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

ADAVALLI-2 (4D4A2O3b) MICROWATERSHED

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

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

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

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

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

ICAR-NBSS&LUP, Regional Centre, Bangalore has taken up a project sponsored by the Karnataka Watershed Development Project-II, (Sujala-III), Government of Karnataka funded by the World Bank under Component -1 Land Resource Inventry. This study was taken up to demonstrate the utility of such a database in reviewing, monitoring and evaluating all the land based watershed development programs on a scientific footing. To meet the requirements of various land use planners at grassroots level, the present study on "Land Resource Inventory and Socio-Economic Status of Farm Households for Watershed Planning and Development of for Adavalli-2 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 micowatershed. The project report with the accompanying maps for the microwatershed will provide required detailed database for evolving effective land use plan, alternative land use options and conservation plans for the planners, administrators, agricutural extention personnel, KVK officials, developmental departments and other land users to manage the land resources in a sustainable manner.

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

S.K. SINGH

Date: 22.03.2018 Director, ICAR - NBSS&LUP Nagpur

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PART-A

LAND RESOURCE INVENTORY

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EXECUTIVE SUMMARY

The land resource inventory of Adavalli-2 microwatershed was conducted using village cadastral maps and IRS satellite imagery on 1:7920 scale. The false colour composites of IRS imagery were interpreted for physiography and 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, behaviour and use potentials of the soils in the microwartershed.

The present study covers an area of 313 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 97 per cent is covered by soils, three per cent by waterbodies, settlements and others. The salient findings from the land resource inventory are summarized briefly below.

- *The soils belong to 9 soil series and 11 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 40 per cent of the soils are very shallow (<25 cm) to shallow (25-50 cm) and about 56 per cent are moderately deep to very deep soils (75->150 cm).*
- *Entire area has clayey soils at the surface.*
- *About 44 per cent of the area has non-gravelly soils, 45 per cent gravelly soils (15-35 % gravel) and 7 per cent very gravelly (35- 60% gravel) soils.*
- *About 40 per cent area has very low (<50mm/m) to low (51-100 mm/m), 8 per cent medium (101-150 mm/m) and 49 per cent area very high (>200mm/m) available water capacity.*
- *Entire area has very gently sloping (1-3%) lands.*
- *Entire area has moderately eroded (e2) lands.*

- *Entire area has soils that are strongly alkaline (pH 8.4 to 9.0) to 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 44 per cent, 35 per cent of the soils are medium (0.5-0.75%) and 18 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.*
- *Available potassium is high (<337 kg/ha) in the entire area of the microwatershed.*
- *Available sulphur is low (<10 ppm) in 76 per cent area, medium (10-20 ppm) in about <1 per cent area and about 20 per cent area is high (>20 ppm).*
- *Available boron is low (<0.5 ppm) in about 78 per cent area and medium (0.5-1.0 ppm) in 18 per cent area.*
- *Available iron is sufficient (>4.5 ppm) in the entire area.*
- *Available zinc is deficient (<0.6 ppm) in the entire area.*
- *Available manganese and copper are sufficient in all the soils.*
- *The land suitability for 24 major crops grown in the microwatershed were assessed and the areas that are highly suitable (S1) and moderately suitable (S2) are given below. It is however to be noted that a given soil may be suitable for various crops but what specific crop to be grown may be decided by the farmer looking to his capacity to invest on various inputs, marketing infrastructure, market price and finally the demand and supply position.*

Land suitability for various crops in the microwatershed

Crop	Suitability Area in ha (%)			Crop	Suitability Area in ha (%)	
	Highly suitable (S1)	Moderately suitable (S2)			Highly suitable (S1)	Moderately suitable (S2)
Sorghum	148 (47)	28 (9)		Sapota	-	-
Maize	-	-		Jackfruit	-	-
Bajra	-	-		Jamun	-	152 (48)
Groundnut	-	-		Musambi	148 (47)	28 (9)
Sunflower	148 (47)	28 (9)		Lime	148 (47)	28 (9)
Chilli	-	-		Cashew	-	-
Tomato	-	-		Custard apple	151 (48)	25(8)
Drumstick	-	176 (56)		Amla	-	176 (48)
Mulbery	-	176 (56)		Tamarind	-	151 (48)
Pomegranate	-	176 (56)		Marigold	-	176 (56)
Guava	-	-		Chrysanthemum	-	176 (56)
Mango	-	-		Jasmine	-	-

Apart from the individual crop suitability, a proposed crop plan has been prepared for the 4 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 contributes to mitigating the climate change.*

Chapter 1

INTRODUCTION

Land is a scarce resource and basic unit for any material production. It can support the needs of the growing population, provided they use the land in a rational and judicious manner. But what is happening in many areas of the state is a cause for concern to everyone involved in the management of land resources at the grassroots level. The area available for agriculture is about 51 per cent of the total 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 Adavalli-2 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 Adavalli-2 Microwatershed is located in the central part of northern Karnataka in Koppal Taluk, Koppal District, Karnataka State (Fig.2.1). It comprises parts of Kavalura village. It lies between $15^0$18’ and $15^0$19’North latitudes and $75^0$56’ and $75^0$58’ East longitudes and covers an area of 313 ha. It is about 70 km from Koppal town and is surrounded by Kavalura village on all the sides.

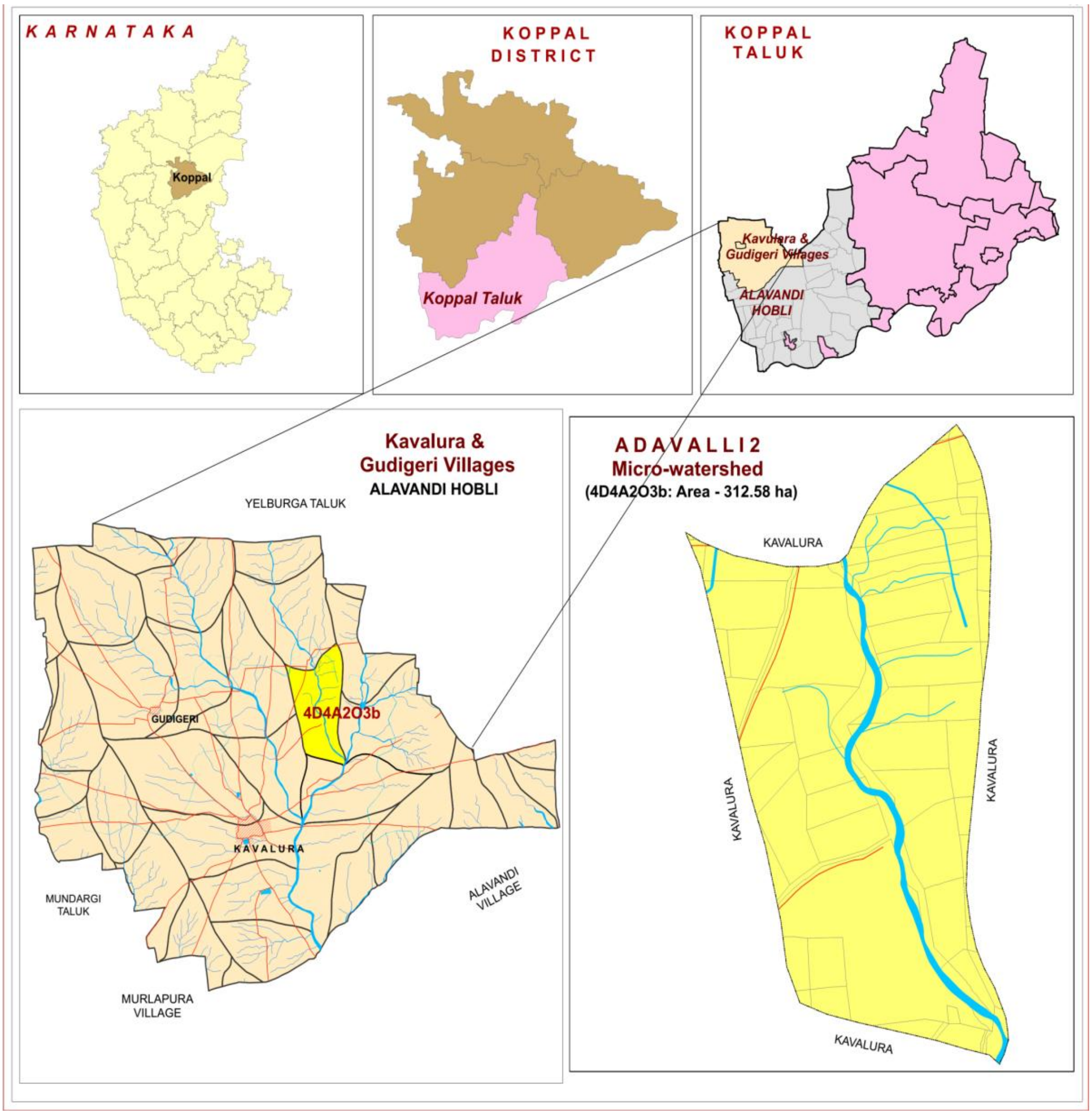


Fig.2.1 Location map of Adavalli-2 Microwatershed

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 Bisarahalli 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 soil originally formed at higher elevation, but now occupying river valleys.

Fig.2.2 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 534-563 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 takes place 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.

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**	

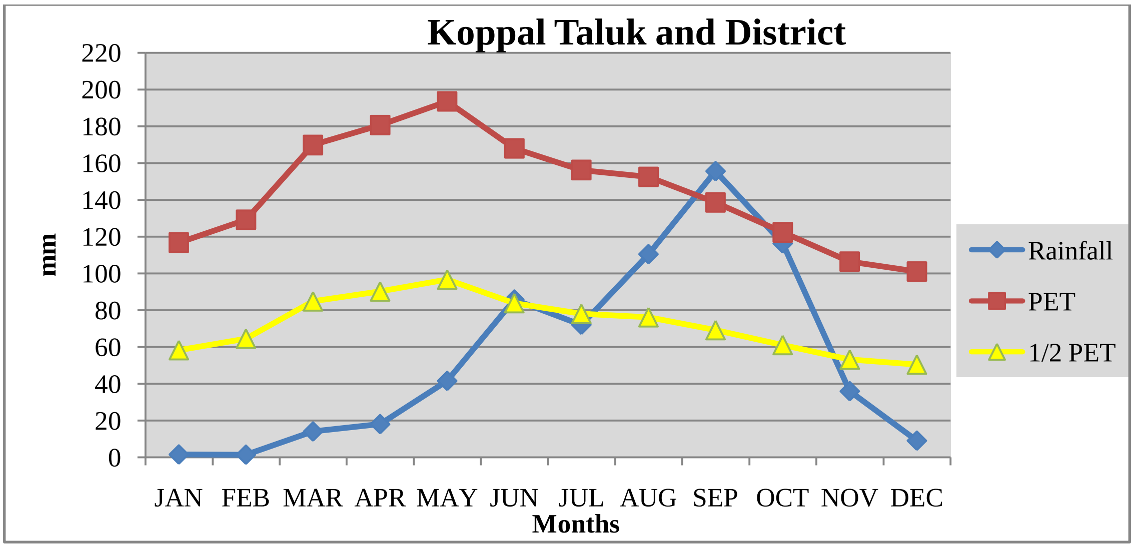


Fig. 2.3 Rainfall distribution in Koppal Taluk and District

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 and 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.

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.

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.

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 bouldery 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 2.5). 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 Adavalli-2 Microwatershed is presented in Fig.2.4. Simultaneously, enumeration of existing wells (bore wells and open wells) and other soil and water conservation structures in the microwatershed is made and their location in different survey numbers is marked on the cadastral map. Map showing the location of wells, soil conservation structures and other water bodies in Adavalli-2 Microwatershed is given Fig.2.6

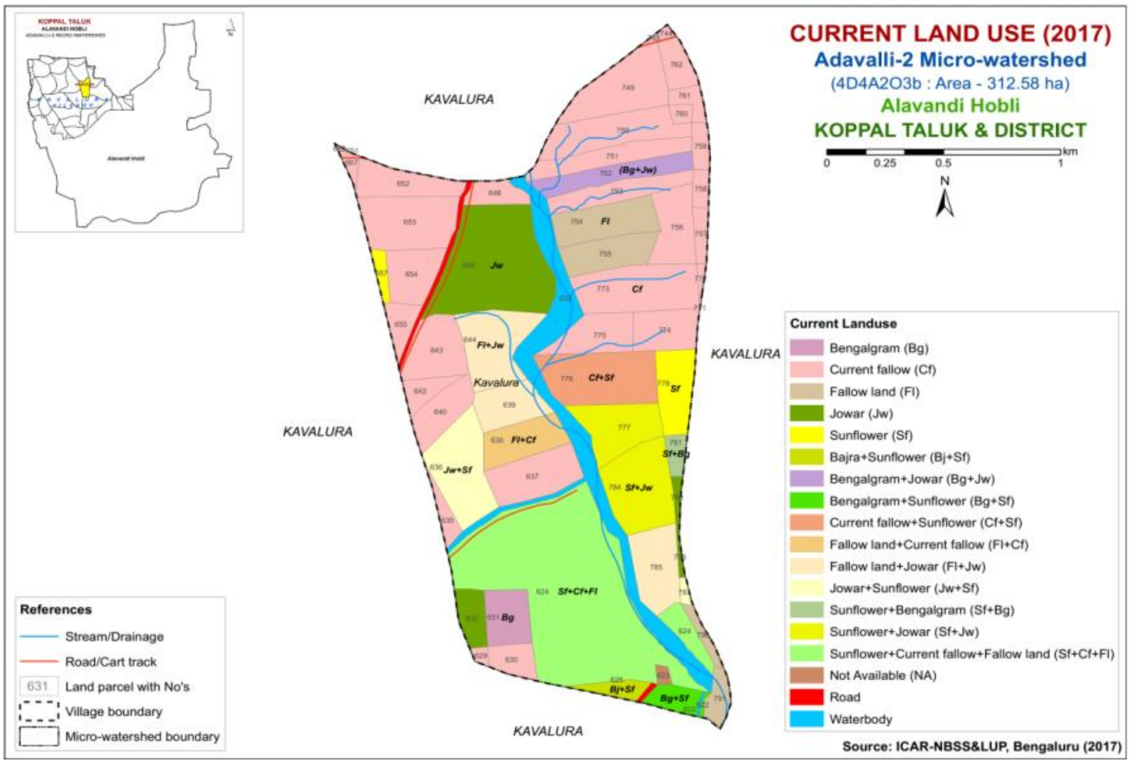


Fig.2.4 Current Land Use – Adavalli-2 Microwatershed

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

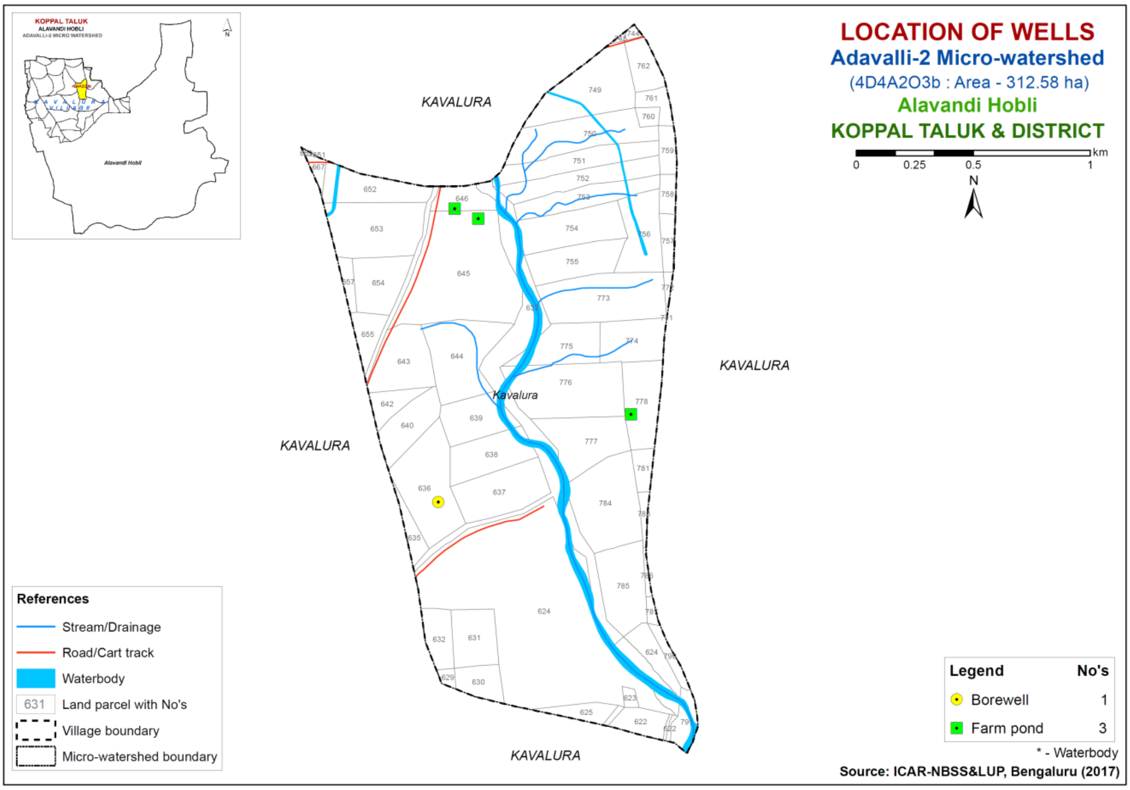


Fig.2.5 Location of wells and conservation structures- Adavalli-2 Microwatershed

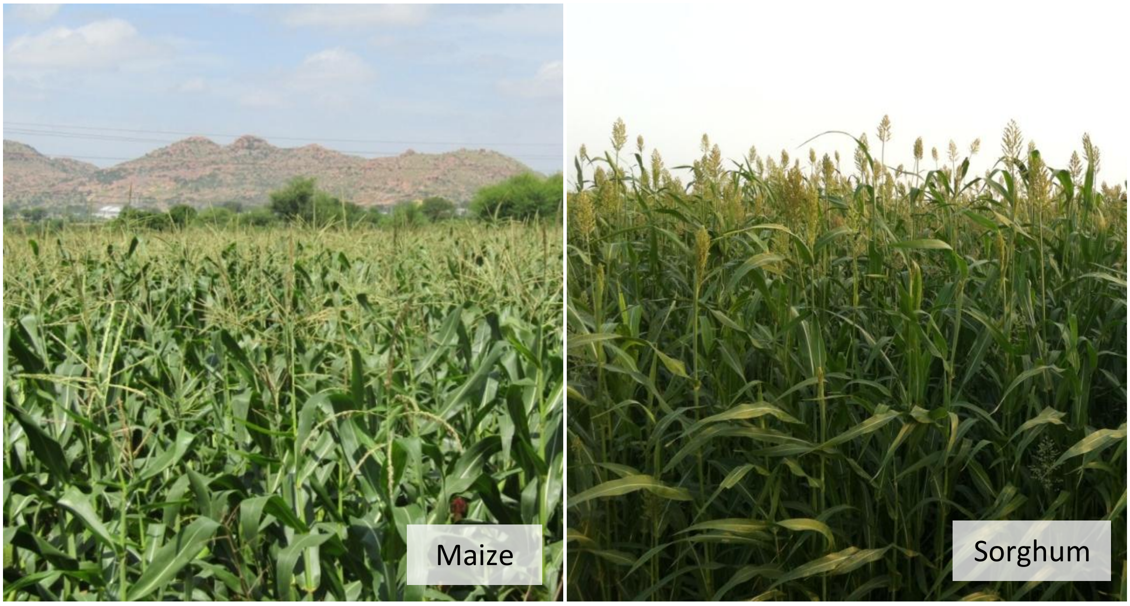


Fig.2.6 a. Different crops and cropping systems in Adavalli-2 Microwatershed

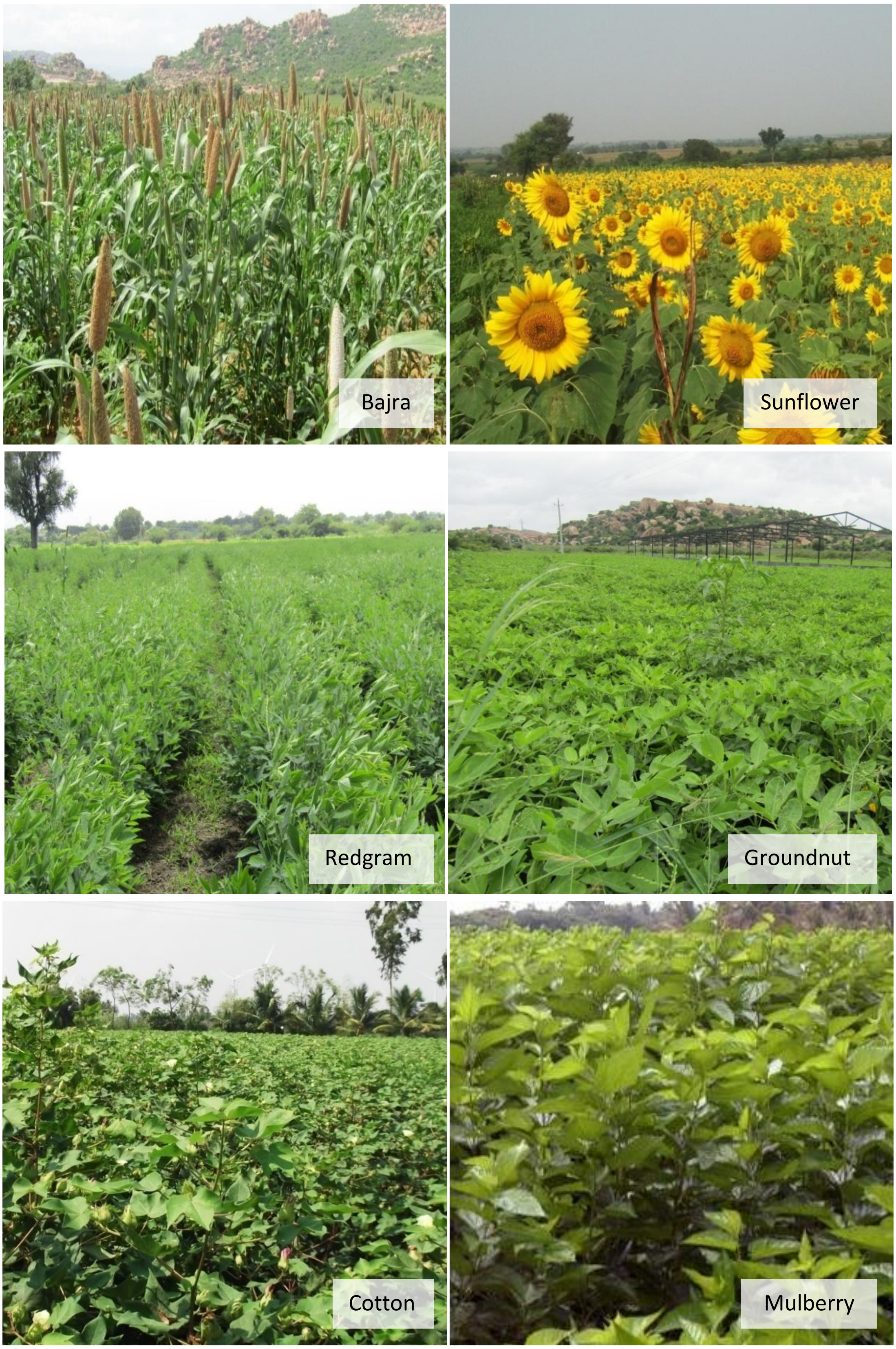


Fig.2.6 b. Different crops and cropping systems in Adavalli-2 Microwatershed

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 Adavalli-2 Microwatershed by the detailed study of all the soil characteristics (depth, texture, colour, structure, consistence, coarse fragments, porosity, soil reaction, soil horizons etc.) and site (slope, 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 extent and geographic distribution on the microwatershed cadastral map. The detailed soil survey at 1:7920 scale was carried out in 313 ha area. The methodology followed for carrying out land resource inventory was as per the guidelines given in Soil Survey Manual (IARI, 1971; Soil Survey Staff, 2006; Natarajan *et al.*, 2015) which is briefly described below.

3.1 Base Maps

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

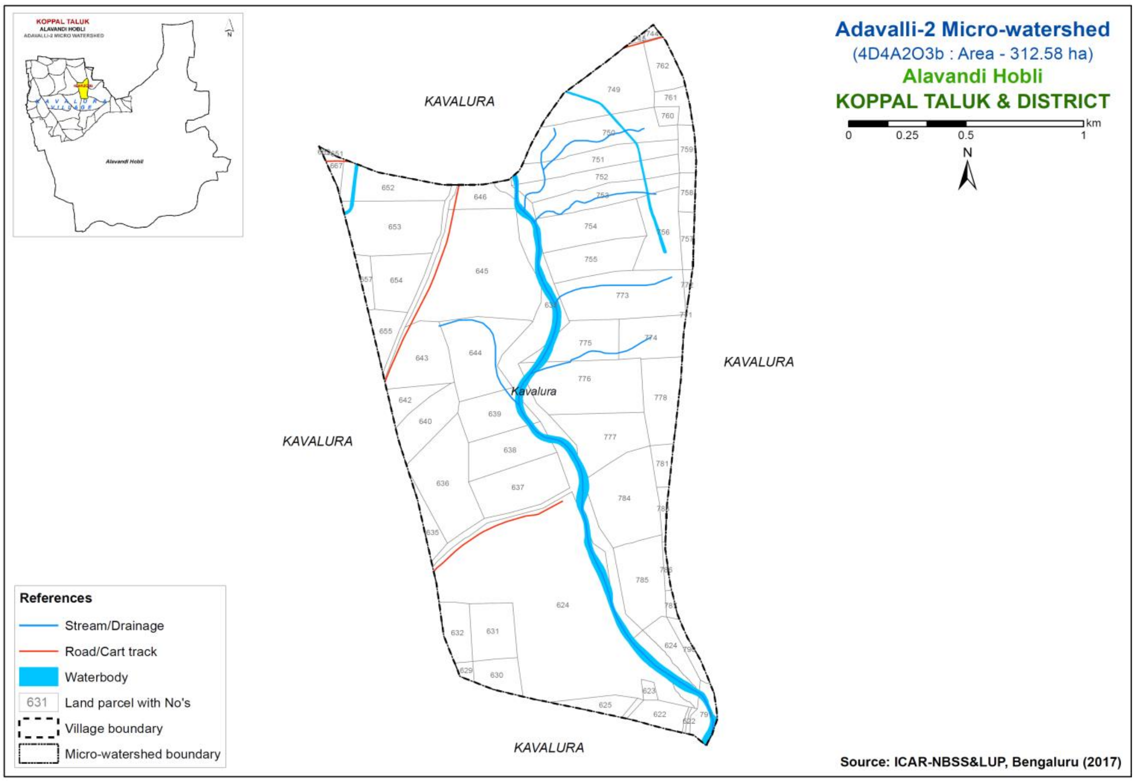


Fig 3.1 Scanned and Digitized Cadastral map of Adavalli-2 Microwatershed

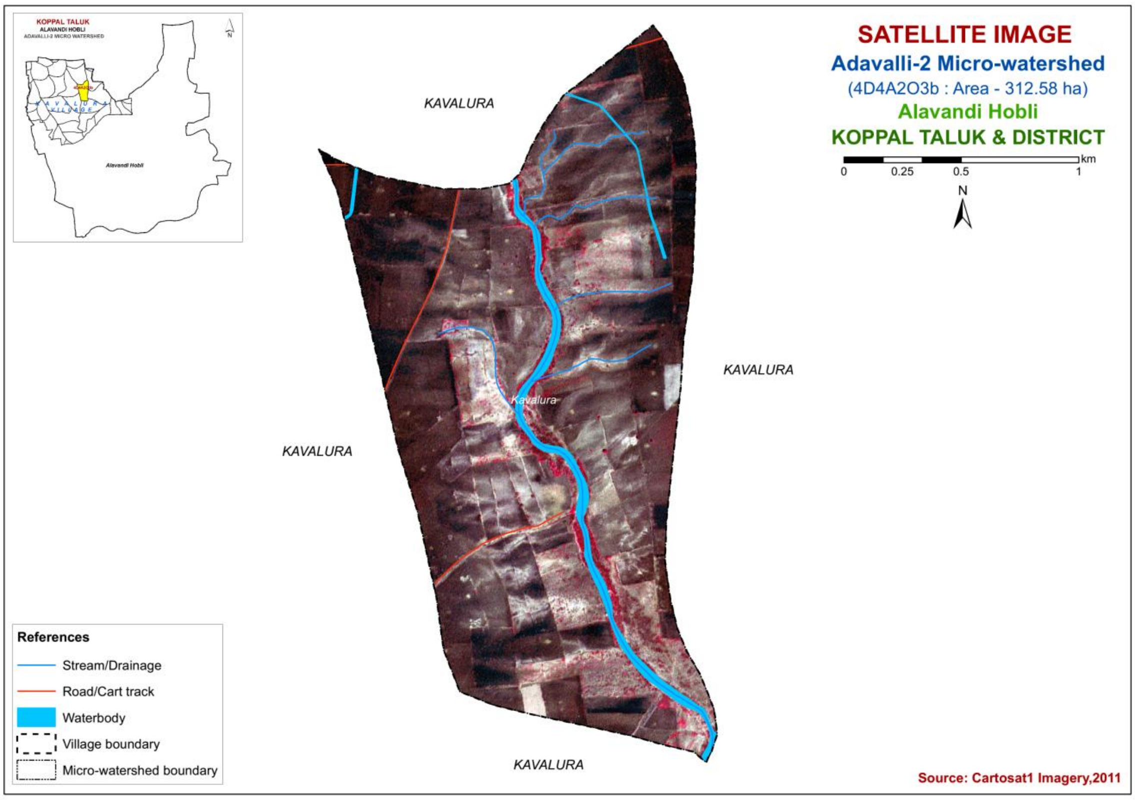


Fig.3.2 Satellite Image of Adavalli-2 Microwatershed

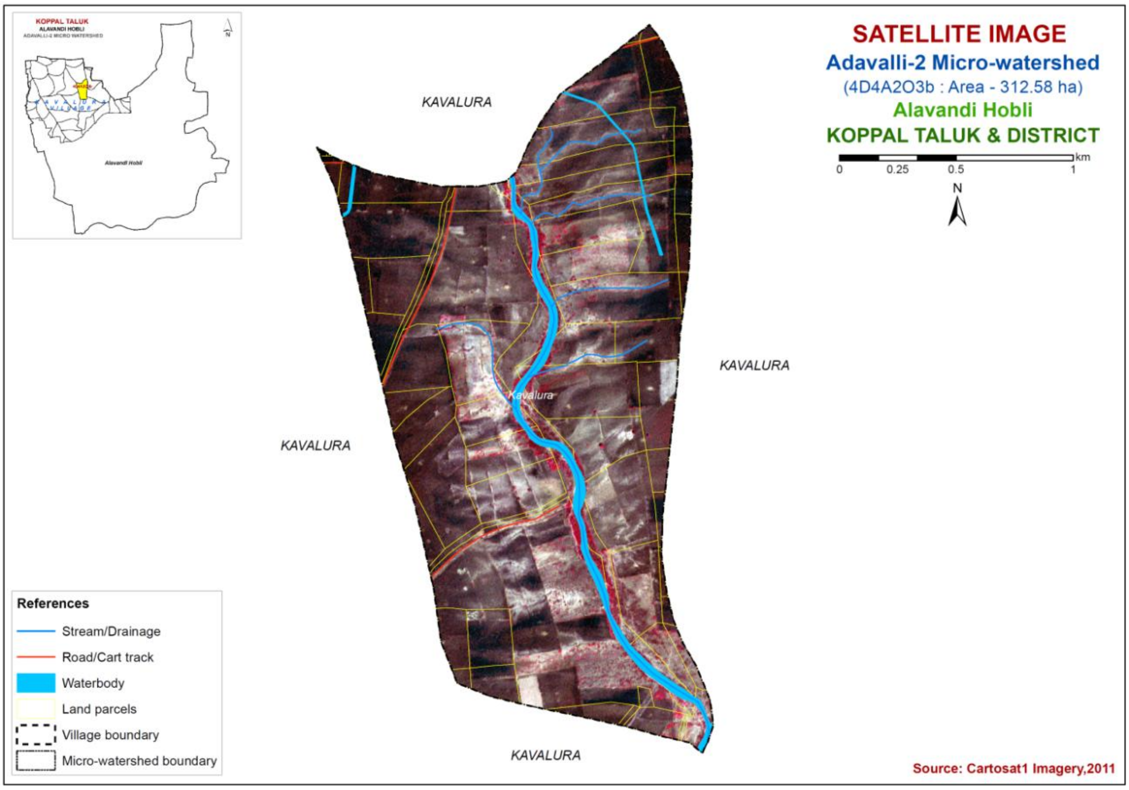


Fig.3.3 Cadastral map overlaid on IRS PAN+LISS IV merged imagery of Adavalli-2 Microwatershed

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).

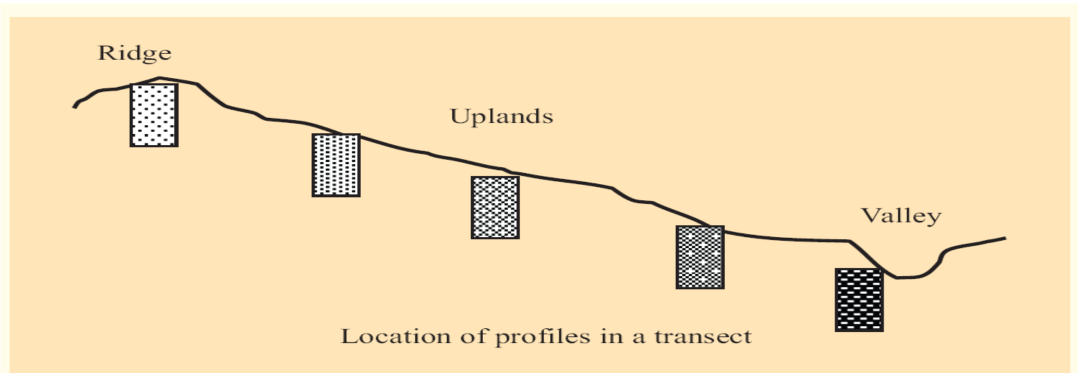


Fig: 3.4. Location of profiles in a transect

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 up to 200 cm or to the depth limited by rock or hard substratum and studied in detail for all their morphological and physical characteristics. The soil and site characteristics were recorded for all profile sites on a standard proforma as per the guidelines given in USDA Soil Survey Manual (Soil Survey Staff, 2012). Apart from the transect study, profiles were also studied at random, almost like in a grid pattern, outside the transect areas 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, 9 soil series were identified in Adavalli-2 Microwatershed.

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

Sl.No	**Soil Series**	**Depth (cm)**	**Colour (moist)**	**Texture**	**Gravel (%)**	**Horizon sequence**	**Calcareo-usness**
Soils of Granite Gneiss Landscape							
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	10YR3/2,3/3,4/2 7.5YR3/2,3/3,6/4	gc	15-35	Ap-Bw-Ck	e-ev
3	Dambarahalli (DRL)	75-100	10YR 2/1, 3/1, 4/3	c	<15	Ap-Bw-Ck	e-es
4	Gatareddihal (GRH)	100-150	10YR 2/1, 3/1, 2.5Y 4/3, 5/4	c	<15	Ap-Bw-BC-C	-
5	Handrala (HDL)	100-150	10 YR 2/1, 3/1,4/1,	c	-	Ap-Bw-Ck	es
6	Kadagathur (KDT)	>150	10 YR 3/1,3/2,3/3, 7.5YR 3/3, 3/4	sc-c	-	Ap-Bw	

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 7 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 9 mapping units representing 6 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 9 phases mapped in the microwatershed. Each mapping unit (soil phase) delineated on the map has similar soil and site characteristics. In other words, all the farms or survey numbers included in one phase will have similar management needs and have to be treated accordingly. The 9 soil phases identified and mapped in the microwatershed were regrouped into 4 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 choosen for identification and delineation of LUCs.

For Adavalli-2 Microwatershed, five soil and site characteristics, namely soil depth, soil texture, slope, erosion and gravel content have been considered for defining LUCs. The land use classes are expected to behave similarly for a given level of management.

3.5 Laboratory Characterization

Soil samples were collected from representative master profiles for laboratory characterization by following the methods outlined in the Laboratory Manual (Sarma *et al*, 1987). Surface soil samples collected in the year 2017 from Adavalli-2 farmer's fields (27 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.

