not Available	IIIes	Graded bunding
Kavalura	444	5.14	MTLmB2g1	LMU-5	Shallow (25-50 cm)	Clay	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Current fallow (Cf)	Not Available	IIIes	Graded bunding
Kavalura	445	3.38	MTLmB2g1	LMU-5	Shallow (25-50 cm)	Clay	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Current fallow (Cf)	Not Available	IIIes	Graded bunding
Kavalura	446	2.62	MTLmB2g1	LMU-5	Shallow (25-50 cm)	Clay	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Current fallow (Cf)	Not Available	IIIes	Graded bunding

Village	Survey NO.	Area (ha)	Soil Phase	LMU	Soil Depth	Surface Soil Texture	Soil Gravelliness	Available Water Capacity	Slope	Soil Erosion	Current Land Use	WELLS	Land Capability	Conservation Plan
Kavalura	447	4.66	RNKmB2g1	LMU-4	Moderately shallow (50-75 cm)	Clay	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Sunflower+Bengalgram (Sf+Bg)	Not Available	IIIes	Graded bunding
Kavalura	448	3.04	RNKmB2g2	LMU-4	Moderately shallow (50-75 cm)	Clay	Very gravelly (35-60%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Sunflower (Sf)	Not Available	IIIes	Graded bunding
Kavalura	449	3.49	RNKmB2g2	LMU-4	Moderately shallow (50-75 cm)	Clay	Very gravelly (35-60%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram+Jowar (Rg+Jw)	Not Available	IIIes	Graded bunding
Kavalura	450	7.09	NSPmB2g1	LMU-2	Moderately deep (75-100 cm)	Clay	Gravelly (15-35%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Moderate	Current fallow (Cf)	Not Available	IIIes	Graded bunding
Kavalura	451	3.26	RNKmB2g1	LMU-4	Moderately shallow (50-75 cm)	Clay	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Current fallow (Cf)	Not Available	IIIes	Graded bunding
Kavalura	452	3.03	RNKmB2g1	LMU-4	Moderately shallow (50-75 cm)	Clay	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Current fallow (Cf)	Not Available	IIIes	Graded bunding
Kavalura	453	9.56	RNKmB2g2	LMU-4	Moderately shallow (50-75 cm)	Clay	Very gravelly (35-60%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Current fallow+Jowar (Cf+Jw)	Not Available	IIIes	Graded bunding
Kavalura	454	0.29	MTLmB2g1	LMU-5	Shallow (25-50 cm)	Clay	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Not Available (NA)	Not Available	IIIes	Graded bunding
Kavalura	455	3.9	MTLmB2g1	LMU-5	Shallow (25-50 cm)	Clay	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Current fallow+Jowar (Cf+Jw)	Not Available	IIIes	Graded bunding
Kavalura	456	6.51	DRLmB1g1	LMU-3	Moderately deep (75-100 cm)	Clay	Gravelly (15-35%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Slight	Current fallow (Cf)	1 Farm pond	IIs	Graded bunding
Kavalura	457	0.21	BGPmB2g1	LMU-1	Very deep (>150 cm)	Clay	Gravelly (15-35%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Moderate	Not Available (NA)	Not Available	IIIes	Graded bunding
Kavalura	458	20.79	RNKmB2	LMU-4	Moderately shallow (50-75 cm)	Clay	Non gravelly (<15%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Current fallow+Fallow land (Cf+Fl)	Not Available	IIIe	Graded bunding
Kavalura	459	3.34	KVRmB1	LMU-1	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Slight	Current fallow (Cf)	Not Available	IIs	Graded bunding
Kavalura	460	7.96	RNKmB2	LMU-4	Moderately shallow (50-75 cm)	Clay	Non gravelly (<15%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Redgram (Rg)	Not Available	IIIe	Graded bunding
Kavalura	461	0.93	NSPmB2g1	LMU-2	Moderately deep (75-100 cm)	Clay	Gravelly (15-35%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Moderate	Current fallow (Cf)	Not Available	IIIes	Graded bunding
Kavalura	462	0.67	NSPmB2g1	LMU-2	Moderately deep (75-100 cm)	Clay	Gravelly (15-35%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Moderate	Current fallow (Cf)	Not Available	IIIes	Graded bunding
Kavalura	587	0.48	DRLmB2g2	LMU-3	Moderately deep (75-100 cm)	Clay	Very gravelly (35-60%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Moderate	Jowar (Jw)	Not Available	IIIes	Graded bunding
Kavalura	588	2.74	DRLmB2g2	LMU-3	Moderately deep (75-100 cm)	Clay	Very gravelly (35-60%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Moderate	Jowar (Jw)	Not Available	IIIes	Graded bunding
Kavalura	589	2.71	DRLmB2g2	LMU-3	Moderately deep (75-100 cm)	Clay	Very gravelly (35-60%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Moderate	Jowar (Jw)	Not Available	IIIes	Graded bunding
Kavalura	590	5.44	RNKmB2g3	LMU-4	Moderately shallow (50-75 cm)	Clay	Extremely gravelly (60-80%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Jowar (Jw)	Not Available	IVes	Graded bunding
Kavalura	591	9.37	RNKmB2g1	LMU-4	Moderately shallow (50-75 cm)	Clay	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Jowar (Jw)	Not Available	IIIes	Graded bunding
Kavalura	592	9.18	RNKmB2g1	LMU-4	Moderately shallow (50-75 cm)	Clay	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Sunflower+Bengalgram+Jowar (Sf+Bg+Jw)	Not Available	IIIes	Graded bunding

Village	Survey NO.	Area (ha)	Soil Phase	LMU	Soil Depth	Surface Soil Texture	Soil Gravelliness	Available Water Capacity	Slope	Soil Erosion	Current Land Use	WELLS	Land Capability	Conservation Plan
Kavalura	593	6.59	RNKmB2g1	LMU-4	Moderately shallow (50-75 cm)	Clay	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Jowar+Sunflower+Current fallow (Jw+Sf+Cf)	Not Available	IIIes	Graded bunding
Kavalura	594	1.15	RNKmB2g1	LMU-4	Moderately shallow (50-75 cm)	Clay	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Sunflower (Sf)	Not Available	IIIes	Graded bunding
Kavalura	595	6.57	RNKmB2g3	LMU-4	Moderately shallow (50-75 cm)	Clay	Extremely gravelly (60-80%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Sunflower (Sf)	Not Available	IVes	Graded bunding
Kavalura	596	8.5	RNKmB2g1	LMU-4	Moderately shallow (50-75 cm)	Clay	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Jowar+Sunflower (Jw+Sf)	Not Available	IIIes	Graded bunding
Kavalura	597	3.71	RNKmB2g1	LMU-4	Moderately shallow (50-75 cm)	Clay	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Jowar (Jw)	Not Available	IIIes	Graded bunding
Kavalura	598	6.15	RNKmB2g1	LMU-4	Moderately shallow (50-75 cm)	Clay	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Sunflower (Sf)	Not Available	IIIes	Graded bunding
Kavalura	599	1.4	RNKmB2g3	LMU-4	Moderately shallow (50-75 cm)	Clay	Extremely gravelly (60-80%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Sunflower (Sf)	Not Available	IVes	Graded bunding
Kavalura	600	0.62	RNKmB2g1	LMU-4	Moderately shallow (50-75 cm)	Clay	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Bengalgram (Bg)	Not Available	IIIes	Graded bunding
Kavalura	601	6.05	RNKmB2g1	LMU-4	Moderately shallow (50-75 cm)	Clay	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Jowar+Current fallow (Jw+Cf)	Not Available	IIIes	Graded bunding
Kavalura	602	2.46	DRLmB2	LMU-3	Moderately deep (75-100 cm)	Clay	Non gravelly (<15%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Moderate	Sunflower+Jowar (Sf+Jw)	Not Available	IIIe	Graded bunding
Kavalura	603	0.27	DRLmB2	LMU-3	Moderately deep (75-100 cm)	Clay	Non gravelly (<15%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Moderate	Jowar+Bengalgram (Jw+Bg)	Not Available	IIIe	Graded bunding
Kavalura	604	1.91	DRLmB2	LMU-3	Moderately deep (75-100 cm)	Clay	Non gravelly (<15%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Moderate	Sunflower (Sf)	Not Available	IIIe	Graded bunding
Kavalura	605	1.22	RNKmB2g1	LMU-4	Moderately shallow (50-75 cm)	Clay	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Bengalgram (Bg)	1 Borewell	IIIes	Graded bunding
Kavalura	606	3.13	DRLmB2	LMU-3	Moderately deep (75-100 cm)	Clay	Non gravelly (<15%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Moderate	Jowar+Fallow land (Jw+Fl)	Not Available	IIIe	Graded bunding
Kavalura	607	0.02	DRLmB2	LMU-3	Moderately deep (75-100 cm)	Clay	Non gravelly (<15%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Moderate	Jowar (Jw)	Not Available	IIIe	Graded bunding
Kavalura	608	0.05	DRLmB2	LMU-3	Moderately deep (75-100 cm)	Clay	Non gravelly (<15%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Moderate	Jowar+Fallow land (Jw+Fl)	Not Available	IIIe	Graded bunding
Kavalura	609	1.29	DRLmB2	LMU-3	Moderately deep (75-100 cm)	Clay	Non gravelly (<15%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Moderate	Fallow land (Fl)	Not Available	IIIe	Graded bunding
Kavalura	610	2.16	RNKmB2g1	LMU-4	Moderately shallow (50-75 cm)	Clay	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Bengalgram+Current fallow (Bg+Cf)	1 Borewell	IIIes	Graded bunding
Kavalura	611	0.03	DRLmB2g1	LMU-3	Moderately deep (75-100 cm)	Clay	Gravelly (15-35%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Moderate	Jowar (Jw)	Not Available	IIIes	Graded bunding
Kavalura	612	2.58	DRLmB2g1	LMU-3	Moderately deep (75-100 cm)	Clay	Gravelly (15-35%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Moderate	Jowar+Maize (Jw+Mz)	Not Available	IIIes	Graded bunding
Kavalura	613	7.21	RNKmB2g1	LMU-4	Moderately shallow (50-75 cm)	Clay	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Current fallow+Bengalgram (Cf+Bg)	Not Available	IIIes	Graded bunding
Kavalura	614	1.65	DRLmB2g1	LMU-3	Moderately deep (75-100 cm)	Clay	Gravelly (15-35%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Moderate	Bengalgram+Jowar (Bg+Jw)	Not Available	IIIes	Graded bunding

Village	Survey NO.	Area (ha)	Soil Phase	LMU	Soil Depth	Surface Soil Texture	Soil Gravelliness	Available Water Capacity	Slope	Soil Erosion	Current Land Use	WELLS	Land Capability	Conservation Plan
Kavalura	624	1.31	HDLmB2	LMU-2	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Sunflower+Current fallow+Fallow land (Sf+Cf+Fl)	Not Available	IIIe	Graded bunding
Kavalura	628	3.46	DRLmB2	LMU-3	Moderately deep (75-100 cm)	Clay	Non gravelly (<15%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Moderate	Jowar (Jw)	Not Available	IIIe	Graded bunding
Kavalura	629	5.26	DRLmB2	LMU-3	Moderately deep (75-100 cm)	Clay	Non gravelly (<15%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Moderate	Current fallow (Cf)	Not Available	IIIe	Graded bunding
Kavalura	632	3.38	DRLmB2	LMU-3	Moderately deep (75-100 cm)	Clay	Non gravelly (<15%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Moderate	Jowar (Jw)	Not Available	IIIe	Graded bunding
Kavalura	633	7.7	DRLmB2g1	LMU-3	Moderately deep (75-100 cm)	Clay	Gravelly (15-35%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Moderate	Jowar (Jw)	Not Available	IIIes	Graded bunding
Kavalura	634	9.07	DRLmB2g1	LMU-3	Moderately deep (75-100 cm)	Clay	Gravelly (15-35%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Moderate	Jowar+Sunflower (Jw+Sf)	Not Available	IIIes	Graded bunding
Kavalura	635	6.46	HDLmB2	LMU-2	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Current fallow (Cf)	Not Available	IIIe	Graded bunding
Kavalura	636	0.01	HDLmB2	LMU-2	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Jowar+Sunflower (Jw+Sf)	Not Available	IIIe	Graded bunding
Kavalura	640	0.63	HDLmB2	LMU-2	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Current fallow (Cf)	Not Available	IIIe	Graded bunding
Kavalura	641	4.31	HDLmB2	LMU-2	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Current fallow (Cf)	Not Available	IIIe	Graded bunding
Kavalura	660	3.05	DRLmB2g2	LMU-3	Moderately deep (75-100 cm)	Clay	Very gravelly (35-60%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Moderate	Jowar+Sunflower (Jw+Sf)	Not Available	IIIes	Graded bunding
Kavalura	892	1.3	DRLmB2g1	LMU-3	Moderately deep (75-100 cm)	Clay	Gravelly (15-35%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Moderate	Current fallow+Sunflower (Cf+Sf)	Not Available	IIIes	Graded bunding
Kavalura	893	0.67	DRLmB2g1	LMU-3	Moderately deep (75-100 cm)	Clay	Gravelly (15-35%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Moderate	Current fallow (Cf)	Not Available	IIIes	Graded bunding
Kavalura	894	3.22	DRLmB2g1	LMU-3	Moderately deep (75-100 cm)	Clay	Gravelly (15-35%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Moderate	Bengalgram (Bg)	Not Available	IIIes	Graded bunding
Kavalura	895	3.7	MTLmB2g1	LMU-5	Shallow (25-50 cm)	Clay	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Maize+Jowar+Paddy (Mz+Jw+Pd)	2 Borewell	IIIes	Graded bunding
Kavalura	896	5.29	MTLmB2g1	LMU-5	Shallow (25-50 cm)	Clay	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Chilly+Jowar (Ch+Jw)	1 Farm pond,1 Borewell	IIIes	Graded bunding
Kavalura	897	1.78	KVRmA1	LMU-1	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Nearly level (0-1%)	Slight	Bengalgram (Bg)	Not Available	IIs	Field bunds
Kavalura	898	0.45	KVRmA1	LMU-1	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Nearly level (0-1%)	Slight	Bengalgram (Bg)	Not Available	IIs	Field bunds
Kavalura	901	0.85	KVRmA1	LMU-1	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Nearly level (0-1%)	Slight	Bengalgram (Bg)	Not Available	IIs	Field bunds
Kavalura	902	0.19	KVRmA1	LMU-1	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Nearly level (0-1%)	Slight	Bengalgram (Bg)	Not Available	IIs	Field bunds
Kavalura	906	0	MTLmB2g1	LMU-5	Shallow (25-50 cm)	Clay	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Maize+Jowar+Chilly (Mz+Jw+Ch)	Not Available	IIIes	Graded bunding
Kavalura	907	0.87	MTLmB2g1	LMU-5	Shallow (25-50 cm)	Clay	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Maize+Jowar+Chilly (Mz+Jw+Ch)	1 Borewell	IIIes	Graded bunding

Village	Survey NO.	Area (ha)	Soil Phase	LMU	Soil Depth	Surface Soil Texture	Soil Gravelliness	Available Water Capacity	Slope	Soil Erosion	Current Land Use	WELLS	Land Capability	Conservation Plan
Kavalura	908	5.17	MTLmB2g1	LMU-5	Shallow (25-50 cm)	Clay	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Sunflower+Bengalgram+Jowar+Fallowland (Sf+Bg+Jw+Fl)	1 Borewell	IIIes	Graded bunding
Kavalura	909	0.66	MTLmB2g2	LMU-5	Shallow (25-50 cm)	Clay	Very gravelly (35-60%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Sunflower (Sf)	Not Available	IIIes	Graded bunding
Kavalura	910	2.88	MTLmB2g1	LMU-5	Shallow (25-50 cm)	Clay	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Fallow land Sunflower (Fl+Sf)	Not Available	IIIes	Graded bunding

