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Land Suitability Evaluation for Legume Crops and Horticulture Crops in Paman Kallur-1 Micro-Watershed using Geospatial Techniques

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A B S T R A C T

A detailed study was conducted to assess the land capability and land suitability of Paman kallur-1 micro-watershed. The micro watershed is located in Lingasugur taluk, Raichur district, Karnataka, India, which lies between the latitude and longitude of $76^0$37' N – $16^0$7' E and $76^0$39' N– $16^0$5' E. Initially, land resource survey was carried out at 1:8000 scale to derive soil phase units based on land surface and profile characters. Four soil series were identified and further mapped into six soil phase units. The soil phase unit "THDhD2g1S1R1" covered maximum area of 137 ha (32.22%) with moderate slope (5-10%) and moderate erosion in Paman kallur-1 micro-watershed. Land capability with subclasses in the study area was III*es* having limitations of soil erosion, texture, soil drainage, soil fertility and topography. Therefore, 97.15 per cent of the study area is suitable for legume and horticultural purposes. Furthur, Soil phase unit wise and with corresponding survey number, crop plan with suitable interventions for field crops, horticultural crops, vegetables, millets and pulses were prepared for the benefit of the farmers.

Introduction

The balance between economic viability and destruction of a nation often depends on how the land resource base is managed. Proper land management cannot be done without land use planning (Geetha *et al.*, 2017). An essential part of land use planning is land evaluation. Land evaluation is the assessment of the potential of land for alternative uses using systematic comparison of the land use requirements (LURs) with land quality/

characteristics (Dent and Young, 1981). Land evaluation forges a link between the basic survey of resources and the taking of decision on land use planning and management. It puts at the disposal of users relevant information about land resources that are necessary for planning development and taking management decisions (Kharche and Gaikawad, 1993).

North-Eastern dry zone part of Karnataka is having very hot and semi-arid climate. The rainfall region is very erratic and prone to drought and most of the region is covered with black cotton soil with Pigeon pea, Paddy and Cotton as major crops. Soil which is a natural resource has variability inherent to how the soil formation factors interact within the landscape. However, variability can occur also as a result of cultivation, land use and erosion. Salviano (1996) reported spatial variability in soil attributes as a result of land degradation due to erosion.

The land resources inventory in the micro watershed for various crops is necessary to choose the right crop and suitable variety for the area. In order to asses, a detailed land resource inventory and its evaluation were undertaken using geospatial technology. The geospatial techniques are essential for the investigation of spatial variations of soil and crop parameters across agricultural fields, which can lead to the efficient implementation of site-specific management systems (Najafian *et al.*, 2012).

Assessing the extent and degree of suitability of the land resources in the micro watershed for various crops is necessary to choose the right crop and suitable variety for the area. In this regard, a detailed land resource inventory and its evaluation were undertaken using geospatial technology in Paman kallur-1 micro watershed of North Eastern Dry Zone of Karnataka, to characterize land capability and crop suitability.

Materials and Methods

Paman Kallur-1 micro-watershed (Chiknagnur sub-watershed, Lingasugur taluk, Raichur district) is located in between $76^0$37’ N – $16^0$7’ E and $76^0$39’ N– $16^0$5’ E, covering an area of about 425.72 ha, bounded by Hirenagnur, Gejjalagata, Paman Kallur and Chikhesrur villages (Fig. 1).

The average rainfall of this region is 335 mm. geologically the study area is characterized by granite and gneiss. The detailed land resource survey (at 1:8000 scale) of the entire micro-watershed was carried out in the year 2016, with the help of cadastral map overlaid on IRS LISS-IV merged Cartosat-1 imagery having 2.5 m spatial resolution (Fig. 2). Rapid traversing was carried out to record soils at varying physiographic position. Based on geology, drainage pattern, surface features, slope characteristics and land use, landforms and soil profile were identified (Soil Survey Staff 1999). Four soil series were identified and further mapped into six soil phase units and their area distribution and description were mapped in Figure 3 and Table 1. Morphological characteristics of different soil are shown in Table 3. These data have been used to evaluate the land capability classification (Sehgal, 1996) and land suitability. For various field crops and horticultural crops based on the soil limitations, climatic regimes and land characteristics the suitable interventions with crop plan were developed by NBSS & LUP.