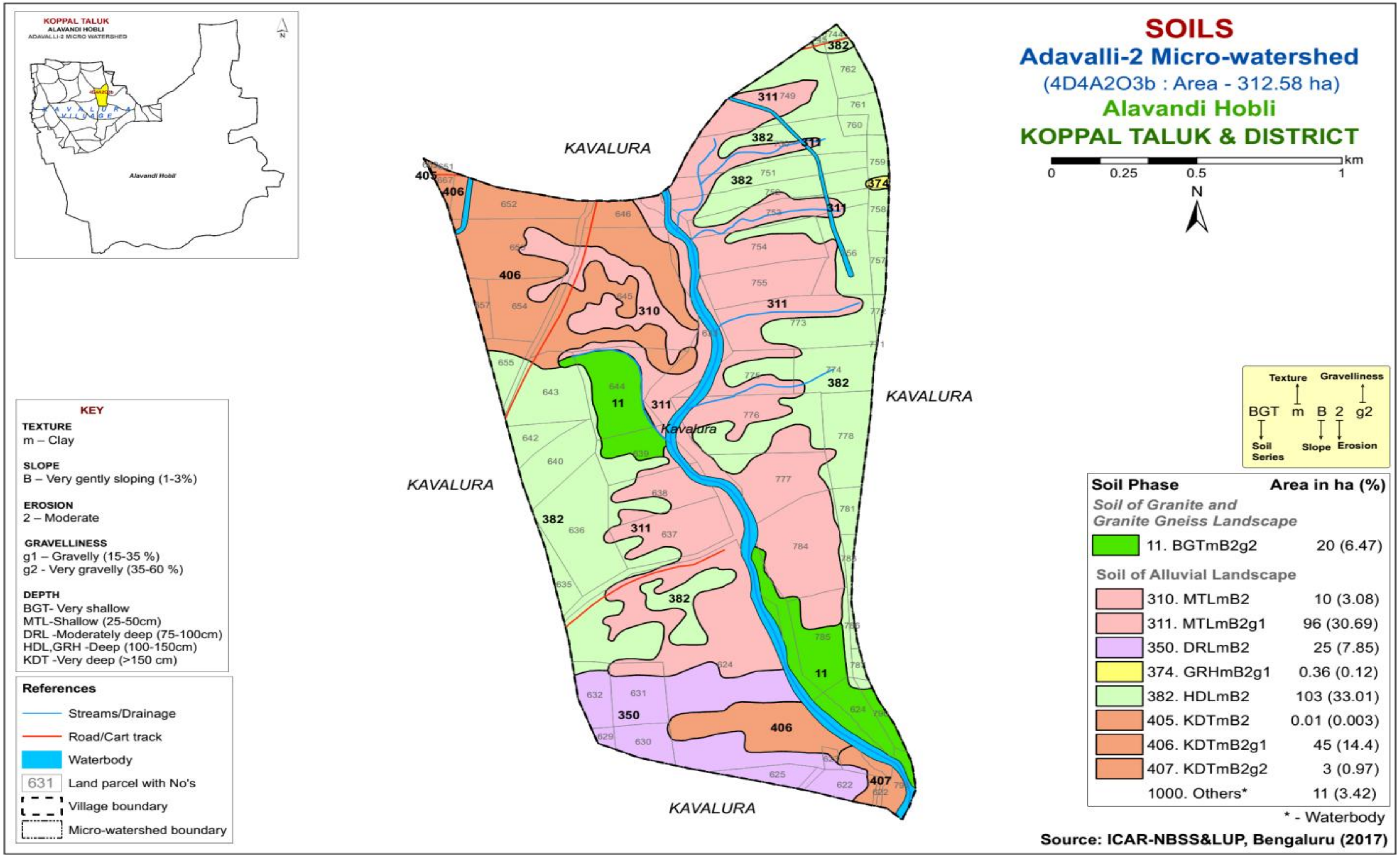


Fig 3.5 Soil Phase or Management Units- Adavalli-2 Microwatershed

Table 3.2 Soil map unit description of Adavalli-2 Microwatershed

Soil map unit No*	Soil Series	Soil Phase Symbol	Mapping Unit Description	Area in ha (%)
SOILS OF GRANITE AND 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		**20 (6.47)**
11		BGTmB2g2	Clay surface, slope 1-3%, moderate erosion, very gravelly (35-60%)	20 (6.47)
SOILS OF ALLUVIAL LANDSCAPE				
	MTL	Muttal soils are shallow (25-50 cm), well drained, have very dark grayish brown to dark brown, calcareous black gravelly sandy clay soils occurring on nearly level to gently sloping plains under cultivation		**106 (33.77)**
310		MTLmB2	Clay surface, slope 1-3%, moderate erosion	10 (3.08)
311		MTLmB2g1	Clay surface, slope 1-3%, moderate erosion, gravelly (15-35%)	96 (30.69)
	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		**29 (6.81)**
350		DRLmB2	Clay surface, slope 1-3%, moderate erosion	29 (6.81)
	GRH	Gatareddihal soils are deep (100-150 cm), moderately well drained, have light olive brown to very dark gray, calcareous black cracking clay soils occurring on very gently sloping uplands under cultivation		**0.37 (0.12)**
374		GRHmB2g1	Clay surface, slope 1-3%, moderate erosion, gravelly (15-35%)	0.37 (0.12)
	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		**103 (33.01)**
382		HDLmB2	Clay surface, slope 1-3%, moderate erosion	103 (33.01)
	KDT	Kadagathur soils are very deep (>150 cm), moderately well drained, have very dark gray to very dark grayish brown and dark brown, black cracking sandy clay to clay soils occurring on very gently sloping uplands under cultivation		**48.01 (15.37)**
405		KDTmB2	Clay surface, slope 1-3%, moderate erosion	0.01(0.0040)
406		KDTmB2g1	Clay surface, slope 1-3%, moderate erosion, gravelly (15-35%)	45 (14.40)
407		KDTmB2g2	Clay surface, slope 1-3%, moderate erosion, very gravelly (35-60%)	3 (0.97)
1000		Others	Habitation and Water body	14 (3.21)

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

Chapter 4

THE SOILS

Detailed information pertaining to the nature, extent and distribution of different kinds of soils occurring in Adavalli-2 Microwatershed is provided in this chapter. The microwatershed area has been identified as Granite gnesis and Alluvial Landscapes based on geology. In all, 6 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 6 soil series identified followed by 9 soil phases (management units) mapped under each series (Fig. 3.5) are furnished below. The physical and chemical characteristics of soil series identified in Adavalli-2 microwatershed is given in Table 4.1. The soils in any one map unit differ from place to place in their depth, texture, slope, gravelliness, erosion or any other site 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

In this landscape, 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 clayey mixed, isohyperthermic 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 (51-100 mm/m). Only one soil phase was identified and mapped.

Landscape and soil profile characteristics of Belagatti (BGT) Series

4.2 Soils of Alluvial Landscape

In this landscape, 4 soil series are identified and mapped. Of these, Muttal (MTL) series occupies maximum area of about 139 ha (36%) followed by Bardur (BDR) series 113 ha (29%). The brief description of each soil series along with the soil phases identified and mapped is given below.

4.2.1 Muttal (MTL) Series: Muttal soils are shallow (25-50 cm), well drained, have dark brown to very dark grayish brown, calcareous gravelly clay soils. They have developed from alluvium and occur on nearly level to very gently sloping uplands. The Muttal series has been classified as 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 with 15-35 per cent gravel. The available water capacity is low (51-100 mm/m). Two soil phases were identified and mapped.

Landscape and soil profile characteristics of Muttal (MTL) 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 Alluvium 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 are calcareous. The available water capacity is high (150-200 mm/m). Only one soil phase was identified and mapped.

Landscape and soil profile characteristics of Dambarahalli (DRL) Series.

4.2.3 Gatareddihal (GRH) Series: Gatareddihal soils are deep (100-150 cm), moderately well drained have black or dark grey to light olive brown clay soils. They are developed from Alluvium and occur on nearly level to very gently sloping uplands under cultivation. The Gatareddihal soil series has been classified as fine, smectitic, isohyperthermic family of Vertic Haplustepts.

The thickness of the solum ranges from 102 to 149 cm. The thickness of A-horizon ranges from 12 to 19 cm. Its colour is in 7.5 YR, 10 YR hue with value 3 to 4 and chroma 1 to 6. The texture is sandy clay loam to clay. The thickness of B-horizon ranges from 86 to 117 cm. Its colour is in 10 YR and 7.5 YR hue with value 3 and chroma 2 to 6. Texture is clay with less than 15 per cent gravel. The available water capacity is very high (>200 mm/m). Only one soil phase was identified and mapped.

Landscape and soil profile characteristics of Gatareddihal (GRH) Series

4.2.4 Handrala (HDL) Series: Handrala soils are deep (100-150 cm), moderately well drained, have black to very dark brown and dark gray calcareous cracking clay soils. They are developed from alluvium and occur on very gently to gently sloping uplands. Handrala series has been classified as 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

4.2.6 Kadagathur (KDT) Series: Kadagathur soils are very deep (>150 cm), moderately well drained, have dark brown to very dark grayish brown sandy clay to clay soils. They have developed from weathered granite gneiss and occur on nearly level to very gently sloping uplands under cultivation.

The thickness of the solum is more than 150 cm. The thickness of A horizon ranges from 8 to 14 cm. Its colour is in 10 YR hue with value 3 and chroma 4. The texture varies is sandy loam. The thickness of B horizon is more than 150 cm. Its colour is in 10 YR and 7.5 YR hue with value 3 and chroma 1 to 4. Its texture is sandy clay to clay. The available water capacity is very high (>200 mm/m). Three soil phases were identified and mapped.

Landscape and soil profile characteristics of Kadagathur (KDT) Series

Table: 4.1 Physical and Chemical Characteristics of Soil Series identified in Adavalli-2 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: Gatareddihalla (GRH), Pedon: RM-2

Location: 15⁰24'01"N, 76⁰09'29"E, Chilavadagi village, Koppal taluk and district

Analysis at: NBSS&LUP, Regional Centre, Bangalore. **Classification:** Fine, Smectitic, isohyperthermic Vertic Haplustepts

Depth (cm)	Horizon	Size class and particle diameter (mm)								Coarse fragments w/w (%)	Texture Class (USDA)	% Moisture	
		Total			Sand								
		Sand (2.0-0.05)	Silt (0.05-0.002)	Clay (<0.002)	Very coarse (2.0-1.0)	Coarse (1.0-0.5)	Medium (0.5-0.25)	Fine (0.25-0.1)	Very fine (0.1-0.05)			1/3 Bar	15 Bar
0-11	Ap	45.30	15.84	38.86	4.01	9.19	10.45	13.31	8.34	-	sc	25.72	17.55
11-35	Bw1	39.72	13.13	47.15	3.41	10.65	11.50	9.05	5.11	-	c	29.58	20.25
35-66	Bw2	34.69	17.29	48.02	3.32	4.93	12.63	8.14	5.67	-	c	35.93	18.05
66-86	Bw3	34.09	18.15	47.76	4.96	10.14	7.98	7.01	3.99	-	c	35.19	16.79
86-112	Bw4	42.55	16.46	40.98	5.53	11.91	9.68	10.21	5.21	-	c	44.70	16.06
112-125	Bc	56.02	14.48	29.50	11.41	17.07	12.36	10.26	4.92	-	scl	37.55	11.51

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}							%	%
0-11	8.27			1.11	0.91	5.40			0.44	3.70		31.60	0.81		11.72
11-35	8.82			0.476	0.67	5.28			0.46	7.29		35.10	0.74		20.77
35-66	9.14			0.637	0.87	3.60			0.45	10.70		37.70	0.79		28.39
66-86	9.11			0.633	0.23	5.60			0.42	10.55		38.10	0.80		27.70
86-112	9.6			0.847	0.35	4.92			0.40	14.55		33.90	0.83		42.93
112-125	9.73			0.783	0.19	4.44			0.25	12.99		25.30	0.86		51.33

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

Location: 15⁰19'69.8"N, 75⁰58'00"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

Chapter 5

INTERPRETATION FOR LAND RESOURCE MANAGEMENT

The most important soil and site characteristics that affect 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 thatrestrict 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 11 soil map units identified in the Adavalli-2 microwatershed are grouped under two land capability classes and three land capability subclasses (Fig. 5.1).

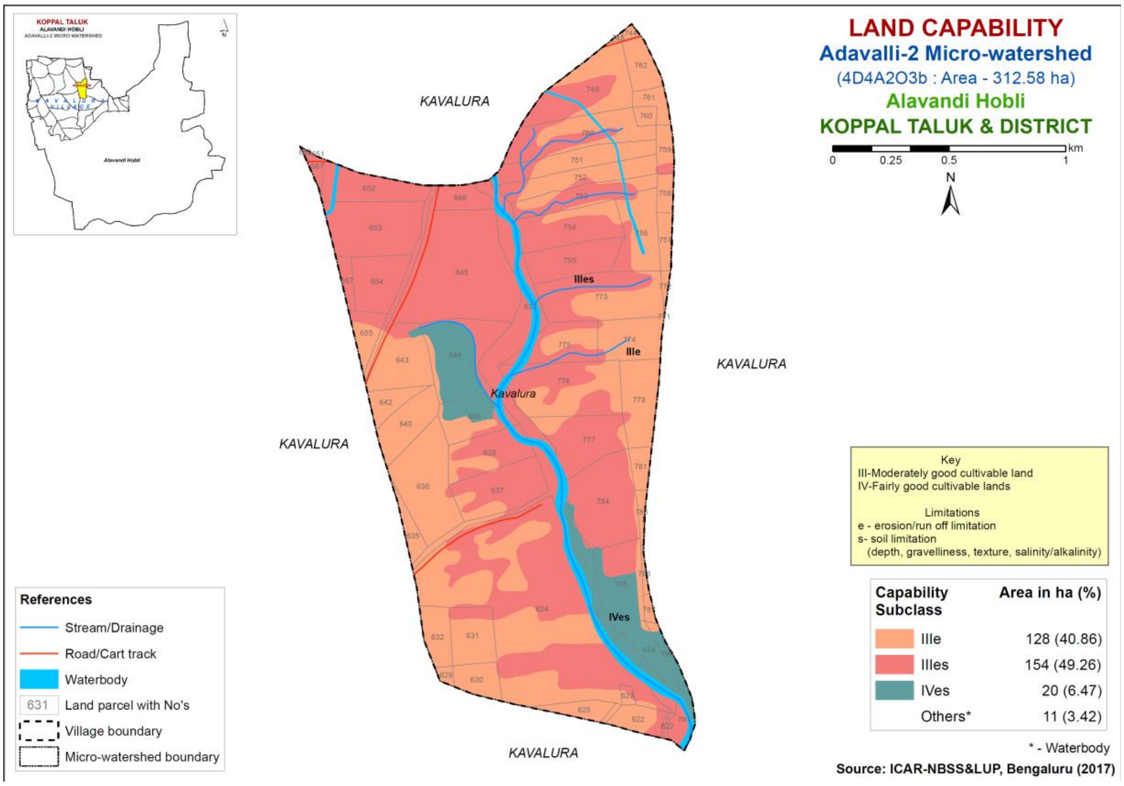


Fig. 5.1 Land Capability map of Adavalli-2 Microwatershed

Entire area in the microwatershed is suitable for agriculture. Moderately good cultivable lands (Class III) cover an area of about 90 per cent and are distributed in all parts of the microwatershed with moderate problems of erosion and soil. Fairly good lands (Class IV) cover an area of 6 per cent and are distributed in the central and southern part of the microwatershed with very severe limitations of soil and erosion.

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).

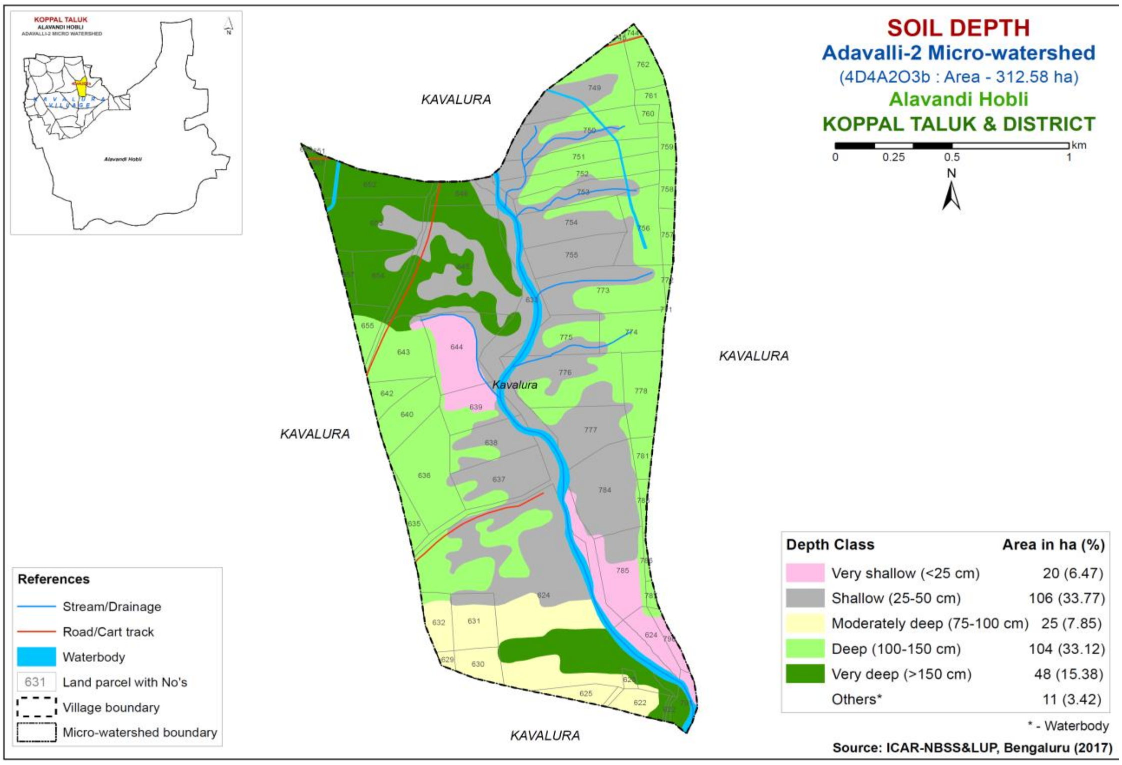


Fig. 5.2 Soil Depth map of Adavalli-2 Microwatershed

Very shallow (<25 cm) soils occupy a small area of about 20 ha (6%) and are distributed in the central and southern part of the microwatershed. Shallow soils (25-50 cm) occupy a maximum area of about 106 ha (34%) and occur in the southern, northern and central part of the microwatershed. An area of about 25 ha (8%) is moderately deep (75-100 cm) and are distributed in the southern part of the microwatershed. Deep (100-150 cm) soils occupy an area of about 104 ha (33%) and occur in the northeastern and southwestern part of the microwatershed. Very deep (>150 cm) soils occupy an area of about 48 ha (15%) and are distributed in the northern and southern part of the microwatershed.

The most problem lands with an area of about 20 ha (6%) having very shallow (<25 cm) rooting depth 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 152 ha (49%) 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.

Entire area has clayey soils at the surface (Fig. 5.3) and 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 in clayey soils.

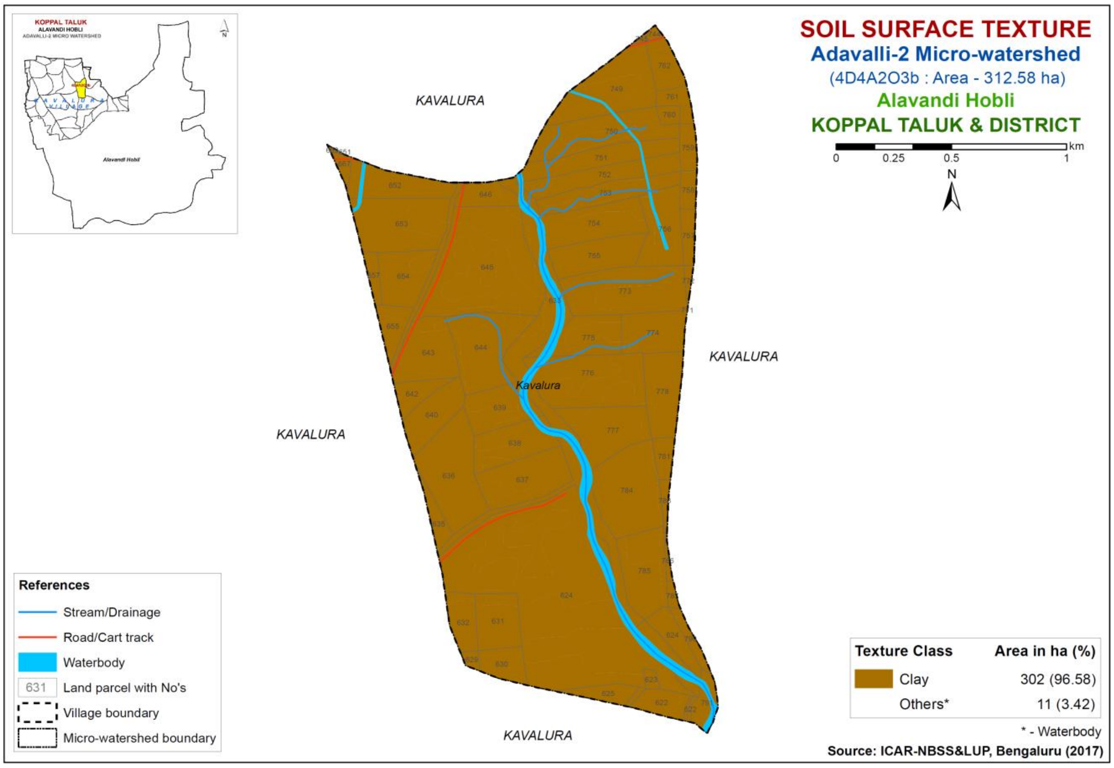


Fig. 5.3 Surface Soil Texture map of Adavalli-2 Microwatershed

5.4 Soil Gravelliness

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

The soils that are non-gravelly (<15% gravel) cover an area of about 137 ha (44%) and are distributed all over the microwatershed. An area of 141 ha (45%) is covered by gravelly (15-35% gravel) soils and are distributed in all parts of the microwatershed. A small area of about 23 ha (7%) has soils that are very gravelly (35-60% gravel) and are distributed in the central and southern part of the microwatershed (Fig. 5.4).

The most productive lands with respect to gravelliness are found to be 44%. They are non-gravelly with less than 15 per cent gravel and have potential for growing both annual and perennial crops. The problem soils (7%) that are very gravelly (35-60%) where only short duration crops can be grown.

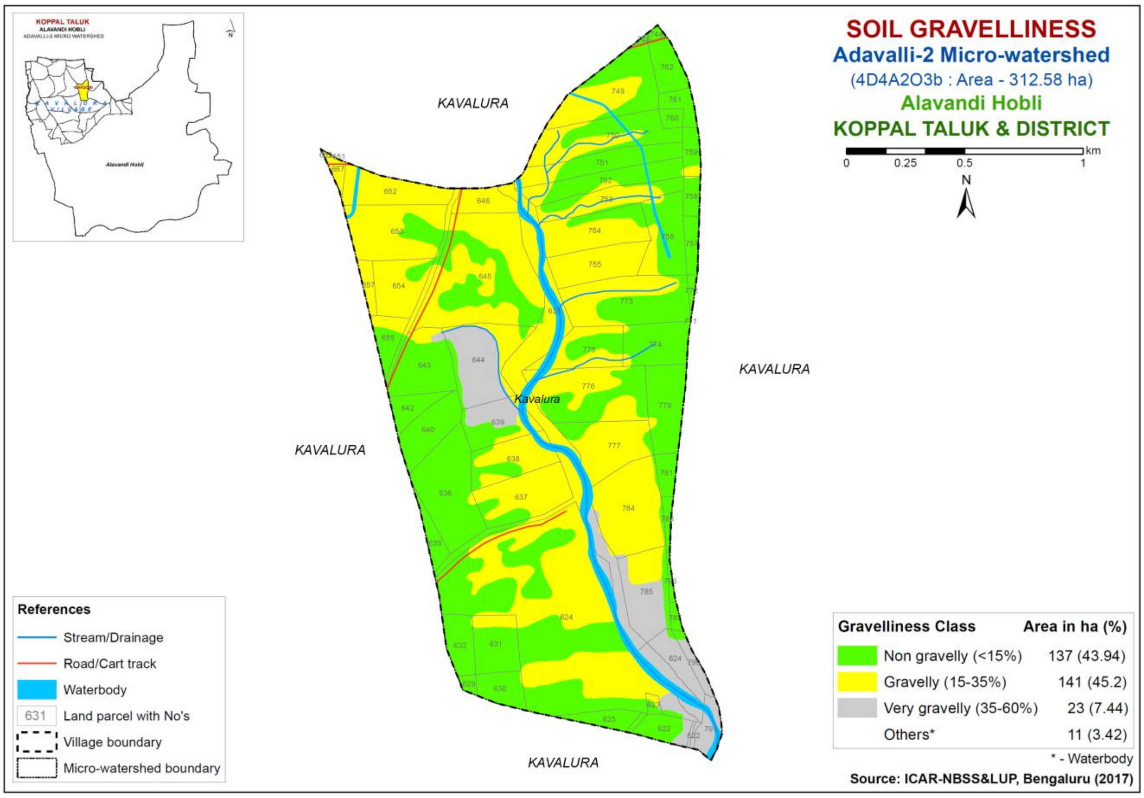


Fig. 5.4 Soil Gravelliness map of Adavalli-2 Microwatershed

5.5 Available Water Capacity

The soil available water capacity (AWC) is estimated based on the ability of the soil column to retain water between the tensions of 0.33 and 15 bar in a depth of 100 cm or the entire solum if the soil is shallower. The AWC of the soils (soil series) as estimated by considering the soil texture, mineralogy, soil depth and gravel content (Sehgal *et al.*,

1990) and accordingly the soil map units were grouped into five AWC classes *viz*, very low (<50 mm/m), low (50-100 mm/m), medium (100-150 mm/m), high (150-200 mm/m) and very high (>200 mm/m) and using these values, an AWC map was generated (Fig. 5.5).

An area of about 20 ha (6%) in the microwatershed has soils that are very low (<50 mm/m) in available water capacity and are distributed in the central and southern part of the microwatershed. An area of about 106 ha (34%) has soils that are low (51-100 mm/m) in available water capacity and are distributed in the northern, central and southern part of the microwatershed. Major area of about 25 ha (8%) area is medium (101-150 mm/m) in available water capacity and are distributed in the southern part of the microwateshed and about 152 ha (50%) area is very high in available water capacity and are distributed in all parts of the microwatershed.

An area of about 26 ha (6%) in the microwatershed has soils that are problematic with regard to available water capacity. Here, only short duration crops can be grown and the probability of crop failure is very high. These areas are best put to other alternative uses. An area of about159 ha (39%) 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.

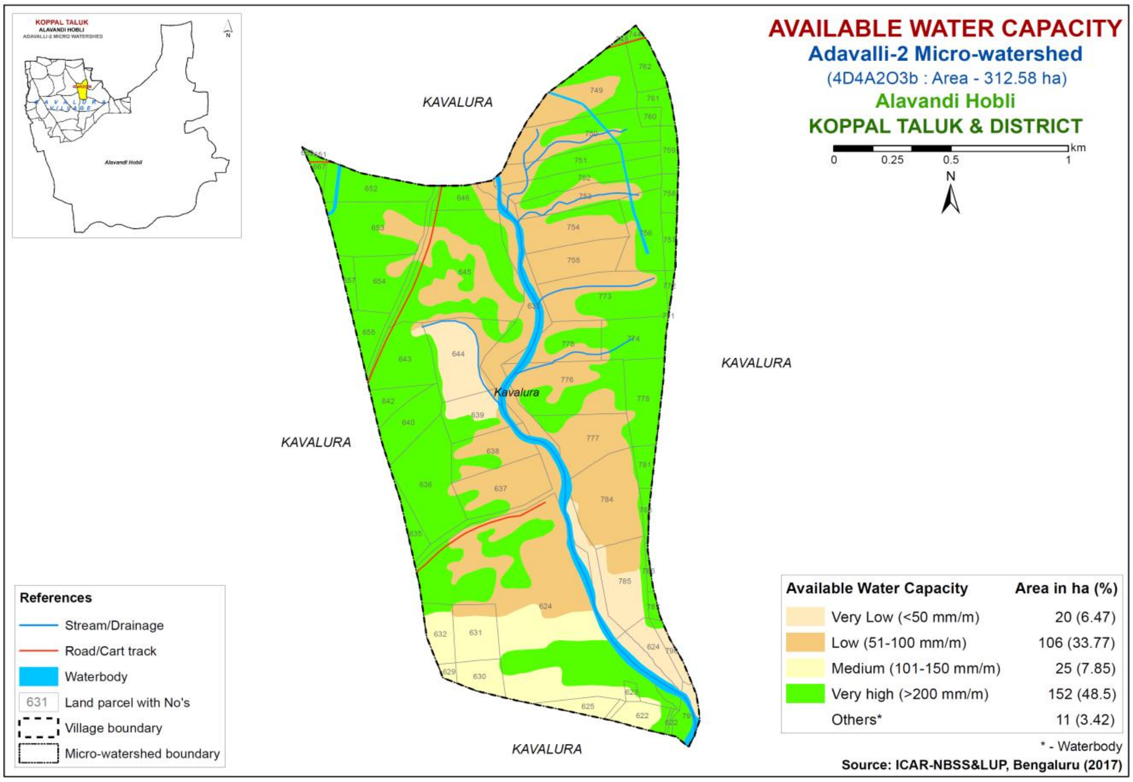


Fig. 5.5 Soil Available Water Capacity map of Adavalli-2 Microwatershed

5.6 Soil Slope

Soil slope refers to the inclination of the surface of the land. It is defined by gradient, shape and length, and is an integral feature of any soil as a natural body. Slope is considered important in soil genesis, land use and land development. The length and gradient of slope influences the rate of runoff, infiltration, erosion and deposition. The soil map units were grouped into 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).

Entire area 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.

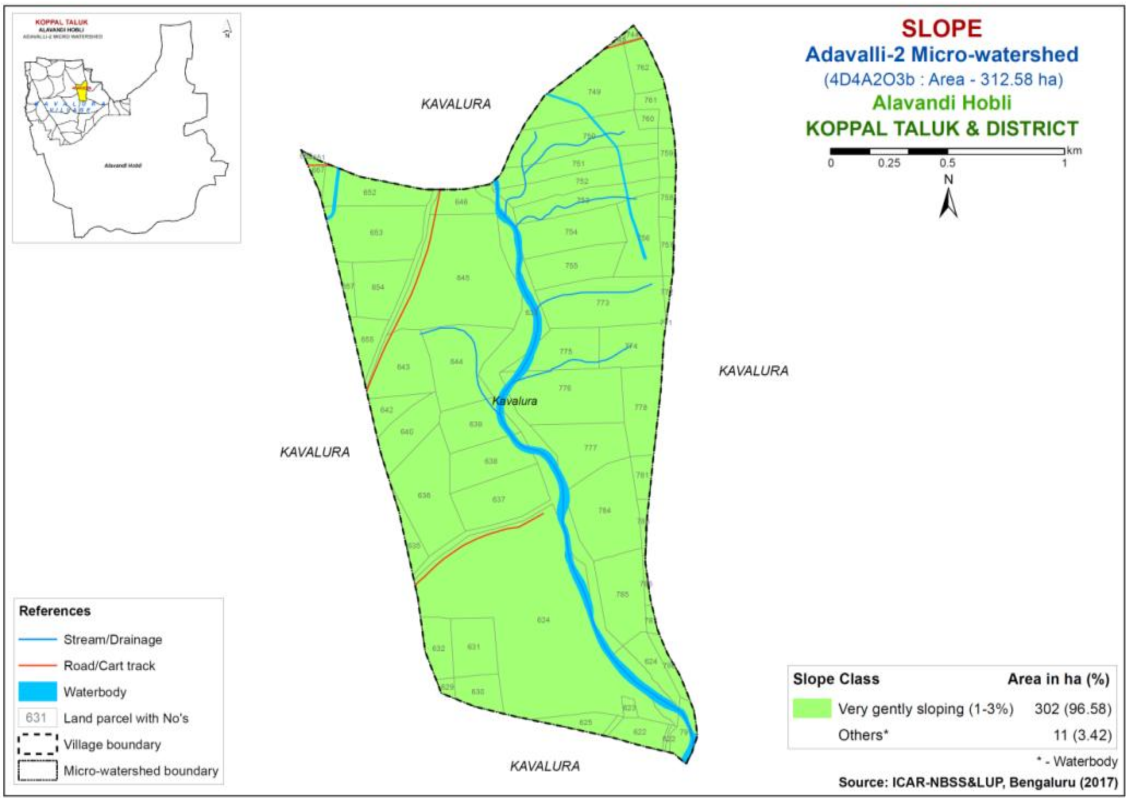


Fig. 5.6 Soil Slope map of Adavalli-2 Microwatershed

5.7 Soil Erosion

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

Entire area has moderately eroded (e2 class) soils. These are problematic and need appropriate soil and water conservation and other land development measures.

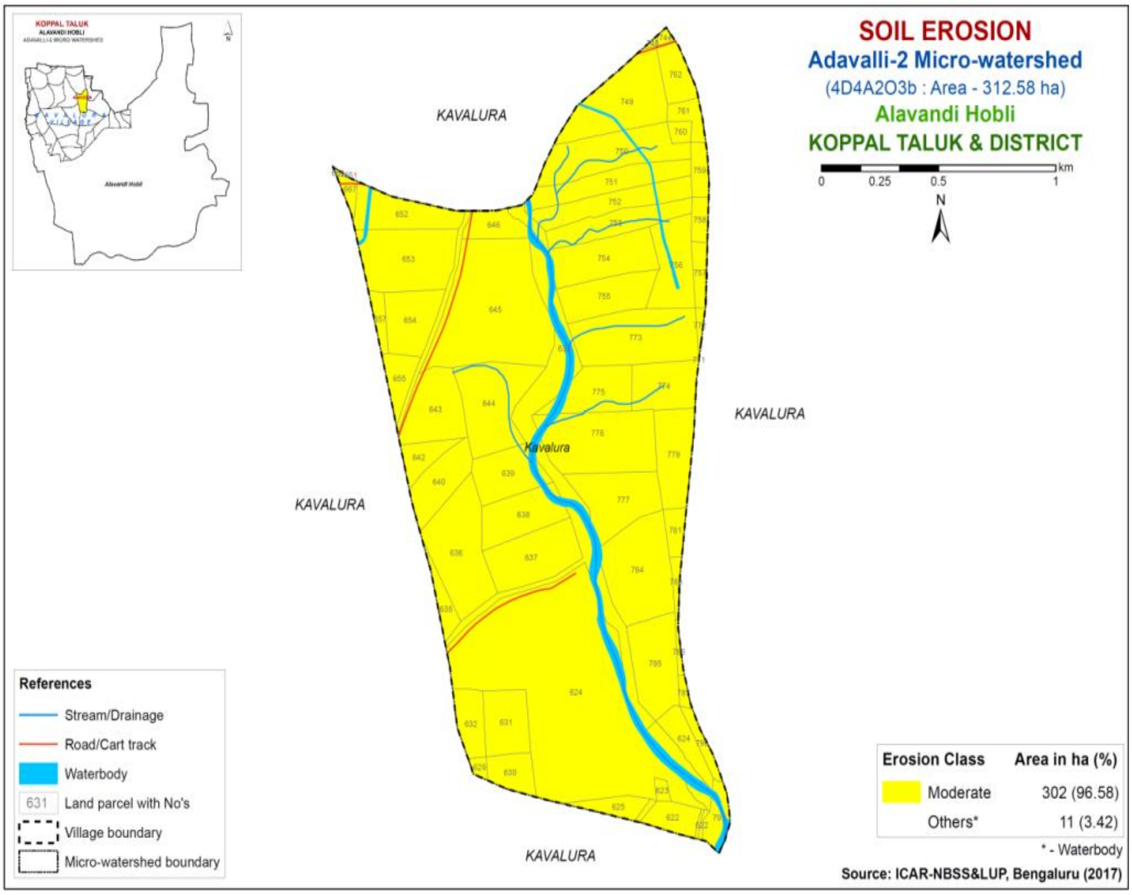


Fig. 5.7 Soil Erosion map of Adavalli-2 Microwatershed

Chapter 6

FERTILITY STATUS

Soil fertility plays an important role in increasing crop yield. The adoption of high yielding varieties that require high amounts of nutrients has resulted in deficiency symptoms in crops and plants due to imbalanced fertilization and poor inherent fertility status, as these 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 Adavalli-2 microwatershed for soil reaction (pH) showed that major area of about 190 ha (61%) is under strongly alkaline (pH 8.4-9.0) and is distributed in major parts of the microwatershed. An area of about 112 ha (36%) is very strongly alkaline (pH > 9.0) and are distributed in the northeastern and southern part of the microwatershed (Fig.6.1).

6.2 Electrical Conductivity (EC)

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

6.3 Organic Carbon

The soil organic carbon content of the microwatershed area of 137 ha (44%) is low (<0.5%) in organic carbon content and is distributed in the northern, northwestern, southern and northeastern part of the microwatershed, medium (0.5-0.75%) in an area of about 109 ha (35%) and is distributed in northern, central and southern part of the microwatershed. An area of about 56 ha (18%) is high (>0.75%) in organic carbon content and occur in the southeastern 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).