Appendix II

Gudigeri-5 Microwatershed

Soil Fertility Information

Village	Survey NO.	Soil Reaction	Salinity	Organic Carbon	Available Phosphorus	Available Potassium	Available Sulphur	Available Boron	Available Iron	Available Manganese	Available Copper	Available Zinc
Kavalura	415	Very strongly alkaline (pH > 9.0)	Non saline (<2 dsm)	High (>0.75%)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 - 20 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	416	Very strongly alkaline (pH > 9.0)	Non saline (<2 dsm)	High (>0.75%)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 - 20 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	417	Very strongly alkaline (pH > 9.0)	Non saline (<2 dsm)	Medium (0.5. - 0.75%	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 - 20 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	418	Very strongly alkaline (pH > 9.0)	Non saline (<2 dsm)	High (>0.75%)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 - 20 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	419	Very strongly alkaline (pH > 9.0)	Non saline (<2 dsm)	High (>0.75%)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 - 20 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	420	Very strongly alkaline (pH > 9.0)	Non saline (<2 dsm)	High (>0.75%)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 - 20 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	422	Very strongly alkaline (pH > 9.0)	Non saline (<2 dsm)	High (>0.75%)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 - 20 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	433	Very strongly alkaline (pH > 9.0)	Non saline (<2 dsm)	Medium (0.5. - 0.75%	Low (< 23 kg/ha)	Medium (145 - 337 kg/ha)	High (> 20ppm)	Medium (0.5 - 1.0 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	434	Very strongly alkaline (pH > 9.0)	Non saline (<2 dsm)	Medium (0.5. - 0.75%	Low (< 23 kg/ha)	Medium (145 - 337 kg/ha)	High (> 20ppm)	Medium (0.5 - 1.0 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	435	Very strongly alkaline (pH > 9.0)	Non saline (<2 dsm)	Medium (0.5. - 0.75%	Low (< 23 kg/ha)	High (> 337 kg/ha)	High (> 20ppm)	Medium (0.5 - 1.0 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	436	Very strongly alkaline (pH > 9.0)	Non saline (<2 dsm)	Medium (0.5. - 0.75%	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 - 20 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	437	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 (> 20ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	438	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 (> 20ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	439	Strongly alkaline (pH 8.4 – 9.0)	Medium (4 – 8 dsm)	High (>0.75%)	Low (< 23 kg/ha)	Medium (145 - 337 kg/ha)	High (> 20ppm)	Medium (0.5 - 1.0 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Sufficient (> 0.6 ppm)
Kavalura	440	Strongly alkaline (pH 8.4 – 9.0)	Medium (4 – 8 dsm)	High (>0.75%)	Low (< 23 kg/ha)	Medium (145 - 337 kg/ha)	High (> 20ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Sufficient (> 0.6 ppm)
Kavalura	441	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	High (>0.75%)	Low (< 23 kg/ha)	Medium (145 - 337 kg/ha)	High (> 20ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	442	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5. - 0.75%	Low (< 23 kg/ha)	Medium (145 - 337 kg/ha)	Medium (10 - 20 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	443	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5. - 0.75%	Low (< 23 kg/ha)	High (> 337 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	444	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5. - 0.75%	Low (< 23 kg/ha)	High (> 337 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	445	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5%)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	446	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5. - 0.75%	Low (< 23 kg/ha)	High (> 337 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	447	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5. - 0.75%	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 - 20 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)

Village	Survey NO.	Soil Reaction	Salinity	Organic Carbon	Available Phosphorus	Available Potassium	Available Sulphur	Available Boron	Available Iron	Available Manganese	Available Copper	Available Zinc
Kavalura	448	Very strongly alkaline (pH > 9.0)	Non saline (<2 dsm)	Medium (0.5. - 0.75%	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 - 20 ppm)	Medium (0.5 - 1.0 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	449	Very strongly alkaline (pH > 9.0)	Non saline (<2 dsm)	Medium (0.5. - 0.75%	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 - 20 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	450	Very strongly alkaline (pH > 9.0)	Non saline (<2 dsm)	Low (< 0.5%)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 - 20 ppm)	Medium (0.5 - 1.0 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	451	Very strongly alkaline (pH > 9.0)	Non saline (<2 dsm)	Low (< 0.5%)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 - 20 ppm)	Medium (0.5 - 1.0 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	452	Very strongly alkaline (pH > 9.0)	Non saline (<2 dsm)	Medium (0.5. - 0.75%	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 - 20 ppm)	Medium (0.5 - 1.0 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	453	Very strongly alkaline (pH > 9.0)	Non saline (<2 dsm)	Low (< 0.5%)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 - 20 ppm)	Medium (0.5 - 1.0 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	454	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5. - 0.75%	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 - 20 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	455	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5. - 0.75%	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 - 20 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	456	Very strongly alkaline (pH > 9.0)	Non saline (<2 dsm)	High (>0.75%)	Low (< 23 kg/ha)	High (> 337 kg/ha)	High (> 20ppm)	Medium (0.5 - 1.0 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	457	Very strongly alkaline (pH > 9.0)	Non saline (<2 dsm)	Medium (0.5. - 0.75%	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 - 20 ppm)	Medium (0.5 - 1.0 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	458	Very strongly alkaline (pH > 9.0)	Non saline (<2 dsm)	High (>0.75%)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 - 20 ppm)	Medium (0.5 - 1.0 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	459	Very strongly alkaline (pH > 9.0)	Non saline (<2 dsm)	Low (< 0.5%)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 - 20 ppm)	Medium (0.5 - 1.0 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	460	Very strongly alkaline (pH > 9.0)	Non saline (<2 dsm)	Medium (0.5. - 0.75%	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 - 20 ppm)	Medium (0.5 - 1.0 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	461	Very strongly alkaline (pH > 9.0)	Non saline (<2 dsm)	Medium (0.5. - 0.75%	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 - 20 ppm)	Medium (0.5 - 1.0 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	462	Very strongly alkaline (pH > 9.0)	Non saline (<2 dsm)	Low (< 0.5%)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 - 20 ppm)	Medium (0.5 - 1.0 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	587	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5. - 0.75%	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 - 20 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	588	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	High (>0.75%)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 - 20 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	589	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5. - 0.75%	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 - 20 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	590	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5%)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 - 20 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	591	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5%)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 - 20 ppm)	Medium (0.5 - 1.0 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	592	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5%)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 - 20 ppm)	Medium (0.5 - 1.0 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	593	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Low (< 0.5%)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 - 20 ppm)	Medium (0.5 - 1.0 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	594	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5. - 0.75%	Low (< 23 kg/ha)	High (> 337 kg/ha)	Low (< 10 ppm)	Medium (0.5 - 1.0 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	595	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5. - 0.75%	Low (< 23 kg/ha)	High (> 337 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)

Village	Survey NO.	Soil Reaction	Salinity	Organic Carbon	Available Phosphorus	Available Potassium	Available Sulphur	Available Boron	Available Iron	Available Manganese	Available Copper	Available Zinc
Kavalura	596	Very strongly alkaline (pH > 9.0)	Non saline (<2 dsm)	Medium (0.5. - 0.75%	Low (< 23 kg/ha)	High (> 337 kg/ha)	Low (< 10 ppm)	Medium (0.5 - 1.0 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	597	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5. - 0.75%	Low (< 23 kg/ha)	High (> 337 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	598	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5. - 0.75%	Low (< 23 kg/ha)	High (> 337 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	599	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5. - 0.75%	Low (< 23 kg/ha)	High (> 337 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	600	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5. - 0.75%	Low (< 23 kg/ha)	High (> 337 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	601	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5. - 0.75%	Low (< 23 kg/ha)	High (> 337 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	602	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5. - 0.75%	Low (< 23 kg/ha)	High (> 337 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	603	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5. - 0.75%	Low (< 23 kg/ha)	High (> 337 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	604	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5. - 0.75%	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 - 20 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	605	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5. - 0.75%	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 - 20 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	606	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5. - 0.75%	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 - 20 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	607	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5. - 0.75%	Low (< 23 kg/ha)	High (> 337 kg/ha)	Low (< 10 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	608	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5. - 0.75%	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 - 20 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	609	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 (> 20ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	610	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 (> 20ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	611	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5. - 0.75%	Low (< 23 kg/ha)	Medium (145 - 337 kg/ha)	Medium (10 - 20 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	612	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 (> 20ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	613	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	High (>0.75%)	Low (< 23 kg/ha)	Medium (145 - 337 kg/ha)	High (> 20ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	614	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 (> 20ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	624	Very strongly alkaline (pH > 9.0)	Non saline (<2 dsm)	Low (< 0.5%)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 - 20 ppm)	Medium (0.5 - 1.0 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	628	Very strongly alkaline (pH > 9.0)	Non saline (<2 dsm)	Low (< 0.5%)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Low (< 10 ppm)	Medium (0.5 - 1.0 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	629	Very strongly alkaline (pH > 9.0)	Non saline (<2 dsm)	Low (< 0.5%)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 - 20 ppm)	Medium (0.5 - 1.0 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	632	Very strongly alkaline (pH > 9.0)	Non saline (<2 dsm)	Low (< 0.5%)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 - 20 ppm)	Medium (0.5 - 1.0 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	633	Very strongly alkaline (pH > 9.0)	Non saline (<2 dsm)	Low (< 0.5%)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 - 20 ppm)	Medium (0.5 - 1.0 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)

Village	Survey NO.	Soil Reaction	Salinity	Organic Carbon	Available Phosphorus	Available Potassium	Available Sulphur	Available Boron	Available Iron	Available Manganese	Available Copper	Available Zinc
Kavalura	634	Very strongly alkaline (pH > 9.0)	Non saline (<2 dsm)	Low (< 0.5%)	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 - 20 ppm)	Medium (0.5 - 1.0 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	635	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5. - 0.75%	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 - 20 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	636	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5. - 0.75%	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 - 20 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	640	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5. - 0.75%	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 - 20 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	641	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5. - 0.75%	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 - 20 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	660	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5. - 0.75%	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 - 20 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	892	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5. - 0.75%	Low (< 23 kg/ha)	High (> 337 kg/ha)	Medium (10 - 20 ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	893	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	High (>0.75%)	Low (< 23 kg/ha)	High (> 337 kg/ha)	High (> 20ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	894	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	High (>0.75%)	Low (< 23 kg/ha)	High (> 337 kg/ha)	High (> 20ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	895	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	High (>0.75%)	Low (< 23 kg/ha)	High (> 337 kg/ha)	High (> 20ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	896	Moderately alkaline (pH 7.8 – 8.4)	Medium (4 – 8 dsm)	High (>0.75%)	Low (< 23 kg/ha)	High (> 337 kg/ha)	High (> 20ppm)	Medium (0.5 - 1.0 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Sufficient (> 0.6 ppm)
Kavalura	897	Moderately alkaline (pH 7.8 – 8.4)	Medium (4 – 8 dsm)	High (>0.75%)	Low (< 23 kg/ha)	High (> 337 kg/ha)	High (> 20ppm)	Medium (0.5 - 1.0 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Sufficient (> 0.6 ppm)
Kavalura	898	Moderately alkaline (pH 7.8 – 8.4)	Medium (4 – 8 dsm)	High (>0.75%)	Low (< 23 kg/ha)	High (> 337 kg/ha)	High (> 20ppm)	Medium (0.5 - 1.0 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Sufficient (> 0.6 ppm)
Kavalura	901	Moderately alkaline (pH 7.8 – 8.4)	Medium (4 – 8 dsm)	High (>0.75%)	Low (< 23 kg/ha)	High (> 337 kg/ha)	High (> 20ppm)	Medium (0.5 - 1.0 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Sufficient (> 0.6 ppm)
Kavalura	902	Moderately alkaline (pH 7.8 – 8.4)	Medium (4 – 8 dsm)	High (>0.75%)	Low (< 23 kg/ha)	High (> 337 kg/ha)	High (> 20ppm)	Medium (0.5 - 1.0 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Sufficient (> 0.6 ppm)
Kavalura	906	Moderately alkaline (pH 7.8 – 8.4)	Medium (4 – 8 dsm)	High (>0.75%)	Low (< 23 kg/ha)	High (> 337 kg/ha)	High (> 20ppm)	Medium (0.5 - 1.0 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Sufficient (> 0.6 ppm)
Kavalura	907	Moderately alkaline (pH 7.8 – 8.4)	Low (2 – 4 dsm)	High (>0.75%)	Low (< 23 kg/ha)	High (> 337 kg/ha)	High (> 20ppm)	Medium (0.5 - 1.0 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Sufficient (> 0.6 ppm)
Kavalura	908	Moderately alkaline (pH 7.8 – 8.4)	Low (2 – 4 dsm)	High (>0.75%)	Low (< 23 kg/ha)	High (> 337 kg/ha)	High (> 20ppm)	Medium (0.5 - 1.0 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	909	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	High (>0.75%)	Low (< 23 kg/ha)	High (> 337 kg/ha)	High (> 20ppm)	Medium (0.5 - 1.0 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	910	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	High (>0.75%)	Low (< 23 kg/ha)	High (> 337 kg/ha)	High (> 20ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)