Results and Discussion

Land capability classification

The classification is based on the inherent soil characteristics, external land features and environmental factors that limit the use of land (Table 2). Based on the susceptibility of soils to erosion (e), soils (s), topography (t) and

drainage (d) limitations the study area was classified into different land capability classes. Arable lands that are fit for agriculture were grouped under I to IV and non-arable lands were grouped class VI to VIII. Soil morphological characteristics of soil units are matched with land capability classification (Sehgal, 1996).

Based on soil properties, the soils of Paman kallur-1 micro-watershed of Lingasugur taluk have been classified into only one land capability class *i.e.*, III*es* (Fig. 4). All the series of micro-watershed was grouped under class III which is moderately good cultivable lands. These soils were marginally cultivable lands due to severe limitations of erosion, Slope, texture, soil depth limitations. The entire micro-watershed area was fall under IIIes of about 414 ha. Similar findings were also reported by (Leelavathi *et al.*, 2009).

Land suitability classification for crops

Land suitability was evaluated following FAO (1979) guidelines. It involved formulation of climate and soil requirements of the crop and ratings of these parameters highly suitable (S1), moderately suitable (S2), marginally suitable (S3), and unsuitable (N1). The suitability criteria for sorghum, cotton, tomato and coconut are given by Naidu *et al.*, (2006) was followed and was given in Table 2.

Land suitability for Horticultural crops

The suitability assessment for horticultural crops in Paman kallur-1 MWS showed that an area of 60 ha (14.10 %) was moderately suitable (S2) and 354 ha (83.06%) was marginally suitable (S3) for Custard Apple with limitations of rooting condition, slope, texture and gravel (Fig. 10). Sapota, Jamun, Guava, Jackfruit, Musambi and Pomegranate covering an area of 197 ha (46.32 %) was marginally suitable and 216 ha (50.83%) was currently not suitable with the limitations of rooting condition, slope, texture and gravel (Fig. 11, 12, 14, 15, 17 and 18). Mango and Tamarind tree crops were found to be currently not suitable (N1) due to severe limitations of rooting condition slope, texture and gravel (Fig. 13 and 16, respectively).

Land suitability for legume crops

The suitability assessment for Pulse crops in Paman kallur-1 MWS showed that an area of 393 ha (90.05 %) was marginally suitable (S3) and 30 ha (7.11%) was currently not suitable (N1) for Ground nut with limitations of rooting condition, texture, slope and gravel (Fig. 5).

In case of Green gram, Bengal gram and Black gram an area of 246 ha (57.83%) was moderately suitable,137 ha (32.22%) area was marginally suitable and 30 ha(7.11%) area was found to be currently not suitable (N1) due to severe limitations of rooting condition slope, texture and gravel (Fig. 6, 7 and 8 respectively).

Redgram covering an area of 60 ha (14.10%) was moderately suitable, 323 ha (75.95%) was marginally suitable and 30 ha (7.11%) area was found to be currently not suitable (N1) due to severe limitations of rooting condition slope, texture and gravel (Fig. 9). Similar findings were also reported by (Rajesh *et al.*, 2018).

Proposed crop plan

Crop plan for field crops and horticulture crops for HEGmC2 soil phase unit has suitable interventions such as, Deep and wider size pit, Drip irrigation with suitable soil and water conservation measures Cultivation on raised beds with mulches, Graded bunds and strengthening of field bunds for vegetables and field crops.