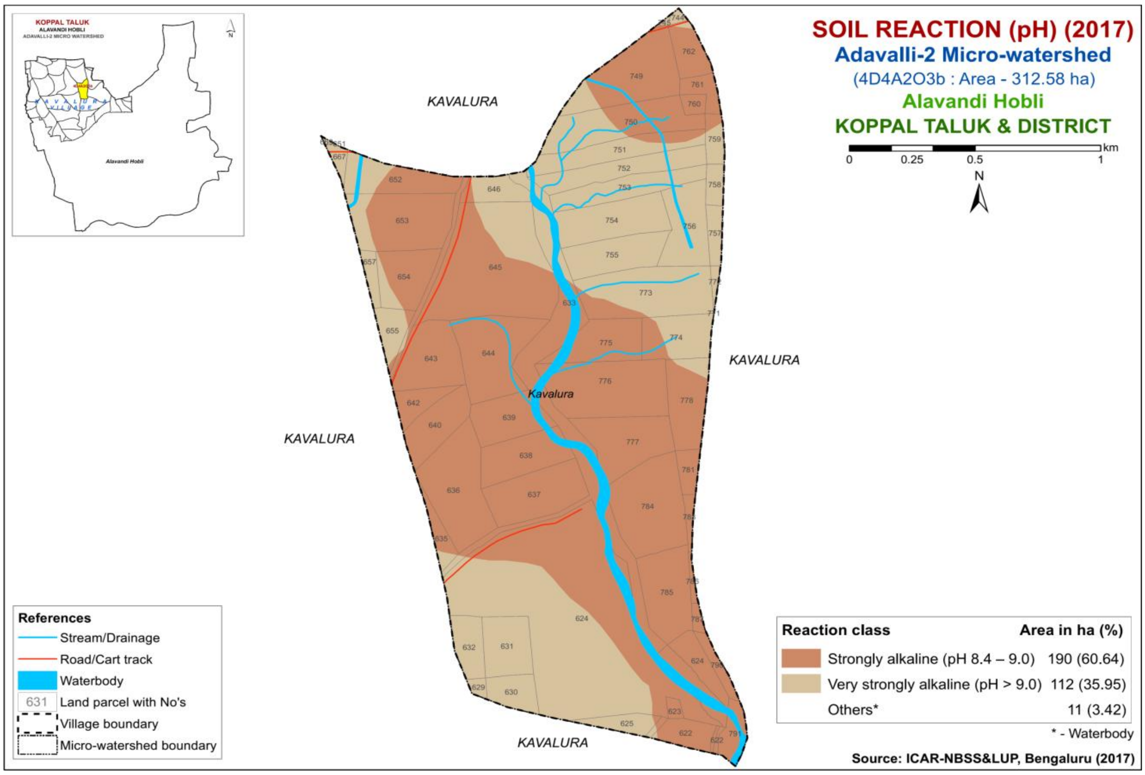


Fig.6.1 Soil Reaction (pH) map of Adavalli-2 Microwatershed

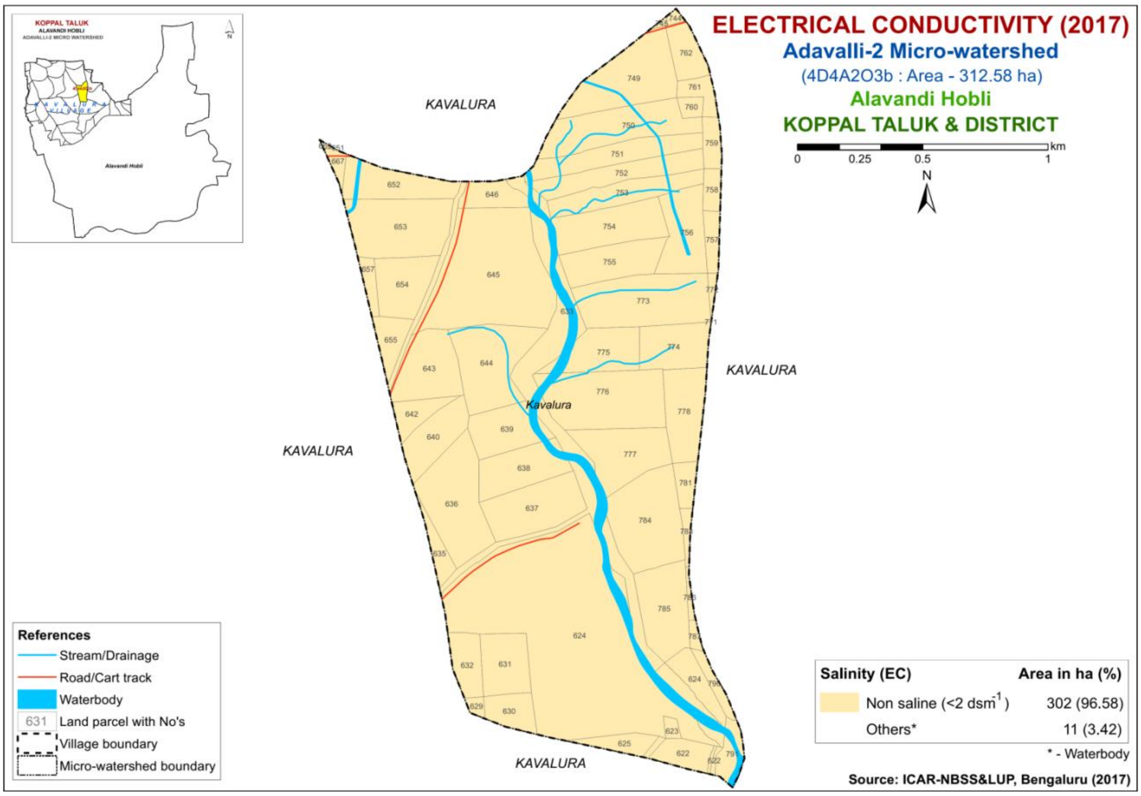


Fig.6.2 Electrical Conductivity (EC) map of Adavalli-2 Microwatershed

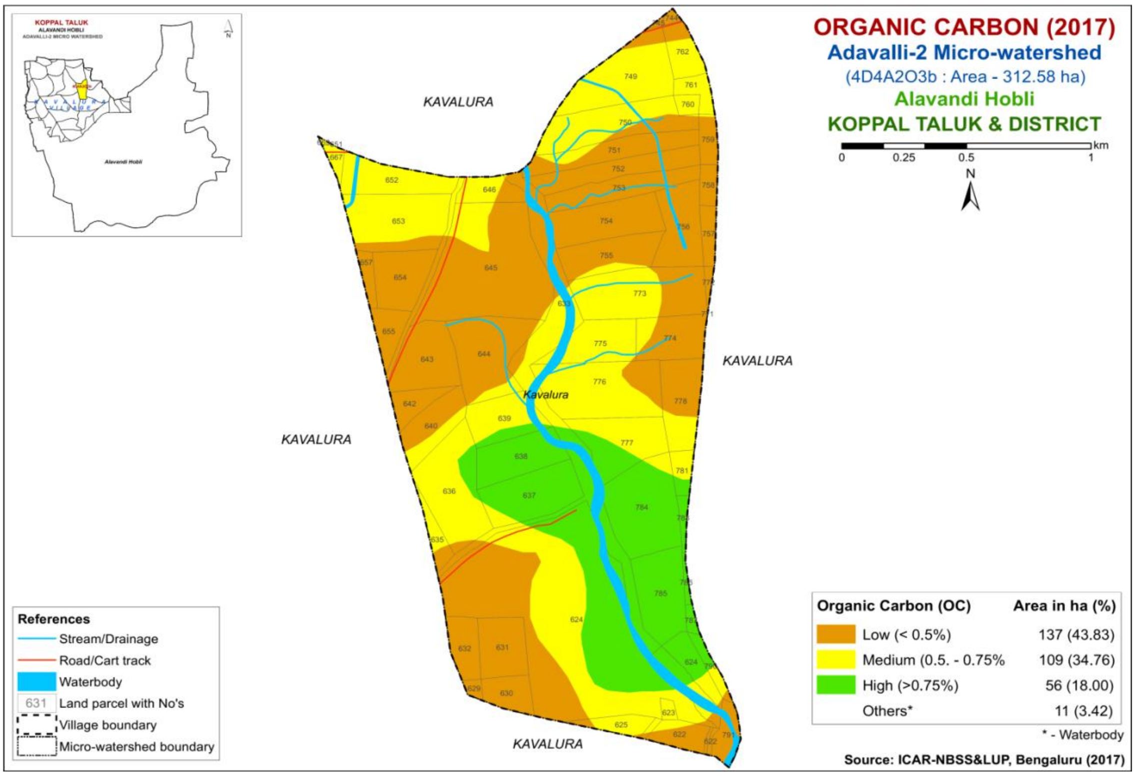


Fig.6.3 Soil Organic Carbon map of Adavalli-2 Microwatershed

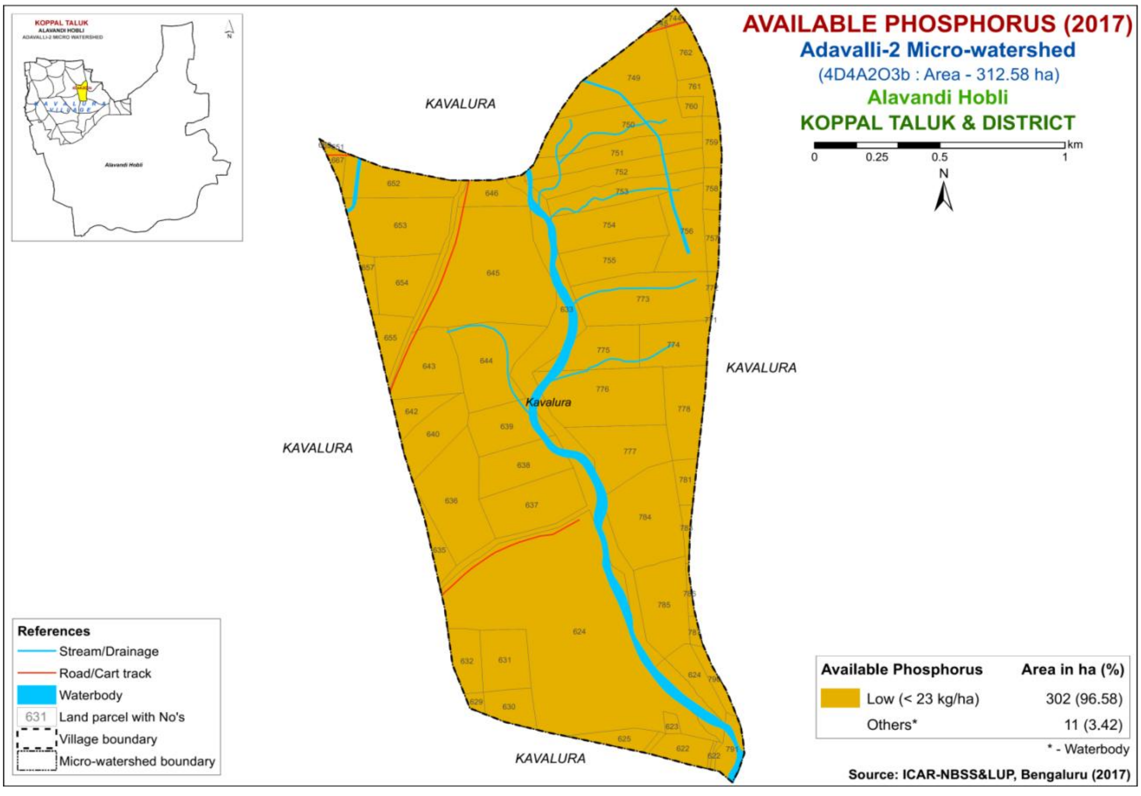


Fig.6.4 Soil Available Phosphorus map of Adavalli-2 Microwatershed

6.5 Available Potassium

Available potassium is high in the entire area of the microwatershed (Fig.6.5).

6.6 Available Sulphur

Major area of 239 ha (76%) is low (<10 ppm) in available sulphur and distributed in all parts of the microwatershed, very minor area of <1 ha (0.08%) is medium (10-20 ppm) in available sulphur and small area of about 63 ha (20%) is high (>20 ppm) in available sulphur and are distributed in the southern and northern part of the microwatershed (Fig.6.6). The areas that are low and medium in available sulphur 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 maximum area of 245 ha (78%) in the microwatershed and is distributed in all parts of the microwatershed. An area of about 57 ha (18%) is medium (0.5-1.0 ppm) in available boron and is distributed in the northern and southern part of the microwatershed (Fig.6.7).

6.8 Available Iron

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

6.9 Available Manganese

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

6.10 Available Copper

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

6.11 Available Zinc

Available zinc content is deficient (<0.6 ppm) in the entire microwatershed (Fig 6.11).

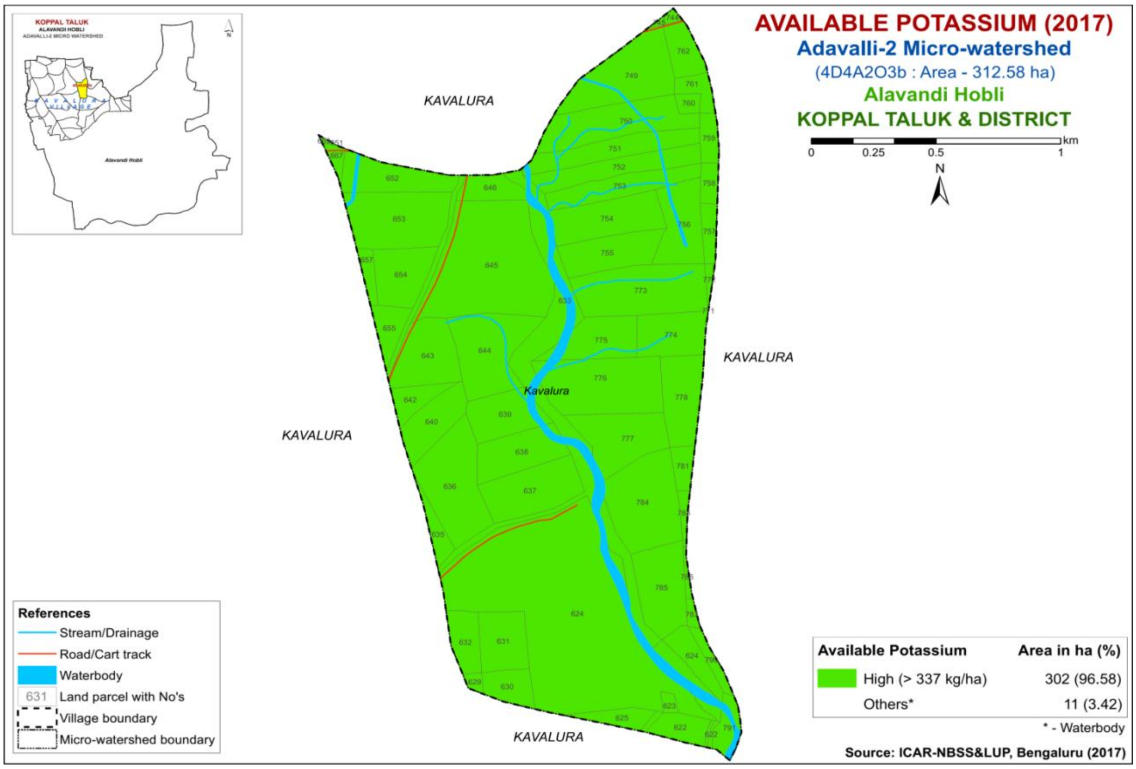


Fig.6.5 Soil Available Potassium map of Adavalli-2 Microwatershed

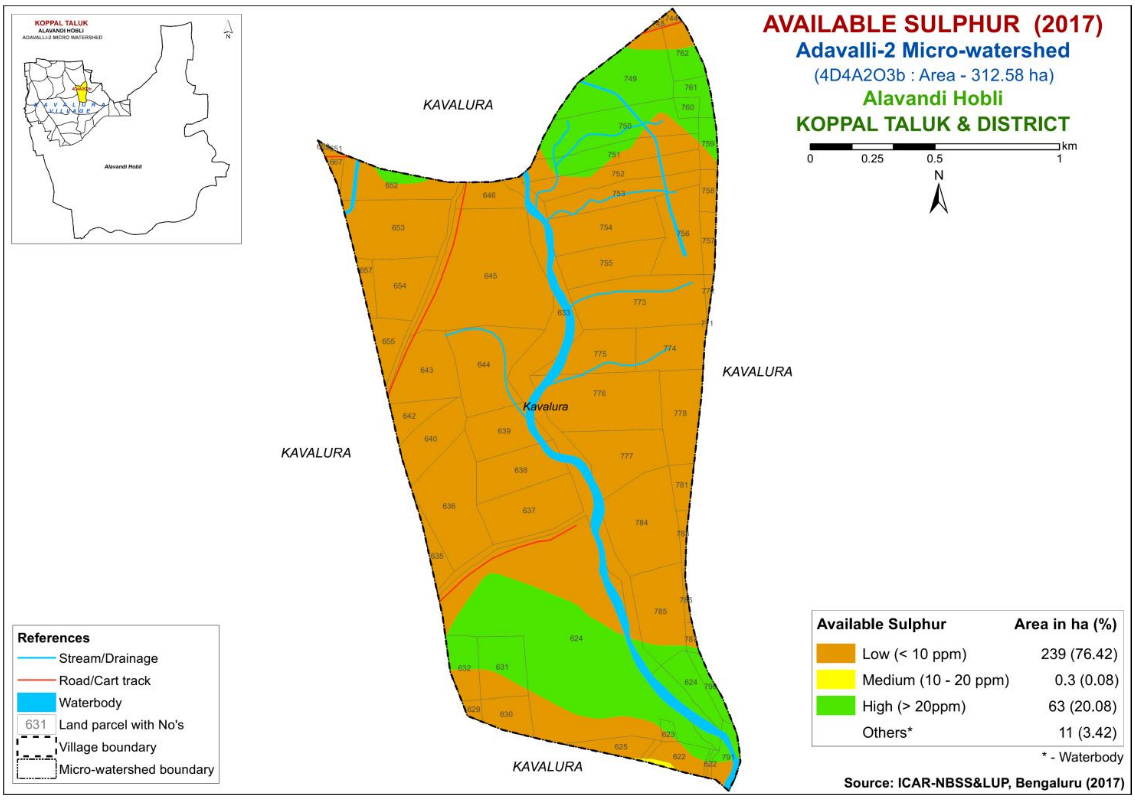


Fig.6.6 Soil Available Sulphur map of Adavalli-2 Microwatershed

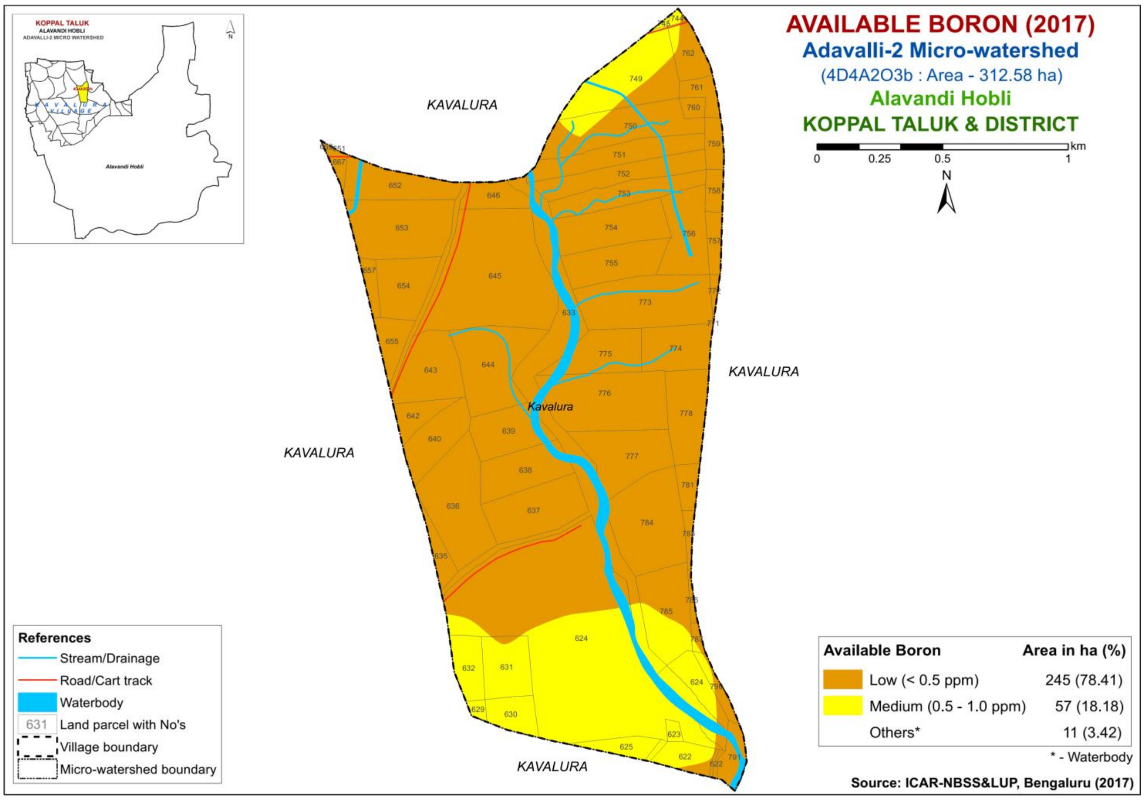


Fig.6.7 Soil Available Boron map of Adavalli-2 Microwatershed

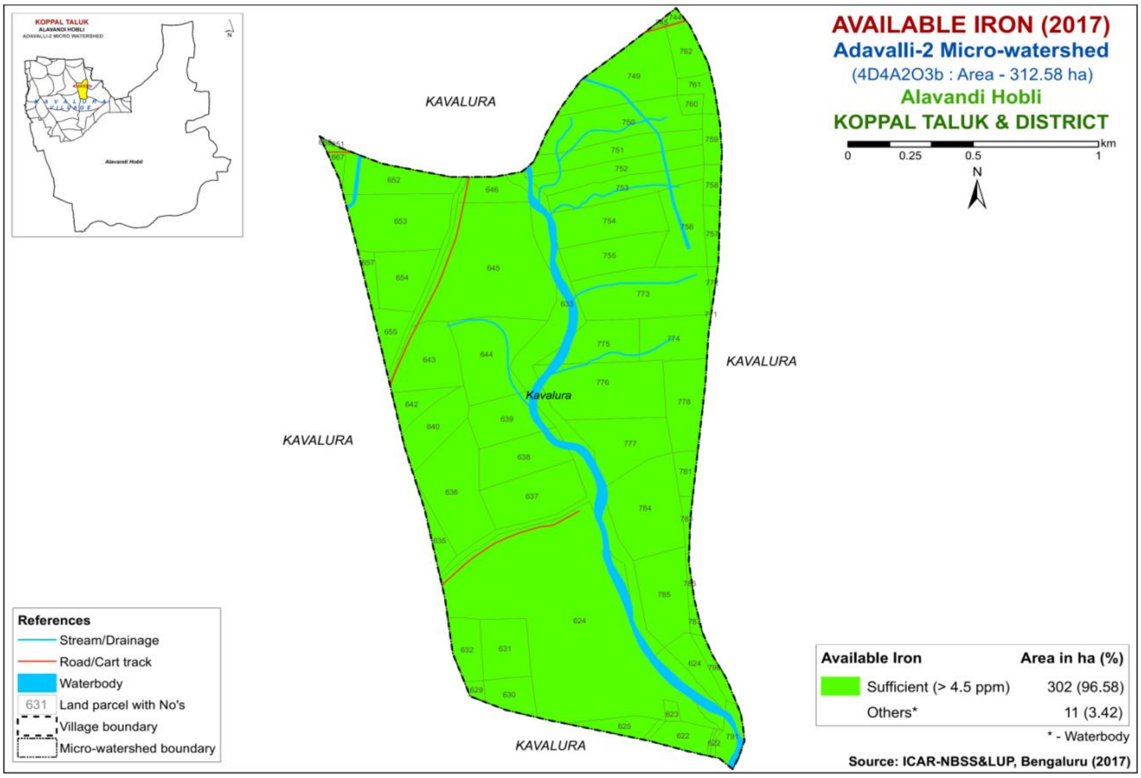


Fig.6.8 Soil Available Iron map of Adavalli-2 Microwatershed

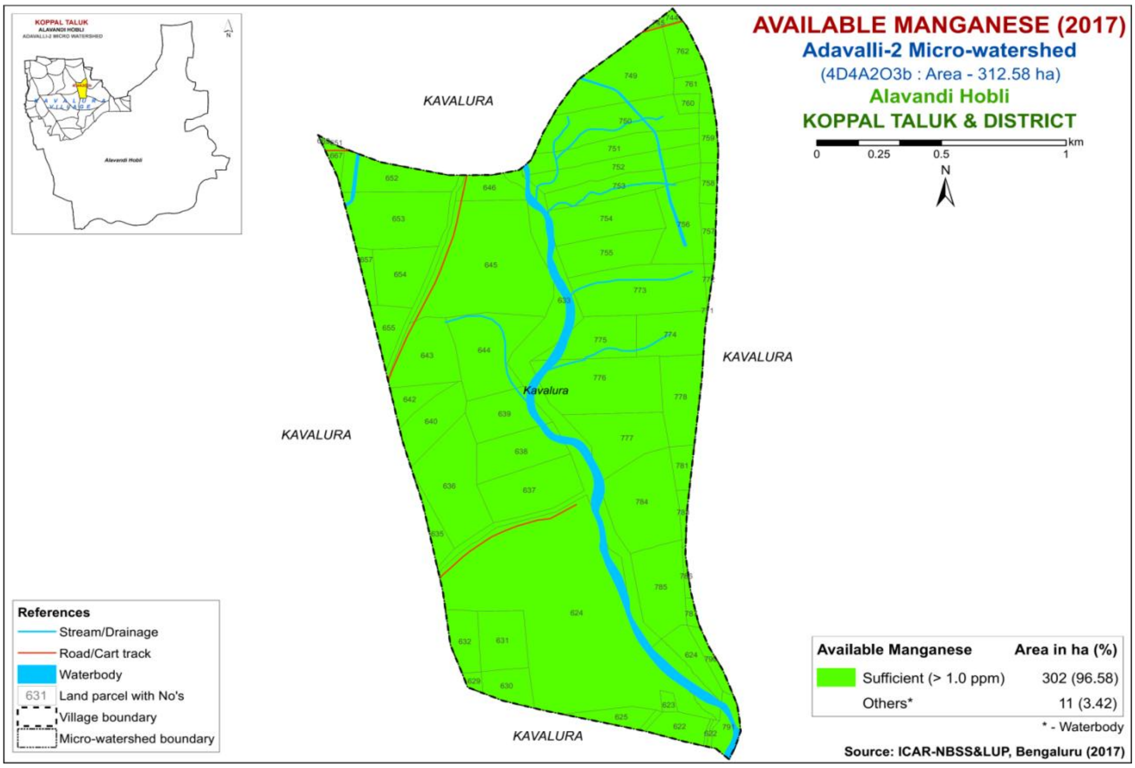


Fig.6.9 Soil Available Manganese map of Adavalli-2 Microwatershed

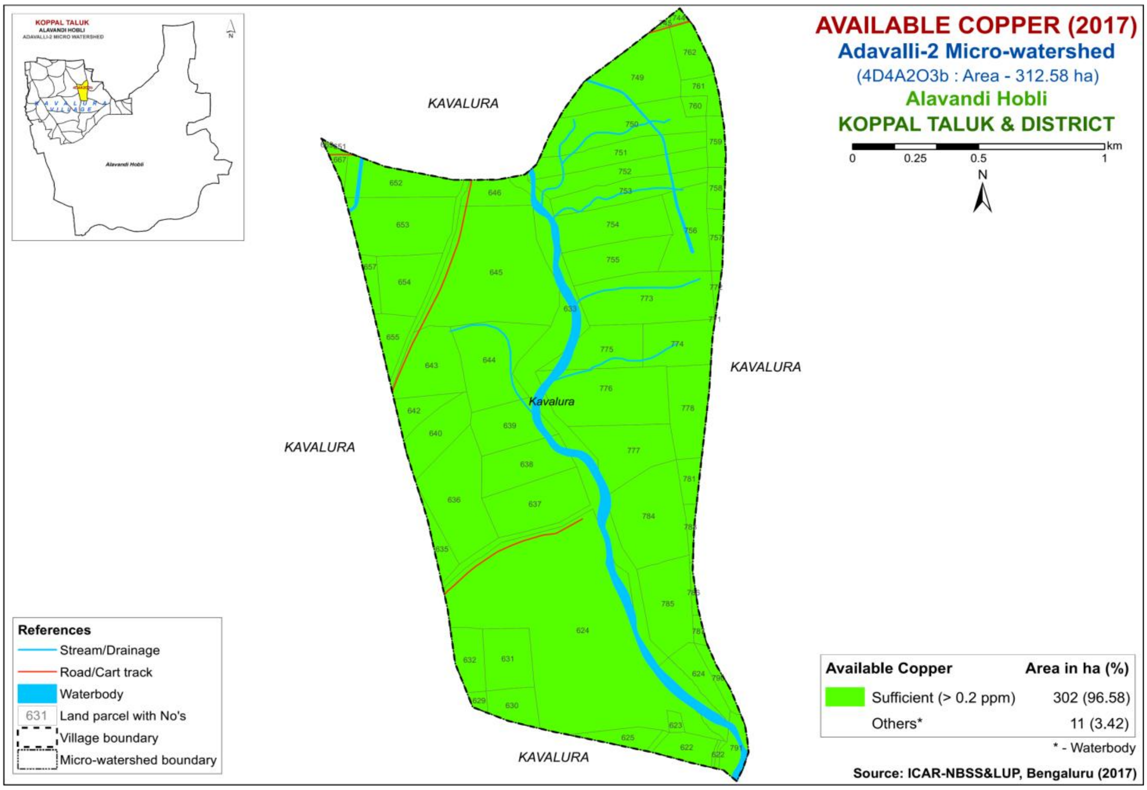


Fig.6.10 Soil Available Copper map of Adavalli-2 Microwatershed

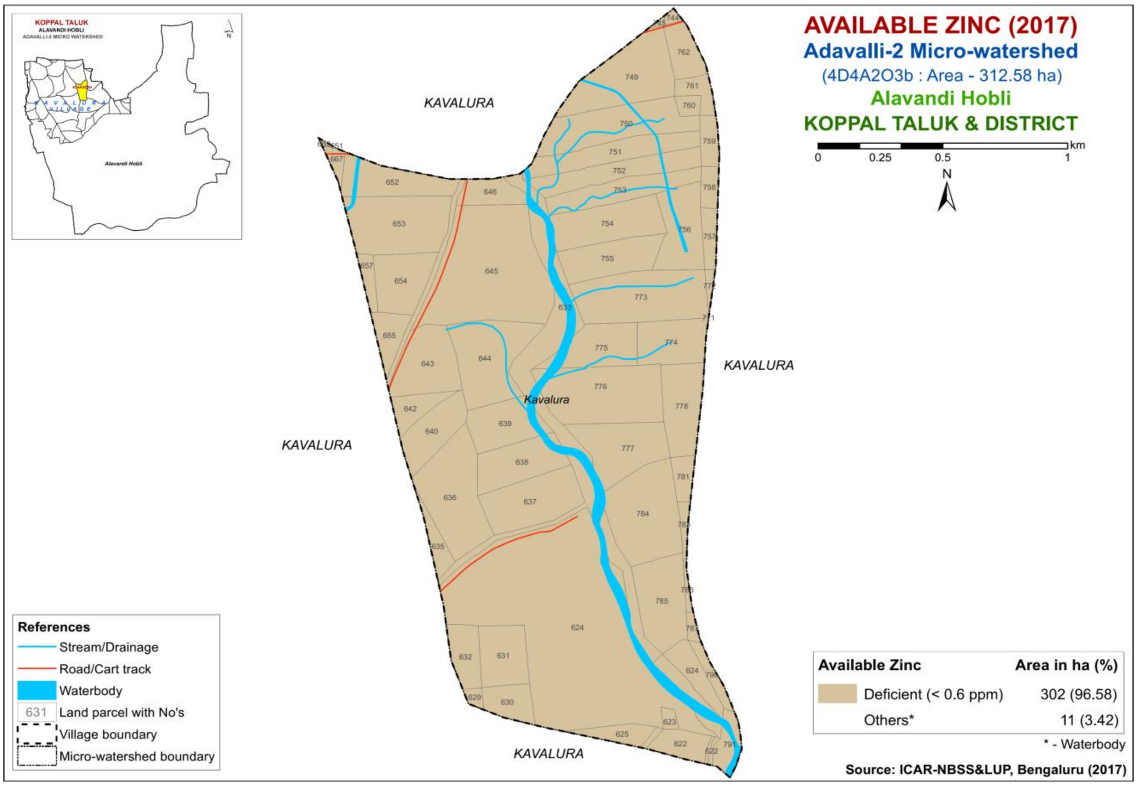


Fig.6.11 Soil Available Zinc map of Adavalli-2 Microwatershed

LAND SUITABILITY FOR MAJOR CROPS

The soil and land resource units (soil phases) of Adavalli-2 Microwatershed were assessed for their suitability for growing food, fodder, fibre and other horticulture crops by following the procedure as outlined in FAO, 1976 and 1983. Crop requirements were developed for each of the crop from the available research data and also by referring to Naidu *et. al.* (2006) and Natarajan *et. al* (2015). The crop requirements were matched with the soil and land characteristics (Table 7.1) to arrive at the crop suitability. In FAO land suitability classification, two orders are recognized. Order S- Suitable and Order N- Not suitable. The orders have Classes, subclasses and units. Order-S has three classes, Class S1- Highly Suitable, Class S2- Moderately Suitable and Class S3- Marginally Suitable. Order N has two Classes, N1- Currently not Suitable and N2- Permanently not Suitable. There are no subclasses within the Class S1 as they will have very minor or no limitations for crop growth. Classes S2 and S3 are divided into subclasses based on the kinds of limitations encountered. The limitations that affect crop production are 'c' for erratic rainfall and its distribution and length of growing period (LGP), 'e' for erosion hazard, 'r' for rooting condition, 't' for lighter or heavy texture, 'g' for gravelliness or stoniness, 'n' for nutrient availability, 'l' for topography, 'm' for moisture availability, 'z' for calcareousness and 'w' for drainage. These limitations are indicated as lower case letters to the class symbol. For example, moderately suitable 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 occupying an area of about 148 ha (47%) for growing sorghum occur in all parts of the microwatershed. Small area of about 28 ha (9%) is moderately suitable (Class S2) for growing sorghum and are distributed in the southern part of the microwatershed.

Table 7.1 Soil-Site Characteristics of Adavalli-2 Microwatershed

Soil Map Units	Climate (P) (mm)	Growing period (Days)	Drainage Class	Soil depth (cm)	Soil texture		Gravelliness		AWC (mm/m)	Slope (%)	Erosion	pH	EC	ESP	CEC [Cmol $(p^+)kg^{-1}$]	BS (%)
					Surf-ace	Sub-surface	Sur-face	Sub-surface								
BGTmB1g1	662	150	WD	<25	c	c	15-35	>35	51-100	1-3	slight	8.4	0.15	1.11	44.84	-
HRViB2g1	662	150	WD	25-50	sc	scl	15-35	>35	<50	1-3	moderate	-	-	-	-	-
LKRcB2g1	662	150	WD	50-75	sl	sc	15-35	40-60	51-100	1-3	moderate	8.18	0.30	4.51	12.19	100
MKHcB2g1	662	150	WD	50-75	sl	scl	15-35	>35	51-100	1-3	moderate	7.38	0.09	1.49	14.84	93.0
HTIiB1g1	662	150	WD	50-75	sc	sc	15-35	15-35	51-100	1-3	slight	-	-	-	-	-
MTLmB2g1	662	150	WD	25-50	c	scl-sc	15-35	15-35	51-100	1-3	moderate	8.27	0.20	0.69	36.64	-
RNKmB2	662	150	MWD	50-75	c	c	-	<15	51-100	1-3	moderate	8.86	0.48	16.94	37.00	-
HDLmA1	662	150	MWD	100-150	c	c	-	-	>200	0-1	slight	9.06	0.37	12.72	62.33	-
HDLmB2	662	150	MWD	100-150	c	c	-	-	>200	1-3	moderate	9.06	0.37	12.72	62.33	-
BDRmA1	662	150	MWD	>150	c	c	-	<15	>200	0-1	slight	8.73	0.20	1093	40.56	-
BDRmB2	662	150	MWD	>150	c	c	-	<15	>200	1-3	moderate	8.73	0.20	1093	40.56	-

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

They have minor limitations of rooting depth, gravelliness, nutrient availability and calcareousness. An area of 106 ha (34%) is marginally suitable (Class S3) for growing sorghum with moderate limitations of rooting depth and calacreousness and are distributed in the central part of the microwatershed. A very small area of about 20 ha (6%) is not suitable (Class N1) for growing sorghum and occur in the central part of the microwatershed with severe limitations of gravelliness and rooting depth.