Appendix III

Gudigeri-5 Microwatershed

Soil Suitability Information

Village	Survey Number	Mango	Maize	Sapota	Sorghum	Guava	Tamarind	Lime	Sunflower	Amla	Jackfruit	Custard-apple	Cashew	Jamun	Musambi	Groundnut	Chilly	Tomato	Marigold	Chrysanthemum	Pomegranate	Bajra	Jasmine	Drumstick	Mulberry
Kavalura	415	S2rz	S3tz	S3tz	S2z	S3tz	S2rz	S2z	S2z	S2tz	S3tz	S2z	N1tz	S2rz	S2z	S3tz	S3tz	S3tz	S2tz	S2tz	S2tz	S3tz	S3tz	S2tz	S2tz
Kavalura	416	S3tz	S3tz	S3tz	S2z	S3tz	S2tz	S2z	S2z	S2tz	S3tz	S2z	N1tz	S2tz	S2z	S3tz	S3tz	S3tz	S2tz	S2tz	S2tz	S3tz	S3tz	S2tz	S2tz
Kavalura	417	S2rz	S3tz	S3tz	S2z	S3tz	S2rz	S2z	S2z	S2tz	S3tz	S2z	N1tz	S2rz	S2z	S3tz	S3tz	S3tz	S2tz	S2tz	S2tz	S3tz	S3tz	S2tz	S2tz
Kavalura	418	S3tz	S3tz	S3tz	S2z	S3tz	S2tz	S2z	S2z	S2tz	S3tz	S2z	N1tz	S2tz	S2z	S3tz	S3tz	S3tz	S2tz	S2tz	S2tz	S3tz	S3tz	S2tz	S2tz
Kavalura	419	S3tz	S3tz	S3tz	S2z	S3tz	S2tz	S2z	S2z	S2tz	S3tz	S2z	N1tz	S2tz	S2z	S3tz	S3tz	S3tz	S2tz	S2tz	S2tz	S3tz	S3tz	S2tz	S2tz
Kavalura	420	S3tz	S3tz	S3tz	S2z	S3tz	S2tz	S2z	S2z	S2tz	S3tz	S2z	N1tz	S2tz	S2z	S3tz	S3tz	S3tz	S2tz	S2tz	S2tz	S3tz	S3tz	S2tz	S2tz
Kavalura	422	S3tz	S3tz	S3tz	S2z	S3tz	S2tz	S2z	S2z	S2tz	S3tz	S2z	N1tz	S2tz	S2z	S3tz	S3tz	S3tz	S2tz	S2tz	S2tz	S3tz	S3tz	S2tz	S2tz
Kavalura	433	S2rz	S3tz	S3tz	S2z	S3tz	S2rz	S2z	S2z	S2tz	S3tz	S2z	N1tz	S2rz	S2z	S3tz	S3tz	S3tz	S2tz	S2tz	S2tz	S3tz	S3tz	S2tz	S2tz
Kavalura	434	S2rz	S3tz	S3tz	S2z	S3tz	S2rz	S2z	S2z	S2tz	S3tz	S2z	N1tz	S2rz	S2z	S3tz	S3tz	S3tz	S2tz	S2tz	S2tz	S3tz	S3tz	S2tz	S2tz
Kavalura	435	S2rz	S3tz	S3tz	S2z	S3tz	S2rz	S2z	S2z	S2tz	S3tz	S2z	N1tz	S2rz	S2z	S3tz	S3tz	S3tz	S2tz	S2tz	S2tz	S3tz	S3tz	S2tz	S2tz
Kavalura	436	N1rt	S3tz	N1rz	S3rz	N1rt	N1rz	N1rz	N1rz	S3tz	N1rt	S3z	N1rt	N1rt	N1rz	S3tz	S3rz	S3rz	S3rz	S3rz	N1rz	S3rz	S3rz	N1rz	S3rz
Kavalura	437	N1rt	N1tz	N1rz	N1gz	N1rt	N1rz	N1rz	N1rg	S3rg	N1rt	S3z	N1rt	N1rt	N1rz	N1tz	N1tz	N1tz	N1gz	N1gz	N1rz	N1gz	N1gz	N1rz	N1gz
Kavalura	438	S2rz	S3tz	S3tz	S2z	S3tz	S2rz	S2z	S2z	S2tz	S3tz	S2z	N1tz	S2rz	S2z	S3tz	S3tz	S3tz	S2tz	S2tz	S2tz	S3tz	S3tz	S2tz	S2tz
Kavalura	439	S2rz	S3tz	S3tz	S2z	S3tz	S2rz	S2z	S2z	S2tz	S3tz	S2z	N1tz	S2rz	S2z	S3tz	S3tz	S3tz	S2tz	S2tz	S2tz	S3tz	S3tz	S2tz	S2tz
Kavalura	440	N1rt	S3tz	N1rz	S3rz	N1rt	N1rz	N1rz	N1rz	S3tz	N1rt	S3z	N1rt	N1rt	N1rz	S3tz	S3rz	S3rz	S3rz	S3rz	N1rz	S3rz	S3rz	N1rz	S3rz
Kavalura	441	N1rt	S3tz	N1rz	S3rg	N1rt	N1rz	N1rz	N1rg	S3tz	N1rt	S3z	N1rt	N1rt	N1rz	S3tz	S3rz	S3rz	S3rz	S3rz	N1rz	S3rz	S3rz	N1rz	S3rz
Kavalura	442	N1rt	N1tz	N1rz	N1gz	N1rt	N1rz	N1rz	N1rg	S3rg	N1rt	S3z	N1rt	N1rt	N1rz	N1tz	N1tz	N1tz	N1gz	N1gz	N1rz	N1gz	N1gz	N1rz	N1gz
Kavalura	443	N1rt	S3tz	N1rz	S3rz	N1rt	N1rz	N1rz	N1rz	S3tz	N1rt	S3z	N1rt	N1rt	N1rz	S3tz	S3rz	S3rz	S3rz	S3rz	N1rz	S3rz	S3rz	N1rz	S3rz
Kavalura	444	N1rt	S3tz	N1rz	S3rz	N1rt	N1rz	N1rz	N1rz	S3tz	N1rt	S3z	N1rt	N1rt	N1rz	S3tz	S3rz	S3rz	S3rz	S3rz	N1rz	S3rz	S3rz	N1rz	S3rz
Kavalura	445	N1rt	S3tz	N1rz	S3rz	N1rt	N1rz	N1rz	N1rz	S3tz	N1rt	S3z	N1rt	N1rt	N1rz	S3tz	S3rz	S3rz	S3rz	S3rz	N1rz	S3rz	S3rz	N1rz	S3rz
Kavalura	446	N1rt	S3tz	N1rz	S3rz	N1rt	N1rz	N1rz	N1rz	S3tz	N1rt	S3z	N1rt	N1rt	N1rz	S3tz	S3rz	S3rz	S3rz	S3rz	N1rz	S3rz	S3rz	N1rz	S3rz
Kavalura	447	N1rz	S3tz	S3rz	S2rz	S3tz	N1rz	S3rz	S3rz	S2rz	S3tz	S2rz	N1tz	S3tz	S3rz	S2tz	S3tz	S3tz	S2rz	S2rz	S3rz	S3tz	S2rz	S3rz	S2rz
Kavalura	448	N1rz	S3tz	S3rz	S2rz	S3tz	N1rz	S3rz	S3rz	S2rz	S3tz	S2rz	N1tz	S3tz	S3rz	S2tz	S3tz	S3tz	S2rz	S2rz	S3rz	S3tz	S2rz	S3rz	S2rz
Kavalura	449	N1rz	S3tz	S3rz	S2rz	S3tz	N1rz	S3rz	S3rz	S2rz	S3tz	S2rz	N1tz	S3tz	S3rz	S2tz	S3tz	S3tz	S2rz	S2rz	S3rz	S3tz	S2rz	S3rz	S2rz
Kavalura	450	S3rt	S3t	S3rt	S1	S3t	S3rz	S2r	S2r	S2t	S3t	S1	N1t	S3rt	S2r	S3t	S3t	S3t	S2t	S2t	S2rt	S3t	S3t	S2rt	S2t

Village	Survey Number	Mango	Maize	Sapota	Sorghum	Guava	Tamarind	Lime	Sunflower	Amla	Jackfruit	Custard-apple	Cashew	Jamun	Musambi	Groundnut	Chilly	Tomato	Marigold	Chrysanthemum	Pomegranate	Bajra	Jasmine	Drumstick	Mulberry
Kavalura	451	N1rz	S3tz	S3rz	S2rz	S3tz	N1rz	S3rz	S3rz	S2rz	S3tz	S2rz	N1tz	S3tz	S3rz	S2tz	S3tz	S3tz	S2rz	S2rz	S3rz	S3tz	S2rz	S3rz	S2rz
Kavalura	452	N1rz	S3tz	S3rz	S2rz	S3tz	N1rz	S3rz	S3rz	S2rz	S3tz	S2rz	N1tz	S3tz	S3rz	S2tz	S3tz	S3tz	S2rz	S2rz	S3rz	S3tz	S2rz	S3rz	S2rz
Kavalura	453	N1rz	S3tz	S3rz	S2rz	S3tz	N1rz	S3rz	S3rz	S2rz	S3tz	S2rz	N1tz	S3tz	S3rz	S2tz	S3tz	S3tz	S2rz	S2rz	S3rz	S3tz	S2rz	S3rz	S2rz
Kavalura	454	N1rt	S3tz	N1rz	S3rz	N1rt	N1rz	N1rz	N1rz	S3tz	N1rt	S3z	N1rt	N1rt	N1rz	S3tz	S3rz	S3rz	S3rz	S3rz	N1rz	S3rz	S3rz	N1rz	S3rz
Kavalura	455	N1rt	S3tz	N1rz	S3rz	N1rt	N1rz	N1rz	N1rz	S3tz	N1rt	S3z	N1rt	N1rt	N1rz	S3tz	S3rz	S3rz	S3rz	S3rz	N1rz	S3rz	S3rz	N1rz	S3rz
Kavalura	456	S3rz	S3tz	S3tz	S2nz	S3tz	S3rz	S2rz	S2rz	S2tz	S3tz	S2z	N1tz	S3rz	S2rz	S3tz	S3tz	S3tz	S2tz	S2tz	S2rt	S3tz	S3tz	S2rz	S2tz
Kavalura	457	S3tz	S3tz	S3tz	S2z	S3tz	S2tz	S2z	S2z	S2tz	S3tz	S2z	N1tz	S2tz	S2z	S3tz	S3tz	S3tz	S2tz	S2tz	S2tz	S3tz	S3tz	S2tz	S2tz
Kavalura	458	N1rz	S3tz	S3rz	S2rz	S3tz	N1rz	S3rz	S3rz	S2rz	S3tz	S2rz	N1tz	S3tz	S3rz	S2tz	S3tz	S3tz	S2rz	S2rz	S3rz	S3tz	S2rz	S3rz	S2rz
Kavalura	459	S2rz	S3tz	S3tz	S2z	S3tz	S2rz	S2z	S2z	S2tz	S3tz	S2z	N1tz	S2rz	S2z	S3tz	S3tz	S3tz	S2tz	S2tz	S2tz	S3tz	S3tz	S2tz	S2tz
Kavalura	460	N1rz	S3tz	S3rz	S2rz	S3tz	N1rz	S3rz	S3rz	S2rz	S3tz	S2rz	N1tz	S3tz	S3rz	S2tz	S3tz	S3tz	S2rz	S2rz	S3rz	S3tz	S2rz	S3rz	S2rz
Kavalura	461	S3rt	S3t	S3rt	S1	S3t	S3rz	S2r	S2r	S2t	S3t	S1	N1t	S3rt	S2r	S3t	S3t	S3t	S2t	S2t	S2rt	S3t	S3t	S2rt	S2t
Kavalura	462	S3rt	S3t	S3rt	S1	S3t	S3rz	S2r	S2r	S2t	S3t	S1	N1t	S3rt	S2r	S3t	S3t	S3t	S2t	S2t	S2rt	S3t	S3t	S2rt	S2t
Kavalura	587	S3rz	S3tz	S3tz	S2zg	S3tz	S3rz	S2rz	S2rz	S2tz	S3tz	S2gz	N1tz	S3rz	S2rz	S3tz	S3tz	S3tz	S2tz	S2tz	S2rt	S3tz	S3tz	S2rz	S2tz
Kavalura	588	S3rz	S3tz	S3tz	S2zg	S3tz	S3rz	S2rz	S2rz	S2tz	S3tz	S2gz	N1tz	S3rz	S2rz	S3tz	S3tz	S3tz	S2tz	S2tz	S2rt	S3tz	S3tz	S2rz	S2tz
Kavalura	589	S3rz	S3tz	S3tz	S2zg	S3tz	S3rz	S2rz	S2rz	S2tz	S3tz	S2gz	N1tz	S3rz	S2rz	S3tz	S3tz	S3tz	S2tz	S2tz	S2rt	S3tz	S3tz	S2rz	S2tz
Kavalura	590	N1rz	N1tz	N1rg	N1gz	N1gt	N1rz	N1rg	N1gz	S3gz	N1gt	S3gz	N1tz	N1gt	N1rg	S3gz	N1gz	N1gz	N1gz	N1gz	S3rg	N1gz	N1gz	S3rz	N1gz
Kavalura	591	N1rz	S3tz	S3rz	S2rz	S3tz	N1rz	S3rz	S3rz	S2rz	S3tz	S2rz	N1tz	S3tz	S3rz	S2tz	S3tz	S3tz	S2rz	S2rz	S3rz	S3tz	S2rz	S3rz	S2rz
Kavalura	592	N1rz	S3tz	S3rz	S2rz	S3tz	N1rz	S3rz	S3rz	S2rz	S3tz	S2rz	N1tz	S3tz	S3rz	S2tz	S3tz	S3tz	S2rz	S2rz	S3rz	S3tz	S2rz	S3rz	S2rz
Kavalura	593	N1rz	S3tz	S3rz	S2rz	S3tz	N1rz	S3rz	S3rz	S2rz	S3tz	S2rz	N1tz	S3tz	S3rz	S2tz	S3tz	S3tz	S2rz	S2rz	S3rz	S3tz	S2rz	S3rz	S2rz
Kavalura	594	N1rz	S3tz	S3rz	S2rz	S3tz	N1rz	S3rz	S3rz	S2rz	S3tz	S2rz	N1tz	S3tz	S3rz	S2tz	S3tz	S3tz	S2rz	S2rz	S3rz	S3tz	S2rz	S3rz	S2rz
Kavalura	595	N1rz	N1tz	N1rg	N1gz	N1gt	N1rz	N1rg	N1gz	S3gz	N1gt	S3gz	N1tz	N1gt	N1rg	S3gz	N1gz	N1gz	N1gz	N1gz	S3rg	N1gz	N1gz	S3rz	N1gz
Kavalura	596	N1rz	S3tz	S3rz	S2rz	S3tz	N1rz	S3rz	S3rz	S2rz	S3tz	S2rz	N1tz	S3tz	S3rz	S2tz	S3tz	S3tz	S2rz	S2rz	S3rz	S3tz	S2rz	S3rz	S2rz
Kavalura	597	N1rz	S3tz	S3rz	S2rz	S3tz	N1rz	S3rz	S3rz	S2rz	S3tz	S2rz	N1tz	S3tz	S3rz	S2tz	S3tz	S3tz	S2rz	S2rz	S3rz	S3tz	S2rz	S3rz	S2rz
Kavalura	598	N1rz	S3tz	S3rz	S2rz	S3tz	N1rz	S3rz	S3rz	S2rz	S3tz	S2rz	N1tz	S3tz	S3rz	S2tz	S3tz	S3tz	S2rz	S2rz	S3rz	S3tz	S2rz	S3rz	S2rz
Kavalura	599	N1rz	N1tz	N1rg	N1gz	N1gt	N1rz	N1rg	N1gz	S3gz	N1gt	S3gz	N1tz	N1gt	N1rg	S3gz	N1gz	N1gz	N1gz	N1gz	S3rg	N1gz	N1gz	S3rz	N1gz
Kavalura	600	N1rz	S3tz	S3rz	S2rz	S3tz	N1rz	S3rz	S3rz	S2rz	S3tz	S2rz	N1tz	S3tz	S3rz	S2tz	S3tz	S3tz	S2rz	S2rz	S3rz	S3tz	S2rz	S3rz	S2rz
Kavalura	601	N1rz	S3tz	S3rz	S2rz	S3tz	N1rz	S3rz	S3rz	S2rz	S3tz	S2rz	N1tz	S3tz	S3rz	S2tz	S3tz	S3tz	S2rz	S2rz	S3rz	S3tz	S2rz	S3rz	S2rz