Table.1 Mapping units description of Paman kallur-1 micro-watershed

Sl. No.	Map symbol	Description	ha (%)
1	CHRhC2g1S1	Chatra series, Shallow (25-50 cm), Gently sloping (1-3%), Sandy Clay loam, textured soil with moderate erosion, Gravelly(15-35%), Strong (0.01 to 0.1%).	60 (14.08)
2	CHRhD2g1S1R1	Chatra series, Very shallow (>25 cm), Moderately sloping (5-10%), Sandy Clay loam, textured soil with moderate erosion, Gravelly(15-35%), Strong (0.01 to 0.1%), Fairly rocky(2-10%).	49 (11.46)
3	CHRhE2g1S1R1	Chatra series, Very shallow (>25 cm), Strongly sloping (10-15%), Sandy Clay loam, textured soil with moderate erosion, Gravelly (15-35%), Strong (0.01 to 0.1%), Fairly rocky(2-10%).	30 (7.11)
4	HEGmC2	Heggapur series, Moderately shallow (50-75 cm), Gently sloping (1-3%), Clay, textured soil with moderate erosion.	60 (14.1)
5	KMThC2g1S1	KumarKhed Tanda series, Shallow (25-50 cm), Gently sloping(1-3%), Sandy Clay loam, textured soil with moderate erosion, erosion, Gravelly(15-35%), Strong (0.01 to 0.1%).	77 (18.19)
6	THDhD2g1S1R1	Thodki series, Moderately shallow (50-75 cm), Moderately sloping (5-10%), Sandy Clay loam, textured soil with moderate erosion, Gravelly (15-35%), Strong (0.01 to 0.1%), Fairly rocky (2-10%).	137 (32.22)
7	Others*	Water body	12 (2.85)
8	**Total**		**425.72**

Table.2 Suitability criteria table

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
Length of Growing period	Days	>110	90-110	60-90	<60
Soil drainage	class	Well to mod. drained	imperfect	Poorly/excessively	V. poorly
Soil reaction	pH	5.5-7.5	7.6-8.5, 4.5-5.4	8.6-9.5, 4.0-4.4	<4.0
Surface soil texture	Class	L, sil, Sl, Cl, Sicl, Scl	Sic, C, Sc	Ls, S, c>60%	S, fragmental skeletal
Soil depth	Cm	>75	50-75	25-50	<25
Gravel content	% vol.	<15	15-30	30-60	>60
Salinity (EC)	dSm^{-1}	<1.0	1.0-2.0	2.0-4.0	>4
Sodicity (ESP)	%	<10	10-15	15-25	>25

Table.3 Physico-chemical properties of soil series

Series	Mapping unit	Geology	Depth (cm)	Slope %	Colour		Texture		Land use	Drainage
					Surface	Subsurface	Surface	Subsurface		
CHR	CHRhC2g1S1	Granite	25-50	3-10%	5 YR 4/4,3/3	5 YR 3/4,4/6	Sandy clay loam, sandy loam	Sandy clay loam, sandy loam	Agriculture	Well drained
	CHRhD2g1S1R1	Granite								
	CHRhE2g1S1R1	Granite								
HEG	HEGmC2	Gneiss	50-75	1-5 %	10YR 3/3,3/1	10YR 3/3,3/2,,4/4	Sandy clay loam	Sandy clay loam	Agriculture	Well drained
KMT	KMThC2g1S1	Gneiss	25-50	3-10%	7.5 YR 4/3,5/3	7.5 YR 4/3,3/2	Sandy clay	Sandy Clay	Agriculture	Moderately well drained
THD	THDhD2g1S1R1	Granite	50-75	1-5 %	5 YR 3/4,2.5 YR 5/6	5 YR 3/4,2.5 YR 3/4	Sandy clay loam	Sandy clay loam	Agriculture	Moderately well drained