Table 7.2 Crop suitability criteria for Sorghum

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

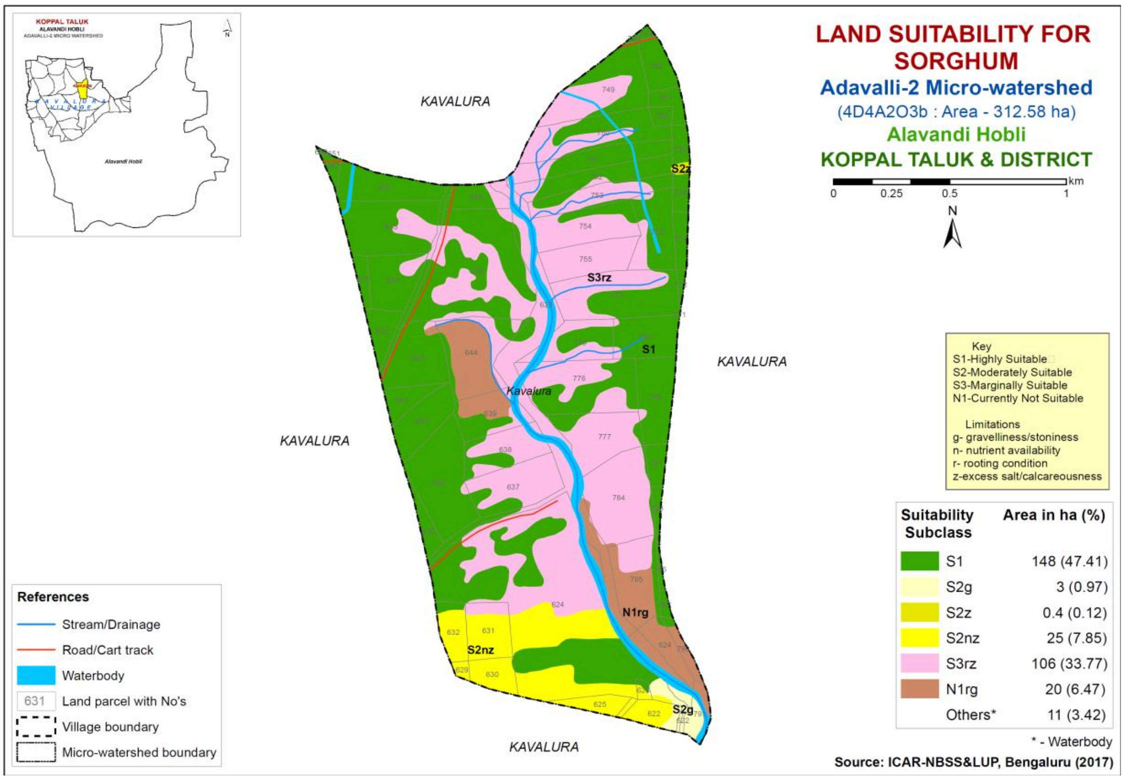


Fig. 7.1 Land Suitability map of Sorghum

7.2 Land Suitability for Maize (*Zea mays*)

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

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	

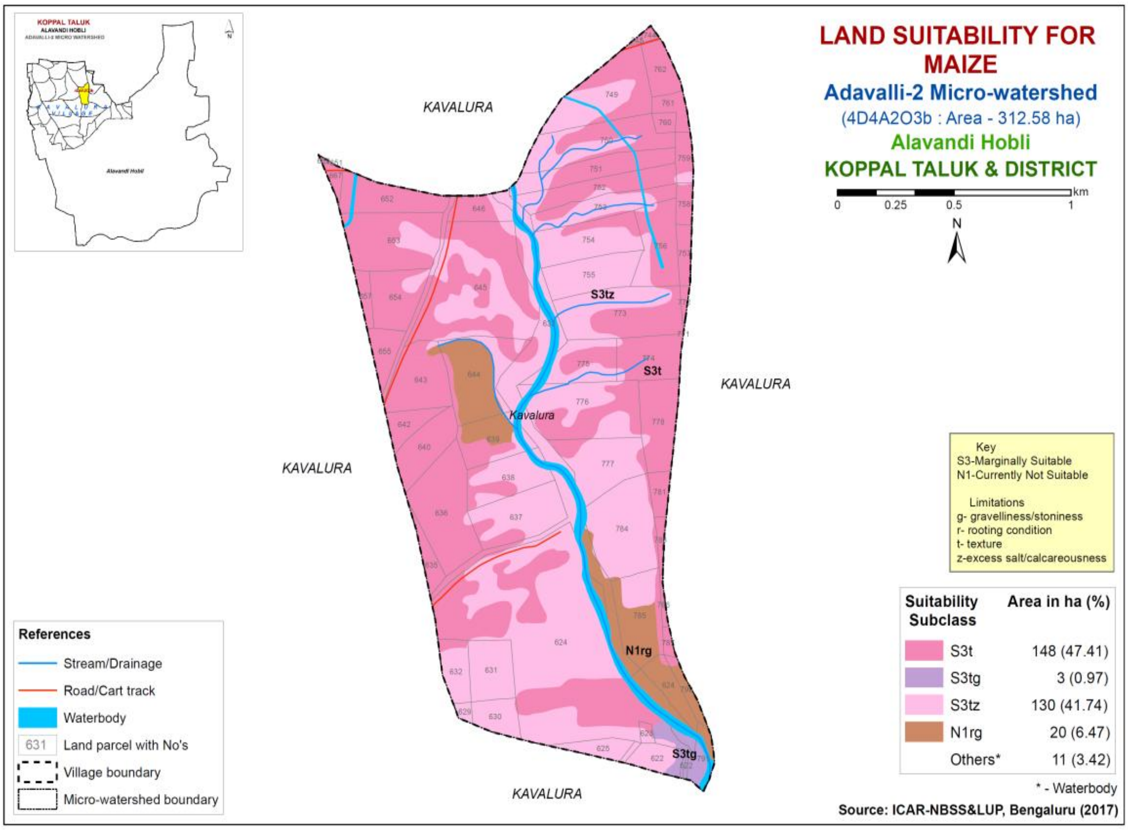


Fig. 7.2 Land Suitability map of Maize

The area extent and their geographical distribution of different suitability subclasses in the microwatershed is given in Figure 7.2.

There are no highly (S1) and moderately suitable (S2) lands for growing maize. Marginally suitable (Class S3) lands cover a maximum area of about 281 ha (90%) and occur in all parts of the microwatershed. They have moderate limitations of gravelliness, texture and calcareousness and a small area of about 20 ha (6%) is not suitable (Class N1) for growing maize and occur in the central part of the microwatershed with severe limitations of gravelliness and rooting depth.

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 a 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.

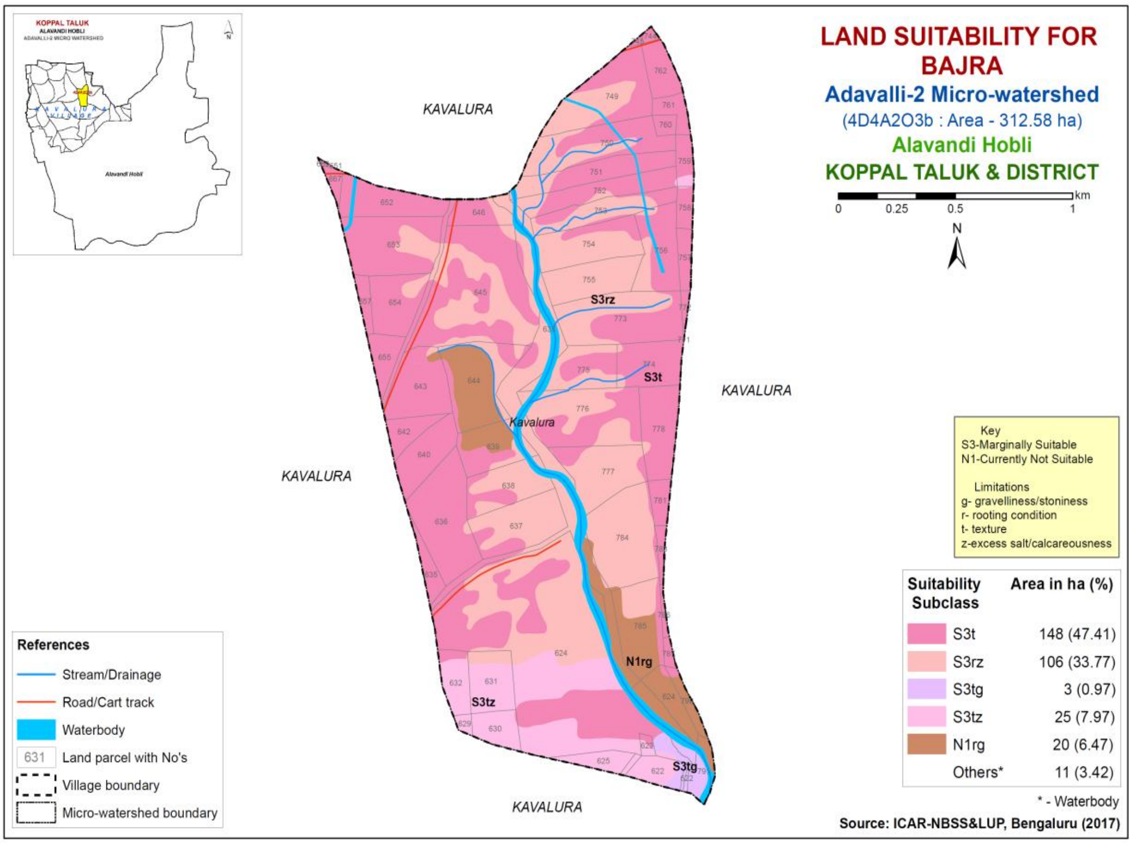


Fig. 7.3 Land Suitability map of Bajra

There are no highly (S1) and moderately suitable (S2) lands for growing bajra. Marginally suitable (Class S3) lands cover a maximum area of about 282 ha (90%) and occur in all parts of the microwatershed. They have moderate limitations of rooting depth, gravelliness, texture and calcareousness and a small area of about 20 ha (6%) is not suitable (Class N1) for growing bajra and occur in the central part of the microwatershed with severe limitations of gravelliness and rooting depth.

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	

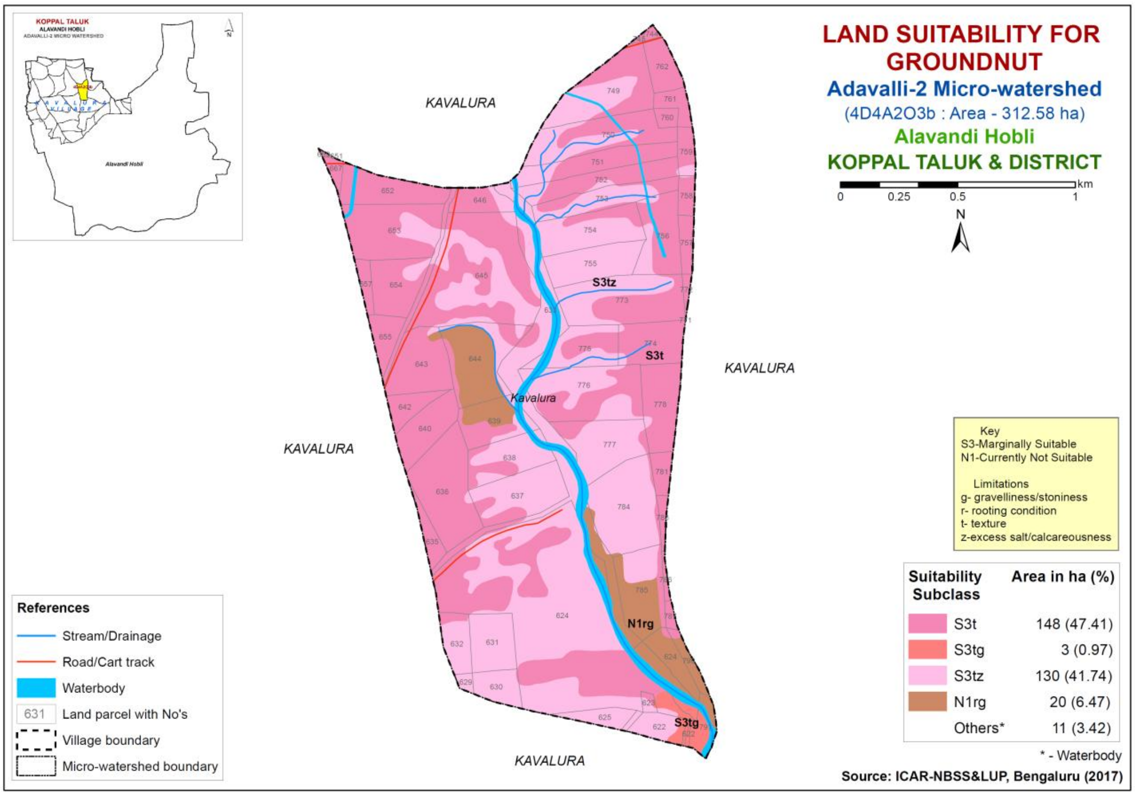


Fig. 7.4 Land Suitability map of Groundnut

There are no highly (S1) and moderately suitable (S2) lands for growing groundnut. Marginally suitable (Class S3) lands cover a maximum area of about 282 ha (90%) and occur in all parts of the microwatershed. They have moderate limitations of gravelliness, texture and calcareousness and a small area of about 20 ha (6%) is not suitable (Class N1) for growing maize and occur in the central part of the microwatershed with severe limitations of gravelliness and rooting depth.

7.5 Land Suitability for Sunflower (*Helianthus annus*)

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

An area of about 148 ha (47%) is highly suitable (Class S1) for growing sunflower and are distributed in all parts of the microwatershed. An area of about 28 ha (9%) is moderately suitable (Class S2) for sunflower and are distributed in the southern part of the microwatershed. They have minor limitations of gravelliness, rooting depth and calcareousness and an area of about 106 ha (34%) is not suitable (Class N1) for growing sunflower and occur in the central 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	

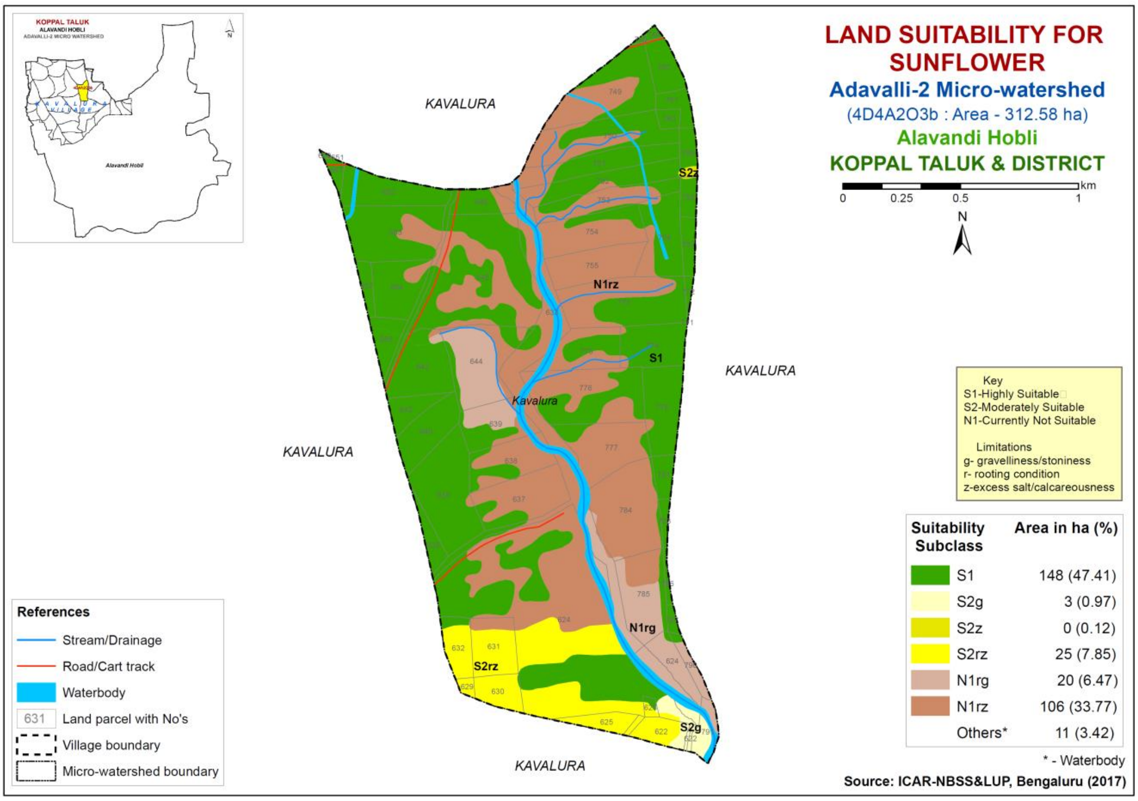


Fig. 7.5 Land Suitability map of Sunflower

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	

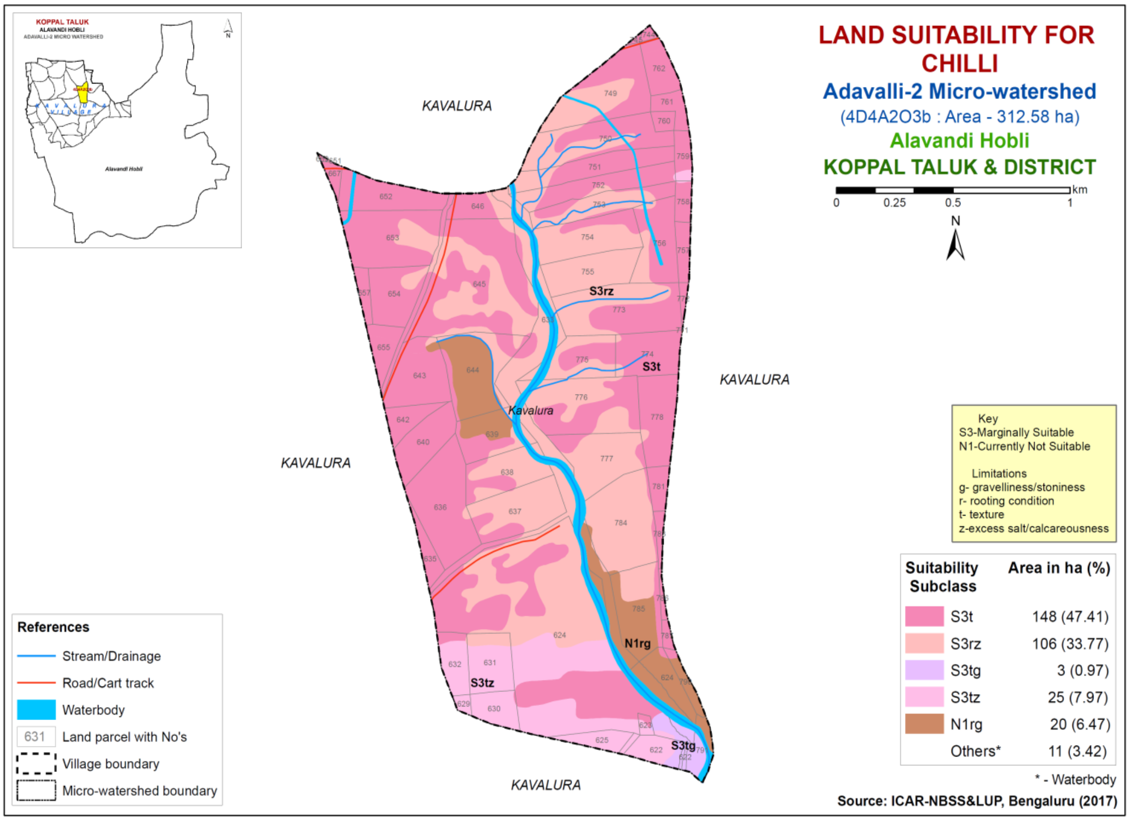


Fig. 7.6 Land Suitability map of Chilli

There are no highly (S1) and moderately suitable (S2) lands for growing Chilli. Marginally suitable (Class S3) lands cover a maximum area of about 282 ha (90%) and occur in all parts of the microwatershed. They have moderate limitations of gravelliness, texture, rooting depth and calcareousness and about 20 ha (6%) is not suitable (Class N1) for growing chilli and occur in the central part of the microwatershed with severe limitations of gravelliness and rooting depth.

7.7 Land Suitability for Tomato (*Solanum lycopersicum*)

Tomato is the most important vegetable 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 is no highly (S1) and moderately suitable (S2) lands for growing tomato. Marginally suitable (Class S3) lands cover a maximum area of about 282 ha (90%) and occur in all parts of the microwatershed. They have moderate limitations of gravelliness, texture, rooting depth and calcareousness and about 20 ha (7%) is not suitable (Class N1) for growing chilli and occur in the central part of the microwatershed with severe limitations of gravelliness and rooting depth.

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

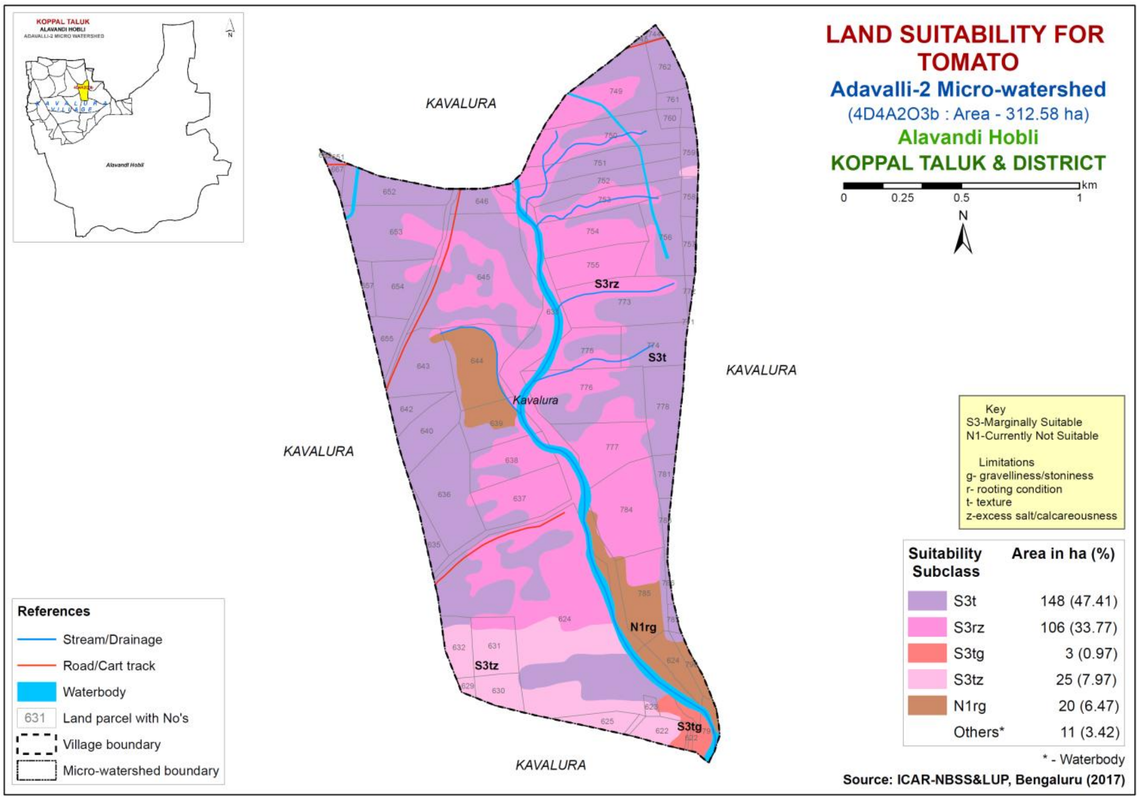


Fig. 7.7 Land Suitability map of Tomato

7.8 Land Suitability for Drumstick (*Moringa oleifera)*

Drumstick is 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

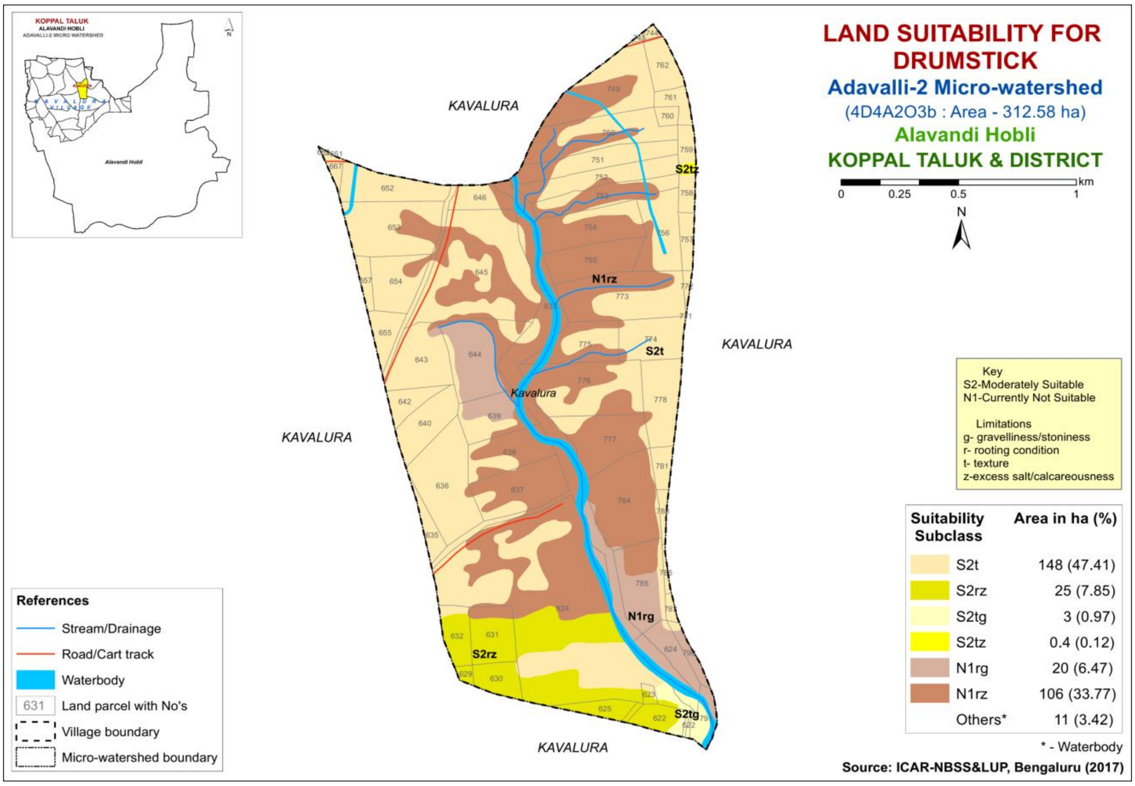


Fig. 7.8 Land Suitability map of Drumstick

Moderately suitable (Class S2) lands occupy an area of about 176 ha (56%) and occur in all parts of the microwatershed. They have minor limitation of gravelliness, rooting depth, texture and calcareousness and an area of about 126 ha (40%) is not suitable (Class N1) and occur in the northern and central part of the microwatershed and have severe limitations of rooting depth, calcareousness and gravelliness.

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
	Gravelcontent	% 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

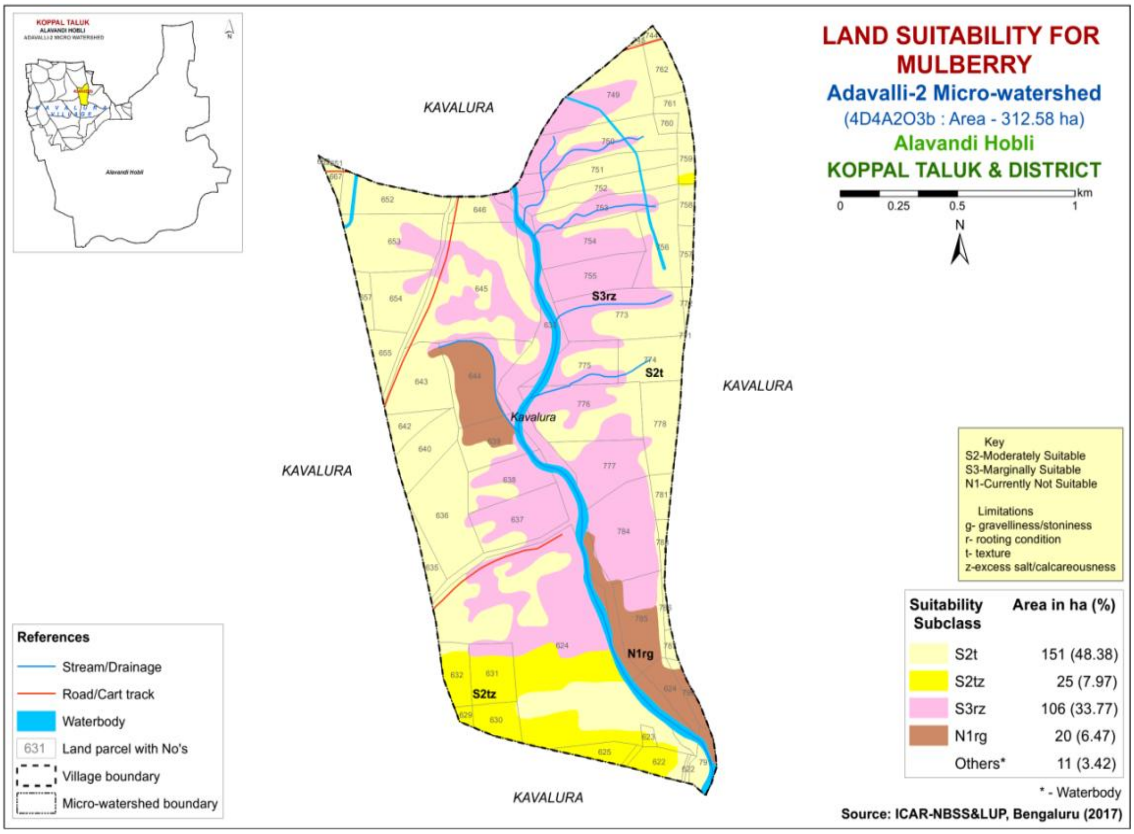


Fig. 7.9 Land Suitability map of Mulberry

Moderately suitable (Class S2) lands occupy maximum area of about 176 ha (56%) and occur in all parts of the microwatershed. They have minor limitations of texture and calcareousness. Marginally suitable lands cover an area of about 106 ha (34%) and occur in the northern and central part of the microwatershed. They have moderate limitations of rooting depth and calcareousness and small area of 20 ha (6%) is not suitable (Class N1) for growing mulberry with severe limitations of rooting depth and gravelliness and are distributed in the central and southern part of the microwatershed.

7.10 Land suitability for Mango (*Mangifera indica*)

Mango is 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) and moderately suitable (S2) lands for growing mango. Marginally suitable (Class S3) lands cover a maximum area of about 176 ha (56%) and occur in all parts of the microwatershed. They have moderate limitations of rooting depth, texture and calcareousness and about 126 ha (40%) is not suitable (Class N1) for growing mango and occur in the northern and central part of the microwatershed with severe limitations of gravelliness, rooting depth and texture.

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	^0C	28-32	24-27 33-35	36-40	20-24
	Min. temp. before flowering	^0C	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 imperfe ctly drained	Poor drained	Very poorly drained
	Water table	M	>3	2.50-3.0	2.5-1.5	<1.5
Nutrient availability	Texture	Class	Sc, l, sil, cl	Sl, sc, sic, l, c	C (<60%)	C (>60%),
	pH	1:2.5	5.5-7.5	7.6-8.55.0-5.4	8.6-9.0,4.0-4.9	>9.0<4.0
	OC	%	High	medium	low	
	$CaCO_3$ in root zone	%	Non calcareous	<5	5-10	>10
Rooting conditions	Soil depth	cm	>200	125-200	75-125	<75
	Gravel content	%vol	Non-gravelly	<15	15-35	>35
Soil toxicity	Salinity	dS/m	Non saline	<2.0	2.0-3.0	>3.0
	Sodicity	%	Non sodic	<10	10-15	>15
Erosion	Slope	%	<3	3-5	5-10	

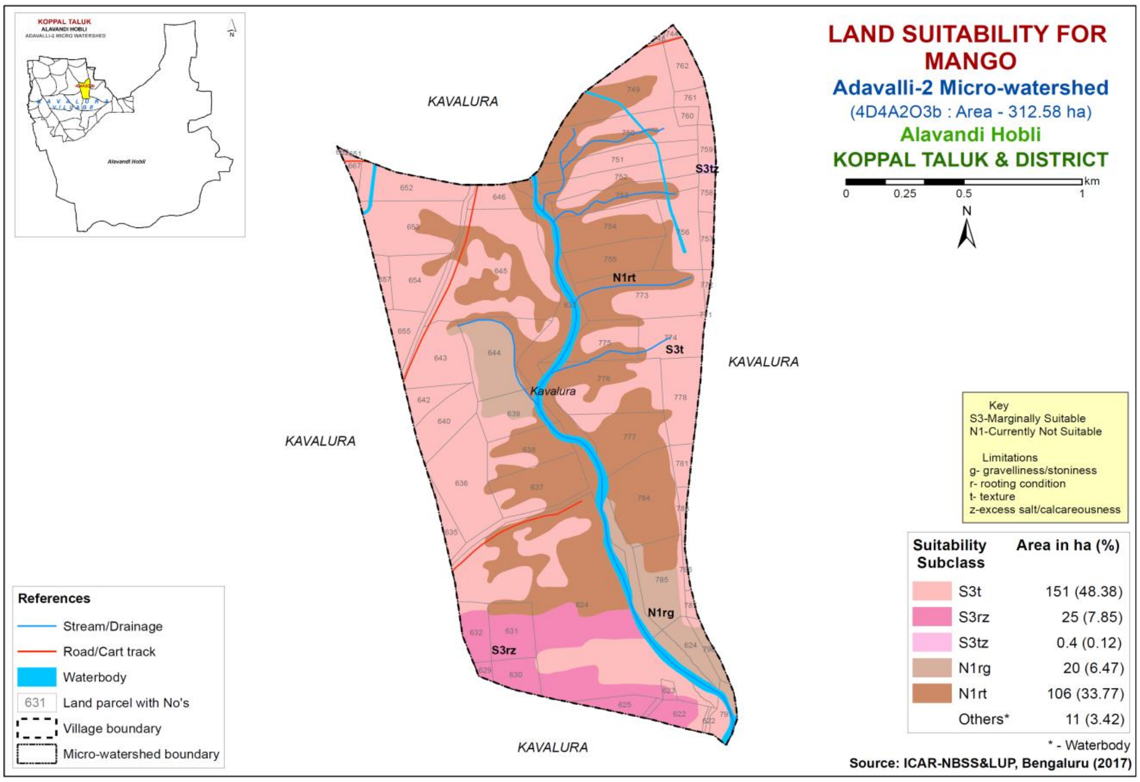


Fig. 7.10 Land Suitability map of Mango

7.11 Land suitability for Sapota (*Manilkara zapota*)

Sapota is the most important fruit crop grown in 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

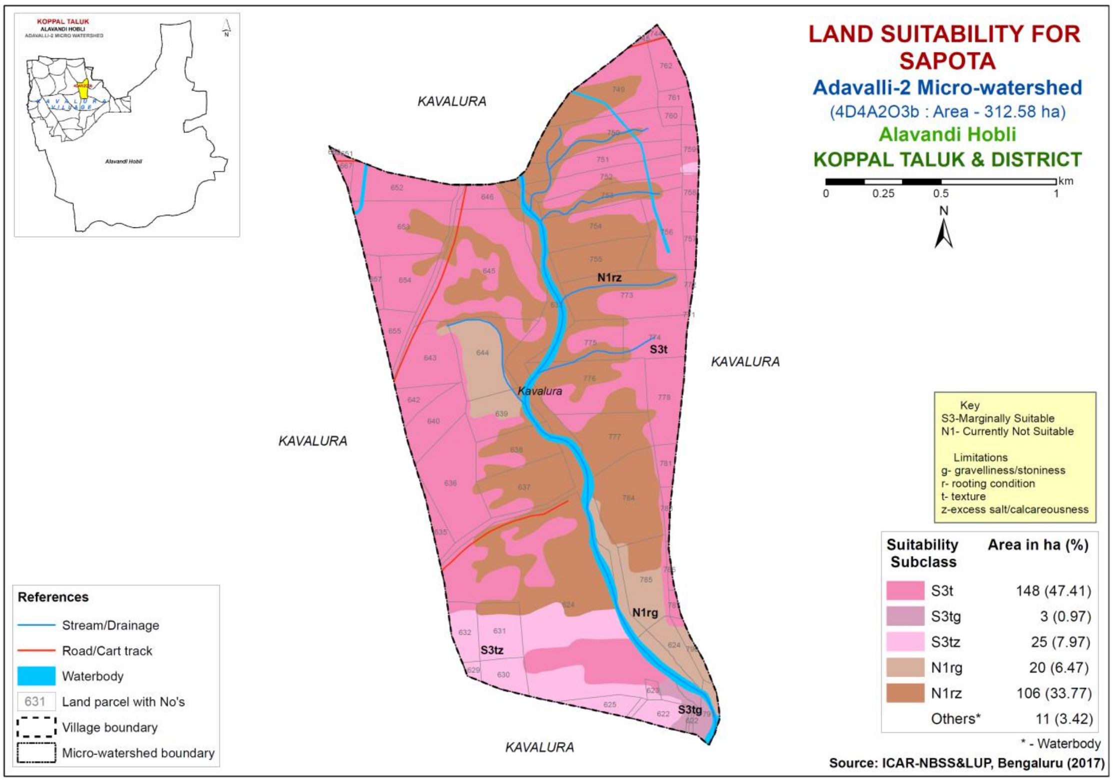


Fig. 7.11 Land Suitability map of Sapota

There are no highly (S1) and moderately suitable (S2) lands for growing sapota. Marginally suitable (Class S3) lands cover a maximum area of about 176 ha (56%) and occur in all parts of the microwatershed. They have moderate limitations of rooting depth, texture and calcareousness and about 126 ha (40%) is not suitable (Class N1) for growing sapota and occur in the northern 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.