Village	Survey Number	Mango	Maize	Sapota	Sorghum	Guava	Tamarind	Lime	Sunflower	Amla	Jackfruit	Custard-apple	Cashew	Jamun	Musambi	Groundnut	Chilly	Tomato	Marigold	Chrysanthemum	Pomegranate	Bajra	Jasmine	Drumstick	Mulberry
Kavalura	602	S3rz	S3tz	S3tz	S2nz	S3tz	S3rz	S2rz	S2rz	S2tz	S3tz	S2z	N1tz	S3rz	S2rz	S3tz	S3tz	S3tz	S2tz	S2tz	S2rt	S3tz	S3tz	S2rz	S2tz
Kavalura	603	S3rz	S3tz	S3tz	S2nz	S3tz	S3rz	S2rz	S2rz	S2tz	S3tz	S2z	N1tz	S3rz	S2rz	S3tz	S3tz	S3tz	S2tz	S2tz	S2rt	S3tz	S3tz	S2rz	S2tz
Kavalura	604	S3rz	S3tz	S3tz	S2nz	S3tz	S3rz	S2rz	S2rz	S2tz	S3tz	S2z	N1tz	S3rz	S2rz	S3tz	S3tz	S3tz	S2tz	S2tz	S2rt	S3tz	S3tz	S2rz	S2tz
Kavalura	605	N1rz	S3tz	S3rz	S2rz	S3tz	N1rz	S3rz	S3rz	S2rz	S3tz	S2rz	N1tz	S3tz	S3rz	S2tz	S3tz	S3tz	S2rz	S2rz	S3rz	S3tz	S2rz	S3rz	S2rz
Kavalura	606	S3rz	S3tz	S3tz	S2nz	S3tz	S3rz	S2rz	S2rz	S2tz	S3tz	S2z	N1tz	S3rz	S2rz	S3tz	S3tz	S3tz	S2tz	S2tz	S2rt	S3tz	S3tz	S2rz	S2tz
Kavalura	607	S3rz	S3tz	S3tz	S2nz	S3tz	S3rz	S2rz	S2rz	S2tz	S3tz	S2z	N1tz	S3rz	S2rz	S3tz	S3tz	S3tz	S2tz	S2tz	S2rt	S3tz	S3tz	S2rz	S2tz
Kavalura	608	S3rz	S3tz	S3tz	S2nz	S3tz	S3rz	S2rz	S2rz	S2tz	S3tz	S2z	N1tz	S3rz	S2rz	S3tz	S3tz	S3tz	S2tz	S2tz	S2rt	S3tz	S3tz	S2rz	S2tz
Kavalura	609	S3rz	S3tz	S3tz	S2nz	S3tz	S3rz	S2rz	S2rz	S2tz	S3tz	S2z	N1tz	S3rz	S2rz	S3tz	S3tz	S3tz	S2tz	S2tz	S2rt	S3tz	S3tz	S2rz	S2tz
Kavalura	610	N1rz	S3tz	S3rz	S2rz	S3tz	N1rz	S3rz	S3rz	S2rz	S3tz	S2rz	N1tz	S3tz	S3rz	S2tz	S3tz	S3tz	S2rz	S2rz	S3rz	S3tz	S2rz	S3rz	S2rz
Kavalura	611	S3rz	S3tz	S3tz	S2nz	S3tz	S3rz	S2rz	S2rz	S2tz	S3tz	S2z	N1tz	S3rz	S2rz	S3tz	S3tz	S3tz	S2tz	S2tz	S2rt	S3tz	S3tz	S2rz	S2tz
Kavalura	612	S3rz	S3tz	S3tz	S2nz	S3tz	S3rz	S2rz	S2rz	S2tz	S3tz	S2z	N1tz	S3rz	S2rz	S3tz	S3tz	S3tz	S2tz	S2tz	S2rt	S3tz	S3tz	S2rz	S2tz
Kavalura	613	N1rz	S3tz	S3rz	S2rz	S3tz	N1rz	S3rz	S3rz	S2rz	S3tz	S2rz	N1tz	S3tz	S3rz	S2tz	S3tz	S3tz	S2rz	S2rz	S3rz	S3tz	S2rz	S3rz	S2rz
Kavalura	614	S3rz	S3tz	S3tz	S2nz	S3tz	S3rz	S2rz	S2rz	S2tz	S3tz	S2z	N1tz	S3rz	S2rz	S3tz	S3tz	S3tz	S2tz	S2tz	S2rt	S3tz	S3tz	S2rz	S2tz
Kavalura	624	S3t	S3t	S3t	S1	S3t	S2rt	S1	S1	S2t	S3t	S1	N1t	S2rt	S1	S3t	S3t	S3t	S2t	S2t	S2t	S3t	S3t	S2t	S2t
Kavalura	628	S3rz	S3tz	S3tz	S2nz	S3tz	S3rz	S2rz	S2rz	S2tz	S3tz	S2z	N1tz	S3rz	S2rz	S3tz	S3tz	S3tz	S2tz	S2tz	S2rt	S3tz	S3tz	S2rz	S2tz
Kavalura	629	S3rz	S3tz	S3tz	S2nz	S3tz	S3rz	S2rz	S2rz	S2tz	S3tz	S2z	N1tz	S3rz	S2rz	S3tz	S3tz	S3tz	S2tz	S2tz	S2rt	S3tz	S3tz	S2rz	S2tz
Kavalura	632	S3rz	S3tz	S3tz	S2nz	S3tz	S3rz	S2rz	S2rz	S2tz	S3tz	S2z	N1tz	S3rz	S2rz	S3tz	S3tz	S3tz	S2tz	S2tz	S2rt	S3tz	S3tz	S2rz	S2tz
Kavalura	633	S3rz	S3tz	S3tz	S2nz	S3tz	S3rz	S2rz	S2rz	S2tz	S3tz	S2z	N1tz	S3rz	S2rz	S3tz	S3tz	S3tz	S2tz	S2tz	S2rt	S3tz	S3tz	S2rz	S2tz
Kavalura	634	S3rz	S3tz	S3tz	S2nz	S3tz	S3rz	S2rz	S2rz	S2tz	S3tz	S2z	N1tz	S3rz	S2rz	S3tz	S3tz	S3tz	S2tz	S2tz	S2rt	S3tz	S3tz	S2rz	S2tz
Kavalura	635	S3t	S3t	S3t	S1	S3t	S2rt	S1	S1	S2t	S3t	S1	N1t	S2rt	S1	S3t	S3t	S3t	S2t	S2t	S2t	S3t	S3t	S2t	S2t
Kavalura	636	S3t	S3t	S3t	S1	S3t	S2rt	S1	S1	S2t	S3t	S1	N1t	S2rt	S1	S3t	S3t	S3t	S2t	S2t	S2t	S3t	S3t	S2t	S2t
Kavalura	640	S3t	S3t	S3t	S1	S3t	S2rt	S1	S1	S2t	S3t	S1	N1t	S2rt	S1	S3t	S3t	S3t	S2t	S2t	S2t	S3t	S3t	S2t	S2t
Kavalura	641	S3t	S3t	S3t	S1	S3t	S2rt	S1	S1	S2t	S3t	S1	N1t	S2rt	S1	S3t	S3t	S3t	S2t	S2t	S2t	S3t	S3t	S2t	S2t
Kavalura	660	S3rz	S3tz	S3tz	S2zg	S3tz	S3rz	S2rz	S2rz	S2tz	S3tz	S2gz	N1tz	S3rz	S2rz	S3tz	S3tz	S3tz	S2tz	S2tz	S2rt	S3tz	S3tz	S2rz	S2tz
Kavalura	892	S3rz	S3tz	S3tz	S2nz	S3tz	S3rz	S2rz	S2rz	S2tz	S3tz	S2z	N1tz	S3rz	S2rz	S3tz	S3tz	S3tz	S2tz	S2tz	S2rt	S3tz	S3tz	S2rz	S2tz
Kavalura	893	S3rz	S3tz	S3tz	S2nz	S3tz	S3rz	S2rz	S2rz	S2tz	S3tz	S2z	N1tz	S3rz	S2rz	S3tz	S3tz	S3tz	S2tz	S2tz	S2rt	S3tz	S3tz	S2rz	S2tz
Kavalura	894	S3rz	S3tz	S3tz	S2nz	S3tz	S3rz	S2rz	S2rz	S2tz	S3tz	S2z	N1tz	S3rz	S2rz	S3tz	S3tz	S3tz	S2tz	S2tz	S2rt	S3tz	S3tz	S2rz	S2tz
Kavalura	895	N1rt	S3tz	N1rz	S3rz	N1rt	N1rz	N1rz	N1rz	S3tz	N1rt	S3z	N1rt	N1rt	N1rz	S3tz	S3rz	S3rz	S3rz	S3rz	N1rz	S3rz	S3rz	N1rz	S3rz

Village	Survey Number	Mango	Maize	Sapota	Sorghum	Guava	Tamarind	Lime	Sunflower	Amla	Jackfruit	Custard-apple	Cashew	Jamun	Musambi	Groundnut	Chilly	Tomato	Marigold	Chrysanthemum	Pomegranate	Bajra	Jasmine	Drumstick	Mulberry
Kavalura	896	N1rt	S3tz	N1rz	S3rz	N1rt	N1rz	N1rz	N1rz	S3tz	N1rt	S3z	N1rt	N1rt	N1rz	S3tz	S3rz	S3rz	S3rz	S3rz	N1rz	S3rz	S3rz	N1rz	S3rz
Kavalura	897	S2rz	S3tz	S3tz	S2z	S3tz	S2rz	S2z	S2z	S2tz	S3tz	S2z	N1tz	S2rz	S2z	S3tz	S3tz	S3tz	S2tz	S2tz	S2tz	S3tz	S3tz	S2tz	S2tz
Kavalura	898	S2rz	S3tz	S3tz	S2z	S3tz	S2rz	S2z	S2z	S2tz	S3tz	S2z	N1tz	S2rz	S2z	S3tz	S3tz	S3tz	S2tz	S2tz	S2tz	S3tz	S3tz	S2tz	S2tz
Kavalura	901	S2rz	S3tz	S3tz	S2z	S3tz	S2rz	S2z	S2z	S2tz	S3tz	S2z	N1tz	S2rz	S2z	S3tz	S3tz	S3tz	S2tz	S2tz	S2tz	S3tz	S3tz	S2tz	S2tz
Kavalura	902	S2rz	S3tz	S3tz	S2z	S3tz	S2rz	S2z	S2z	S2tz	S3tz	S2z	N1tz	S2rz	S2z	S3tz	S3tz	S3tz	S2tz	S2tz	S2tz	S3tz	S3tz	S2tz	S2tz
Kavalura	906	N1rt	S3tz	N1rz	S3rz	N1rt	N1rz	N1rz	N1rz	S3tz	N1rt	S3z	N1rt	N1rt	N1rz	S3tz	S3rz	S3rz	S3rz	S3rz	N1rz	S3rz	S3rz	N1rz	S3rz
Kavalura	907	N1rt	S3tz	N1rz	S3rz	N1rt	N1rz	N1rz	N1rz	S3tz	N1rt	S3z	N1rt	N1rt	N1rz	S3tz	S3rz	S3rz	S3rz	S3rz	N1rz	S3rz	S3rz	N1rz	S3rz
Kavalura	908	N1rt	S3tz	N1rz	S3rz	N1rt	N1rz	N1rz	N1rz	S3tz	N1rt	S3z	N1rt	N1rt	N1rz	S3tz	S3rz	S3rz	S3rz	S3rz	N1rz	S3rz	S3rz	N1rz	S3rz
Kavalura	909	N1rt	S3tz	N1rz	S3rg	N1rt	N1rz	N1rz	N1rg	S3tz	N1rt	S3z	N1rt	N1rt	N1rz	S3tz	S3rz	S3rz	S3rz	S3rz	N1rz	S3rz	S3rz	N1rz	S3rz
Kavalura	910	N1rt	S3tz	N1rz	S3rz	N1rt	N1rz	N1rz	N1rz	S3tz	N1rt	S3z	N1rt	N1rt	N1rz	S3tz	S3rz	S3rz	S3rz	S3rz	N1rz	S3rz	S3rz	N1rz	S3rz

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: *The Gudigeri-5 micro-watershed is located in between $15^0$17' – $15^0$18' North latitudes and $75^0$55' – $75^0$57' East longitudes, covering an area of about 355.37 ha and bounded by Kavalura, and Gudigeri villages in Koppal taluk and district. It falls under Agro Ecological Region (AER)–3: (Deccan plateau, hot arid ecosubregion) Karnataka Plateau (Rayalseema as inclusion), hot arid ESR with deep loamy and clayey mixed red and black soils, low to medium AWC and LGP 60-90 days We used soil resource map as basis for sampling farm households to test the hypothesis that soil quality influence crop selection, and conservation investment of farm households. The level of technology adoption and productivity gaps and livelihood patterns were analyses. The cost of soil degradation and ecosystem services were quantified for each watershed.*

Results: *We found that*

Social Indicators;

- *Male and female ratio is 50 to 50 per cent to the total sample population.*
- *Younger age groups of population is around 48 per cent to the total population.*
- *Literacy population is around 77 per cent.*
- *Wood is the source of energy for a cooking among 67 per cent.*
- *About 17 per cent of households have a yashaswini health card.*
- *Majority of farm households (75 %) are having MGNREGA card for rural employments.*
- *Dependence on ration cards through public distribution system is around 67 per cent*
- *Swach bharath program providing closed toilet facilities around 58 per cent of sample households.*
- *Institutional participation is only 6.3 per cent of sample households.*
- *Rural migration to unban centre for employment is prevent among 42 per cent of farm households.*
- *Women participation is decisions making are around 12 per cent of households were found.*

Economic Indicators;

- *The average land holding is 3.7 ha indicates that majority of farm households are belong to marginal and small farmers.*
- *Agriculture is the main occupation among 95 per cent and Diary farming is predominant subsidiary occupation for 2.7 per cent of sample households.*

- *The average value of domestic assets is around Rs 21479 per household. Mobile and television are mass popular mass communication media.*
- *The average farm assets a value is around Rs 90330 per household, about 21 per cent of sample farmers are owing tractors.*
- *The average livestock value is around Rs 30967 per livestock; about 33 per cent of household are having livestock.*
- *The average per capita food consumption is around 799 grams (1921 kilo calories) against national institute of nutrition recommendation at 827 gram. Around 56 per cent of sample farmers are consuming less than the NIN recommendation.*
- *The annual average income is around Rs 38608 per household. About 50 per cent of farm households are below poverty line.*
- *The per capita monthly expenditure is around Rs 1069 per household.*

Environmental Indicators-Ecosystem Services;

- *The value of ecosystem service helps to support investment to decision on soil and water conservation and in promoting sustainable land use.*
- *The onsite cost of different soil nutrients lost due to soil erosion is around Rs 12946 per ha/year. The total cost of annual soil nutrients is around Rs 4414535 per year for the total area of 355.57 ha.*
- *The average value of ecosystem service for food production is around Rs 3139/ ha/year. Per ha food production services is maximum in green gram (Rs 7992/ha) followed by wheat (Rs 5270/ha), bengal gram (Rs 4275/ha), groundnut (Rs 2964/ha), sorghum (Rs 2936/ha), Bajra (Rs 2881/ha), onion (Rs 1473/ha) and sunflower (Rs 1786/ha).*
- *The average value of ecosystem service for fodder production is around Rs 533/ ha/year. Per ha fodder production services is maximum in sorghum (Rs 1263 /ha) followed by maize (Rs 1235 /ha), groundnut (Rs 419/ha) and green gram (Rs 14/ha).*
- *The data on water requirement for producing one quintal of grain is considered for estimating the total value of water required for crop production. The per hectare value of water used and value of water was maximum in bajra (Rs 52814) followed by green gram (Rs 40870), sorghum (Rs 20034), bengal gram (Rs 17058), sunflower (Rs 14268), ground nut (Rs 10482), maize (Rs 7546) and onion (Rs 6718).*

Economic Land Evaluation;

- *The major cropping pattern is sunflower (41.1%) followed by green gram (25.2%), sorghum (16.9 %), onion (5.8 %), bengal gram (5 %), groundnut (4.3 %) and maize (1.7 %).*

- *In Gudigeri-5 micro watershed, major soils are Ravanaki (RNK) series are having moderately shallow soil deep cover around 29.4 % of area. On this soil farmers are presently growing sunflower (41.9 %) sorghum (20.9%), green gram (19 %) and Bengal gram (17.9 %). Narasapura (NSP) and Dambarahalli (DRL) soil series are having moderately deep soil depth cover around 3.13 % and 20.98 per cent of area, respectively. The major crops grown are green gram (33.7 %), onion (10.7 %), sorghum (33.7 %) and sunflower 21.7 %). Muttal (MTL) soil series are having very shallow soil depth covers around 19.7 % of area, the major crop grown is maize. Kavalur (KVR) soil series having deep soil depth cover around 9.45 % of area, crops are green gram (6.84 %), groundnut (2016 %) and sunflower (73 %) and Belagatti (BLT) soil series having very deep soil depth cover 0.46 % of area, crops are wheat.*
- *The total cost of cultivation in study area for green gram ranges between Rs.36247/ha in KVR soil (with BCR of 1.42) and Rs.12773/ha in RNK soil (with BCR of 1.15).*
- *In sorghum the cost of cultivation range between Rs 12768/ha in RNK soil (with of 0.93) and Rs.6890/ha in DRL soil (With BCR of 1.64).*
- *In sunflower the cost of cultivation range between Rs. 13032/ha in RNK soil (with BCR of 1.20) and Rs. 10194/ha in NSP soil (with BCR of 1.09).*
- *In maize the cost of cultivation in MTL soil is Rs.13677/ha (with BCR of 0.99).*
- *In bengal gram the cost of cultivation in RNK soil is Rs.4370/ha (with BCR of 1.98).*
- *In onion the cost of cultivation in NSP soil is Rs 12112/ha (with BCR of 1.26) and wheat cultivation in BGT soil is Rs 72994/ha (with BCR of 0.89).*

Suggestions;

- *Involving farmers is watershed planning helps in improving 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 strengthen 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 bengal gram (72.2 %), green gram (16.7 to 43.3) groundnut (57.6%), maize (89.1%), onion (88.9 %), sorghum (68.9 to 77.1 %), sunflower (54.9 to 68.7 %) and wheat (50 %).*

Chapter 2

INTRODUCTION

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

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 and 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

Agro-climatic Zone 3: Northern Dry Zone: This zone is the largest in the state with a geographical area of 5.04 M ha, of which about 3.55 M ha is under cultivation. Irrigation is available to about 0.49 M ha. The zone encompasses the entire districts of Bijapur and Bellary, 6 taluks of Koppal, 5 taluks of Dharwad and 5 taluks of Belgaum. Of the 35 taluks in the zone, 9 taluks have a mean elevation of 800-900 m MSL while the rest have an elevation of 450-800 m. The rainfall is similar to that of the northeastern dry zone, ranging between 465 and 785 mm. Black soils are predominant in the zone with depth ranging from shallow to deep. General cropping season is *kharif* in shallow black soils and *rabi* in medium and deep black soils. Important crops grown are jowar, maize, bajra, groundnut, pulses, sunflower, cotton and sugarcane.