Series	Mapping unit	Rockiness	Gravelliness %	Stoniness	Structure		Consistency		pH	EC
					Surface	Subsurface	Surface	Subsurface		
CHR	CHRhC2g1S1	nil	Gravelly	strong	1 fmsbk	2 fmsbk	sh, fr, ss, sp	h, fr, vs, vp	Neutral	Non saline
	CHRhD2g1S1R1	Fairly rocky								
	CHRhE2g1S1R1	Fairly rocky								
HEG	HEGmC2	nil	nil	nil	1ffmgrsbk	2 fmsbk	sh, fr, ss, sp	h, fr, vs, vp	Moderately alkaline	Non saline
KMT	KMThC2g1S1	nil	Gravelly	strong	1 fmsbk	2 fmsbk	sh, fr, ss, sp	vh, fr, vs, vp	Slightly alkaline	Non saline
THD	THDhD2g1S1R1	Fairly rocky	Gravelly	strong	1 fmsbk	2fmsbk	sh, fr, ss, sp	h, fr, s, vp	Moderately alkaline	Non saline

Note: sh – slighly hard, fr – friable, ss – slightly sticky, sp – slightly plastic, fi – firm, vs – very sticky, v p – very plastic, h – hard, m – medium, sbk – sub angular blocky, abk-angular bloky, gr-granular, c – coarse, fc –few common roots, f-fine root

Table.4 Proposed Crop Plan for Paman kallur-1 Micro-watershed

LMU	Mapping unit	Survey number	Field crops	Horticulture crops	Suitable Intervention
LMU-1	CHRhC2g1S1 CHRhD2g1S1R1 CHRhE2g1S1R1	**Hirenagnur:-** 165,70,193,194,198, 193,210,209,208. **Gejjalagatta:-** 76,73,74,75,3 **Chikhesrur:-** 23,22,65,62,66,61,58 ,35,34,33,30,32,180, 149,51,151,158.	**Sole crop**; sorghum, Bajra, Navni, Red gram, Green gram, Cotton, Maize, Sun flower, black gram, bengal gram, ground nut , maize	**Fruit crops :** custard apple, Tamarind, jamun, Ber, Sapota, Anola, **Veg:** Onion, Tomato, Brinjal, Chilli, Bhendi, Green leaf, cury leaf, Tomato, **Flowers**-Gaillardia, marigold, Chrysanthemum, lilly	Deep and wider size pit, Drip irrigation with suitable soil and water conservation measures Cultivation on raised beds with mulches and drip.
LMU-2	KMThC2g1S1	**Paman kallur:-** 172,171,170/1,173/2, 170/2,7,8,169,179,9(1),170,177/1,177/2,1 80/1,180/1,152,150,1 84. **Hirenagnur:-** 212. **Chikhesrur:-** 27,26,31.	**Sole crop**; sorghum, Bajra, Navni, Red gram, Green gram, Cotton, Maize, Sun flower, black gram, bengal gram, ground nut , maize	**Fruit crops :** custard apple, Tamarind, jamun, Ber, Sapota, Anola, **Veg:** Onion, Tomato, Brinjal, Chilli, Bhendi, Green leaf, cury leaf, Tomato, **Flowers**-Gaillardia, marigold, Chrysanthemum, lilly	Deep and wider size pit, Drip irrigation with suitable soil and water conservation measures Cultivation on raised beds with mulches and drip.
LMU-3	THDhD2g1S1R1	**Hirenagnur:-** 84,192,191,200,205, 206,207,204,203. **Gejjalagatta:-** 4(1),2.	**Sole crop**; sorghum, Bajra, Navni, Red gram, Green gram, Cotton, Maize, Sun flower, black gram, bengal gram, ground nut , maize	**Fruit crops :** custard apple, Tamarind, jamun, Ber, Sapota, Anola, **Veg:** Onion, Tomato, Brinjal, Chilli, Bhendi, Green leaf, cury leaf, Tomato, **Flowers**-Gaillardia, marigold, Chrysanthemum, lilly	Deep and wider size pit, Drip irrigation with suitable soil and water conservation measures Cultivation on raised beds with mulches and drip.
LMU-4	HEGmC2	**Hirenagnur:-** 186/1,189,70,158,15 5,154/2,154/3.	**Sole crop;** sorghum, Bajra, Navni, Red gram, Green gram, Cotton, Maize, Sun flower, black gram, bengal gram, ground nut , maize	**Fruit crops :** Sapota, Jamun, Guava, Tamarind, Lime, Musambhi, Custard apple, Jackfruit, Amla, pomegranate, **Veg:** Onion, Tomato, Brinjal, Chilli, Bhendi, Green leaf, curry leaf, Tomato, **Flowers**-Gaillardia, marigold, Chrysanthemum, lilly	Deep and wider size pit, Drip irrigation with suitable soil and water conservation measures Cultivation on raised beds with mulches and drip. Graded bunds and strengthening of field bunds