There are no highly (S1) suitable lands for growing pomegranate Moderately suitable (Class S2) lands cover a maximum area of about 176 ha (56%) and occur in all parts of the microwatershed. They have moderate limitations of rooting depth, gravelliness, texture and calcareousness and about 126 ha (40%) is not suitable (Class N1) for growing pomegranate and occur in the northern and central part of the microwatershed with 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	

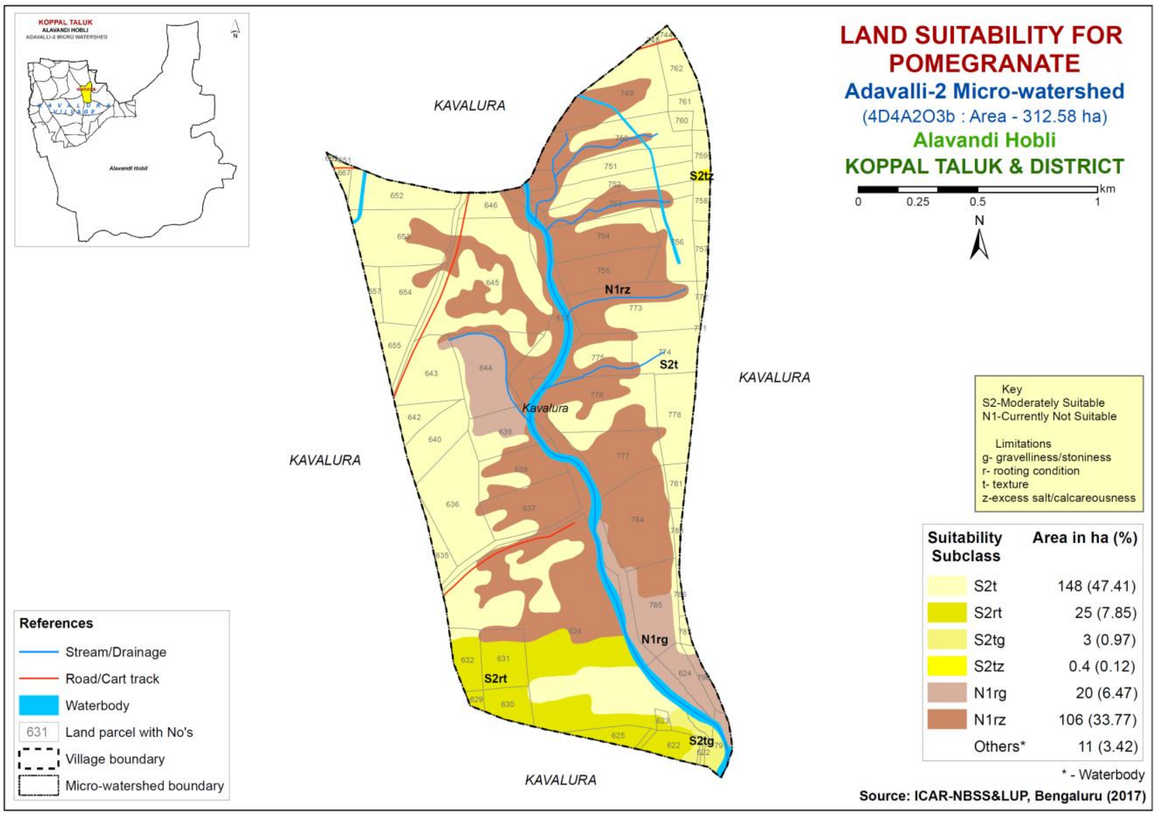


Fig. 7.12 Land Suitability map of Pomegranate

7.13 Land suitability for Guava (*Psidium guajava*)

Guava is 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.

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 176 ha (56%) and occur in all parts of the microwatershed. They have moderate limitations of gravelliness, texture and calcareousness and about 126 ha (40%) is not suitable (Class N1) for growing guava and occur in the central and northern part of the microwatershed with severe limitations of gravelliness, rooting depth and texture.

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 imperfectly	poor	Very poor
Nutrient availability	Texture	Class	Scl, l, cl, sil	Sl,sicl,sic.,sc,c	C (<60%)	C (>60%)
	pH	1:2.5	6.0-7.5	7.6-8.0:5.0-5.9	8.1-8.5:4.5-4.9	>8.5:<4.5
	$CaCO_3$ in root zone	%	Non calcareous	<10	10-15	>15
Rooting conditions	Soil depth	Cm	>100	75-100	50-75	<50
	Gravel content	% vol.	<15	15-35	>35	
Soil toxicity	Salinity	dS/m	<2.0	2.0-4.0	4.0-6.0	
	Sodicity	%	Non sodic	10-15	15-25	>25
Erosion	Slope	%	<3	3-5	5-10	>10

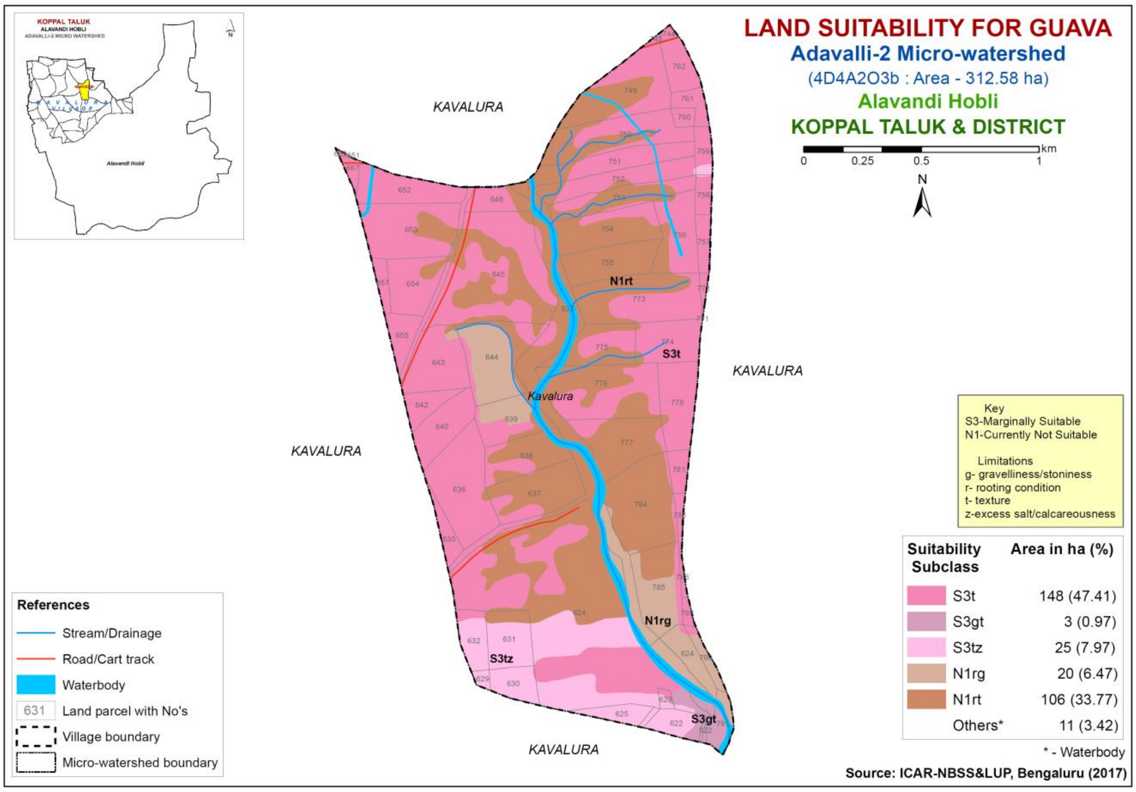


Fig. 7.13 Land Suitability map of Guava

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 176 ha (56%) and occur in all parts of the microwatershed. They have moderate limitations of gravelliness, texture and calcareousness and about 126 ha (40%) is not suitable (Class N1) for growing jackfruit and occur in the central and northern part of the microwatershed with severe limitations of gravelliness, rooting depth and texture.

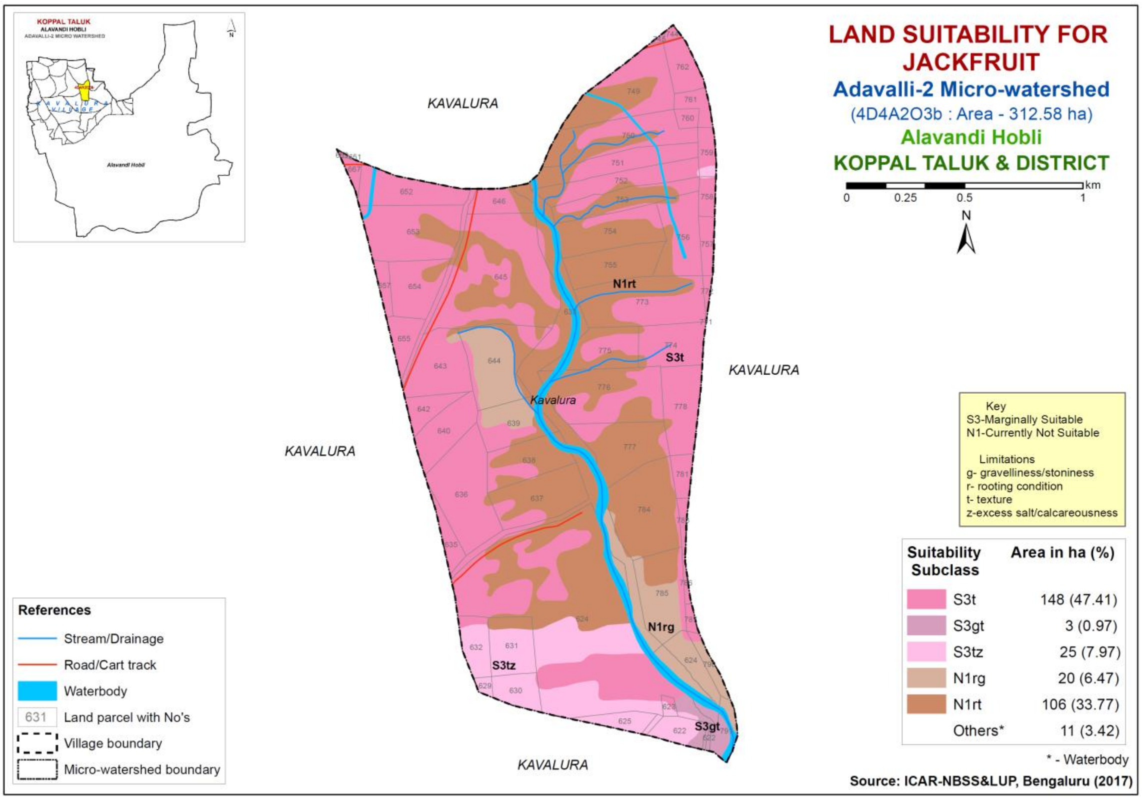


Fig. 7.14 Land Suitability map of Jackfruit

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 152 ha (48%) is moderately suitable (Class S2) and occur in the northwestern and eastern part of the microwatershed. They have minor limitations of gravelliness, rooting depth and texture. The marginally suitable (Class S3) lands cover a small area of about 25 ha (8%) and are distributed in the southern part of the microwatershed with moderate limitations of rooting depth and calcareousness. An area of about 126 ha (40%) is not suitable (Class N1) for growing jamun and are distributed in the central part of the microwatershed with severe limitations of gravelliness, rooting depth and texture.

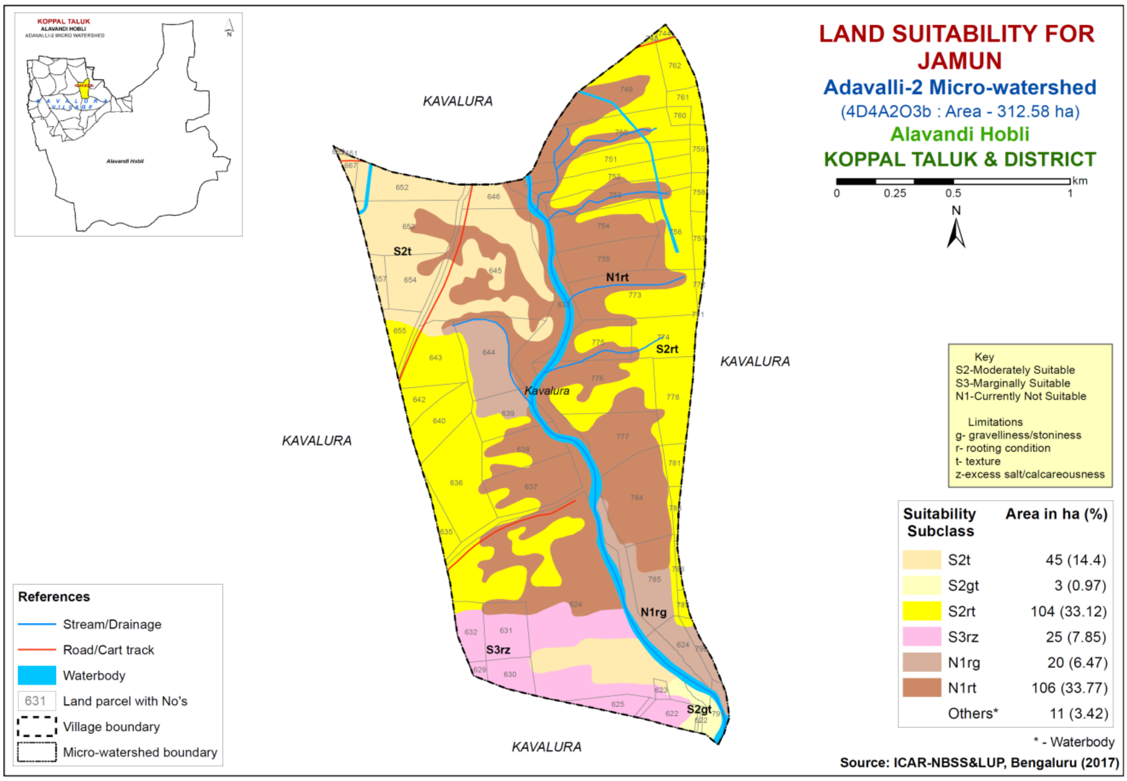


Fig. 7.15 Land Suitability map of Jamun

7.16 Land Suitability for Musambi (*Citrus limetta*)

Musambi is the most important fruit crop grown in an area of 5446 ha in almost all the districts of the state. The crop requirements for growing musambi were matched with the soil-site characteristics (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.

An area of about 148 ha (47%) is highly suitable (Class S1) for growing musambi and are distributed in all parts of the microwatershed. An area of about 28 ha (9%) is moderately suitable (Class S2) and occurs in the southern part of the microwatershed. They have minor limitations of gravelliness, rooting depth and calcareousness. An area of about 126 ha (40%) is not suitable (Class N1) for growing musambi with severe limitations of rooting depth, calcareousness and gravelliness and are distributed in the central part of the microwatershed.

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. Toimperfect ly 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	

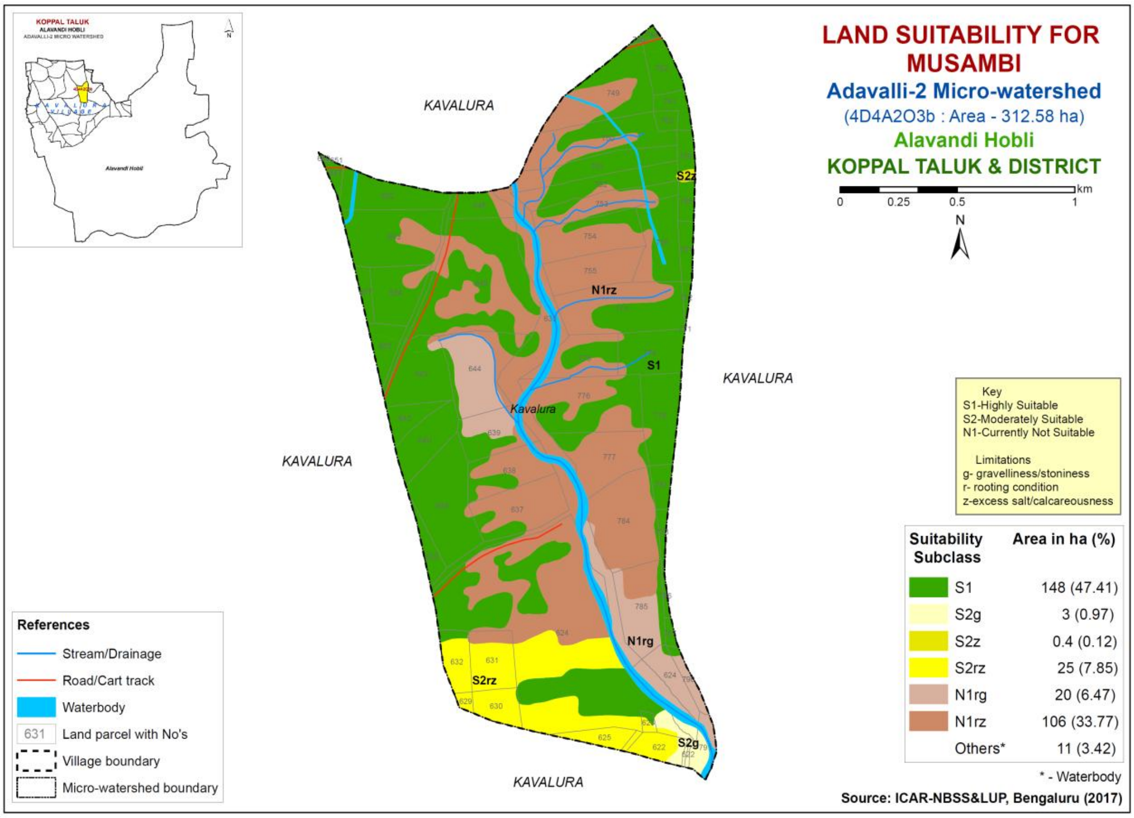


Fig. 7.16 Land Suitability map of Musambi

7.17 Land Suitability for Lime (*Citrus sp*)

Lime is one of the most important fruit crop grown in an area of 11752 ha in almost all the districts of the State. The crop requirements for growing lime (Table 7.15) were matched with the soil-site characteristics (Table 7.1) and a land suitability map for growing lime was generated. The area extent and their 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	^0C	28-30	31-35 24-27	36-40 20-23	>40 <20
Soil moisture	Growing period	Days	240-265	180-240	150-180	<150
Soil aeration	Soil drainage	Class	Well drained	Mod.toimperfectly 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	

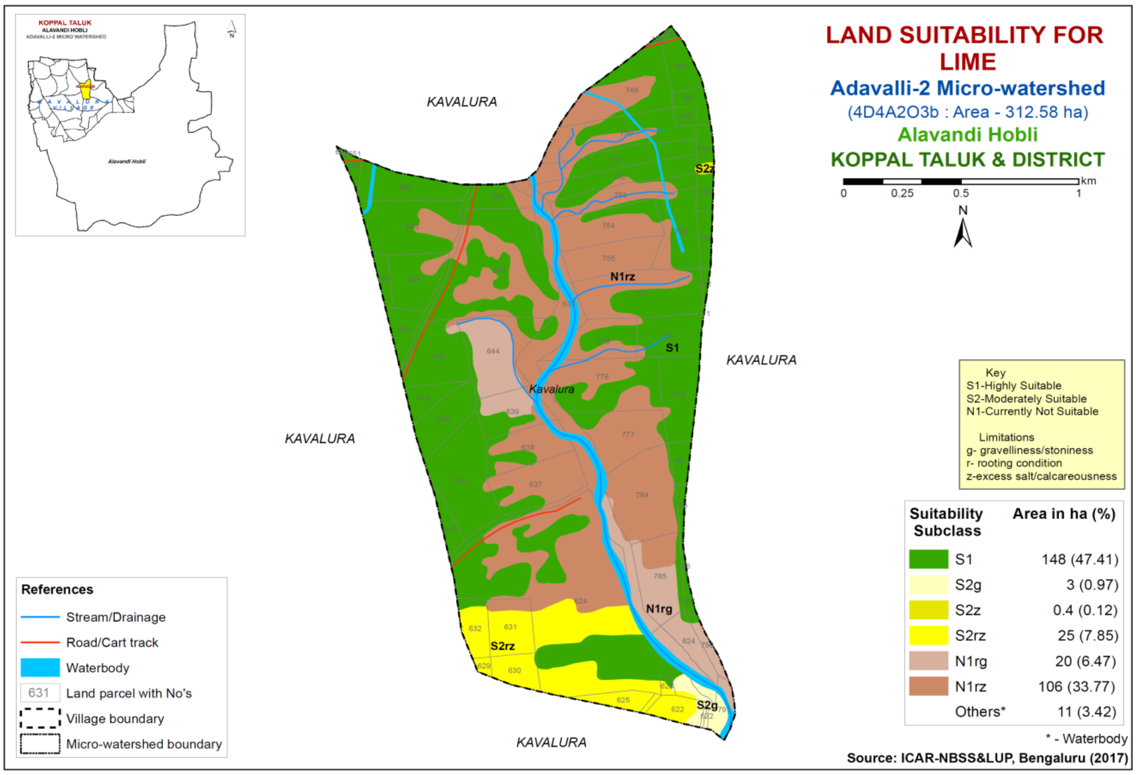


Fig. 7.17 Land Suitability map of Lime

An area of about 148 ha (47%) is highly suitable (Class S1) for growing lime and are distributed in all parts of the microwatershed. An area of about 28 ha (9%) is moderately suitable (Class S2) and occurs in the southern part of the microwatershed.

They have minor limitations of gravelliness, rooting depth and calcareousness. An area of about 126 ha (40%) is not suitable (Class N1) for growing lime with severe limitations of rooting depth, gravelliness and calcareousness and are distributed in the central part of the microwatershed.

7.18 Land Suitability for Cashew (*Anacardium occidentale)*

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

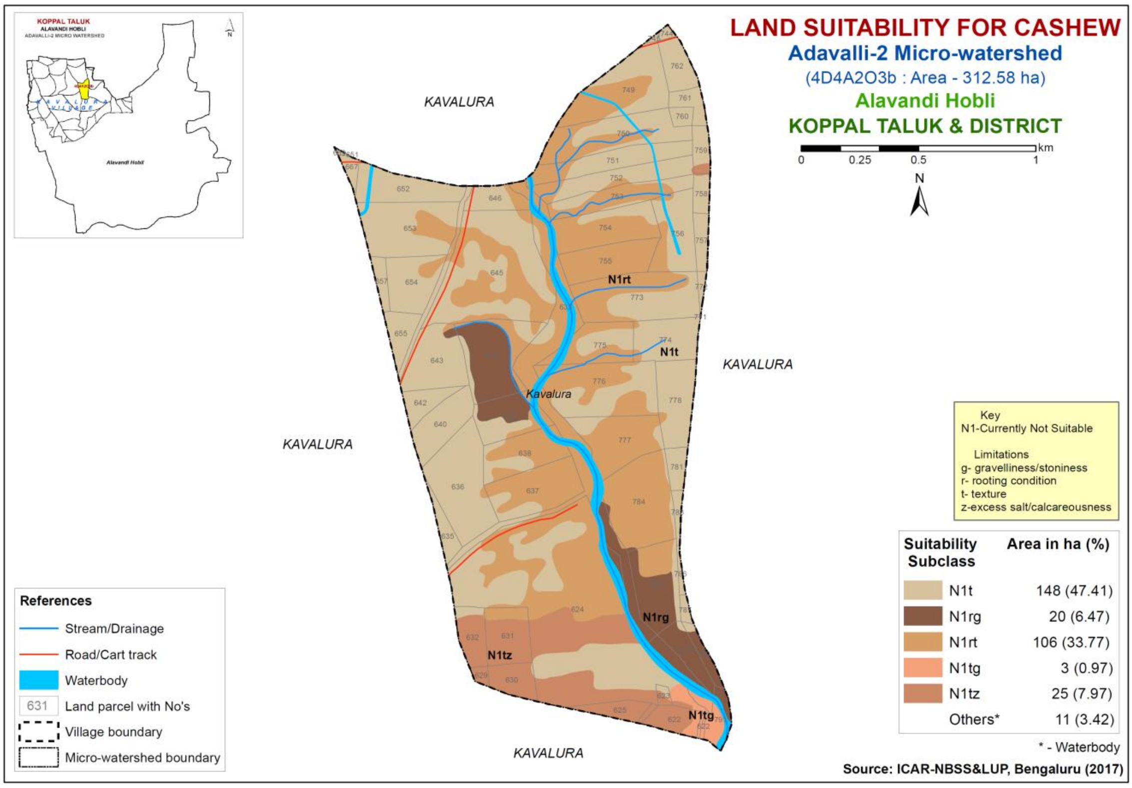


Fig. 7.18 Land Suitability map of Cashew

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.

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 151 ha (48%) is highly suitable (Class S1) for growing custard apple. They are distributed in all parts of the microwatershed, small area of about 25 ha (8%) is moderately suitable (Class S2) and occur in the southern part of the microwatershed. They have minor limitations of calcareousness. An area of about 106 ha (34%) is marginally suitable (Class S3) for growing custard apple and are distributed in the central part of the microwatershed with moderate limitations of calcareousness and an area of 20 ha (6%) is not suitable (Class N1) for growing custard apple with severe limitations of rooting depth and gravelliness and are distributed in the central and southern part of the microwatershed.

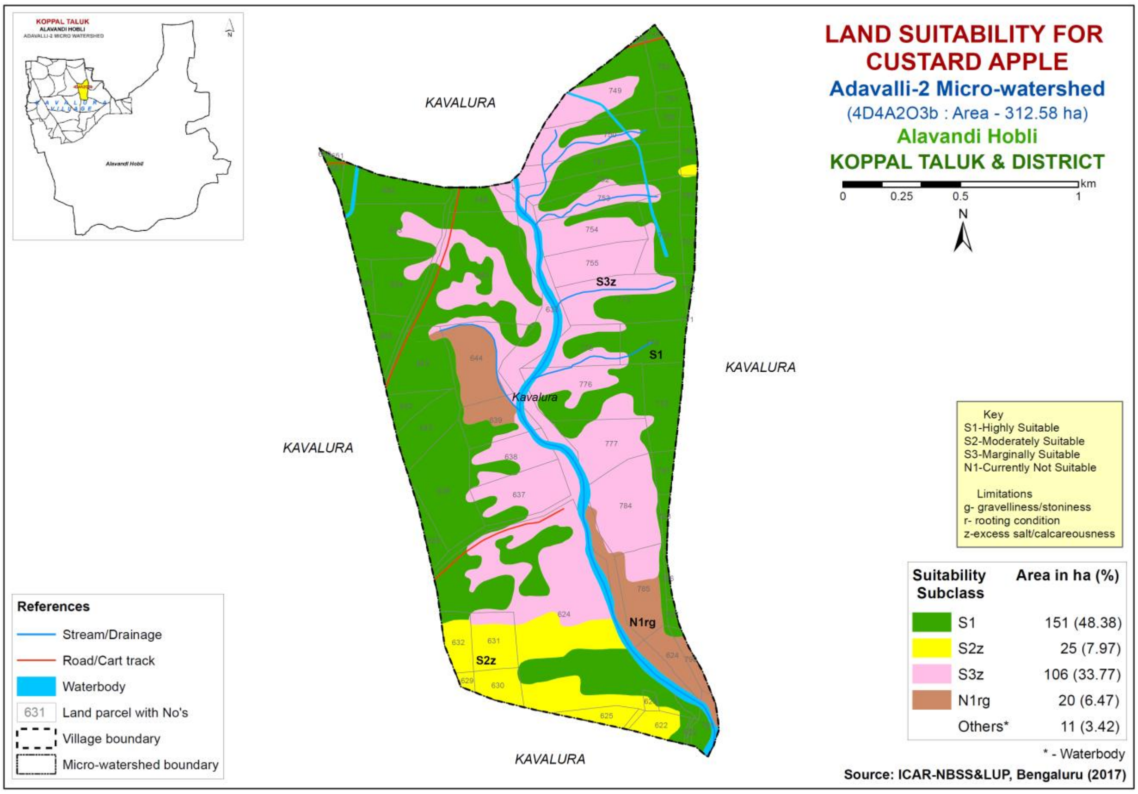


Fig. 7.19 Land Suitability map of Custard Apple

7.20 Land Suitability for Amla (*Phyllanthus emblica*)

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

Maximum area of about 176 ha (48%) has soils that are moderately suitable (Class S2) and are distributed in all parts of the microwatershed. They have minor limitations of gravelliness, texture and calcareousness. The marginally suitable (Class S3) lands cover an area of about 106 ha (34%) and occur in the central part of the microwatershed with moderate problems of calcareousness and texture. and an area of 20 ha (6%) is not suitable (Class N1) for growing custard apple with severe limitations of rooting depth and gravelliness and are distributed in the central and southern part of the microwatershed.

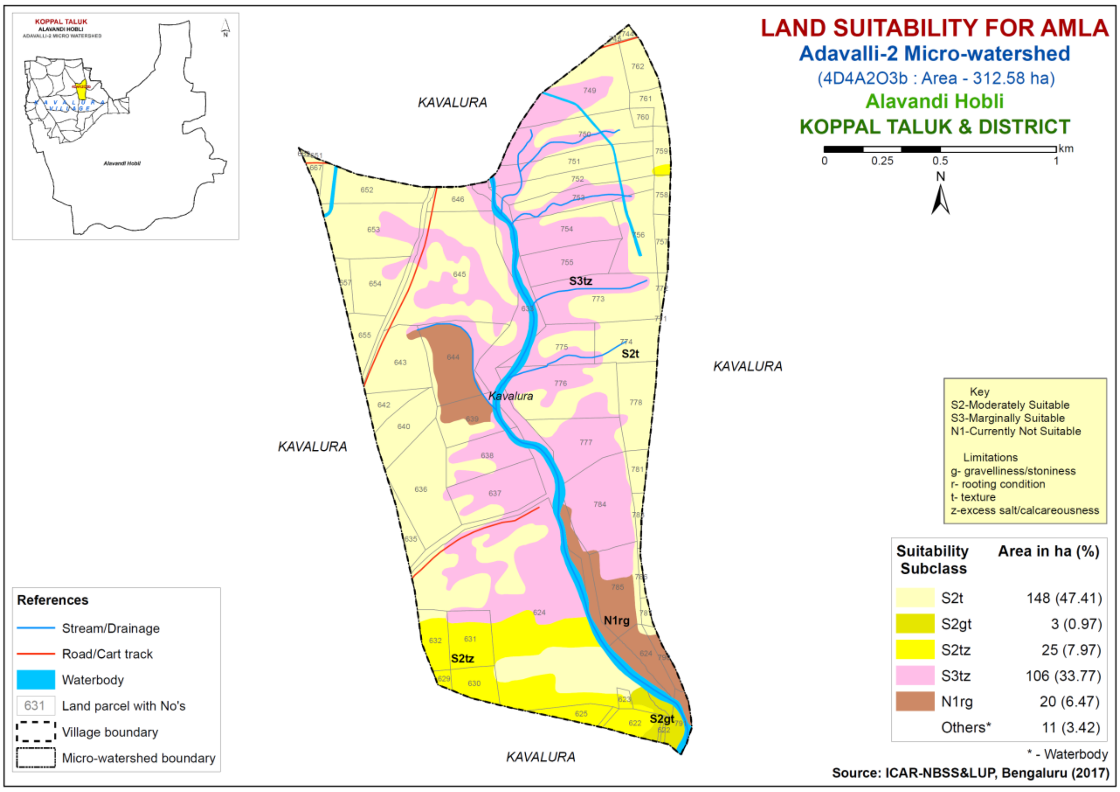


Fig. 7.20 Land Suitability map of Amla

7.21 Land Suitability for Tamarind (*Tamarindus indica*)

Tamarind is the most important spice crop grown in 14897 ha 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 151 ha (48%) is moderately suitable (Class S2) and occurs in all parts of the microwatershed. They have minor limitations of gravellines, texture, calcareousness and rooting depth. An area of about 25 ha (8%) is marginally suitable (Class S3) and occur in the southern part of the microwatershed. They have moderate limitations of rooting depth and calcareousness. An area of about 126 ha (40%) is not suitable (Class N1) for growing tamarind and are distributed in the central part of the microwatershed. They have severe limitations of rooting depth, gravelliness and calcareousness.

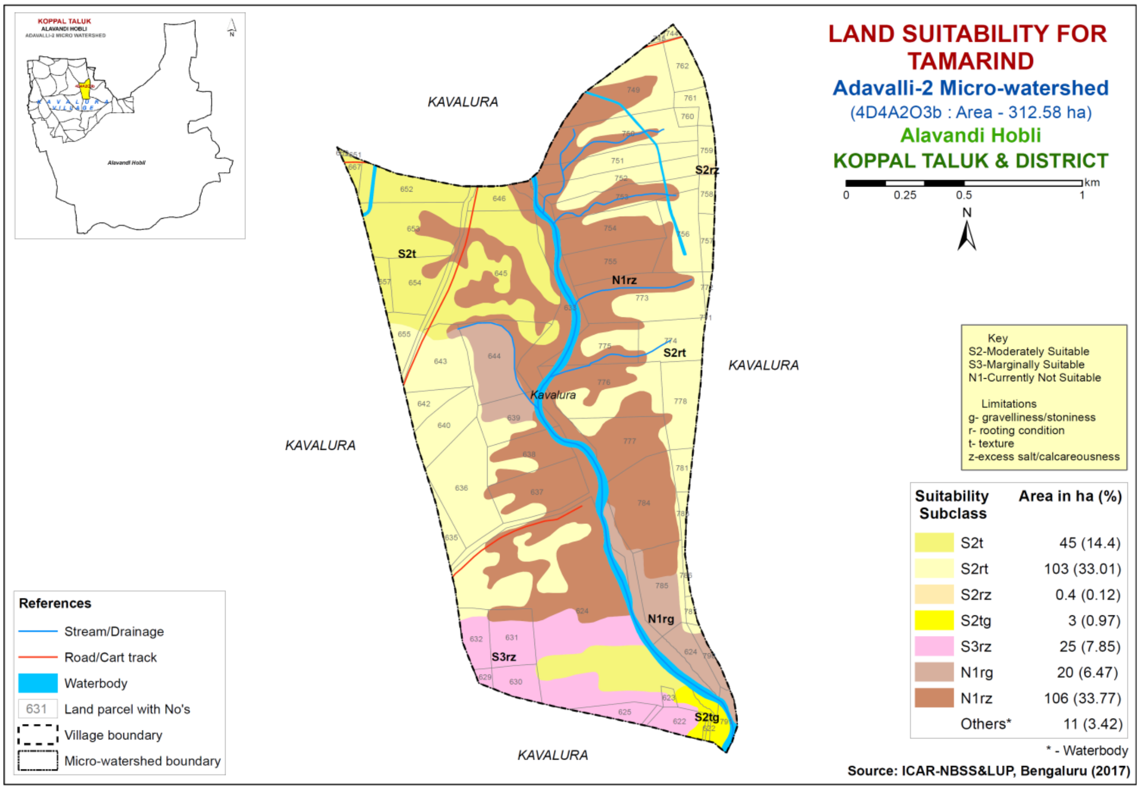


Fig. 7.21 Land Suitability map of Tamarind

7.22 Land Suitability for Marigold (*Tagetes erecta*)

Marigold is 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.

Maximum area of about 176 ha (56%) is moderately suitable (Class S2) for growing marigold and occur in all parts of the microwatershed. They have minor limitations of gravelliness, rooting depth, calcareousness and texture. An area of about 106 ha (34%) is marginally suitable (Class S3) for growing marigold with moderate limitations of rooting depth and calacreousness and are distributed in the northern and southern part of the microwatershed.

A small area of about 20 ha (6%) is not suitable (Class N1) for growing marigold and occur in the central and southern part of the microwatershed. They have severe limitations of gravelliness and rooting depth.