The Gudigeri-5 micro-watershed (Koppal taluk and district) is located in between $15^0$17' – $15^0$18' North latitudes and $75^0$55' – $75^0$57' East longitudes, covering an area of about 355.37 ha and bounded by Kavalura, and Gudigeri villages. It falls under **Agro Ecological Region (AER)–3: (Deccan plateau, hot arid ecosubregion)** Karnataka Plateau (Rayalseema as inclusion), hot arid ESR with deep loamy and clayey mixed red and black soils, low to medium AWC and LGP 60-90 days (Figure 1).

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).

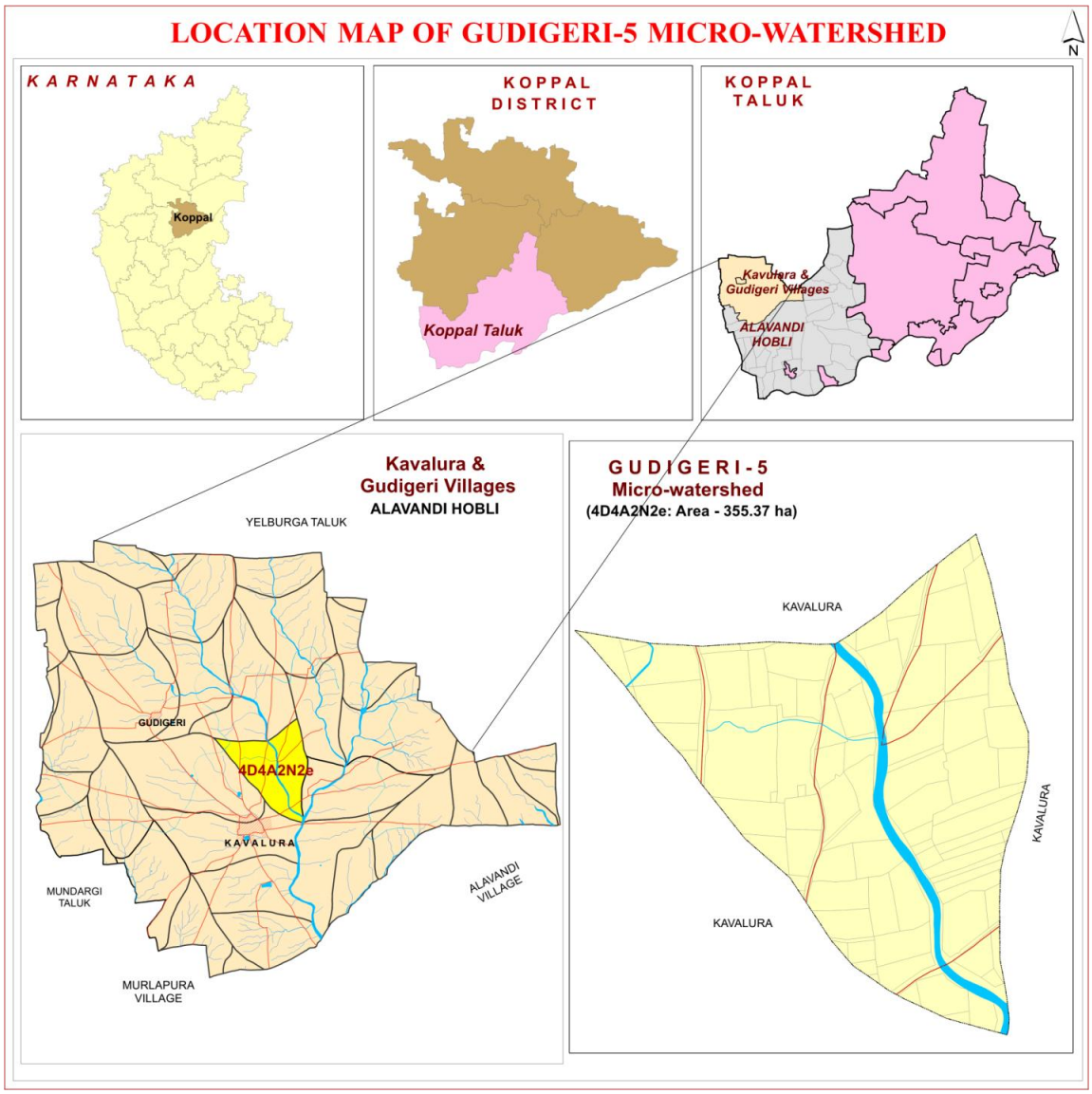


Figure 1: Location of study area

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 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 .

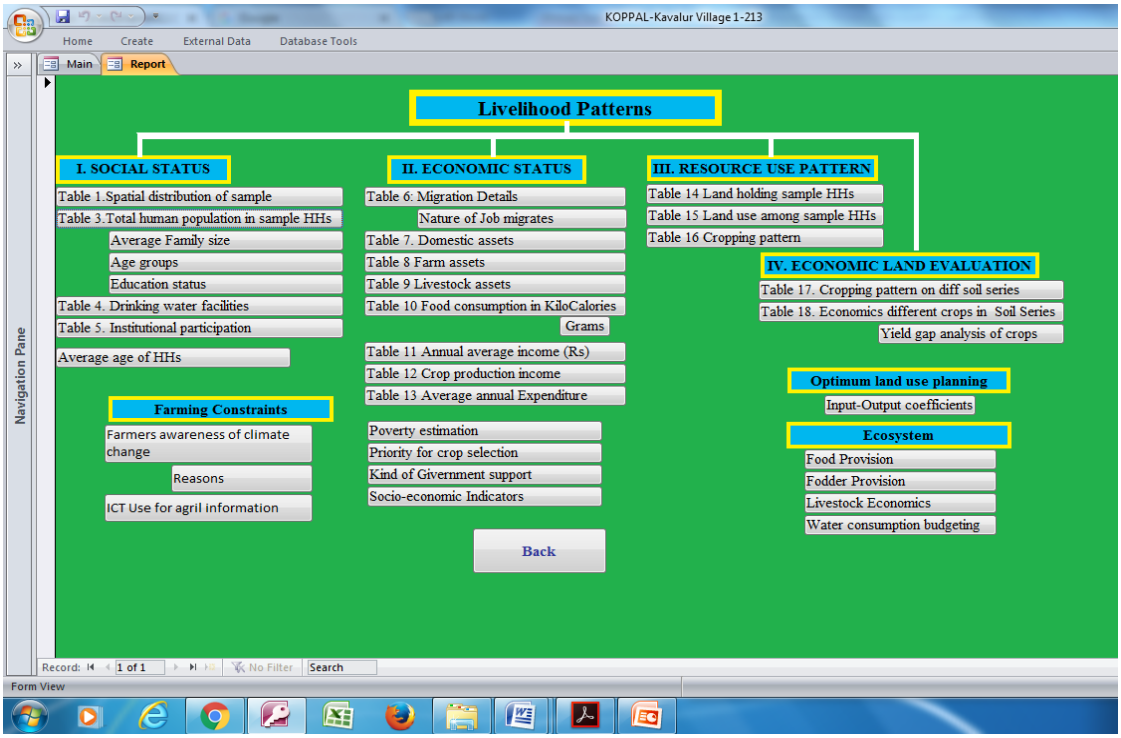


Figure 2: ALPES FRAMEWORK

The sample farmers were post classified in to marginal and small (0.00 to <=4.94 acres), medium and semi medium (>4.94 to <=24.7 acres) and large (>24.7 acres). The steps involved in estimation of soil potential involve estimation of total cost of cultivation, the yield/gross returns and net income per hectare. The cost of inputs such seed, manure and fertilizer, plant protection chemicals, payment towards human and bullock labour and interest on working capita are included under operational costs. In the case of perennial crops, the cost of establishment was estimated by using actual physical requirements and prevailing market prices. Estimation cost included maintenance cost up to bearing period. The value of main product and by product from the crop enterprise at the market rates were the gross returns of the crop. Net returns were worked out by deducting establishment and maintained cost from gross returns.

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

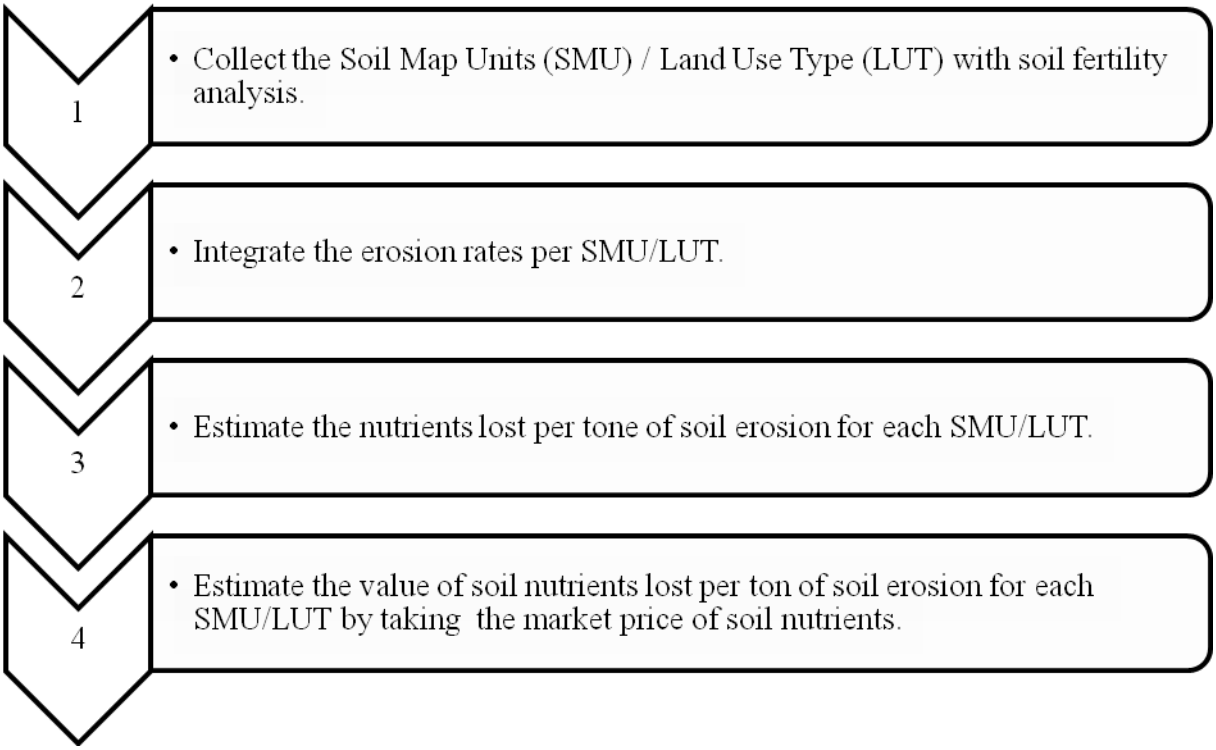
Economic suitability classes: once each land use –land area combination has been assigned an economic value by the land evaluation, the question arises as to its ‘suitability’, that is, the degree to which it satisfies the land user. The FAO framework defines two suitability orders: ’S’(suitable if benefit cost ratio (BCR)>1) and ‘N’(not suitable if (BCR<1), which are dived into five economic suitability classes:’S1’(highly

suitable if BCR>3), 'S2'(suitable if BCR>2 and <3),'S3'(Marginally suitable if BCR >1 and <2), 'N1'(Not suitable for economic reasons but physically suitable) and 'N2'(not suitable for physical reasons). The limit between 'S3' and 'N1'must be at least at the point of financial feasibility (i.e. net returns, NPV, or IRR>0 and BCR>1). The other limits depend on social factors such as farm size, family size, alternative employment or investment possibilities and wealth expectations; these need to be specified for the Soil series.

Economic Valuation of Soil ecosystem services:

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

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



Chapter 4

RESULTS AND DISCUSSIONS

The 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. 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 48, out of which 50 per cent were males and 50 per cent females. Average family size of the households is 4. Age is an important factor, which affects the potential employment and mobility status of respondents. The data on age wise distribution of farmers in the sample households indicated that majority of the farmers are coming under the age group of 30 to 50 years (37.5 %) followed by more than 50 years (27.1 %), 0 to18 years (25 %) and 18 to 30 years (10.4 %). 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 22.9 per cent of respondents were illiterate and 77.1 per cent literate (Table 1).

Table 1: Human population among sample households in Gudigeri-5 Microwatershed

Particulars	**Units**	**Value**
Total human population in sample HHs	Number	48.0
Male	% to total Population	50.0
Female	% to total Population	50.0
Average family size	Number	4.0
Age group		
0 to 18 years	% to total Population	25.0
18 to 30 years	% to total Population	10.4
30 to 50 years	% to total Population	37.5
>50 years	% to total Population	27.1
Average age	Age in years	39.0
Education Status		
Illiterates	% to total Population	22.9
Literates	% to total Population	77.1
Primary School (<5 class)	% to total Population	12.5
Middle School (6- 8 Class)	% to total Population	22.9
High School (9- 10 Class	% to total Population	22.9
Others	% to total Population	18.8

The ethnic groups among the sample farm households found to be 50 per cent belonging to General Castes and 50 per cent belonging to Other Backward Castes (OBC) (Table 2 and Figure 3). About 66.7 per cent of sample households are using fire wood as

source of fuel for cooking. All the sample farmers (100 %) are having electricity connection. About 16.7 per cent are sample households having health cards. Majority (75 %) are having MNREGA job cards for employment generation. About 66.7 per cent of farm households are having ration cards for taking food grains from public distribution system. About 58.3 per cent of farm households are having toilet facilities.

Table 2: Basic needs of sample households in Gudigeri-5 Microwatershed

Particulars	Units	Value
Social groups		
OBC	% of Households	50.0
Others	% of Households	50.0
Types of fuel use for cooking		
Fire wood	% of Households	66.7
Fire wood & Gas	% of Households	16.7
Gas	% of Households	16.7
Energy supply for home		
Electricity	% of Households	100
Number of households having Health card		
Yes	% of Households	16.7
No	% of Households	83.3
MGNREGA Card		
Yes	% of Households	75.0
No	% of Households	25.0
Ration Card		
Yes	% of Households	66.7
No	% of Households	33.3
Households with toilet		
Yes	% of Households	58.3
No	% of Households	41.7
Drinking water facilities		
Dug well	% of Households	33.3
Tube Well	% of Households	66.7

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 (66.7 %).