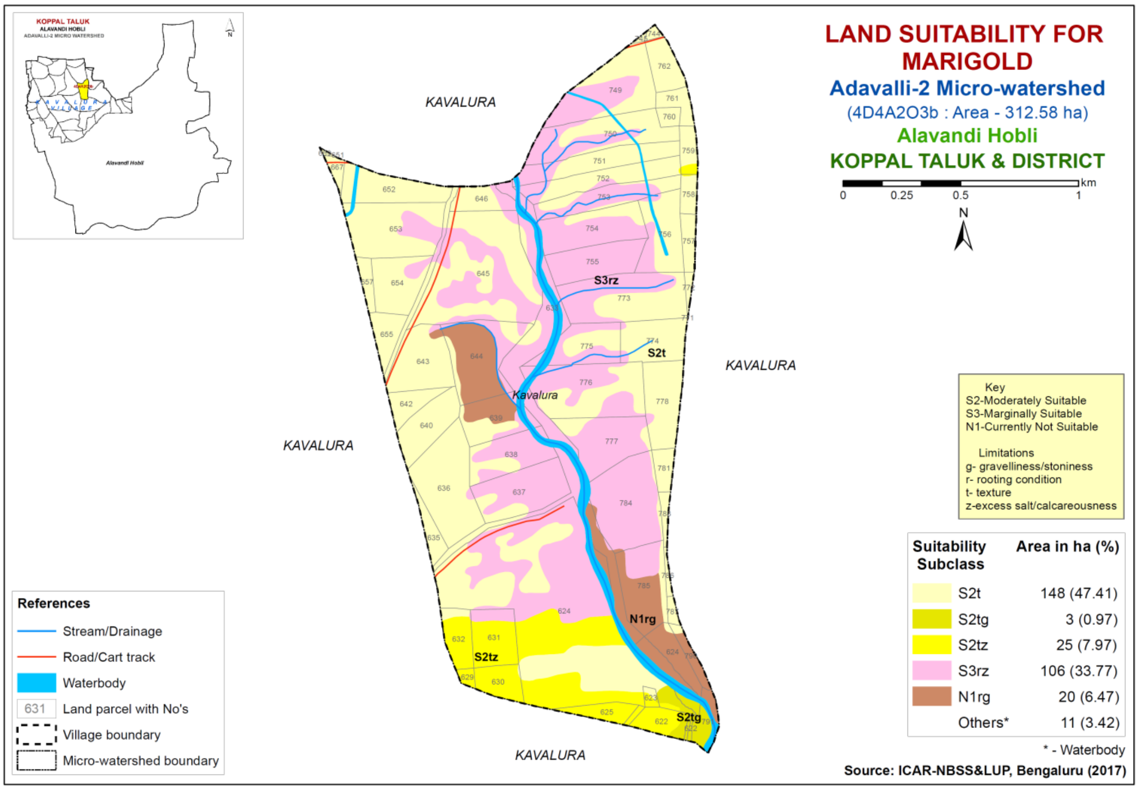


Fig. 7.22 Land Suitability map of Marigold

7.23 Land Suitability for Chrysanthemum (*Chrysanthemum indicum*)

Chrysanthemum is the most important flower crop grown in an area of 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.

Maximum area of about 176 ha (56%) is moderately suitable (Class S2) for growing chrysanthemum and occur in all parts of the microwatershed. They have minor limitations of gravelliness, rooting depth, calcareousness and texture. An area of about 106 ha (34%) is marginally suitable (Class S3) for growing chrysanthemum with moderate limitations of rooting depth and calacreousness and are distributed in the northern and southern part of the microwatershed.

A small area of about 20 ha (6%) is not suitable (Class N1) for growing chrysanthemum and occur in the central and southern part of the microwatershed. They have severe limitations of gravelliness and rooting depth.

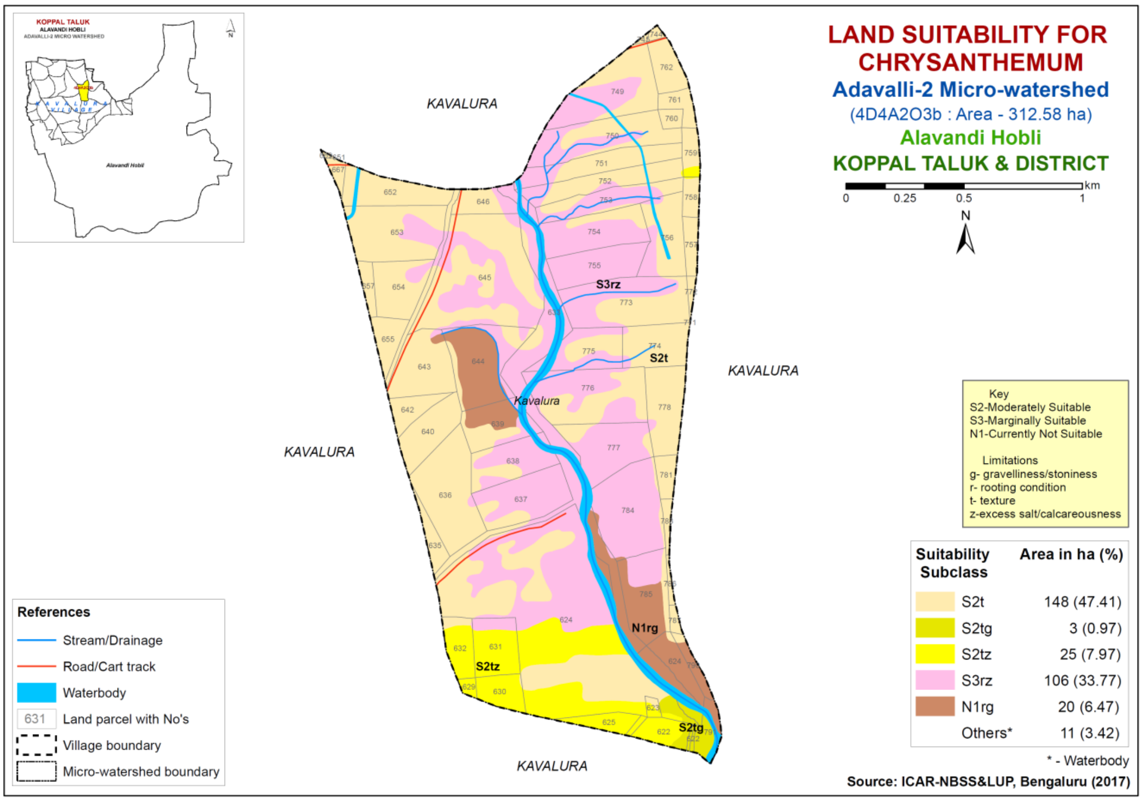


Fig. 7.23 Land Suitability map of Chrysanthemum

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

Jasmine is 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.

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	

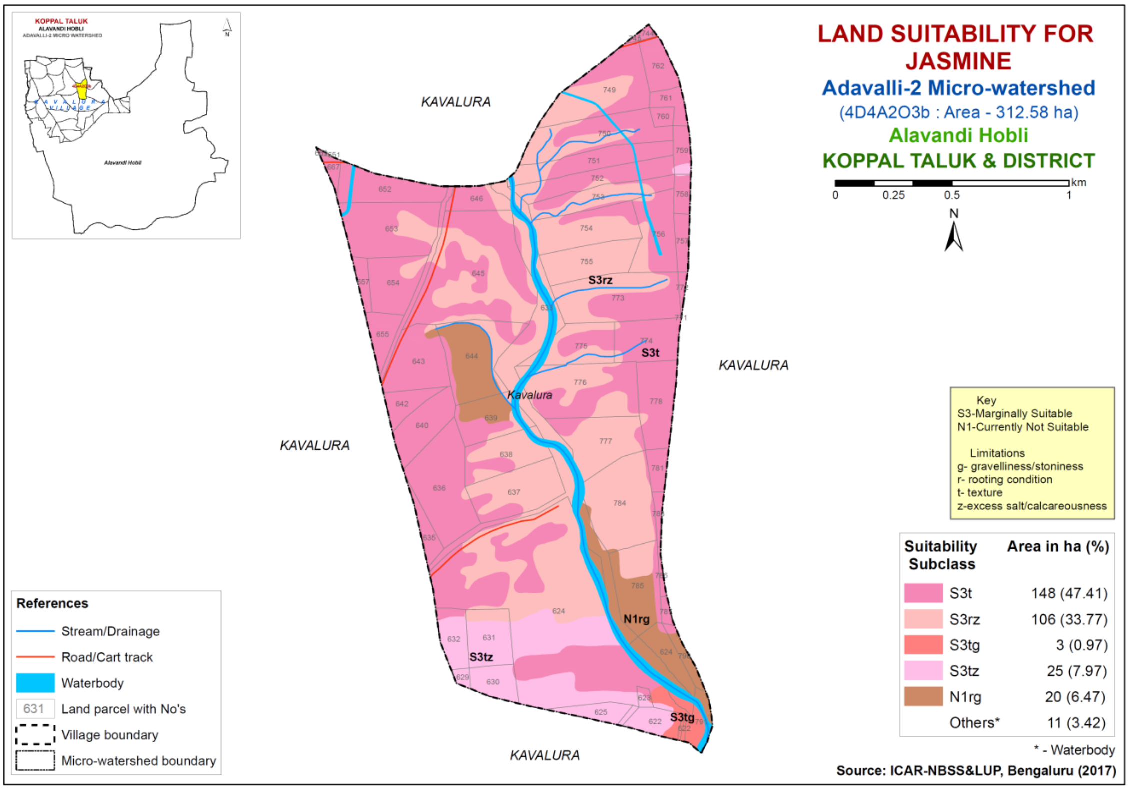


Fig. 7.24 Land Suitability map of Jasmine

An area of about 282 ha (90%) is marginally suitable (Class S3) for growing jasmine and occur in all parts of the microwatershed. They have moderate limitations of gravelliness, rooting depth, texture and calcareousness and about 20 ha (6%) area is not suitable (Class N1) for growing jasmine with severe limitations of rooting depth, and gravelliness and are distributed in the central and southern part of the microwatershed.

7.25 Land Use Classes (LUCs)

The 11 soil map units identified in Adavalli-2 microwatershed have been grouped into 4 Land Use Classes (LUCs) for the purpose of preparing a Proposed Crop Plan. Land Use Classes are grouped based on the similarities in respect of the type of soil, the depth of the soil, the surface soil texture, gravel content, AWC, slope, erosion etc. and a Land Use Class map (Fig.7.25) has been generated. These Land Use Classes are expected to behave similarly for a given level of management.

The map units that have been grouped into four Land Use Classes along with brief description of soil and site characteristics are given below.

LUCs	Mapping unit	Soil and site characteristics
1	HDLmB2 ,KDTmB2 KDTmB2g1, KDTmB2g2	Deep to very deep, black clayey soils with slopes of 1-3%, gravelly to very gravelly (15-60%), moderate erosion
2	DRLmB2, GRHmB2g1	Moderately deep to deep, calcareous black clayey soils with slopes of 1-3%, moderate erosion, gravelly (15-35%),
3	MTLmB2 , MTLmB2g1	Shallow, calcareous black gravelly clay soils with slopes of 1-3%, moderate erosion, gravelly (15-35%)
4	BGTmB2g2	Very shallow, calcareous black gravelly clay soils with slopes of 1-3%, moderate erosion, very gravelly (35-60%)

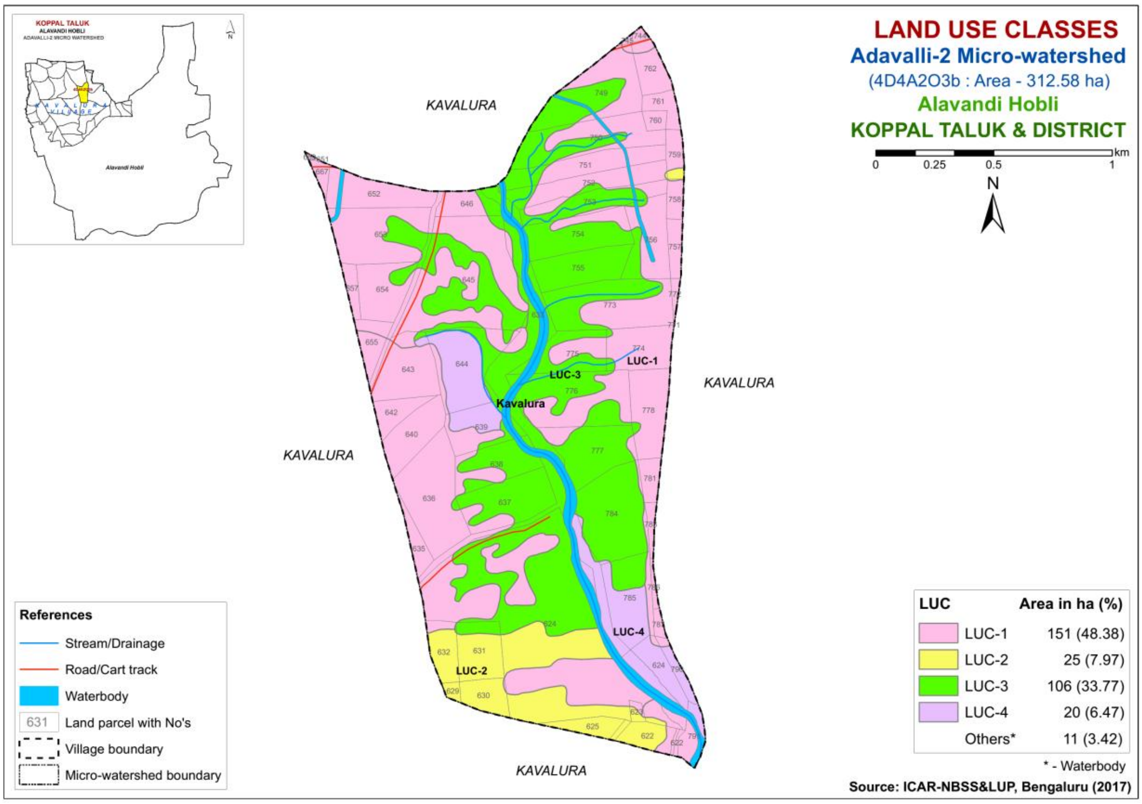


Fig 7.25 Land Use Classes map of Adavalli-2 microwatershed

7.26 Proposed Crop Plan for Adavalli-2 Microwatershed

After assessing the land suitability for the 24 crops, the proposed crop plan has been prepared for the 4 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 Adavalli-2 Microwatershed

Proposed Land Use Class	Soil Map Units	Survey Number	Field Crops	Horticulture Crops	Suitable Interventions
1	382. HDLmB2 405. KDTmB2 406. KDTmB2g1 407. KDTmB2g2 (Deep to very deep, black clayey soils)	**Kavalura:** 635,636,640,642,643,645,646, 651,652,653,654,655,657,667, 669,744,745,749,750,751,752, 756,757,758,759,760,761,762, 771,772,774,778,781,783,786, 787,791	Sorghum, Sunflower, Cotton, Bengal gram, Safflower, Linseed, Bajra	**Fruit crops:** Amla,Custard apple,Jamun,Lime,Musambi, Tamarind, Pomegranate **Vegetables:** Drumstick, Chilli, Coriander **Flowers:** Marigold,Chrysanthemum	Application of FYM, Biofertilizers and micronutrients, drip irrigation, Mulching, suitable conservation practises
2	350. DRLmB2 374. GRHmB2g1 (Moderately deep to deep,calcareous black clayey soils)	**Kavalura:** 622,623,625,629,630,631,632	Bengalgram, Sorghum, Sunflower , Bajra, Safflower, Linseed, Coriander	**Fruit crops:** Amla, Custard apple, Lime, Pomegranate **Vegetables:** Drumstick **Flowers:** Marigold, Chrysanthemun, Jasmine	Application of FYM, Biofertilizers and micronutrients, drip irrigation, Mulching, suitable conservation practises
3	310. MTLmB2 311. MTLmB2g1 (Shallow, calcareous black gravelly claysoils)	**Kavalura:** 624,633,637,638,753,754,755, 773,775,776,777,784	Bengal gram, Horsegram	**Agri-Silvi-Pasture:** Hybrid Napier, *Styloxanthes hamata*, Glyricidia, *Styloxanthes scabra*	Use of medium duration varieties, and deep rooted crops, sowing across the slope, drip irrigation and mulching is recommended
4	11. BGTmB2g2 (Very shallow, calcareous black gravelly claysoils)	**Kavalura:** 639,644,785,790	-	**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 unfavorable conditions occur

Characteristics of Adavalli-2 Microwatershed

- The soil phases with sizeable area identified in the microwatershed belonged to the soil series of MTL (106 ha), HDL (103 ha) and KDT (48 ha) and other soil phases occur in small areas.
- As per land capability classification, entire area in the microwatershed falls under arable land category (Class III and IV). The major limitations identified in the arable lands were soil and erosion.
- On the basis of soil reaction, An area of about 190 ha (61%) under strongly alkaline (pH 8.4-9.0) and 112 ha (36%) (pH >9.0) very strongly 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 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 Adavalli-2 Microwatershed.
- ❖ **Organic Carbon:** The OC content is medium (0.5-0.75%) in an area of about 109 ha (35%), low (<0.5%) in 137 ha (44%) and high (>0.5%) in about 56 ha (18%). 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

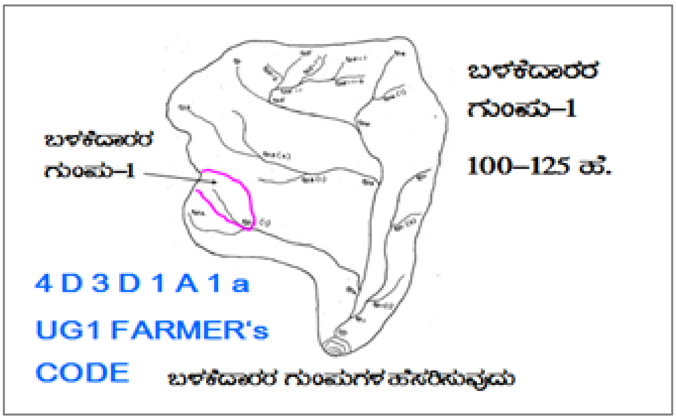
fertilizer needs to be supplemented by 25% in addition to the recommended level in 44 ha area where OC is less than 0.5% and 109 ha area medium (0.5-0.75%). For example, for rainfed maize, recommended level is 50 kg N per ha and an additional 12 kg /ha needs to be applied for all the crops grown in these plots.

- **Available Phosphorus**: Entire area is low in available phosphorus. Hence for all the crops, 25% additional P-needs to be applied.
- **Available Potassium:** Available potassium is high (>337 kg/ha) in the entire area of the microwatershed.
- **Available Sulphur:** Available sulphur is a very critical nutrient for oilseed crops. Available sulphur is low (<10 ppm) in 239 ha (76%) area and medium in an area of about 0.3 ha (0.08%) in the microwatershed. These areas need to be applied with magnesium sulphate or gypsum or Factamphos (p) fertitilizer (13% sulphur) for 2-3 years for the deficiency to be corrected. It is high in 63 ha (20%) area of the microwatershed**.**
- **Available Boron:** It is low in major area of 245 ha (78%) in the microwatershed, medium in an area of 57 ha (18%).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 Iron:** It is sufficient in the entire area of the microwatershed.
- **Available Zinc:** It is deficient (<0.6 ppm) in entire area of the microwatershed. Application of zinc sulphate @ 25kg/ha is to be followed in areas that are deficient in available zinc
- **Soil alkalinity:** The entire area in the microwatershed has soils that are strongly 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, Acasia, Neem, Ber etc, are recommended.

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

SOIL AND WATER CONSERVATION TREATMENT PLAN

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



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

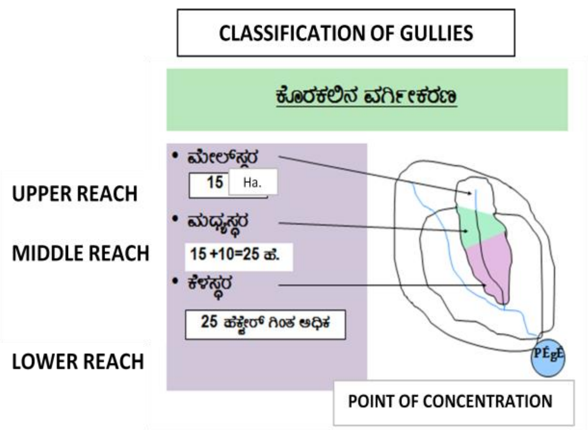
The treatment plan recommended for arable lands is briefly described below.

9.1.1 Arable Land Treatment

A. BUNDING

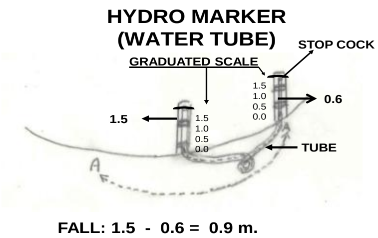
Steps for Survey and Preparation of Treatment Plan	
Cadastral map (1:7920 scale) is enlarged to a scale of 1:2500 scale Existing network of waterways, pothissa boundaries, grass belts, natural drainage lines/ watercourse, cut ups/ terraces are marked on the cadastral map to the scale Drainage lines are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

USER GROUP-1



Measurement of Land Slope

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



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

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

Note: i) The above intervals are maximum.

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

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

Section of the Bund

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

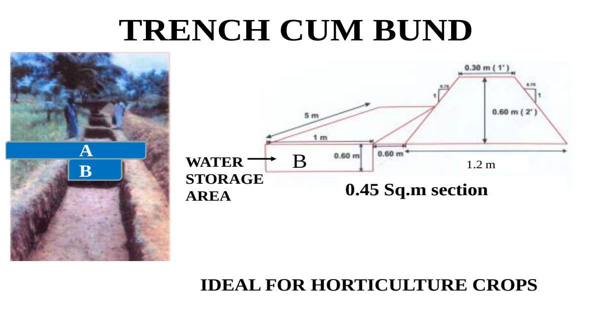
Recommended Bund Section

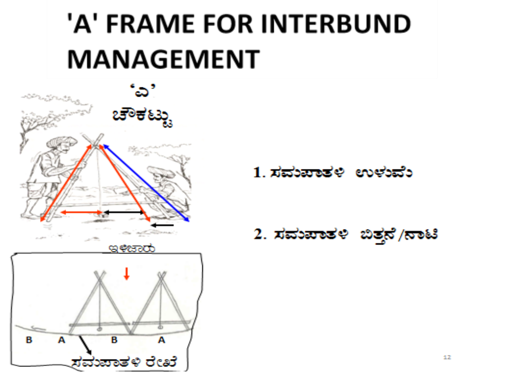
Top width(m)	Base width(m)	Height (m)	Side slope (Z:1;H:V)	Cross section (sq m)	Soil Texture	Remarks
0.3	0.9	0.3	01:01	0.18	Sandy loam	Vegetative bund
0.3	1.2	0.3	1.5:1	0.225	Sandy clay	
0.3	1.2	0.5	0.9:1	0.375	Red gravelly soils	
0.3	1.2	0.6	0.75:1	0.45		
0.3	1.5	0.6	01:01	0.54	Red sandy loam	
0.3	2.1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

Formation of Trench cum Bund

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

Details of Borrow Pit dimensions are given below





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

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

B. 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.

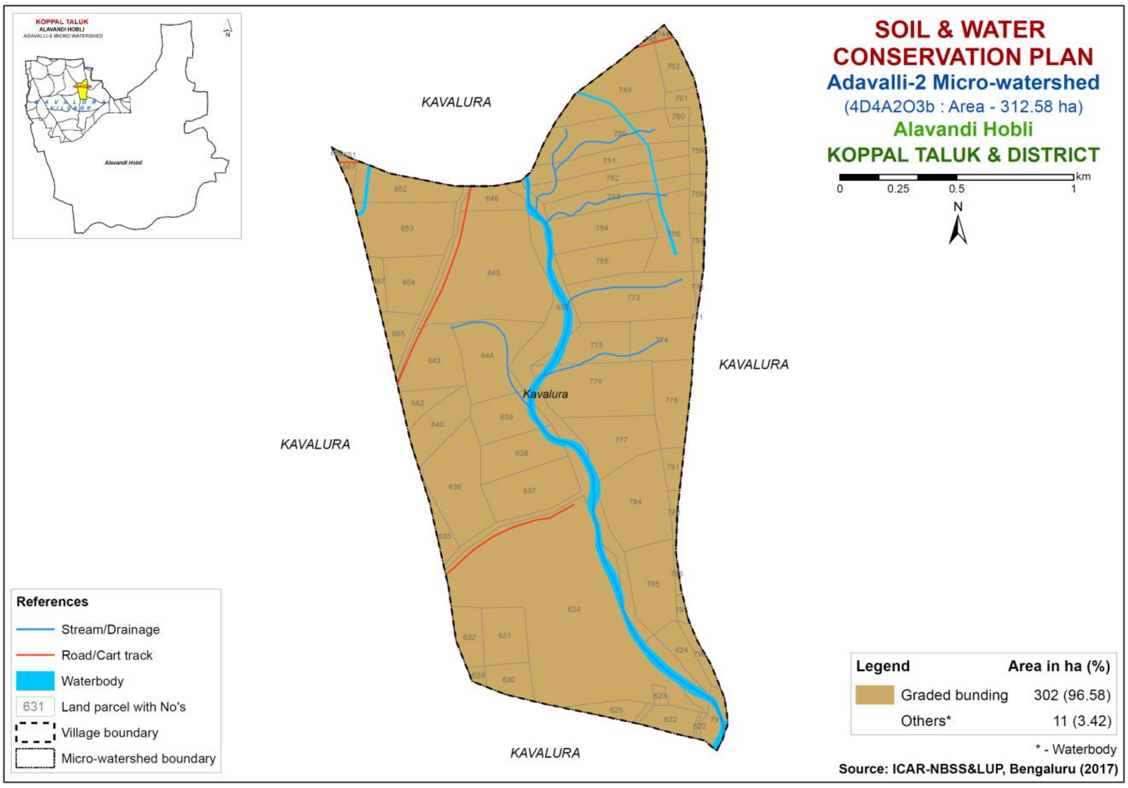


Fig. 9.1 Soil and Water Conservation Plan map of Adavalli-2 Microwatershed

9.3 Greening of Microwatershed

As part of the greening programme in the watersheds, it is envisaged to plant a variety of horticultural and other tree plants that are edible, economical and produce lot of biomass which helps to restore the ecological balance in the watersheds. The lands that are suitable for greening programme are non-arable lands (land capability classes V, VI 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 dug out soil on the lower side of the slope in order to harness the flowing water and facilitate weathering of soil in the pit. Exposure of soil in the pit also prevents spread of pests and diseases due to scorching sun rays. The pits should be filled with mixture of soil and organic manure during the second week of April and keep ready with sufficiently tall seedlings produced either in poly bags or in root trainer nurseries so that planting can be done during the 2nd or 3rd week of April depending on the rainfall.

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

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

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Appendix I

Adavalli-2 Microwatershed

Soil Phase Information

Village	Survey No.	Total Area (ha)	Soil Phase	Parent Material	Land Use Classes	Soil Depth	Surface Soil Texture	Soil Gravelliness	Available Water Capacity	Slope	Soil Erosion	Current Land Use	WELLS	Land Capability	Conservation Plan
Kavalura	622	2.55	DRLmB2	SALS	LUC-2	Moderately deep (75-100 cm)	Clay	Non gravelly (<15%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Moderate	Bengalgram+Sunflower (Bg+Sf)	Not Available	IIIe	Graded bunding
Kavalura	623	0.48	DRLmB2	SALS	LUC-2	Moderately deep (75-100 cm)	Clay	Non gravelly (<15%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Moderate	Not Available (NA)	Not Available	IIIe	Graded bunding
Kavalura	624	50.1	MTLmB2g1	SALS	LUC-3	Shallow (25-50 cm)	Clay	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Sunflower+Current fallow+Fallow land (Sf+Cf+Fl)	Not Available	IIIes	Graded bunding
Kavalura	625	1.86	DRLmB2	SALS	LUC-2	Moderately deep (75-100 cm)	Clay	Non gravelly (<15%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Moderate	Bajra+Sunflower (Bj+Sf)	Not Available	IIIe	Graded bunding
Kavalura	629	0.5	DRLmB2	SALS	LUC-2	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	630	2.63	DRLmB2	SALS	LUC-2	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	631	4.62	DRLmB2	SALS	LUC-2	Moderately deep (75-100 cm)	Clay	Non gravelly (<15%)	Medium (101-150 mm/m)	Very gently sloping (1-3%)	Moderate	Bengalgram (Bg)	Not Available	IIIe	Graded bunding
Kavalura	632	2.9	DRLmB2	SALS	LUC-2	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	16.26	MTLmB2g1	SALS	LUC-3	Shallow (25-50 cm)	Clay	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Waterbody	Not Available	IIIes	Graded bunding
Kavalura	635	1.6	HDLmB2	SALS	LUC-1	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	9.74	HDLmB2	SALS	LUC-1	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Jowar+Sunflower (Jw+Sf)	1 Borewell	IIIe	Graded bunding
Kavalura	637	7.15	MTLmB2g1	SALS	LUC-3	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	638	5.59	MTLmB2g1	SALS	LUC-3	Shallow (25-50 cm)	Clay	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Fallowland+Current fallow (Fl+Cf)	Not Available	IIIes	Graded bunding
Kavalura	639	5.08	BGTmB2g2	SGGGLS	LUC-4	Very shallow (<25 cm)	Clay	Very gravelly (35-60%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Fallowland+ Jowar (Fl+Jw)	Not Available	IVes	Graded bunding
Kavalura	640	4.54	HDLmB2	SALS	LUC-1	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	642	2.12	HDLmB2	SALS	LUC-1	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	643	6.37	HDLmB2	SALS	LUC-1	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	644	8.82	BGTmB2g2	SGGGLS	LUC-4	Very shallow (<25 cm)	Clay	Very gravelly (35-60%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Fallow land+Jowar (Fl+Jw)	Not Available	IVes	Graded bunding
Kavalura	645	20.01	KDTmB2g1	SALS	LUC-1	Very deep (>150 cm)	Clay	Gravelly (15-35%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Jowar (Jw)	1 Farm pond	IIIes	Graded bunding

Village	Survey No.	Total Area (ha)	Soil Phase	Parent Material	Land Use Classes	Soil Depth	Surface Soil Texture	Soil Gravelliness	Available Water Capacity	Slope	Soil Erosion	Current Land Use	WELLS	Land Capability	Conservation Plan
Kavalura	646	2.54	KDTmB2g1	SALS	LUC-1	Very deep (>150 cm)	Clay	Gravelly (15-35%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Current fallow (Cf)	1 Farm pond	IIIes	Graded bunding
Kavalura	651	0.01	KDTmB2g1	SALS	LUC-1	Very deep (>150 cm)	Clay	Gravelly (15-35%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Current fallow (Cf)	Not Available	IIIes	Graded bunding
Kavalura	652	5.28	KDTmB2g1	SALS	LUC-1	Very deep (>150 cm)	Clay	Gravelly (15-35%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Current fallow (Cf)	Not Available	IIIes	Graded bunding
Kavalura	653	9.19	KDTmB2g1	SALS	LUC-1	Very deep (>150 cm)	Clay	Gravelly (15-35%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Current fallow (Cf)	Not Available	IIIes	Graded bunding
Kavalura	654	5.01	KDTmB2g1	SALS	LUC-1	Very deep (>150 cm)	Clay	Gravelly (15-35%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Current fallow (Cf)	Not Available	IIIes	Graded bunding
Kavalura	655	2.28	HDLmB2	SALS	LUC-1	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	657	1.13	KDTmB2g1	SALS	LUC-1	Very deep (>150 cm)	Clay	Gravelly (15-35%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Sunflower (Sf)	Not Available	IIIes	Graded bunding
Kavalura	667	0.74	KDTmB2g1	SALS	LUC-1	Very deep (>150 cm)	Clay	Gravelly (15-35%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Current fallow (Cf)	Not Available	IIIes	Graded bunding
Kavalura	669	0.07	KDTmB2g1	SALS	LUC-1	Very deep (>150 cm)	Clay	Gravelly (15-35%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Current fallow (Cf)	Not Available	IIIes	Graded bunding
Kavalura	744	0.3	HDLmB2	SALS	LUC-1	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	745	0.13	HDLmB2	SALS	LUC-1	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	749	9.16	HDLmB2	SALS	LUC-1	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	750	8.35	HDLmB2	SALS	LUC-1	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	751	5.55	HDLmB2	SALS	LUC-1	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	752	5.38	HDLmB2	SALS	LUC-1	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Bengalgram+Jowar (Bg+Jw)	Not Available	IIIe	Graded bunding
Kavalura	753	5.06	MTLmB2g1	SALS	LUC-3	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	754	6.75	MTLmB2g1	SALS	LUC-3	Shallow (25-50 cm)	Clay	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Fallow land (Fl)	Not Available	IIIes	Graded bunding
Kavalura	755	5.47	MTLmB2g1	SALS	LUC-3	Shallow (25-50 cm)	Clay	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Fallow land (Fl)	Not Available	IIIes	Graded bunding
Kavalura	756	5.75	HDLmB2	SALS	LUC-1	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	757	1.41	HDLmB2	SALS	LUC-1	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	758	1.19	HDLmB2	SALS	LUC-1	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	759	1.49	HDLmB2	SALS	LUC-1	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

Village	Survey No.	Total Area (ha)	Soil Phase	Parent Material	Land Use Classes	Soil Depth	Surface Soil Texture	Soil Gravelliness	Available Water Capacity	Slope	Soil Erosion	Current Land Use	WELLS	Land Capability	Conservation Plan
Kavalura	760	0.77	HDLmB2	SALS	LUC-1	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	761	1.55	HDLmB2	SALS	LUC-1	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	762	2.66	HDLmB2	SALS	LUC-1	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	771	0	HDLmB2	SALS	LUC-1	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	772	0.42	HDLmB2	SALS	LUC-1	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	773	10.36	MTLmB2g1	SALS	LUC-3	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	774	4.95	HDLmB2	SALS	LUC-1	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	775	5.34	MTLmB2g1	SALS	LUC-3	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	776	11.06	MTLmB2g1	SALS	LUC-3	Shallow (25-50 cm)	Clay	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Current fallow+ Sunflower (Cf+Sf)	Not Available	IIIes	Graded bunding
Kavalura	777	7.1	MTLmB2g1	SALS	LUC-3	Shallow (25-50 cm)	Clay	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Sunflower+Jowar (Sf+Jw)	Not Available	IIIes	Graded bunding
Kavalura	778	5.51	HDLmB2	SALS	LUC-1	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Sunflower (Sf)	1 Farm pond	IIIe	Graded bunding
Kavalura	781	1.42	HDLmB2	SALS	LUC-1	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Sunflower+Bengalgram (Sf+Bg)	Not Available	IIIe	Graded bunding
Kavalura	783	0.68	HDLmB2	SALS	LUC-1	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Jowar (Jw)	Not Available	IIIe	Graded bunding
Kavalura	784	10.05	MTLmB2g1	SALS	LUC-3	Shallow (25-50 cm)	Clay	Gravelly (15-35%)	Low (51-100 mm/m)	Very gently sloping (1-3%)	Moderate	Sunflower+Jowar (Sf+Jw)	Not Available	IIIes	Graded bunding
Kavalura	785	6.74	BGTmB2g2	SGGGLS	LUC-4	Very shallow (<25 cm)	Clay	Very gravelly (35-60%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Fallow land+ Jowar (Fl+Jw)	Not Available	IVes	Graded bunding
Kavalura	786	0.38	HDLmB2	SALS	LUC-1	Deep (100-150 cm)	Clay	Non gravelly (<15%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Jowar (Jw)	Not Available	IIIe	Graded bunding
Kavalura	787	0.47	HDLmB2	SALS	LUC-1	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	790	1.2	BGTmB2g2	SGGGLS	LUC-4	Very shallow (<25 cm)	Clay	Very gravelly (35-60%)	Very Low (<50 mm/m)	Very gently sloping (1-3%)	Moderate	Fallow land (Fl)	Not Available	IVes	Graded bunding
Kavalura	791	2.1	KDTmB2g2	SALS	LUC-1	Very deep (>150 cm)	Clay	Very gravelly (35-60%)	Very high (>200 mm/m)	Very gently sloping (1-3%)	Moderate	Fallow land (Fl)	Not Available	IIIes	Graded bunding

NOTE *: SGGGLS-Soils of Granite and Granite Gnesis Landscape
SALS- Soils of Alluvial Landscape, AWC- Available Water Capacity , CLU- Current Land Use
LUC- Land Use Class , LCC- Land Capability Clas

Appendix II

Adavalli-2 Microwatershed

Soil Fertility Information

Village	Survey No.	Soil Reaction	Salinity (EC)	Organic Carbon	Available Phosphorus	Available Potassium	Available Sulphur	Available Boron	Available Iron	Available Manganese	Available Copper	Available Zinc
Kavalura	622	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	623	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5. - 0.75%	Low (< 23 kg/ha)	High (> 337 kg/ha)	High (> 20ppm)	Medium (0.5 - 1.0 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)	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	625	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	629	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	630	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	631	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)	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	633	Very strongly alkaline (pH > 9.0)	Non saline (<2 dsm)	Low (< 0.5%)	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	635	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	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	637	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	638	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	639	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	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	642	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	643	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	644	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	645	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	646	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)