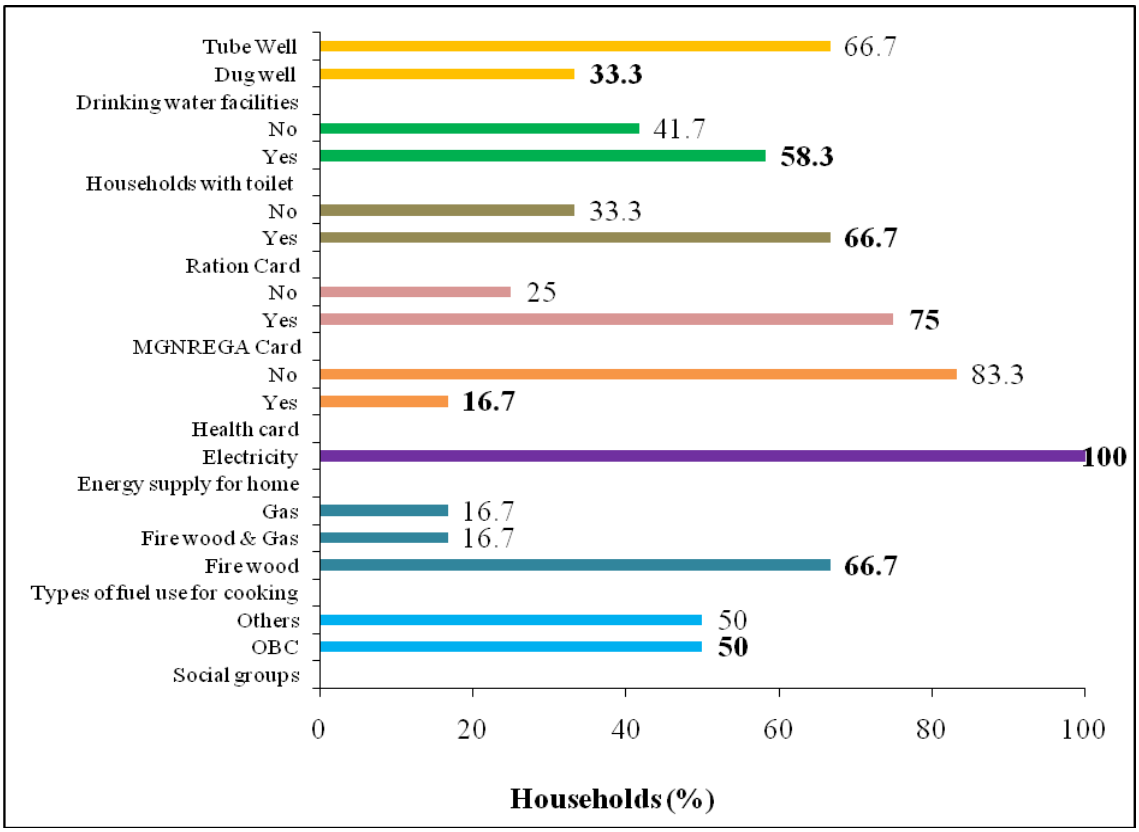


Figure 3: Basic needs of sample households in Gudigeri-5 Microwatershed

Only 6.25 per cent of the farmers are participating in community based organizations (Table 3). Among them majority were participating in Self help Group organization (6.25 %) like Sri Dharmasthala Swasahaya Sangha, Stri Shakhti Sangha.

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

Particulars	Units	Value
No. Of people participating	**% to total Population**	6.3
Self help Groups	% of Participating total Population	6.3
No. Of people not participating	**% to total Population**	93.7

The data on migration in Gudigeri-5 MWS is given in Table 4. It indicated that around 41.7 per cent of samples households were migrated. The average distance travelled for seeking employment is 330 km.

Table 4: Migration details among the sample households in Gudageri 4 micro-watershed

Particulars	Value
% of households showing migration	41.7
% of persons migrating	6.3
No. of months migrated in a year	10.0
Average Distance of migration(Km)	330.0
Nature of job	
Job/wage/work (%)	100.0

The occupational patterns (Table 5) among sample households shows that agriculture is the main occupation around 95 per cent of farmers followed by subsidiary occupations like dairy farming (2.70 %) and Govt. Service (2.70 %).

Table 5: Occupational pattern in sample households in Gudigeri-5 Microwatershed

Occupation		**% to total population**
Main	**Subsidiary**	
Agriculture	Agriculture	94.6
	Dairy farming	2.7
	Govt. service	2.7
Grand Total		100.0
Family labour availability		**(Man days/ month)**
Male		42.5
Female		32.6
Total		75.1

The important assets especially with reference to domestic assets were analyzed and are given in Table 6 and Figure 4. The important domestic assets possessed by all categories of farmers are Mobile phones (100 %) followed by Television (85.7 %), Motor bike (35.7 %), Bicycle (35.7 %), Mixer/grinder (28.6 %), Computer/laptop (7.1 %) and Four wheeler (7.1 %). The average value of domestic assets is around Rs 21479 per households (Table 6).

Table 6: Domestic assets among the sample households in Gudigeri-5 Microwatershed

Particulars	**% of households**	**Average value in Rs**
Bicycle	35.7	1033
Computer/laptop	7.1	28000
Four wheeler	7.1	80000
Mixer/grinder	28.6	650
Mobile Phone	100	3167
Motorcycle	35.7	32100
Television	85.7	5400
Average value	21479	

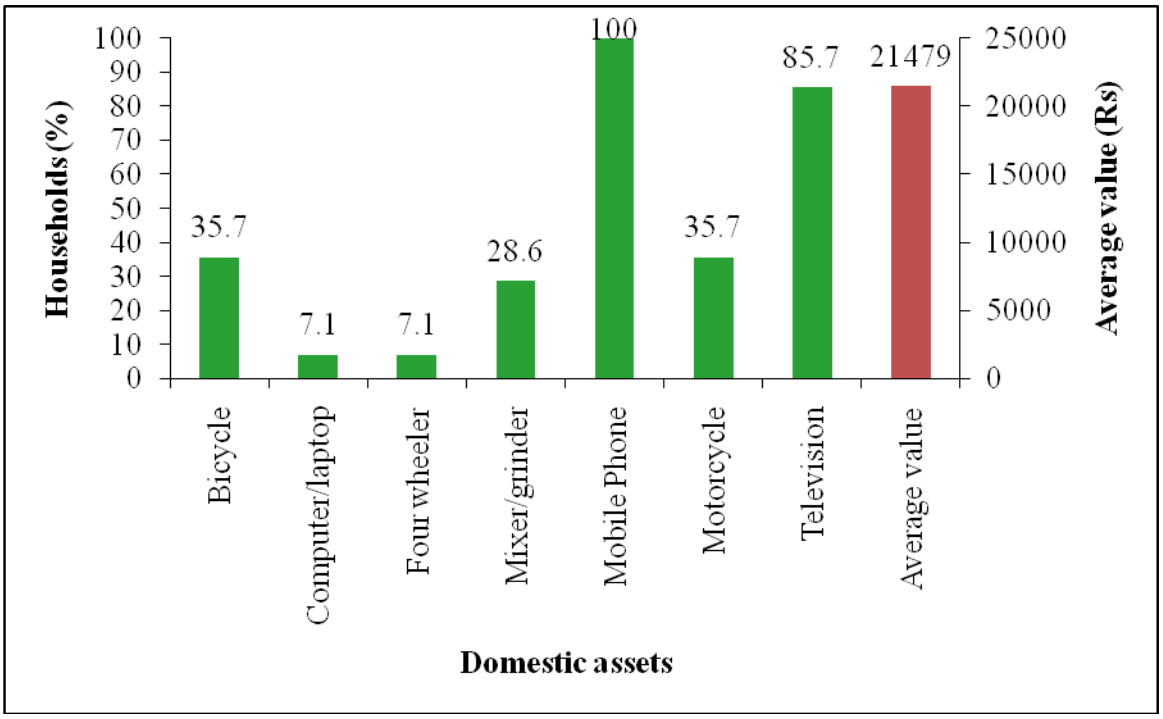


Figure 4: Domestic assets among the sample households in Gudigeri-5 Microwatershed

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 tractor (21.4), bullock cart (28.6), sprayer (28.6), Plough (14.3 %) drip/sprinkler (7.1%), Earth remover (7.1) and Weeder (5) was found highest among the sample farmers (Table 7 and Figure 5).

Table 7: Farm assets among samples households in Gudigeri-5 Microwatershed

Particulars	% of households	Average value in Rs
Bullock cart	28.6	12625
Drip/Sprinkler	7.1	25000
Earth Remover	7.1	6000
Plough	14.3	650
Power Tiller	7.1	25000
Sprayer	28.6	3300
Tractor	21.4	650000
Weeder	5	68
Average value	90330	

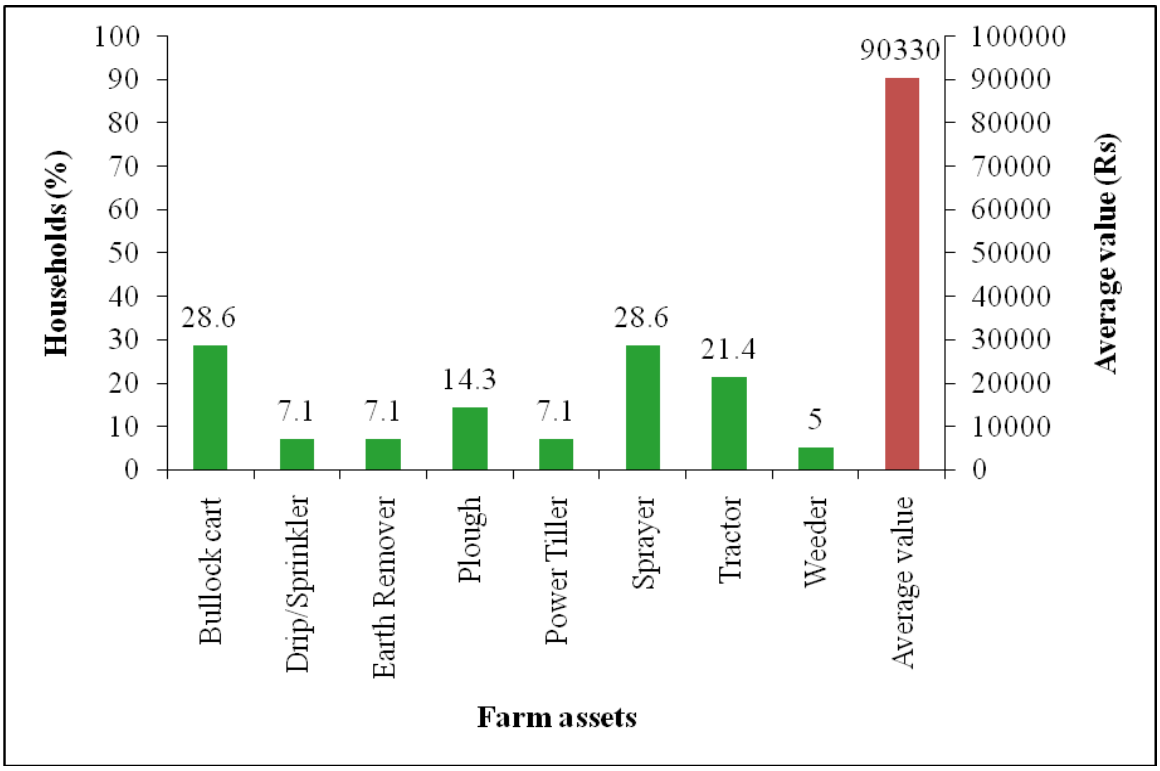


Figure5: Farm assets among samples households in Gudigeri-5 Microwatershed

Livestock is an integral component of the conventional farming systems (Table 8 and Figure 6). The highest livestock population is bullocks were around 21.4 per cent and Local dry cow (21.4%) for cultivation of land, Local mulching cow was found 14.3 per cent for milk purpose and sheeps (7.1%) of meat purpose. The average livestock value was Rs 30967 per livestock.

Table 8: Livestock assets among sample households in Gudigeri-5 micro-watershed

Particulars	% of livestock population	Average value in Rs
Local Dry Cow	21.4	15667
Local Milching Cow	14.3	20500
Bullocks	21.4	78333
Sheeps	7.1	4000
Grand Total	64.3	36333
Average value	30967	

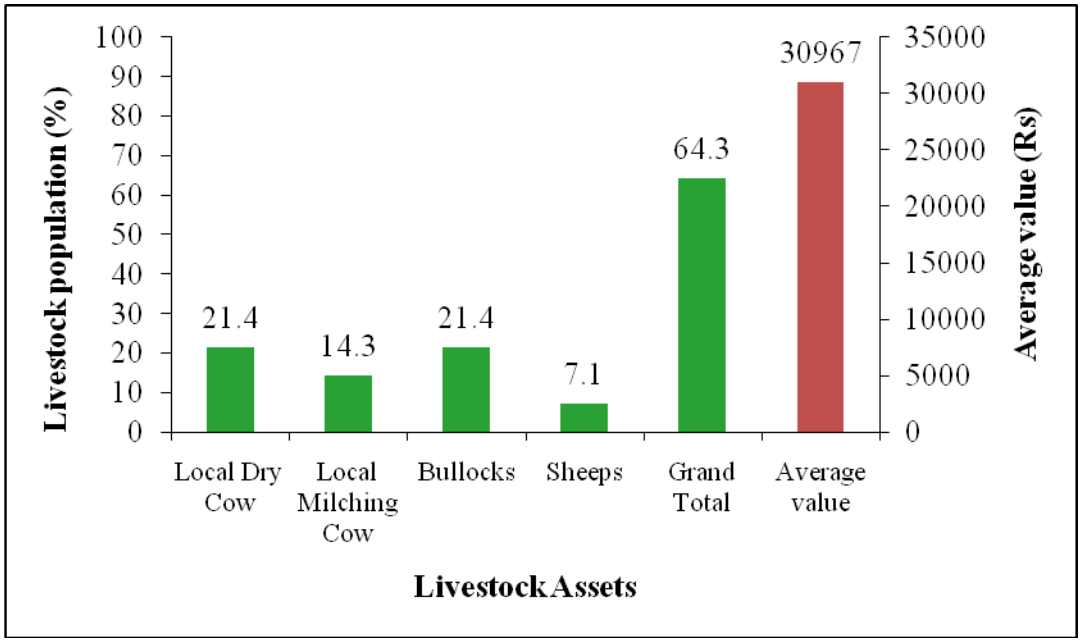


Figure 6: Livestock assets among sample households in Gudigeri-5 micro-watershed

Average milk produced in sample households is 870 litters/ annum. Among the farm households, sorghum and maize are the main crops for domestic food and fodder for animals. About 3532 kg /ha of average fodder is available per season for the livestock feeding (Table 9).

Table 9: Milk produced and fodder availability of sample households in Gudigeri-5 Microwatershed

Particulars	
Name of the Livestock	**Ltr./Lactation/animal**
Local Milching Cow	870
Fodder produces (kg/ha.)	**Fodder yield**
Maize	6250
Sorghum	813
Average food availability	3532
Livestock having households (%)	33
Livestock population (Numbers)	17

A woman participation in decision making is in this micro-watershed is presented in Table 10. About 8.33 per cent of women participation in local organisation, women participates in panchayath around 8.33 Per cent, women earning for her family requirement (16.7 %) and Women taking decision in her family and agriculture related activities 16.7 per cent.