Village	Survey No.	Soil Reaction	Salinity (EC)	Organic Carbon	Available Phosphorus	Available Potassium	Available Sulphur	Available Boron	Available Iron	Available Manganese	Available Copper	Available Zinc
Kavalura	651	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	652	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	653	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	654	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	655	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	657	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)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	667	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)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	669	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	744	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	745	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	749	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	750	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5. - 0.75%	Low (< 23 kg/ha)	High (> 337 kg/ha)	High (> 20ppm)	Medium (0.5 - 1.0 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	751	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5. - 0.75%	Low (< 23 kg/ha)	High (> 337 kg/ha)	High (> 20ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	752	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)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	753	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)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	754	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)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	755	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)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	756	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)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	757	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)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	758	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)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	759	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)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	760	Very strongly alkaline (pH > 9.0)	Non saline (<2 dsm)	Low (< 0.5%)	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)

Village	Survey No.	Soil Reaction	Salinity (EC)	Organic Carbon	Available Phosphorus	Available Potassium	Available Sulphur	Available Boron	Available Iron	Available Manganese	Available Copper	Available Zinc
Kavalura	761	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5. - 0.75%	Low (< 23 kg/ha)	High (> 337 kg/ha)	High (> 20ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	762	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5. - 0.75%	Low (< 23 kg/ha)	High (> 337 kg/ha)	High (> 20ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	771	Strongly alkaline (pH 8.4 – 9.0)	Non saline (<2 dsm)	Medium (0.5. - 0.75%	Low (< 23 kg/ha)	High (> 337 kg/ha)	High (> 20ppm)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	772	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)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	773	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)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	774	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	775	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)	Low (< 0.5 ppm)	Sufficient (> 4.5 ppm)	Sufficient (> 1.0 ppm)	Sufficient (> 0.2 ppm)	Deficient (< 0.6 ppm)
Kavalura	776	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	777	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	778	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	781	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	783	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	784	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	785	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	786	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	787	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	790	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	791	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)

Note: EC- Electrical Conductivity

Appendix III

Adavalli-2 Microwatershed

Soil Suitability Information

Village	Survey No.	Mango	Maize	Sapota	Sorg -hum	Guava	Tama rind	Lime	Sun flower	Amla	Jack fruit	Custard-apple	Cash ew	Jamun	Musam bi	Ground nut	Chilly	Tomato	Mari-gold	Chrysan themum	Pome granate	Bajra	Jasmine	Mul-berry
Kavalura	622	S3rz	S3tz	S3tz	S2nz	S3tz	S3rz	S2rz	S2rz	S2tz	S3tz	S2z	N1tz	S3rz	S2rz	S3tz	S3tz	S3tz	S2tz	S2tz	S2rt	S3tz	S3tz	S2tz
Kavalura	623	S3rz	S3tz	S3tz	S2nz	S3tz	S3rz	S2rz	S2rz	S2tz	S3tz	S2z	N1tz	S3rz	S2rz	S3tz	S3tz	S3tz	S2tz	S2tz	S2rt	S3tz	S3tz	S2tz
Kavalura	624	N1rt	S3tz	N1rz	S3rz	N1rt	N1rz	N1rz	N1rz	S3tz	N1rt	S3z	N1rt	N1rt	N1rz	S3tz	S3rz	S3rz	S3rz	S3rz	N1rz	S3rz	S3rz	S3rz
Kavalura	625	S3rz	S3tz	S3tz	S2nz	S3tz	S3rz	S2rz	S2rz	S2tz	S3tz	S2z	N1tz	S3rz	S2rz	S3tz	S3tz	S3tz	S2tz	S2tz	S2rt	S3tz	S3tz	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	S2tz
Kavalura	630	S3rz	S3tz	S3tz	S2nz	S3tz	S3rz	S2rz	S2rz	S2tz	S3tz	S2z	N1tz	S3rz	S2rz	S3tz	S3tz	S3tz	S2tz	S2tz	S2rt	S3tz	S3tz	S2tz
Kavalura	631	S3rz	S3tz	S3tz	S2nz	S3tz	S3rz	S2rz	S2rz	S2tz	S3tz	S2z	N1tz	S3rz	S2rz	S3tz	S3tz	S3tz	S2tz	S2tz	S2rt	S3tz	S3tz	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	S2tz
Kavalura	633	N1rt	S3tz	N1rz	S3rz	N1rt	N1rz	N1rz	N1rz	S3tz	N1rt	S3z	N1rt	N1rt	N1rz	S3tz	S3rz	S3rz	S3rz	S3rz	N1rz	S3rz	S3rz	S3rz
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
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
Kavalura	637	N1rt	S3tz	N1rz	S3rz	N1rt	N1rz	N1rz	N1rz	S3tz	N1rt	S3z	N1rt	N1rt	N1rz	S3tz	S3rz	S3rz	S3rz	S3rz	N1rz	S3rz	S3rz	S3rz
Kavalura	638	N1rt	S3tz	N1rz	S3rz	N1rt	N1rz	N1rz	N1rz	S3tz	N1rt	S3z	N1rt	N1rt	N1rz	S3tz	S3rz	S3rz	S3rz	S3rz	N1rz	S3rz	S3rz	S3rz
Kavalura	639	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg
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
Kavalura	642	S3t	S3t	S3t	S1	S3t	S2rt	S1	S1	S2t	S3t	S1	N1t	S2rt	S1	S3t	S3t	S3t	S2t	S2t	S2t	S3t	S3t	S2t
Kavalura	643	S3t	S3t	S3t	S1	S3t	S2rt	S1	S1	S2t	S3t	S1	N1t	S2rt	S1	S3t	S3t	S3t	S2t	S2t	S2t	S3t	S3t	S2t
Kavalura	644	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg
Kavalura	645	S3t	S3t	S3t	S1	S3t	S2t	S1	S1	S2t	S3t	S1	N1t	S2t	S1	S3t	S3t	S3t	S2t	S2t	S2t	S3t	S3t	S2t
Kavalura	646	S3t	S3t	S3t	S1	S3t	S2t	S1	S1	S2t	S3t	S1	N1t	S2t	S1	S3t	S3t	S3t	S2t	S2t	S2t	S3t	S3t	S2t
Kavalura	651	S3t	S3t	S3t	S1	S3t	S2t	S1	S1	S2t	S3t	S1	N1t	S2t	S1	S3t	S3t	S3t	S2t	S2t	S2t	S3t	S3t	S2t
Kavalura	652	S3t	S3t	S3t	S1	S3t	S2t	S1	S1	S2t	S3t	S1	N1t	S2t	S1	S3t	S3t	S3t	S2t	S2t	S2t	S3t	S3t	S2t
Kavalura	653	S3t	S3t	S3t	S1	S3t	S2t	S1	S1	S2t	S3t	S1	N1t	S2t	S1	S3t	S3t	S3t	S2t	S2t	S2t	S3t	S3t	S2t
Kavalura	654	S3t	S3t	S3t	S1	S3t	S2t	S1	S1	S2t	S3t	S1	N1t	S2t	S1	S3t	S3t	S3t	S2t	S2t	S2t	S3t	S3t	S2t
Kavalura	655	S3t	S3t	S3t	S1	S3t	S2rt	S1	S1	S2t	S3t	S1	N1t	S2rt	S1	S3t	S3t	S3t	S2t	S2t	S2t	S3t	S3t	S2t
Kavalura	657	S3t	S3t	S3t	S1	S3t	S2t	S1	S1	S2t	S3t	S1	N1t	S2t	S1	S3t	S3t	S3t	S2t	S2t	S2t	S3t	S3t	S2t
Kavalura	667	S3t	S3t	S3t	S1	S3t	S2t	S1	S1	S2t	S3t	S1	N1t	S2t	S1	S3t	S3t	S3t	S2t	S2t	S2t	S3t	S3t	S2t
Kavalura	669	S3t	S3t	S3t	S1	S3t	S2t	S1	S1	S2t	S3t	S1	N1t	S2t	S1	S3t	S3t	S3t	S2t	S2t	S2t	S3t	S3t	S2t
Kavalura	744	S3t	S3t	S3t	S1	S3t	S2rt	S1	S1	S2t	S3t	S1	N1t	S2rt	S1	S3t	S3t	S3t	S2t	S2t	S2t	S3t	S3t	S2t
Kavalura	745	S3t	S3t	S3t	S1	S3t	S2rt	S1	S1	S2t	S3t	S1	N1t	S2rt	S1	S3t	S3t	S3t	S2t	S2t	S2t	S3t	S3t	S2t
Kavalura	749	S3t	S3t	S3t	S1	S3t	S2rt	S1	S1	S2t	S3t	S1	N1t	S2rt	S1	S3t	S3t	S3t	S2t	S2t	S2t	S3t	S3t	S2t
Kavalura	750	S3t	S3t	S3t	S1	S3t	S2rt	S1	S1	S2t	S3t	S1	N1t	S2rt	S1	S3t	S3t	S3t	S2t	S2t	S2t	S3t	S3t	S2t
Kavalura	751	S3t	S3t	S3t	S1	S3t	S2rt	S1	S1	S2t	S3t	S1	N1t	S2rt	S1	S3t	S3t	S3t	S2t	S2t	S2t	S3t	S3t	S2t
Kavalura	752	S3t	S3t	S3t	S1	S3t	S2rt	S1	S1	S2t	S3t	S1	N1t	S2rt	S1	S3t	S3t	S3t	S2t	S2t	S2t	S3t	S3t	S2t
Kavalura	753	N1rt	S3tz	N1rz	S3rz	N1rt	N1rz	N1rz	N1rz	S3tz	N1rt	S3z	N1rt	N1rt	N1rz	S3tz	S3rz	S3rz	S3rz	S3rz	N1rz	S3rz	S3rz	S3rz
Kavalura	754	N1rt	S3tz	N1rz	S3rz	N1rt	N1rz	N1rz	N1rz	S3tz	N1rt	S3z	N1rt	N1rt	N1rz	S3tz	S3rz	S3rz	S3rz	S3rz	N1rz	S3rz	S3rz	S3rz
Kavalura	755	N1rt	S3tz	N1rz	S3rz	N1rt	N1rz	N1rz	N1rz	S3tz	N1rt	S3z	N1rt	N1rt	N1rz	S3tz	S3rz	S3rz	S3rz	S3rz	N1rz	S3rz	S3rz	S3rz
Kavalura	756	S3t	S3t	S3t	S1	S3t	S2rt	S1	S1	S2t	S3t	S1	N1t	S2rt	S1	S3t	S3t	S3t	S2t	S2t	S2t	S3t	S3t	S2t
Kavalura	757	S3t	S3t	S3t	S1	S3t	S2rt	S1	S1	S2t	S3t	S1	N1t	S2rt	S1	S3t	S3t	S3t	S2t	S2t	S2t	S3t	S3t	S2t

Village	Survey No.	Mango	Maize	Sapota	Sorg - hum	Guava	Tama rind	Lime	Sun flower	Amla	Jack fruit	Custard -apple	Cash ew	Jamun	Musa mbi	Ground nut	Chilly	Tomato	Mari- gold	Chrysan themum	Pomegra nate	Bajra	Jasmi ne	Mul- berry
Kavalura	758	S3t	S3t	S3t	S1	S3t	S2rt	S1	S1	S2t	S3t	S1	N1t	S2rt	S1	S3t	S3t	S3t	S2t	S2t	S2t	S3t	S3t	S2t
Kavalura	759	S3t	S3t	S3t	S1	S3t	S2rt	S1	S1	S2t	S3t	S1	N1t	S2rt	S1	S3t	S3t	S3t	S2t	S2t	S2t	S3t	S3t	S2t
Kavalura	760	S3t	S3t	S3t	S1	S3t	S2rt	S1	S1	S2t	S3t	S1	N1t	S2rt	S1	S3t	S3t	S3t	S2t	S2t	S2t	S3t	S3t	S2t
Kavalura	761	S3t	S3t	S3t	S1	S3t	S2rt	S1	S1	S2t	S3t	S1	N1t	S2rt	S1	S3t	S3t	S3t	S2t	S2t	S2t	S3t	S3t	S2t
Kavalura	762	S3t	S3t	S3t	S1	S3t	S2rt	S1	S1	S2t	S3t	S1	N1t	S2rt	S1	S3t	S3t	S3t	S2t	S2t	S2t	S3t	S3t	S2t
Kavalura	771	S3t	S3t	S3t	S1	S3t	S2rt	S1	S1	S2t	S3t	S1	N1t	S2rt	S1	S3t	S3t	S3t	S2t	S2t	S2t	S3t	S3t	S2t
Kavalura	772	S3t	S3t	S3t	S1	S3t	S2rt	S1	S1	S2t	S3t	S1	N1t	S2rt	S1	S3t	S3t	S3t	S2t	S2t	S2t	S3t	S3t	S2t
Kavalura	773	N1rt	S3tz	N1rz	S3rz	N1rt	N1rz	N1rz	N1rz	S3tz	N1rt	S3z	N1rt	N1rt	N1rz	S3tz	S3rz	S3rz	S3rz	S3rz	N1rz	S3rz	S3rz	S3rz
Kavalura	774	S3t	S3t	S3t	S1	S3t	S2rt	S1	S1	S2t	S3t	S1	N1t	S2rt	S1	S3t	S3t	S3t	S2t	S2t	S2t	S3t	S3t	S2t
Kavalura	775	N1rt	S3tz	N1rz	S3rz	N1rt	N1rz	N1rz	N1rz	S3tz	N1rt	S3z	N1rt	N1rt	N1rz	S3tz	S3rz	S3rz	S3rz	S3rz	N1rz	S3rz	S3rz	S3rz
Kavalura	776	N1rt	S3tz	N1rz	S3rz	N1rt	N1rz	N1rz	N1rz	S3tz	N1rt	S3z	N1rt	N1rt	N1rz	S3tz	S3rz	S3rz	S3rz	S3rz	N1rz	S3rz	S3rz	S3rz
Kavalura	777	N1rt	S3tz	N1rz	S3rz	N1rt	N1rz	N1rz	N1rz	S3tz	N1rt	S3z	N1rt	N1rt	N1rz	S3tz	S3rz	S3rz	S3rz	S3rz	N1rz	S3rz	S3rz	S3rz
Kavalura	778	S3t	S3t	S3t	S1	S3t	S2rt	S1	S1	S2t	S3t	S1	N1t	S2rt	S1	S3t	S3t	S3t	S2t	S2t	S2t	S3t	S3t	S2t
Kavalura	781	S3t	S3t	S3t	S1	S3t	S2rt	S1	S1	S2t	S3t	S1	N1t	S2rt	S1	S3t	S3t	S3t	S2t	S2t	S2t	S3t	S3t	S2t
Kavalura	783	S3t	S3t	S3t	S1	S3t	S2rt	S1	S1	S2t	S3t	S1	N1t	S2rt	S1	S3t	S3t	S3t	S2t	S2t	S2t	S3t	S3t	S2t
Kavalura	784	N1rt	S3tz	N1rz	S3rz	N1rt	N1rz	N1rz	N1rz	S3tz	N1rt	S3z	N1rt	N1rt	N1rz	S3tz	S3rz	S3rz	S3rz	S3rz	N1rz	S3rz	S3rz	S3rz
Kavalura	785	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg
Kavalura	786	S3t	S3t	S3t	S1	S3t	S2rt	S1	S1	S2t	S3t	S1	N1t	S2rt	S1	S3t	S3t	S3t	S2t	S2t	S2t	S3t	S3t	S2t
Kavalura	787	S3t	S3t	S3t	S1	S3t	S2rt	S1	S1	S2t	S3t	S1	N1t	S2rt	S1	S3t	S3t	S3t	S2t	S2t	S2t	S3t	S3t	S2t
Kavalura	790	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg	N1rg
Kavalura	791	S3t	S3tg	S3tg	S2g	S3gt	S2tg	S2g	S2g	S2gt	S3gt	S1	N1tg	S2gt	S2g	S3tg	S3tg	S3tg	S2tg	S2tg	S2tg	S3tg	S3tg	S2t

PART-B

SOCIO-ECONOMIC STATUS OF FARM HOUSEHOLDS

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Chapter 1

EXECUTIVE SUMMARY

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

Methodology: *The Adavalli-2 micro-watershed (Koppal taluk and district) is located in between $15^0 18'$ – $15^0 19'$ North latitudes and $75^0 56'$ – $75^0 58'$ East longitudes, covering an area of about 312.58, bounded by Kavalura 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 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 56 to 44 per cent to the total sample population.*
- *Younger age groups of population are around 63 per cent to the total population.*
- *Literacy population is around 74 per cent.*
- *Wood is the source of energy for a cooking among 80 per cent.*
- *About 40 per cent of households have a Yashiswini health card.*
- *Majority of farm households (80 %) are having MGNREGA card for rural employments.*
- *Dependence on ration cards through public distribution system is around 100 per cent*
- *Swach bharath program providing closed toilet facilities around 20 per cent of sample households.*
- *Institutional participation is only 14.8 per cent of sample households.*
- *Rural migration to unban centre for employment is prevent among 33 per cent of farm households.*
- *Women participation is decisions making are around 40 per cent of households were found.*

Economic Indicators;

- *The average land holding is 5.12 ha indicates that majority of farm households are belong to marginal and small farmers.*

- *Agriculture is the main occupation among 56 per cent and agricultural labours is predominant subsidiary occupation for 39 per cent of sample households.*
- *The average value of domestic assets is around Rs 16744 per household. Mobile and television are mass popular mass communication media.*
- *The average farm assets values is around 1.05 lakhs, about 40 per cent of sample farmers are owing tractors.*
- *The average per capita food consumption is around 683 grams (1860 kilo calories) against national institute of nutrition recommendation at 827 gram. Around 80 per cent of sample farmers are consuming less than the NIN recommendation.*
- *The annual average income is around Rs 21973 per household. About 75 per cent of farm households are below poverty line.*
- *The per capita monthly expenditure is around Rs 776 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 8468 per ha/year. The total cost of annual soil nutrients is around Rs 2560349 per year for the total area of 312.58 ha.*
- *The average value of ecosystem service for food production is around Rs 8749/ ha/year. Per ha food production services is maximum in chillies (Rs 34357/ha) followed by Bengal gram (Rs 5289/ha), Green gram (Rs. 4483/ha), Maize (Rs. 3801), sunflower (Rs. 3484) and onion (Rs. 1080/ha).*
- *The average value of ecosystem service for fodder production is around Rs 4613/ ha/year of maize crop.*
- *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 Bengal gram (Rs 41564) followed by Green gram (Rs 40906), Sunflower (Rs 20351), Maize (Rs 15217), chillies (Rs. 2438) and Onion (Rs 672).*

Economic Land Evaluation;

- *The major cropping pattern is onion (39.32%) followed by sugarcane (17.1%), maize (13.76 %), Bengal gram (9.83 %), green gram (8.2 %), sunflower (7.86 %) and chillies (3.93 %).*
- *In Adavalli-2 micro watershed, major soils are Muttal (MTL) series are having shallow soil deep cover around 34 % of area. On this soil farmers are presently growing onion (38 %), sunflower (33 %), bengal gram (19.5 %), maize (5.7 %) and chillies (3.8 %). Dambarahalli (DRL) soil series are having moderately deep soil depth cover around 7 per cent of area, major crops grown are maize.*

Belagatti (BGT) soil series are having very shallow soil depth covers around 5.23 % of area, the major crop grown is green gram.

- *The total cost of cultivation in the study area for maize ranges between Rs. 17038/ha in MTL soil (with BCR of 1.60) and Rs. 14774/ha in DRL soil (with BCR of 1.34).*
- *Green gram in the cost of cultivation of Rs. 20579/ ha in BGT soil (with BCR of 1.15).*
- *In bengal gram the cost of cultivation in MTL soil is Rs. 19989 /ha (with BCR of 1.26).*
- *In chillies the cost of cultivation in MTL soil is Rs. 27301/ha (with BCR of 2.17).*
- *In onion the cost of cultivation in MTL soil is Rs. 7207/ ha (with BCR of 1.1) and sunflower cost of cultivation in MTL soil is Rs. 18680/ha (with BCR of 1.07).*

Suggestions;

- *Involving farmers is watershed planning helps in strengthing institutional participation.*
- *The per capita food consumption and monthly income is very low. Diversifying income generation activities from crop and livestock production in order to reduce risk related to drought and market prices.*
- *Majority of farmers reported that they are not getting timely support/extension services from the concerned development departments.*
- *By strengthing agricultural extension for providing timely advice improved technology there is scope to increase in net income of farm households.*
- *By adopting recommended package of practices by following the soil test fertiliser recommendation, there is scope to increase yield in bengal gram (32.3 %), chillies (97 %), green gram (4.1 %), maize (72.5 to 83.7%), onion (98.9%) and sunflower (49.4%).*

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 Adavalli-2 micro-watershed (Koppal taluk, Koppal district) is located in between $15^0$18’ – $15^0$19’ North latitudes and $75^0$56’ – $75^0$58’ East longitudes, covering an area of about 312.58, bounded by Kavalura 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).

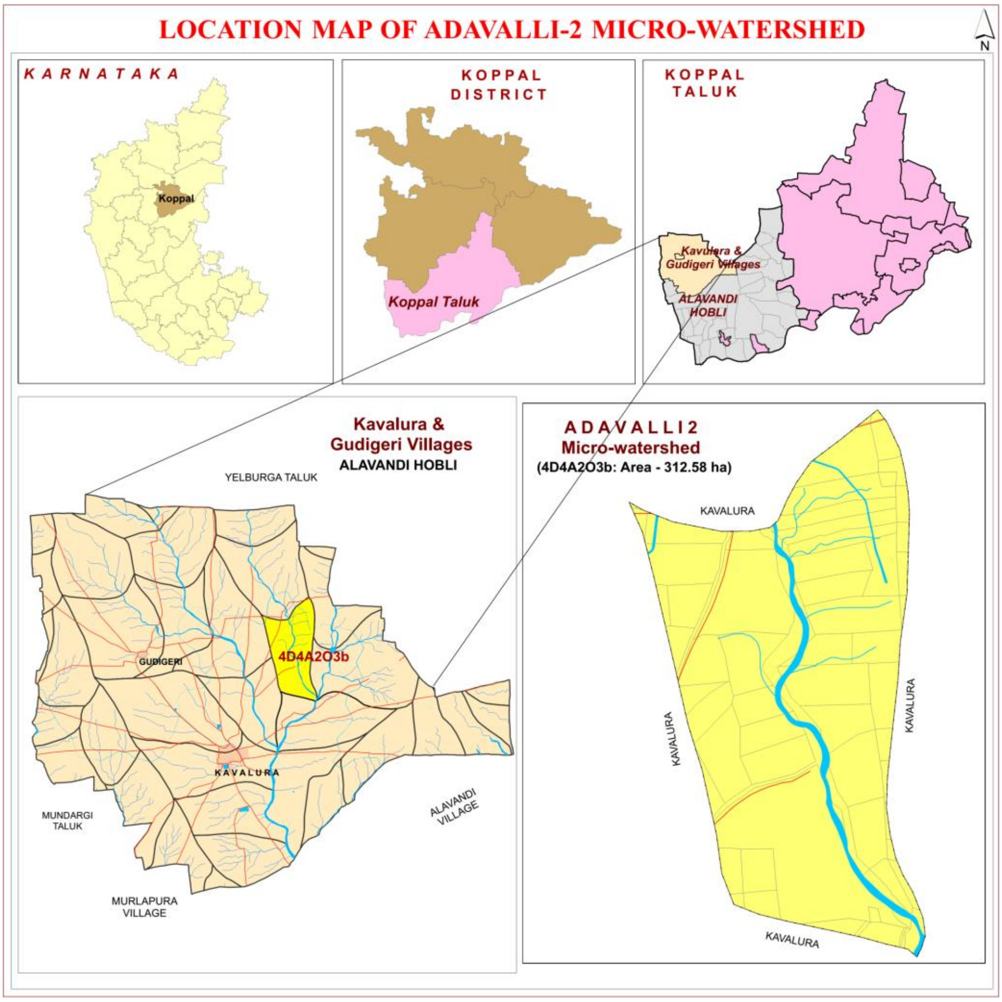


Figure 1: Location of study area

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 .

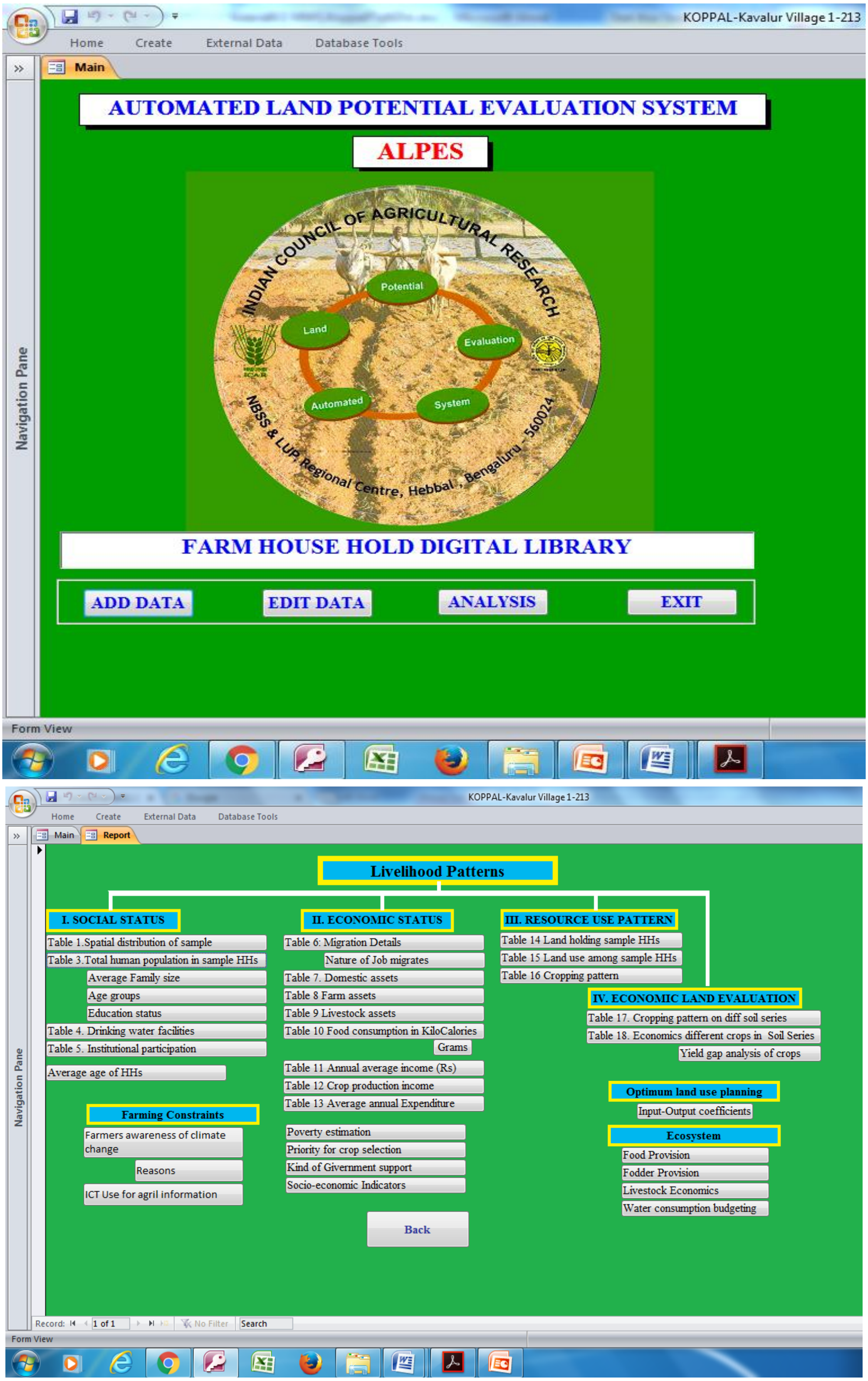


Figure 2: ALPES FRAMEWORK

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.

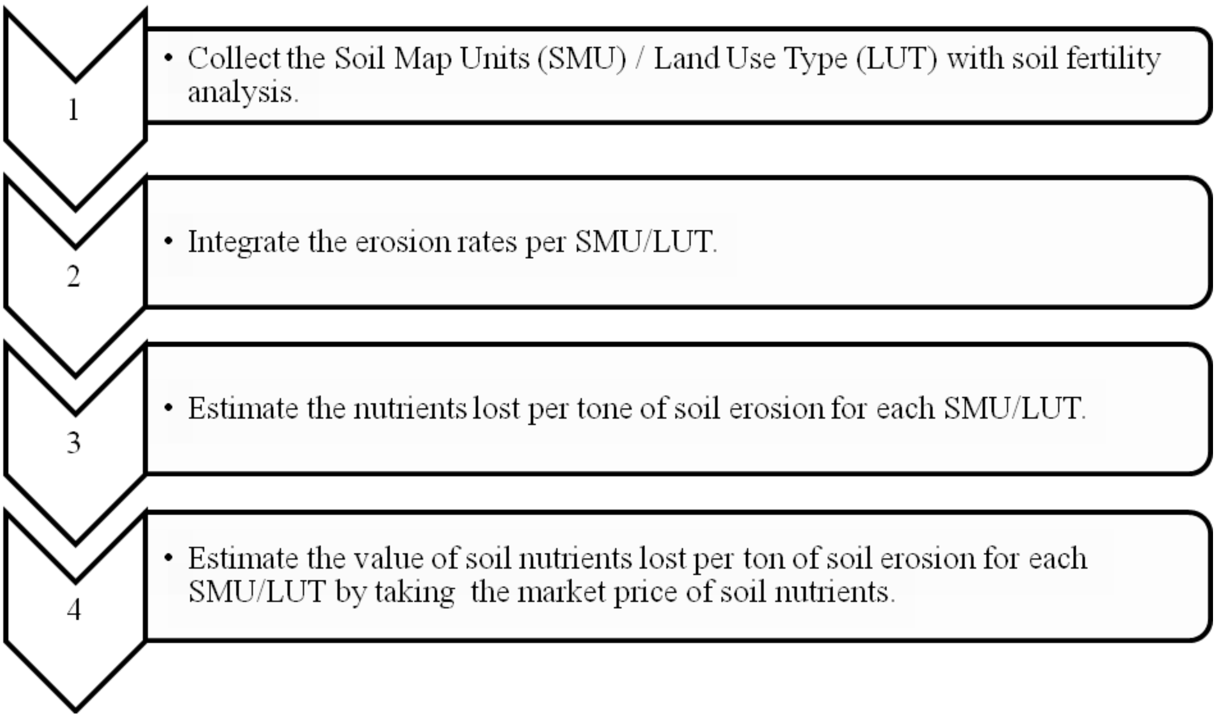
Operational Cost = cost of seeds, fertilizers, pesticides. Cost of human and bullock labour, cost of machinery, cost of irrigation water + interest on working capital.
Gross returns = Yield (Quintals/hectare)*Price (Rs/Quintal)
Net returns = Gross returns-Operational cost.
Benefit Cost Ratio = Net returns/Total 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 57, out of which 55.6 per cent were males and 44.4 per cent females. Average family size of the households is 5.4. 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 18 to 30 years (33.3 %) followed by 30 to 50 years (29.6 %), more than 50 years (29.6 %) and 0 to18 years (7.4 %). 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 25.9 per cent of respondents were illiterate and 74.1 per cent literate (Table 1).

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

Particulars	**Units**	**Values**
Total human population in sample HHs	Number	27.0
Male	% to total Population	55.6
Female	% to total Population	44.4
Average family size	Number	5.4
Age group		
0 to 18 year	% to total Population	7.4
18 to 30 year	% to total Population	33.3
30 to 50 years	% to total Population	29.6
>50 years	% to total Population	29.6
Average age of population	Age in years	39.7
Education Status		
Illiterates	% to total Population	25.9
Literates	% to total Population	74.1
Primary School (<5 class)	% to total Population	22.2
Middle School (6- 8 Class)	% to total Population	14.8
High School (9- 10 Class	% to total Population	25.9
Others	% to total Population	11.1

The ethnic groups among the sample farm households found to be 40 per cent belonging to Other Backward Castes (OBC) (Table 2 and Figure 3). About 80 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 40 per cent are sample households are having health cards. Majority (80 %) are having MNREGA job cards for employment generation. About 100 per cent of farm households are having ration cards for taking food grains from public distribution system. About 20 per cent of farm households are having toilet facilities.

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

Particulars	**units**	**Value**
Social groups		
OBC	% of Households	40.0
Others	% of Households	60.0
Types of fuel use for cooking		
Fire wood	% of Households	80.0
Gas	% of Households	20.0
Energy supply for home		
Electricity	% of Households	100
Number of households having Health card		
Yes	% of Households	40.0
No	% of Households	60.0
MGNREGA Card		
Yes	% of Households	80.0
No	% of Households	20.0
Ration Card		
Yes	% of Households	100.0
No	% of Households	0.0
Households with toilet		
Yes	% of Households	20.0
No	% of Households	80.0
Drinking water facilities		
Tube Well	% of Households	80.0
Dug well	% of Households	20.0

The data collected on the source of drinking water in the study area is presented in Table 2. Majority of the sample respondents are having tube well source for water supply for domestic purpose (80 %) and Dug well (20%).

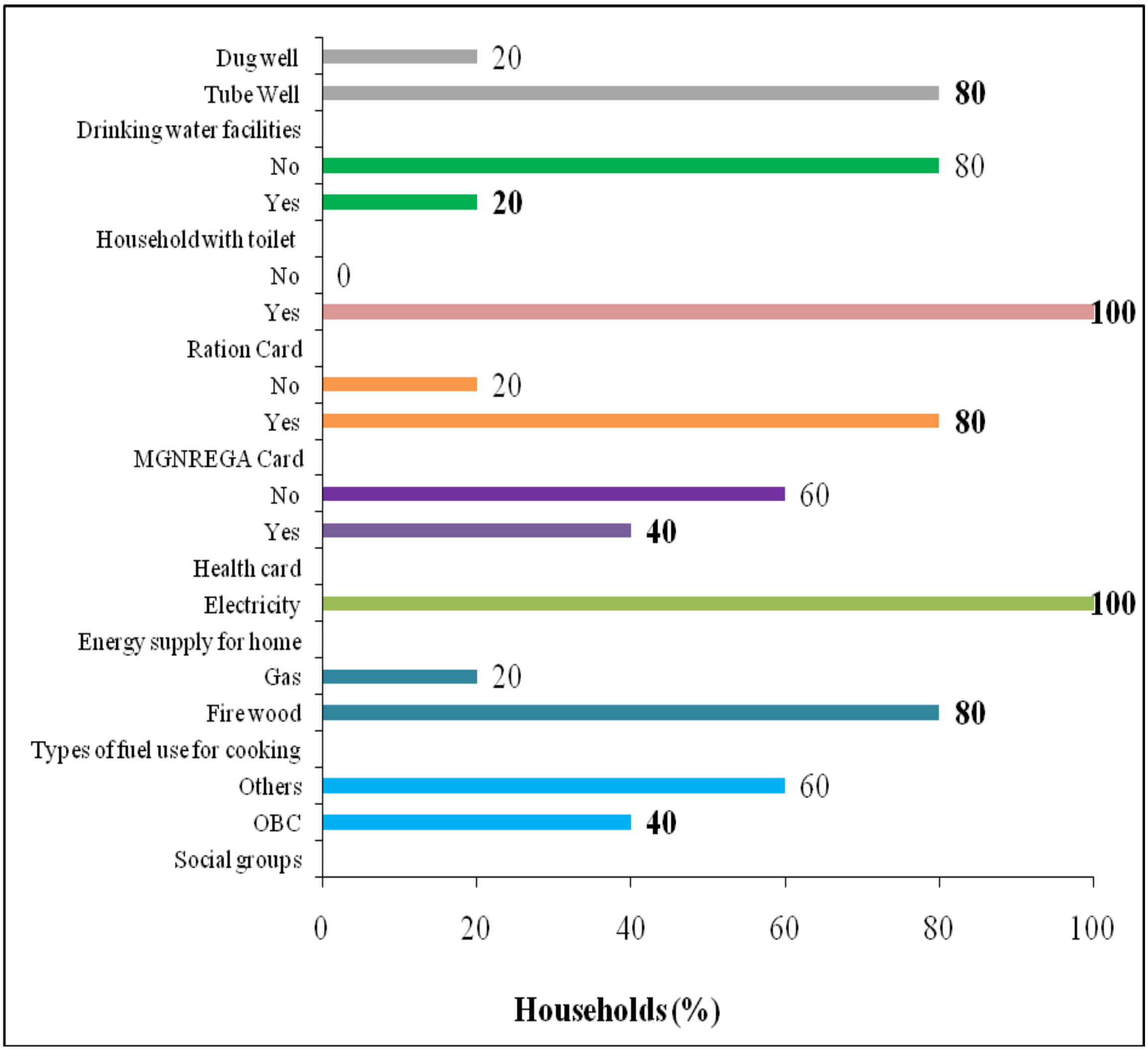


Figure 3: Basic needs of sample households in Adavalli-2 Microwatershed

Only 14.8 per cent of the farmers are participating in community based organizations (Table 3). Among them majority were participating in Self help group organization (11.1 %) like Sri Dharmasthala Swasahaya Sangha, Stri Shakhti Sangha, and 3.7 per cent of the households were members of the Users groups.