Table 10: Women empowerment of sample households in Gudigeri-5 Microwatershed % to Grand Total

Particulars	Yes	No
Women participation in local organization activities	8.3	91.7
Women elected as panchayat member	8.3	91.7
Women earning for her family requirement	16.7	83.3
Women taking decision in her family and agriculture related activities	16.7	83.3

The food intake in terms of kilo calorie (kcal) per person per day was calculated and presented in the Table 11 and Figure 7. More quantity of cereals are consumed by sample farmers which accounted for 1362.4 kcal per person. The other important food items consumed was pulses 153.9 kcal followed by cooking oil 253.6 kcal, milk 107.6 kcal, and Vegetables 23.4 kcal, Egg 16.7 k cal and Meat 4.2 k cal. In the sampled households, farmers were consuming less (1921.6 kcal) than NIN- recommended food requirement (2250 kcal).

Table 11: Per capita daily consumption of food among the sample farmers in Gudigeri-5 Microwatershed

Particulars	NIN recommendation (gram/ per day/ person)	Present level of consumption (gram/ per day/ person)	Kilo Calories /day/person
Cereals	396.0	400.7	1362.4
Pulses	43.0	44.9	153.9
Milk	200.0	165.5	107.6
Vegetables	143.0	97.5	23.4
Cooking Oil	31.0	44.5	253.6
Egg	0.48	11.1	16.7
Meat	14.2	2.8	4.2
Total	827.68	766.9	1921.6
Threshold of NIN recommendation		827 gram*	2250 Kcal*
% Below NIN		56	100
% Above NIN		44	0

Note: * day/person

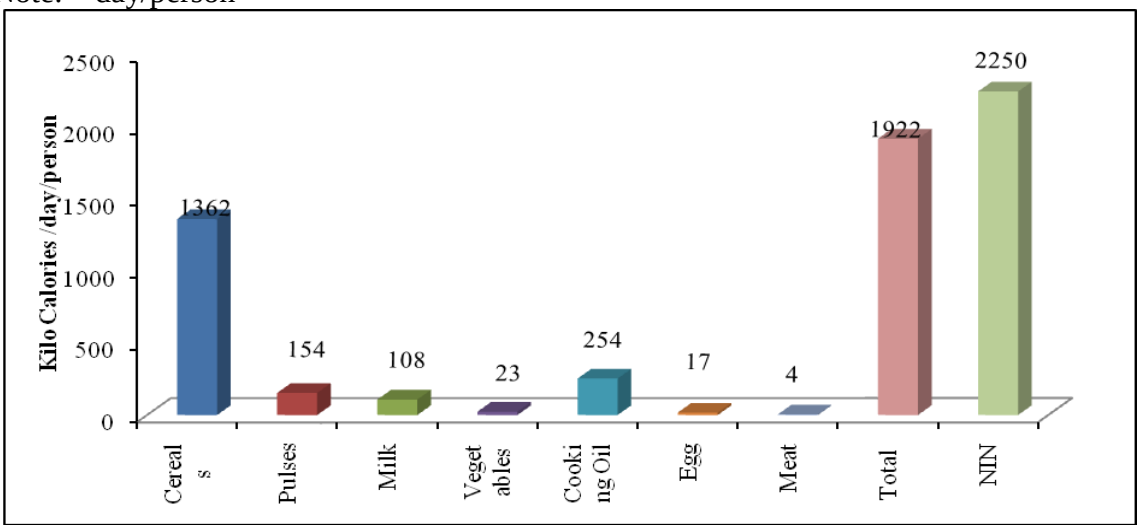


Figure 7: Per capita daily consumption of food among the sample farmers in Gudigeri-5 Microwatershed

Annual income of the sample HHs: The average annual household income is around Rs 38608. Major source of income to the farmers in the study area is from Livestock (Rs 18290) followed by crop production (Rs. 14890). The income from Non farm income was very low at Rs 5428. The monthly per capita income is Rs.804, which is less than the threshold monthly income of Rs 975 for considering above poverty line. Due to the fact that erratic rainfall and shortage of water, farmers are diverting from crop production activities to enable the household for a comfortable livelihood. The incomes from the other aforesaid sources are very meagre (Table 12).

Table 12: Annual average income of HHs from various sources in Gudigeri-5 Microwatershed

Particulars	Income *
Nonfarm income (Rs)	5428 (17)
Livestock income (Rs)	18290 (17)
Crop Production (Rs)	14890 (100)
Total Annual Income (Rs)	***38608***
Average monthly per capita income (Rs)	804
Threshold for Poverty level (Rs 975 per month/person)	
% of households below poverty line	50
% of households above poverty line	50

* 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. 34645) followed by education, clothing, social function and health. Now a days 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 1069 and about 50 per cent of farm households are below poverty line and 50 per of farm households are above poverty line (Table 13 and Figure 8).

Table 13: Average annual expenditure of sample HHs in Gudigeri-5 Microwatershed

Particulars	Value in Rupees	Per cent
Food	34645	66.5
Education	9545	18.3
Clothing	2500	4.8
Social functions	2458	4.7
Health	2958	5.7
Total Expenditure (Rs/year)	52107	100
Monthly per capita expenditure (Rs)	1069	

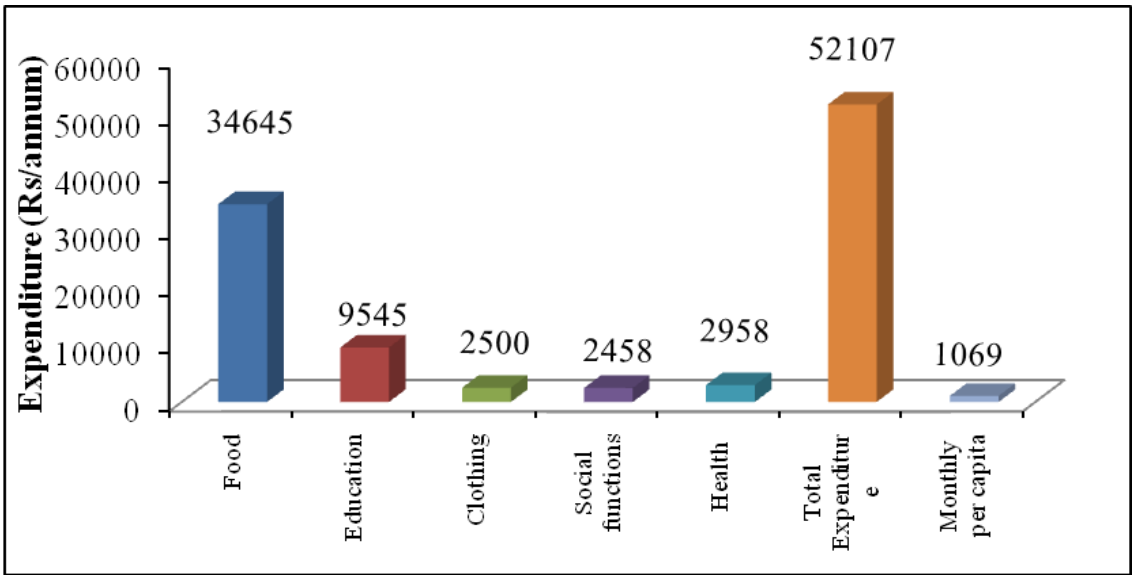


Figure 8: Average annual expenditure of sample HHs in Gudigeri-5 Microwatershed

The total land owned by the sample households of area were 44.9 ha which was under dry land area was 30 ha and fallow land was 14.9 ha. The average land holding per household is worked out to be 3.7 ha (Table 14).

Table 14: Land holding among samples households in Gudigeri-5 Microwatershed

Particulars	Per cent	Area in ha
Irrigated land	0.0	0.0
Rainfed Land	66.7	30.0
Fallow Land	33.3	14.9
Total land holding	100.0	44.9
Average land holding	3.7	

In the micro-watershed, the prevalent present land uses under perennial plants are cashew (84.21 %), followed by banyan tree (11.84 %), neem trees (3.95 %) (Table 15).

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

Particulars	Number of Plants/trees	Per cent
Banyan tree (Alada)	9	11.8
Cashew	64	84.3
Neem trees	3	3.9
Grand Total	76	100.0

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

The present dominant crops grown in dry lands in the study area were by sunflower (41 %) followed by green gram (25.2 %), onion (5.8 %), maize (1.7%) and sorghum (11.6 %) which are taken during *Kharif* and sorghum (5.3%) and bengal gram (5 %) during *Rabi* season respectively. The cropping intensity was 111.42 per cent (Table 16 and Figure 9).

Table 16: Present cropping pattern and cropping intensity in Gudigeri-5 Microwatershed

% to Grand Total

Crops	Kharif	Rabi	Grand Total
Green gram	25.2	0.0	25.2
Sorghum	11.6	5.3	16.9
Sunflower	41.1	0.0	41.1
Bengal gram	0.0	5.0	5.0
Groundnut	4.3	0.0	4.3
Maize	1.7	0.0	1.7
Onion	5.8	0.0	5.8
Grand Total	89.7	10.3	100.0
Cropping intensity (%)	111.42		

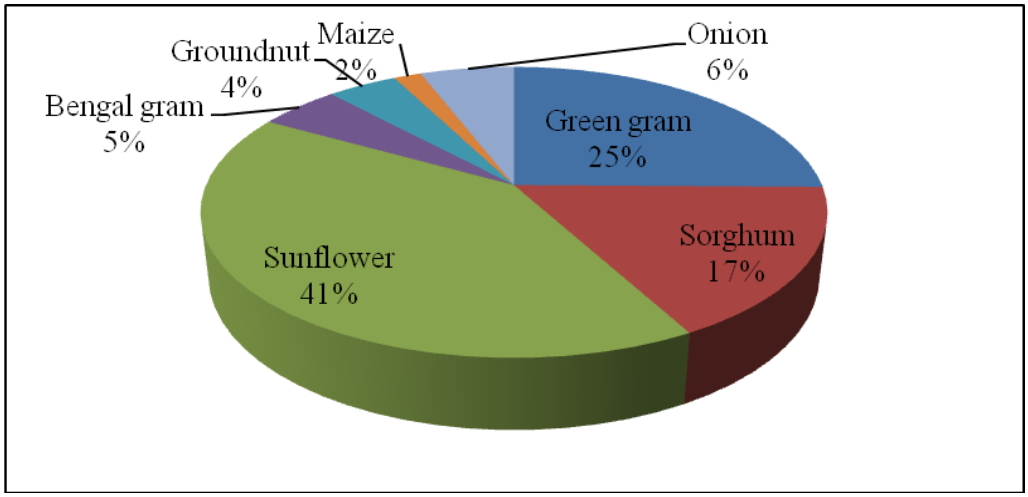


Figure 9: Present cropping pattern in Gudigeri-5 Microwatershed

Economic land evaluation

In Gudigeri-5 micro-watershed, 8 soil series are identified and mapped (Table 17). The distribution of major soil series are Ravanaki covering an area around 104 ha (29.42 %) followed by Dambarahalli 74 ha (20.98 %), Muttal 70 ha (19.77 %), Kavalur 34 ha (9.45 %), Budagumpa 32 ha (9.12 %), Handrala 14 ha (4.05%), Narasapur 11 (3.13%) and Belagatti 2 ha (0.46 %).

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

Sl. No	**Soil Series**	**Area in ha (%)**
1	Belagatti (BGT)	2 (0.46)
2	Budagumpa (BGP)	32 (9.12)
3	Dambarahalli (DRL)	74 (20.98)
4	Handrala (HDL)	14 (4.05)
5	Kavalur (KVR)	34 (9.45)
6	Muttal (MTL)	70 (19.77)
7	Narasapura (NSP)	11 (3.13)
8	Ravanaki (RNK)	104 (29.42)
	Others	13 (3.62)
	Total	355.37

Present cropping pattern on different soil series are given in Table 18. Crops grown on Muttal soils are Maize. Sorghum on Dambarahalli soils is grown. Green gram, onion, sorghum and sunflower are grown on Narasapura soils. Bengal gram, green gram, sorghum, and sunflower on Ravanaki soils are grow. Green gram, ground nut and sunflower on Kavalur soils and wheat on Belagatti soils can grow.

Table 18: Cropping pattern on major soil series in Gudigeri-5 micro-watershed

(Area in per cent)

Soil Series	Soil Depth	Crops	Dry		Grand Total
			Kharif	Rabi	
Muttal	Shallow (25-50 cm)	Maize	100	0.0	100.0
Dambarahalli	Moderately deep (75-100 cm)	Sorghum	100	0.0	100.0
Narasapura	Moderately deep (75-100 cm)	Green gram	33.7	0.0	33.7
		Onion	10.7	0.0	10.7
		Sorghum	0.0	33.7	33.7
		Sunflower	21.7	0.0	21.7
Ravanaki	Moderately shallow (50-75 cm)	Bengal gram	0.0	17.9	17.9
		Green gram	19.0	0.0	19.0
		Sorghum	20.9	0.0	20.9
		Sunflower	41.9	0.0	41.9
Kavalur	Deep (100-150 cm)	Green gram	6.8	0.0	6.8
		Groundnut	20.2	0.0	20.2
		Sunflower	0.0	73.0	73.0
Belagatti	Very deep (>150 cm)	Wheat	100	0.0	100

Land is used for agricultural use for growing cereals, pulse, oilseeds and commercial crops. The soil/ land potential are measures in terms of physical yield and net income. The alternative land use options for each micro-watershed are given below (Table 19)

Table 19: Alternative land use options for different size group of farmers (Benefit Cast Ratio) in Gudigeri-5 Microwatershed

Soil Series	Small Farmers	Medium Farmers	Large Farmers
MTL	Maize (0.99)		
RNK	Bajra (1.26) Sorghum (1.55)	Bengal gram (1.98) Green gram (1.15) Sorghum (0.93) Sunflower (1.1)	Sorghum (2.09), Sunflower (1.3) Wheat (2.25)
NSP			Green gram (1.88), Onion (1.12) Sorghum (1.18), Sunflower (1.09)
DRL		Sorghum (1.64)	
KVR		Groundnut (1.26)	Green gram (1.42) Sunflower (1.25)
BGP	Wheat (0.89)		

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

Table 20: Economic land evaluation and bridging yield gap for different crops in Gudigeri-5 micro-watershed

Particulars	MTL (25-50cm)	RNK (50-75cm)				DRL (75-100cm)	NSP (75-100cm)				KVR (100-150 cm)			BGT (>150cm)
	Maize	Bengal gram	Green gram	Sor ghum	Sun flower	Sor ghum	Green gram	Onion	Sor ghum	Sun flower	Green gram	Ground nut	Sun flower	Wheat
Total cost (Rs/ha)	13677	4370	12773	12768	13032	6890	10992	12112	9666	10194	36247	12861	12974	72994
Gross Return (Rs/ha)	13585	8645	14703	11763	14954	11327	20697	13585	11453	11132	51376	16243	16189	64838
Net returns (Rs/ha)	-92	4275	1930	-1004	1922	4436	9704	1473	1786	939	15129	3383	3215	-8156
B:C	0.99	1.98	1.15	0.93	1.20	1.64	1.88	1.12	1.18	1.09	1.42	1.26	1.25	0.89
Farmers Practices (FP)														
FYM (t/ha)	1.3	0.0	0.8	1.2	1.0	1.4	0.6	0.0	0.3	0.9	0.0	0.8	0.0	0.0
Nitrogen (kg/ha)	40.0	28.8	36.6	48.0	33.8	22.9	20.3	20.1	20.3	20.1	41.9	33.9	41.9	150.0
Phosphorus (kg/ha)	28.8	0.0	15.4	28.9	37.5	16.4	51.8	39.8	51.8	39.8	72.7	30.5	72.7	107.8
Potash (kg/ha)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.5	0.0	3.5	0.0	0.0	0.0	0.0
Grain (Qtl/ha)	6.3	2.5	3.5	5.8	5.1	4.3	5.2	25.0	5.5	3.5	10.0	3.8	4.7	15.6
Price of Yield (Rs/Qtl)	2000	3500	4200	1900	3367	2500	4000	550	1950	3200	5200	4200	3500	4200
Soil test based fertilizer Recommendation (STBR)														
FYM (t/ha)	7.5	7.5	7.5	7.5	6.9	7.5	7.5	30.0	7.5	6.9	7.5	7.5	6.9	7.5
Nitrogen (kg/ha)	100.0	13.0	13.0	81.3	43.8	65.0	16.3	156.3	81.3	46.9	9.8	18.8	28.1	100.0
Phosphorus (kg/ha)	62.5	31.3	31.3	50.0	62.5	50.0	31.3	62.5	50.0	62.5	31.3	62.5	62.5	93.8
Potash (kg/ha)	18.8	18.8	18.8	30.0	28.1	30.0	18.8	56.3	30.0	28.1	25.0	18.8	37.5	37.5
Grain (Qtl/ha)	57.5	9.0	6.3	18.8	11.3	18.8	6.3	225.0	18.8	11.3	6.3	9.0	11.3	31.3
% of Adoption/yield gap (STBR-FP) / (STBR)														
FYM (%)	83.3	100.0	89.5	84.4	84.8	81.0	92.5	100.0	96.7	87.2	100.0	88.7	100.0	100.0
Nitrogen (%)	60.0	-121.2	-181.6	40.9	22.9	64.8	-24.6	87.1	75.1	57.1	-330.0	-80.8	-49.1	-50.0
Phosphorus (%)	54.0	100.0	50.9	42.2	40.0	67.1	-65.6	36.4	-3.5	36.4	-132.8	51.2	-16.4	-15.0
Potash (%)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	93.8	100.0	87.6	100.0	100.0	100.0	100.0
Grain (%)	89.1	72.2	43.3	68.9	54.9	77.1	16.7	88.9	70.8	68.7	-60.0	57.6	58.4	50.0
Value of yield and Fertilizer (Rs)														
Additional Cost (Rs/ha)	8830	9061	7504	8260	7611	8654	6363	33689	8505	7804	5789	8253	7004	7031
Additional Benefits (Rs/ha)	102500	22750	11368	24542	20808	36161	4167	110000	25878	24732	-19500	21783	22989	65625
Net change Income (Rs/ha)	93670	13689	3864	16282	13197	27506	-2196	76311	17373	16928	-25289	13530	15985	58594

The data on cost of cultivation and BCR of different crops across soil series is given in Tables 20. The total cost of cultivation in study area for green gram ranges between Rs.36247/ha in KVR soil (with BCR of 1.42) and Rs.12773/ha in RNK soil (with BCR of 1.15), Sorghum range between Rs 12768/ha in RNK soil (with of 0.93) and Rs.6890/ha in DRL soil (with BCR of 1.64), Sunflower range between Rs. 13032/ha in RNK soil (with BCR of 1.20) and Rs. 10194/ha in NSP soil (with BCR of 1.09), maize cultivation in MTL soil is Rs.13677/ha (with BCR of 0.99), bengal gram cultivation in RNK soil is Rs.4370/ha (with BCR of 1.98), Onion cultivation in NSP soil is Rs 12112/ha (with BCR of 1.26) and wheat cultivation in BGT soil is Rs 72994/ha (with BCR of 0.89).

The data on FYM, Nitrogen, Phosphorus and Potash application by the farmers to different crops and recommended FYM for different crops is given in Table 20. There is a huge gap between FYM application by farmers and recommended FYM in all the crops across the soils. There is a larger yield gap in crops grown across different soil series. Adequate knowledge about recommended package of practices is the pre-requisite for their use in cultivation of crops. It is a fact that, recommended practices are major contributing factors to yield. Inadequate knowledge about recommended practices leads to their improper adoption. Strengthening of extension services by concerned agency is required to increase adoption of recommended cultivation practices and ultimately reducing the gap. By adopting soil-test fertiliser recommendation, there is scope to increase yield and income to a maximum of Rs 93670 in maize and a minimum of Rs 3864 in green gram cultivation.

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

The onsite cost of different soil nutrients lost due to soil erosion is given in Table 21 and Figure 10. The average value of soil nutrient loss is around Rs 12946 per ha/year. The total cost of annual soil nutrients is around Rs 4414535 per year for the total area of 355.37 ha.

Table 21: Estimation of onsite cost of soil erosion in Gudigeri-5 micro-watershed

Particulars	Quantity(kg)		Value (Rs)	
	Per ha	Total	Per ha	Total
Organic matter	1720.09	586550	10837	3695265
Phosphorus	0.9	305	39	13440
Potash	49.78	16974	996	339482
Iron	1.85	629	89	30207
Manganese	1.78	608	490	167231
Cupper	0.24	81	133	45457
Zinc	0.04	15	2	598
Sulphur	8.92	3040	357	121607
Boron	0.09	31	4	1250
Total	1784	608234	12946	4414535

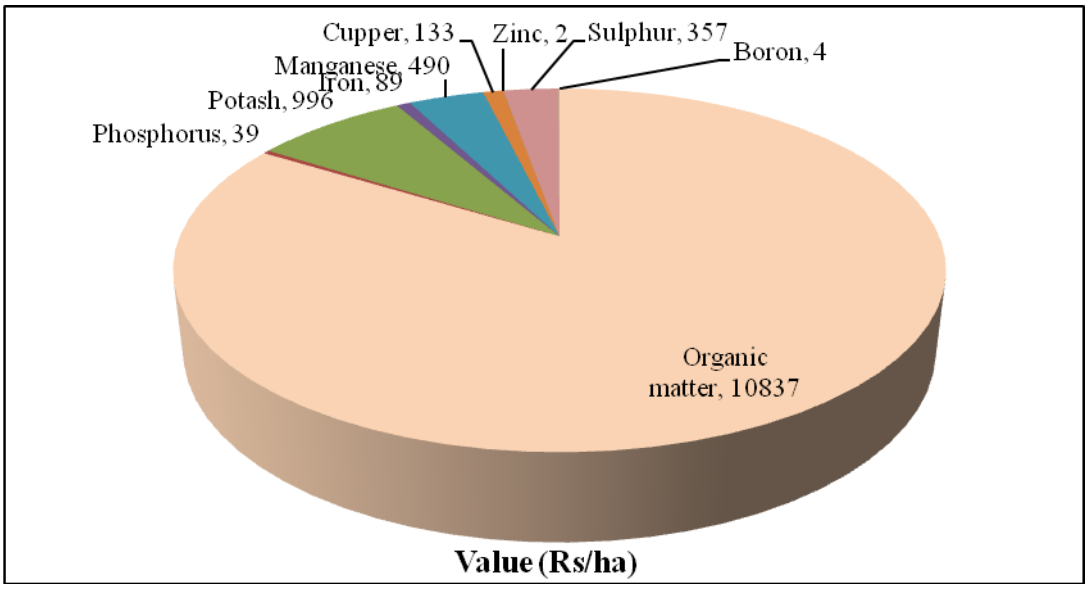


Figure 10: Estimation of onsite cost of soil erosion in Gudigeri-5 micro-watershed

The average value of ecosystem service for food production is around Rs 3139/ ha/year (Table 22 and Figure 11). Per ha food production services is maximum in green gram (Rs 7992/ha) followed by wheat (Rs 5270/ha), bengal gram (Rs 4275/ha), groundnut (Rs 2964/ha), sorghum (Rs 2936/ha), Bajra (Rs 2881/ha), onion (Rs 1473/ha) and sunflower (Rs 1786/ha) and maize is negative returns.

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

Production items	Crops	Area in ha	Yield (Qtl/ha)	Price (Rs/Qtl)	Gross Returns (Rs/ha)	Cost of Cultivation (Rs/ha)	Total Value (Rs)	Net Returns (Rs/ha)
Cereals	Bajra	1.3	11.8	1200	14159	11279	18000	2881
	Maize	0.8	6.2	2000	12350	13677	10000	-1327
	Sorghum	20.0	6.6	2107	13850	10913	276992	2936
	Wheat	3.8	11.7	4200	49260	43989	187466	5270
Pulses	Bengal gram	2.4	2.5	3500	8645	4370	21000	4275
	Green gram	12.3	5.9	4350	25744	17751	316326	7992
Oil seeds	Groundnut	2.4	3.8	4200	15825	12861	37800	2964
	Sunflower	20.1	4.2	3325	14094	12308	282793	1786
Vegetables	Onion	2.8	24.7	550	13585	12112	38500	1473
Grand Total		65.9	7.2	2968	21453	15405	1413527	3139

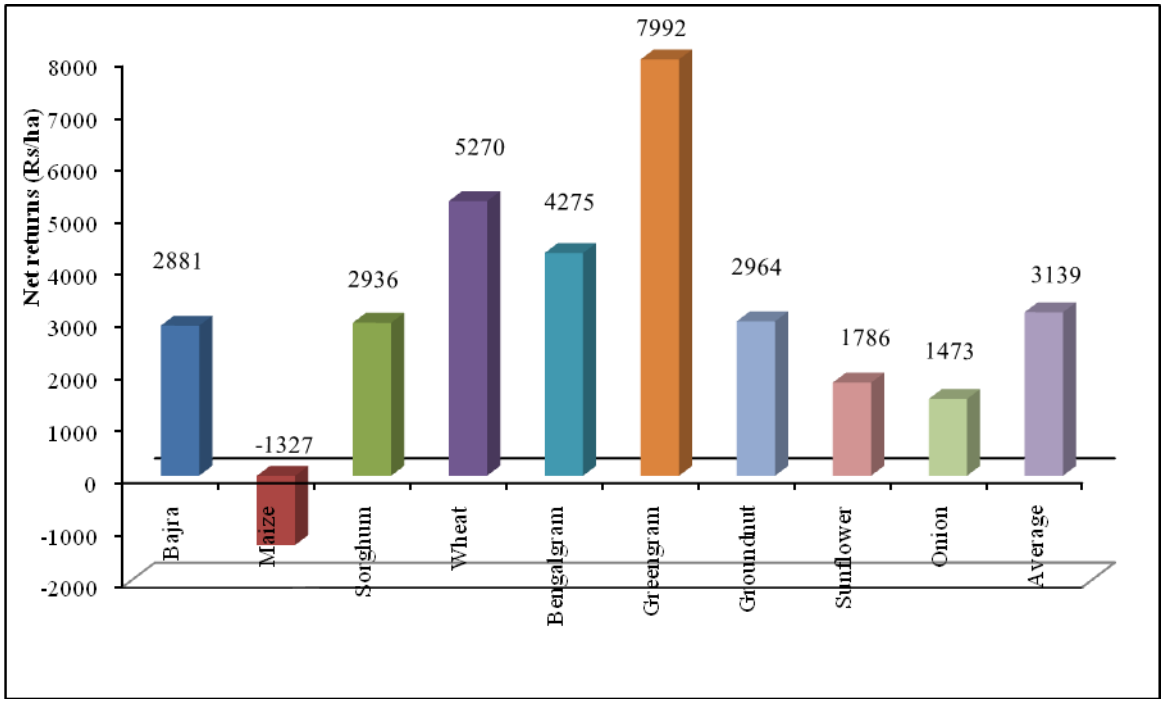


Figure 11: Ecosystem services of food production in Gudigeri-5 Microwatershed

The average value of ecosystem service for fodder production is around Rs 533/ ha/year (Table 23). Per ha fodder production services is maximum in Sorghum (Rs 1263 /ha) followed by Maize (Rs 1235 /ha), Groundnut (Rs 419/ha) and green gram (Rs 14/ha).

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

Production items	Crops	Area in ha	Yield (Qtl/ha)	Price (Rs/Qtl)	Returns (Rs/ha)	Total returns (Rs)
Cereals	Maize	0.81	1.24	1000	1235	1000
	Sorghum	14.57	0.77	1640	1263	18415
Pulses	Green gram	12.29	0.05	275	14	174
Oil seeds	Groundnut	2.39	0.42	1000	419	1000
Grand Total		30.06	0.52	1027	533	16034

The water demand for production of different crops was worked out in arriving at the ecosystem services of water support to crop growth. The data on water requirement for producing one quintal of grain is considered for estimating the total value of water required for crop production. The per hectare value of water used and value of water was maximum (Table 24 and Figure 12) in Bajra (Rs 52814) followed by green gram (Rs 40870), sorghum (Rs 20034), bengal gram (Rs 17058), sunflower (Rs 14268), ground nut (Rs 10482), maize (Rs 7546) and onion (Rs 6718).

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

Crops	Yield (Qtl/ha)	Virtual water (cubic meter) per ha	Value of Water (Rs/ha)	Water consumption (Cubic meters/Qtl)
Bajra	11.80	5281	52814	448
Bengal gram	2.47	1706	17058	691
Green gram	5.92	4087	40870	691
Groundnut	3.77	1048	10482	278
Maize	6.18	755	7546	122
Onion	24.70	672	6718	27
Sorghum	6.57	2003	20034	305
Sunflower	4.24	1427	14268	337
Grand Total	6.78	2277	22770	336

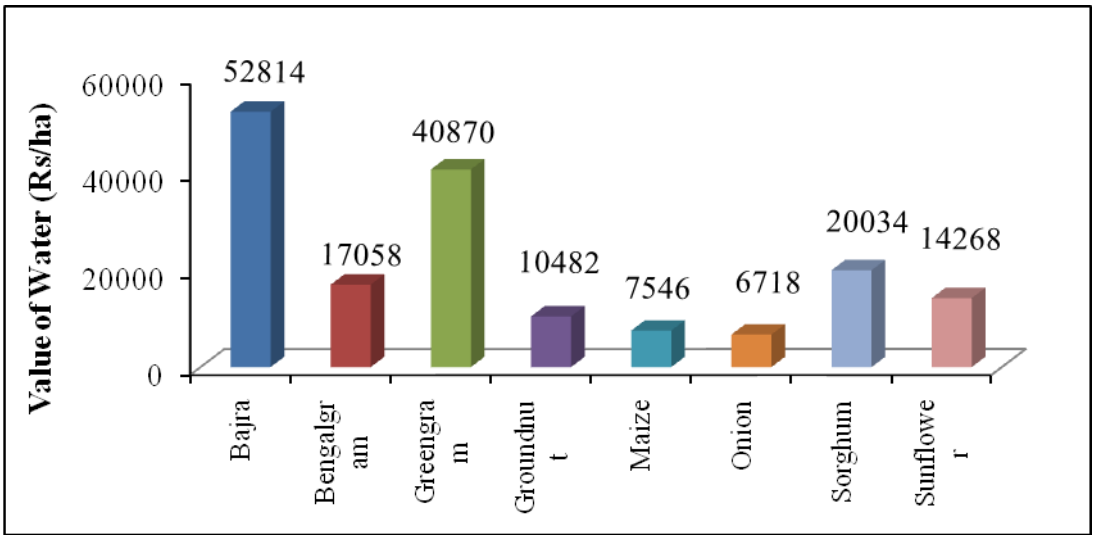


Figure 12: Ecosystem services of water supply in Gudigeri-5 Microwatershed

The main constraints in farming is climate change particularly decline in rainfall and increasing temperature. Farmers reported that they are not getting timely support/extension services from the concerned development department (Table 25).

Table 25: Farming constraints related land resources of sample households in Gudigeri-5 Microwatershed

Particulars	Per cent
Farmers awareness of climate change	
Yes	66.7
No	33.3
Perception on climate change	
Decrease in rainfall	100.0
Availability agricultural technology information	
Yes	25.0
No	75.0

The findings of the study would be very much useful to the planners and policy makers of the study area to identify the irrationality in the existing production pattern and to

suggest appropriate production plans for efficient utilization of their scarce resources resulting in increased net farm incomes and employment. The study also throws light on future potentialities of increasing net farm income and employment under different situations viz., with existing and recommended technology.