Table 3: Institutional participation among the sample population in Adavalli-2 Microwatershed

Particulars	Units	Value
No. Of people participating	**% to total Population**	14.8
User groups	% of Participating total Population	3.7
Self help groups	% of Participating total Population	11.1
No. Of people not participating	**% to total Population**	85.2

The occupational patterns (Table 4) among sample households shows that agriculture is the main occupation for 56.5 per cent of farmers followed by subsidiary occupations like Agricultural labour (34.8 %) and HH industries/Artisan activity (4.4 %).

Table 4: Occupational pattern in sample households in Adavalli-2 Microwatershed

Occupation		% to total population
Main	**Subsidiary**	
Agriculture	Agriculture	56.5
	Agriculture Labour	34.8
	HH industries/Artisan activity	4.4
	Others	4.4
Grand Total		100.0
Family labour availability		**(Man days/ month)**
Male		77.4
Female		34.0
Total		111.4

The important assets especially with reference to domestic assets were analyzed and are given in Table 5 and Figure 4. The important domestic assets possessed by all categories of farmers are Mobile phones (100 %) followed by Television (87.5 %), Mixer/grinder (80 %), Motor bike (60 %), Bicycle (37.5 %) and Auto (40 %). The average value of domestic assets is around Rs 16744 per households.

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

Particulars	% of HHs	Average value in Rs
Auto	40.0	60000
Bicycle	60.0	1067
Mixer/grinder	80.0	1325
Mobile Phone	100.0	3540
Motorcycle	60.0	29333
Television	100.0	5200
Average value	16744	

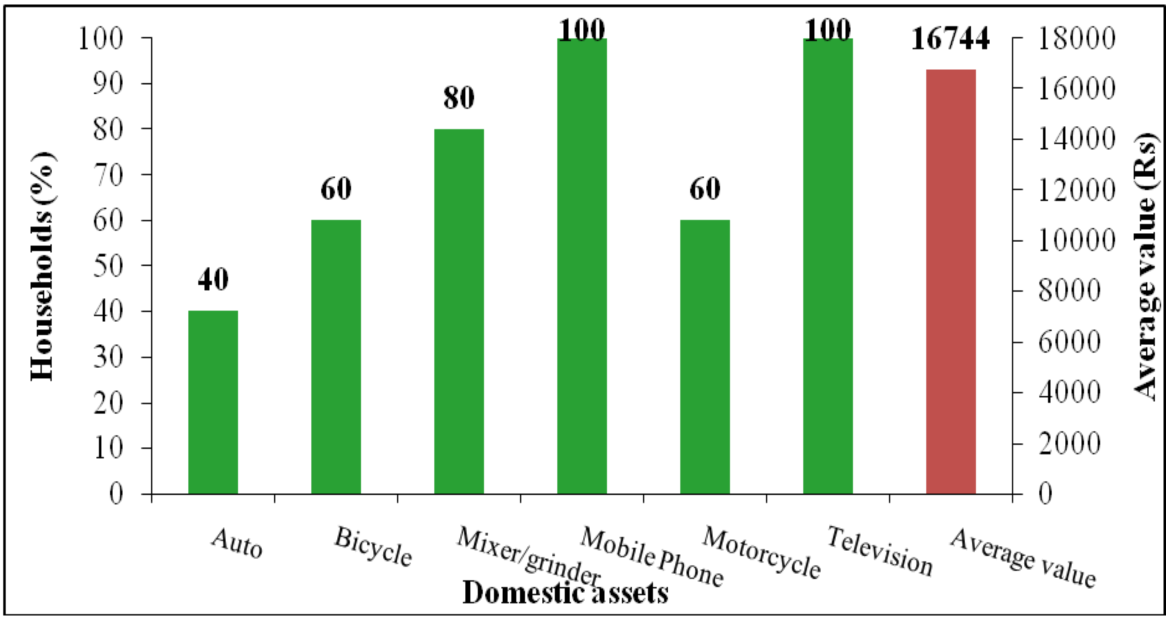


Figure 4: Domestic assets among the sample households in Adavalli-2 Microwatershed

The most popularly owned farm equipments were sickles, plough, cattle shed; pump sets, chaff cutter, bullock cart, sprayer and thresher. Plough and sickle were commonly present in all the sampled farmers; these were primary implements in agriculture. The per cent of households owned tractor (40 %), Harvester (80 %), Sprayer (60 %), and Weeder (100 %) (Table 6 and Figure 5).

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

Particulars	% of HHs	Average value in Rs
Earth Remover	40.0	23500
Harvester	80.0	70
Sprayer	60.0	2167
Tractor	40.0	500000
Weeder	100.0	65
Average value	105160	

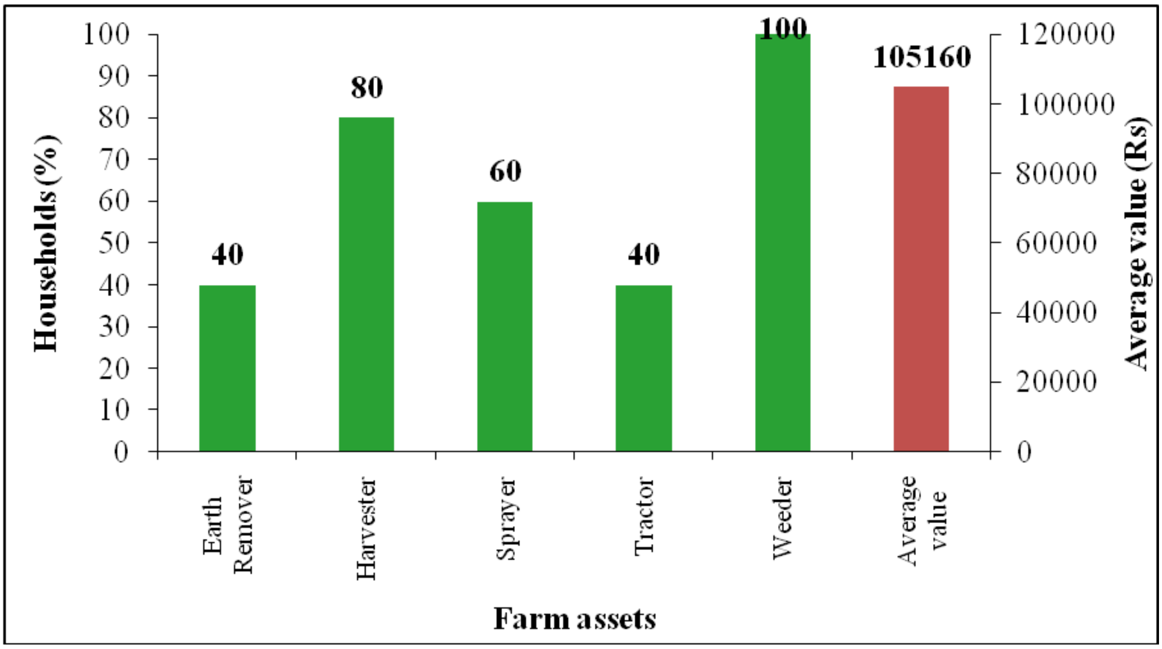


Figure 5: Farm assets among samples households in Adavalli-2 Microwatershed

Livestock is an integral component of the conventional farming systems (Table 7). The majority of the livestock population are goats rearing (12.5 %). The average livestock value was Rs 4500 per livestock.

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

Particulars	% of livestock	Average value in Rs
Goats	12.5	4500

Among the farm household, maize is the main crop for domestic food and fodder for animals. About 12083 kg/ha of average fodder is available per season for the livestock feeding (Table 8).

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

Particulars	
Fodder produces	Fodder yield (Kg/ha.)
Maize	2083
Average fodder availability	2083
Livestock having households (%)	20
Livestock population (Numbers)	2

A woman participation in decision making in is reported in this Microwatershed (Table 9). Forty per cent of women participation in local organisation, around 60 per cent of women earning for her family requirement and women taking decision in her family and agriculture related activities

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

% to Grand Total

Particulars	Yes	No
Women participation in local organization activities	40	60
Women elected as panchayat member	0	100
Women earning for her family requirement	60	40
Women taking decision in her family and agriculture related activities	60	40

The food intake in terms of kilo calorie (kcal) per person per day was calculated and presented in the Table 10 and Figure 6. More quantity of cereals are consumed by sample farmers which accounted for 1403.4 kcal per person. The other important food items consumed was pulses 109.2 kcal followed by vegetable cooking oil 212.6 kcal, milk 60.3 kcal, Egg 50 kcal, vegetables 16.9 kcal and meat 7.5 kcal. In the sampled households, farmers were consuming less (1859.9 kcal) than ICMR- recommended food requirement (2250 kcal).

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

Particulars	**NIN recommendation (gram/ per day/ person)**	**Present level of consumption (gram/ per day/ person)**	**Kilo Calories /day/person**
Cereals	396	412.78	1403.4
Pulses	43	31.83	109.2
Milk	200	92.74	60.3
Vegetables	143	70.40	16.9
Cooking Oil	31	37.30	212.6
Egg	0.48	33.33	50.0
Meat	14.2	5.00	7.5
Total	827.68	683.37	1859.9
Threshold of NIN recommendation		827 gram*	2250 Kcal*
% Below NIN		80	60
% Above NIN		20	40

Note: * day/person

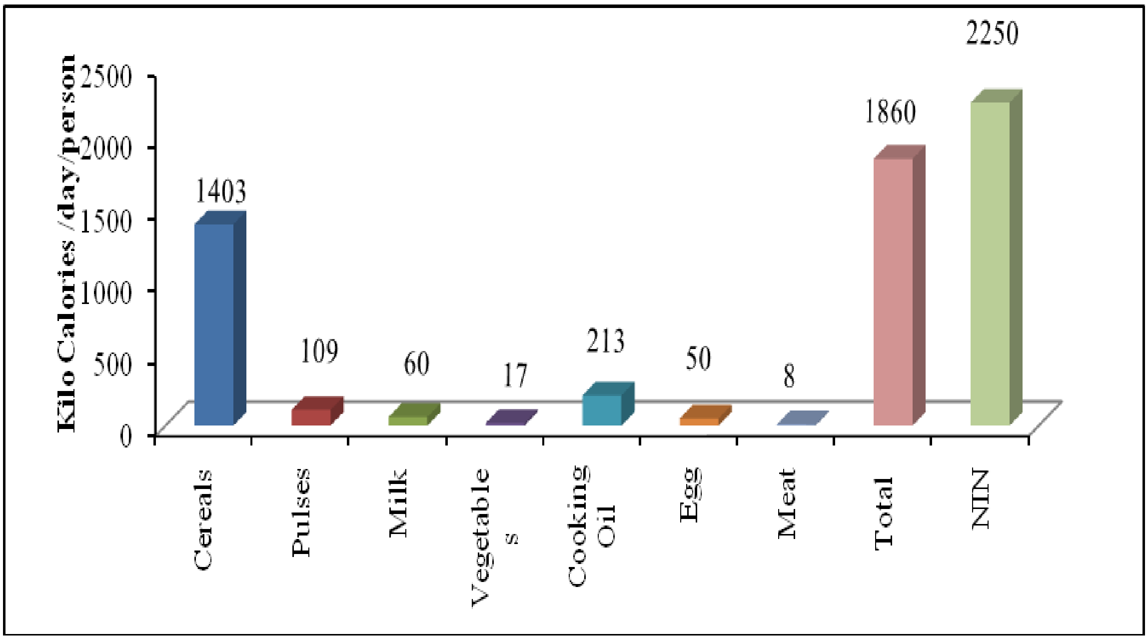


Figure 6: Per capita daily consumption of food among the sample farmers in Adavalli-2 Microwatershed

Annual income of the sample HHs: The average annual household income is around Rs. 21973. Major source of income to the farmers in the study area is from crop production (Rs. 21973). There is no other source of income of sample households. The monthly per capita income is Rs. 339, 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 11).

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

Particulars	Income *
Nonfarm income (Rs)	0
Livestock income (Rs)	0
Crop Production (Rs)	21973 (100)
Total Annual Income (Rs)	21973
Average monthly per capita income (Rs)	339
Threshold for Poverty level (Rs 975 per month/person)	
% of households below poverty line	80.0
% of households above poverty line	20.0

* Figure in the parenthesis indicates % of Households

The average annual expenditure of farm households indicated that farmers in the study area spend highest on food (Rs. 42468) 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 766 and about 80 per cent of farm households are below poverty line and 20 per of farm households are above poverty line (Table 12 and Figure 7).

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

Particulars	Value in Rupees	Per cent
Food	42468	85.5
Education	100	0.2
Clothing	2700	5.4
Social functions	2800	5.6
Health expenditure	1600	3.2
Total Expenditure (Rs/year)	49668	100
Monthly per capita expenditure (Rs)	766	

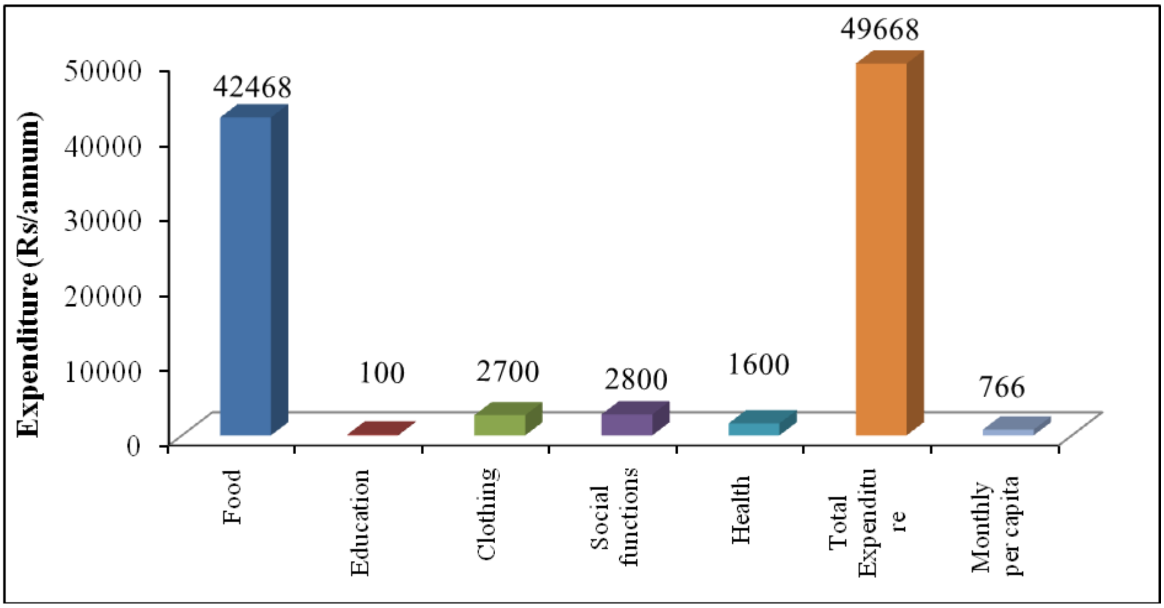


Figure 7: Average annual expenditure of sample HHs in Adavalli-2 Microwatershed

The total land owned by the sample households of area were 25.62 ha which was under dry land area was 16.79 ha and fallow land was 8.83 ha. The average land holding per household is worked out to be 5.12 ha (Table 13).

Table 13: Land holding among samples households in Adavalli-2 Microwatershed

Particulars	Per cent	Area in ha
Irrigated land	0.0	0.00
Rainfed Land	65.5	16.79
Fallow Land	34.5	8.83
Total land holding	100.0	25.62
Average land holding	5.12	

In the watershed, the prevalent present land uses under perennial plants are neem trees (62.5 %) followed by the banyan trees (31.2 %) and Peeple tree (6.5 %) (Table 14).

Table 14: Number of tree/plants covered in sample farm households in Adavalli-2 Microwatershed

Particulars	Number of Plants/trees	Per cent
Banyan tree(Alada)	5	31.2
Neem trees	10	62.5
Peeple tree(Arali)	1	6.5
Grand Total	16	100

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

The present dominant crops grown in dry lands in the study area were onion (39.3 %) followed by sugarcane (17.1 %), maize (13.7 %), green gram (8.2 %), sunflower (7.8 %) and chillies (3.9 %) which are taken during *Kharif* and Bengal gram (9.8 %) during *Rabi* season respectively. The cropping intensity was 110.9 per cent (Table 15 and Figure 8).

Table 15: Present cropping pattern and cropping intensity in Adavalli-2 Microwatershed (% to Grand Total)

Particulars	Kharif	Rabi	Total
Green gram	8.2	0	8.2
Sunflower	7.9	0	7.9
Bengal gram	0.0	9.8	9.8
Chillies	3.9	0	3.9
Maize	13.7	0	13.7
Onion	39.3	0	39.3
Sugarcane	17.1	0	17.1
Grand Total	***90.2***	***9.8***	***100.0***
Cropping intensity (%)	110.9		

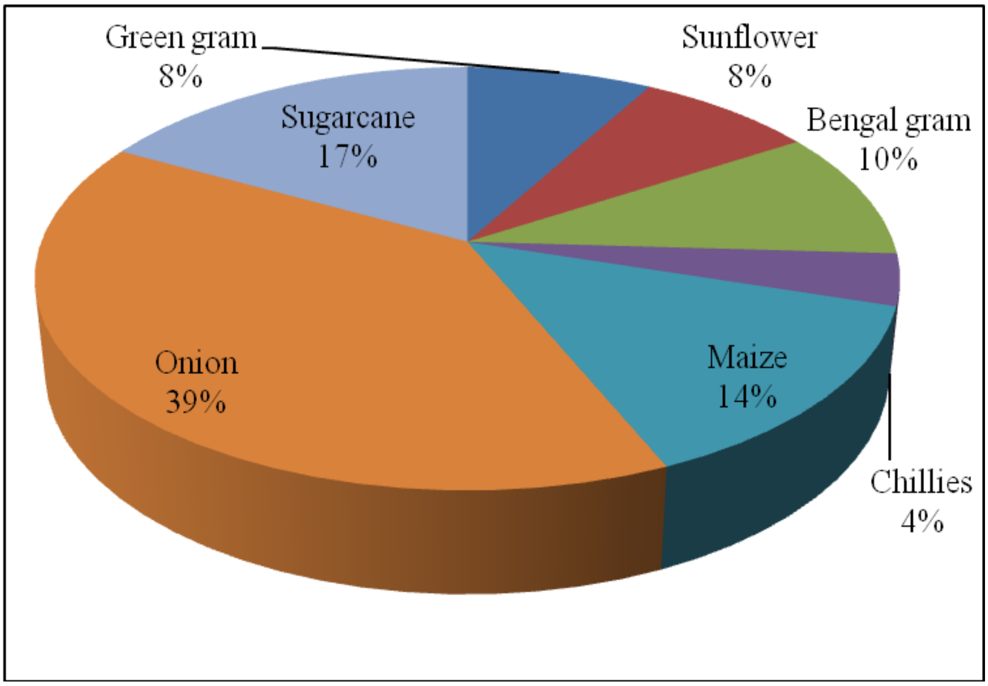


Figure 8: Present cropping pattern and cropping intensity in Adavalli-2 Microwatershed

Economic land evaluation

In Adavalli-2 micro-watershed, 6 soil series are identified and mapped (Table 16). The distribution of major soil series are Muttal covering an area of 106 ha (33.77 %) followed by Handrala 103 ha (33.01 %), Kadagathur 48 ha (15.37 %), Dambarahalli 29 ha (6.81 %), Belagatti 22 ha (5.23 %) and Gatareddihalla 0.37 ha (0.12%).

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

Sl. No	Soil Series	Area in ha (%)
1	Belagatti (BGT)	22 (5.23)
2	Dambarahalli (DRL)	29 (6.81)
3	Gatareddihalla (GRH)	0.37 (0.12)
4	Handrala (HDL)	103 (33.01)
5	Kadagathur (KDT)	48 (15.37)
6	Muttal (MTL)	106 (33.77)
	Others	14 (3.21)
	Total	312.58

Present cropping pattern on different soil series are given in Table 17. Crop grown on Belagatti soils is green gram. Bengal gram, chillies, maize, onion and sunflower on Muttal soils are grown and maize on Gatareddihalla soils.

Table 17: Cropping pattern on major soil series in Adavalli-2 micro-watershed

(Area in per cent)

Soil Series	Soil Depth	Crops	Dry		Grand Total
			Kharif	Rabi	
Belagatti	Very shallow (<25 cm)	Green gram	100.0	0.0	100.0
Muttal	Shallow (25-50 cm)	Bengal gram	0.0	19.5	19.5
		Chillies	3.8	0.0	3.8
		Maize	0.0	5.7	5.7
		Onion	38.0	0.0	38.0
		Sunflower	33.0	0.0	33.0
Dambarahalli	Moderately deep (75-100 cm)	Maize	100.0	0.0	100.0

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

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

Soil Series	Small Farmers	Medium Farmers	Large Farmers
BGT	Green gram (1.23)		
MTL		Sunflower (1.25)	Bengal gram (1.26), Chilli (2.38), Maize (1.73), Onion (1.16), Sunflower (1.12)
DRL			Maize (1.3)

The productivity of different crops grown in Adavalli-2 micro-watershed under different soil series and potential yield of the crops is given in Table 19.

The data on cost of cultivation and BCR of different crops across soil series is given in Tables 19. The total cost of cultivation in the study area for maize ranges between Rs. 17038/ha in MTL soil (with BCR of 1.60) and Rs. 14774/ha in DRL soil (with BCR of 1.34), green gram cost of cultivation of Rs. 20579/ ha in BGT soil (with BCR of 1.15), bengal gram cultivation in MTL soil is Rs. 19989 /ha (with BCR of 1.26), chillies cultivation in MTL soil is Rs. 27301/ha (with BCR of 2.17), onion cultivation in MTL soil is Rs. 7207/ ha (with BCR of 1.1) and sunflower cost of cultivation in MTL soil is Rs. 18680/ha (with BCR of 1.07).

Table 19: Economic Land evaluation and bridging yield gap for different crops in Adavalli-2 micro-watershed

Particulars	BGT (<25 cm)	MTL (25-50 cm)					DRL (75-100 cm)
	Green gram	Bengal gram	Chillies	Maize	Onion	Sun flower	Maize
Total cost (Rs/ha)	20579	19989	27301	17038	7207	18680	14774
Gross Return (Rs/ha)	23693	25278	59280	27294	7904	20101	19760
Net returns (Rs/ha)	3114	5289	31979	10256	697	1421	4986
B:C	1.15	1.26	2.17	1.6	1.1	1.07	1.34
Farmers Practices (FP)							
FYM (t/ha)	0.6	0.0	0.0	0.0	0.0	0.2	1.3
Nitrogen (kg/ha)	62.9	71.8	71.8	71.8	43.9	36.7	58.1
Phosphorus (kg/ha)	55.2	37.8	37.8	37.8	58.0	57.7	55.6
Potash (kg/ha)	18.0	0.0	0.0	0.0	0.0	12.4	12.5
Grain (Qtl/ha)	6.0	6.1	7.5	15.8	2.5	5.7	9.4
Price of Yield (Rs/Qtl)	4000	4200	8000	1100	3200	3400	2000
Soil test based fertilizer Recommendation (STBR)							
FYM (t/ha)	7.5	7.5	25.0	7.5	30.0	6.9	7.5
Nitrogen (kg/ha)	16.3	13.0	142.9	100.0	125.0	37.5	125.0
Phosphorus (kg/ha)	31.3	31.3	89.3	62.5	62.5	62.5	62.5
Potash (kg/ha)	18.8	18.8	53.6	18.8	56.3	28.1	18.8
Grain (Qtl/ha)	6.3	9.0	246.4	57.5	225.0	11.3	57.5
% of Adoption/yield gap (STBR-FP) / (STBR)							
FYM (%)	92.0	100.0	100.0	100.0	100.0	97.0	83.3
Nitrogen (%)	-287.4	-452.5	49.7	28.2	64.9	2.2	53.5
Phosphorus (%)	-76.5	-21.1	57.6	39.4	7.2	7.7	11.0
Potash (%)	4.1	100.0	100.0	100.0	100.0	55.9	33.3
Grain (%)	4.1	32.3	97.0	72.5	98.9	49.4	83.7
Impact of land Resource Information (Rs)							
Additional fertilize cost (Rs/ha)	5304	6879	29187	9298	32297	7201	7480
Additional yield benefits (Rs/ha)	1019	12215	1911429	45833	712000	18880	96250
Net change Income (Rs/ha)	-4284	5336	1882241	36536	679703	11679	88770

The data on FYM, Nitrogen, Phosphorus and Potash application by the farmers to different crops and recommended FYM for different crops is given in Table 19. There is a huge gap between FYM application by farmers and recommended FYM in all the crops across the soils. There is a larger yield gap in crops grown across different soil series.

Adequate knowledge about recommended package of practices is the pre-requisite for their use in cultivation of crops. It is a fact that, recommended practices are major contributing factors to yield. Inadequate knowledge about recommended practices leads to their improper adoption. Strengthening of extension services by concerned agency is required to increase adoption of recommended cultivation practices and ultimately reducing the gap. By adopting soil-test fertiliser recommendation, there is scope to increase yield and income to a maximum of Rs 1882241 in chillies and a minimum of Rs 5336 in bengal 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 20 and Figure 9. The average value of soil nutrient loss is around Rs 8468 per ha/year. The total cost of annual soil nutrients is around Rs 2560349 per year for the total area of 312.58 ha.

Table 20: Estimation of onsite cost of soil erosion in Adavalli-2 micro-watershed

Particulars	Quantity(kg)		Value (Rs)	
	Per ha	Total	Per ha	Total watershed
Organic matter	1130.1	341707	7120	2152752
Phosphorus	0.56	169	24.6	7449
Potash	34.55	10447	691.0	208942
Iron	1.3	393	62.3	18851
Manganese	1.24	375	341.3	103208
Cupper	0.16	48	88.4	26732
Zinc	0.03	9	1.1	344
Sulphur	3.42	1033	136.7	41319
Boron	0.06	19	2.5	752
Total	1171.4	354199	8468	2560349

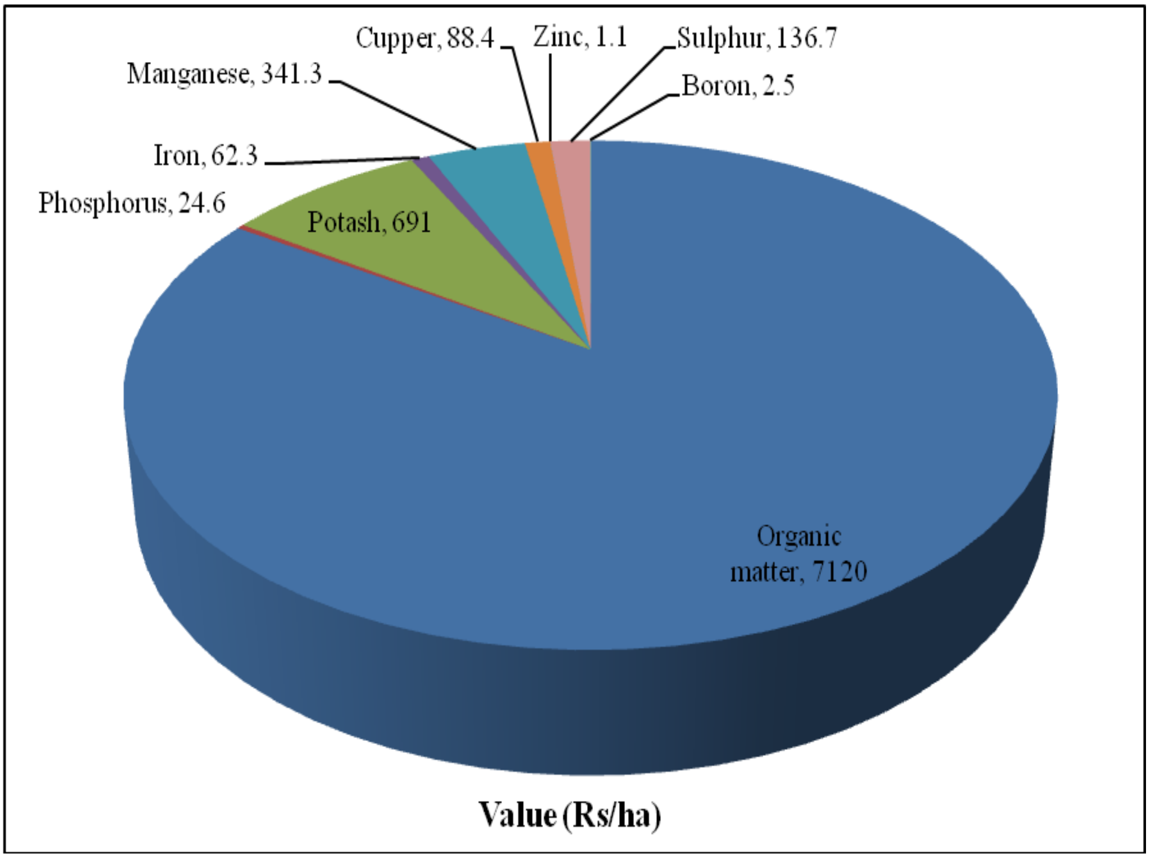


Figure 9: Estimation of onsite cost of soil erosion in Adavalli-2 micro-watershed

The average value of ecosystem service for food production is around Rs 8749/ ha/year (Table 21 and Figure 10). Per ha food production services is maximum in chillies (Rs 34357/ha) followed by bengal gram (Rs 5289/ha), green gram (Rs. 4483/ha), maize (Rs. 3801), sunflower (Rs. 3484) and onion (Rs. 1080/ha).

Table 21: Ecosystem services of food production in Adavalli-2 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	Maize	2.83	12.45	1550	19302	15501	54702	3801
Pulses	Bengal gram	4.15	6.02	4200	25278	19989	105000	5289
	Green gram	1.69	5.92	4000	23693	19210	40000	4483
Oil seeds	Sunflower	7.04	6.06	3350	20294	16810	142883	3484
Vegetables	Chillies	0.81	7.41	8000	59280	24923	48000	34357
	Onion	8.10	2.47	3200	7904	6824	64000	1080
Grand Total		24.62	7.36	3650	26847	16946	661078	8749

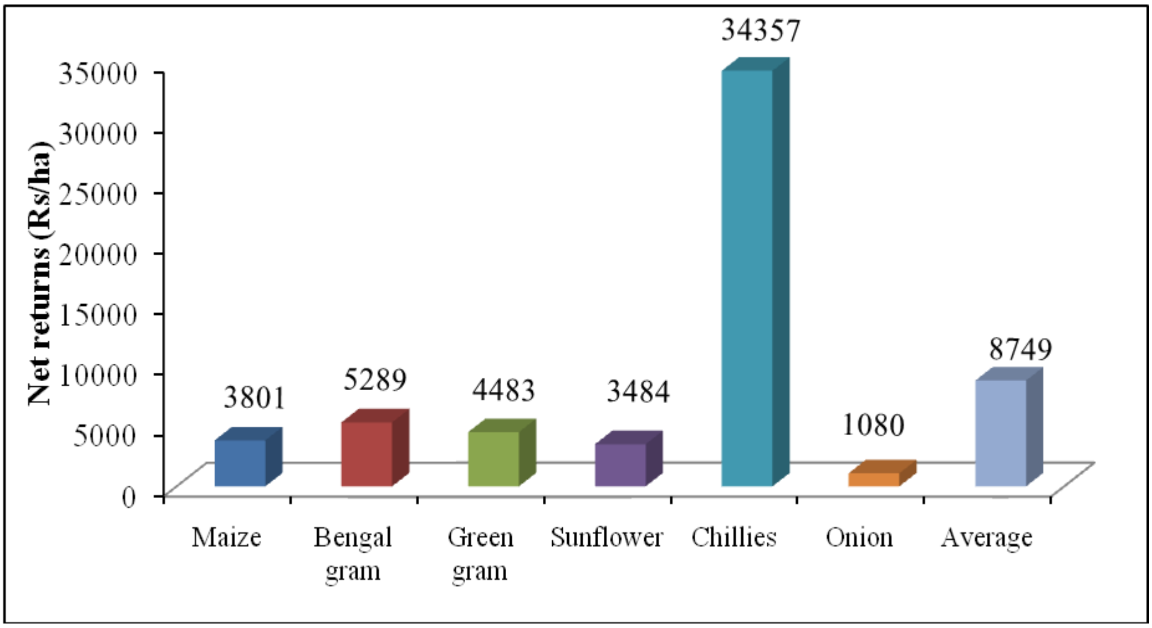


Figure 10: Ecosystem services of food production in Adavalli-2 Microwatershed

The average value of ecosystem service for fodder production is around Rs 4631/ ha/year of maize crop (Table 22).

Table 22: Ecosystem services of fodder production in Adavalli-2 Microwatershed

Production items	Crops	Area in ha	Yield (Qtl/ha)	Price (Rs/Qtl)	Returns (Rs/ha)	Total returns (Rs)
Cereals	Maize	2.83	2.06	2250	4631	13125

The water demand for production of different crops was worked out in arriving at the ecosystem services of water support to crop growth. The data on water requirement for producing one quintal of grain is considered for estimating the total value of water required for crop production. The per hectare value of water used and value of water was maximum (Table 23 and Figure 11) in Bengal gram (Rs 41564) followed by Green gram (Rs 40906), Sunflower (Rs 20351), Maize (Rs 15217), chillies (Rs. 2438) and Onion (Rs 672).

Table 23: Ecosystem services of water supply in Adavalli-2 Microwatershed

Crops	Yield (Qtl/ha)	Virtual water (cubic meter) per ha	Value of Water (Rs/ha)	Water consumption (Cubic meters/Qtl)
Bengal gram	6.02	4156	41564	691
Green gram	5.92	4091	40906	691
Chilli	7.41	244	2438	33
Maize	12.45	1522	15217	122
Onion	2.47	67	672	27
Sunflower	6.06	2039	20391	337
Grand Total	7.36	1960	19600	266

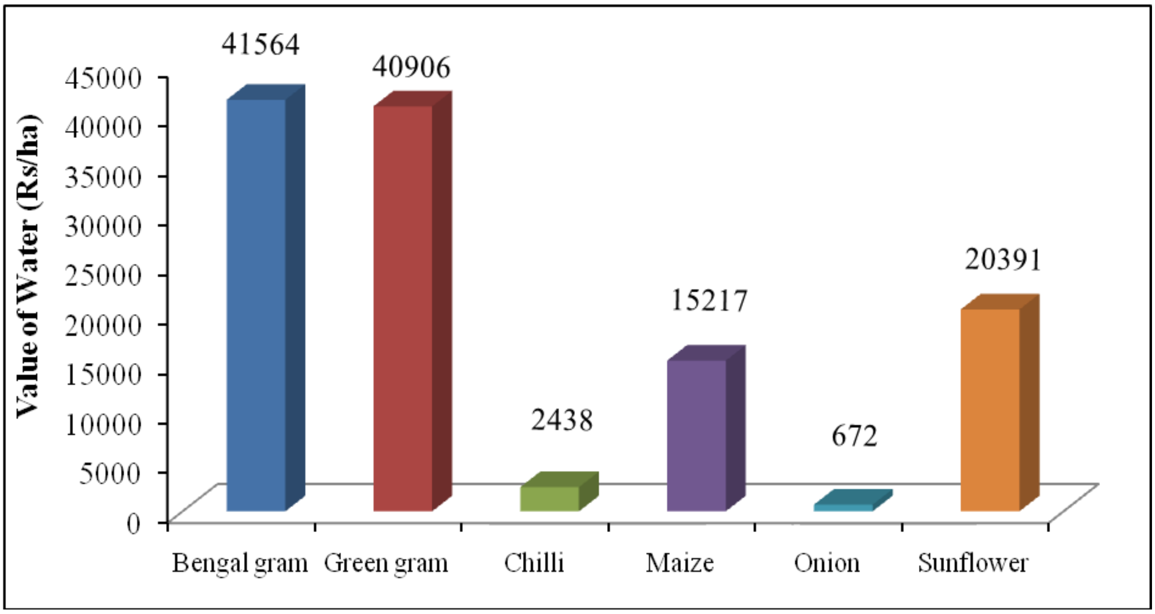


Figure 11: Ecosystem services of water supply in Adavalli-2 Microwatershed

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 departments (Table 24).

Table 24: Farming constraints related land resources of sample households in Adavalli-2 Microwatershed

Particulars	Per cent
Farmers awareness of climate change	
Yes	20
No	80
Perception on climate change	
Decrease in rainfall	100
Increase in temperature	0
Availability agricultural technology information	
Yes	0
No	100

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