Fig.1 Location map of Paman kallur-1 micro-watershed

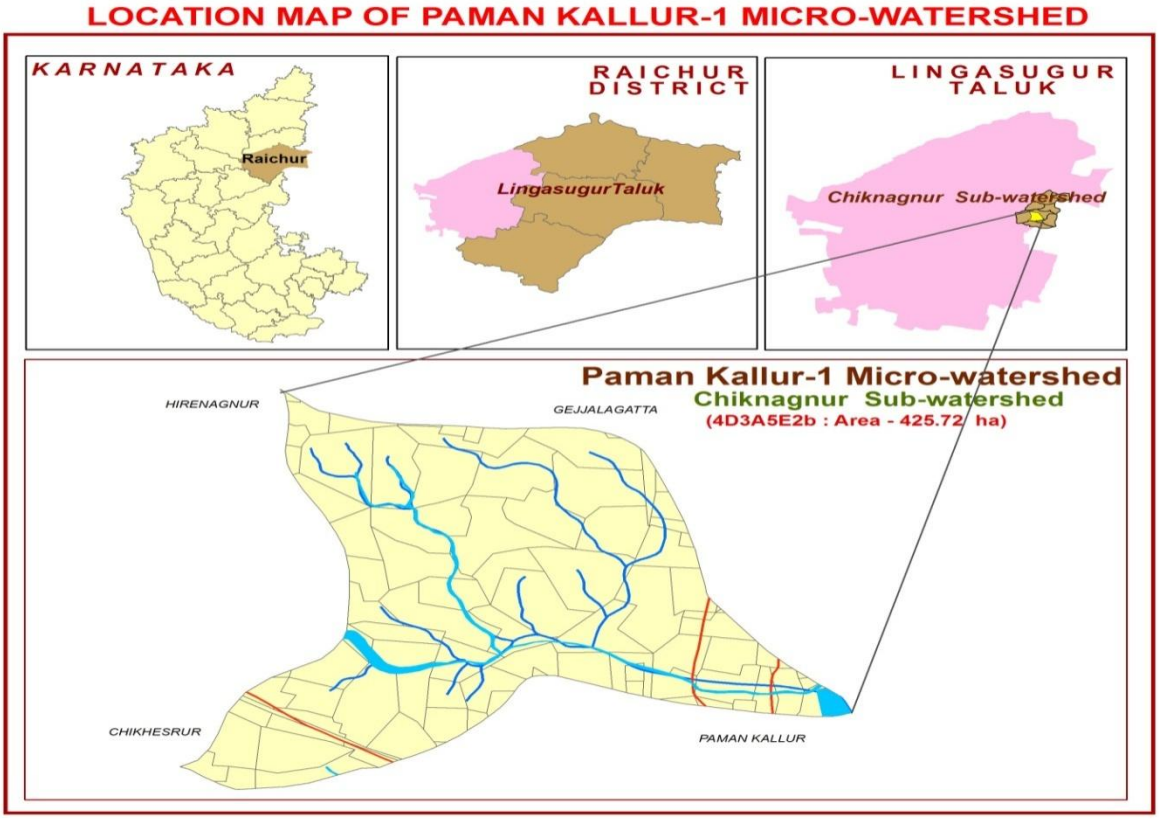


Fig.2 Satellite image of Paman kallur-1 micro-watershed

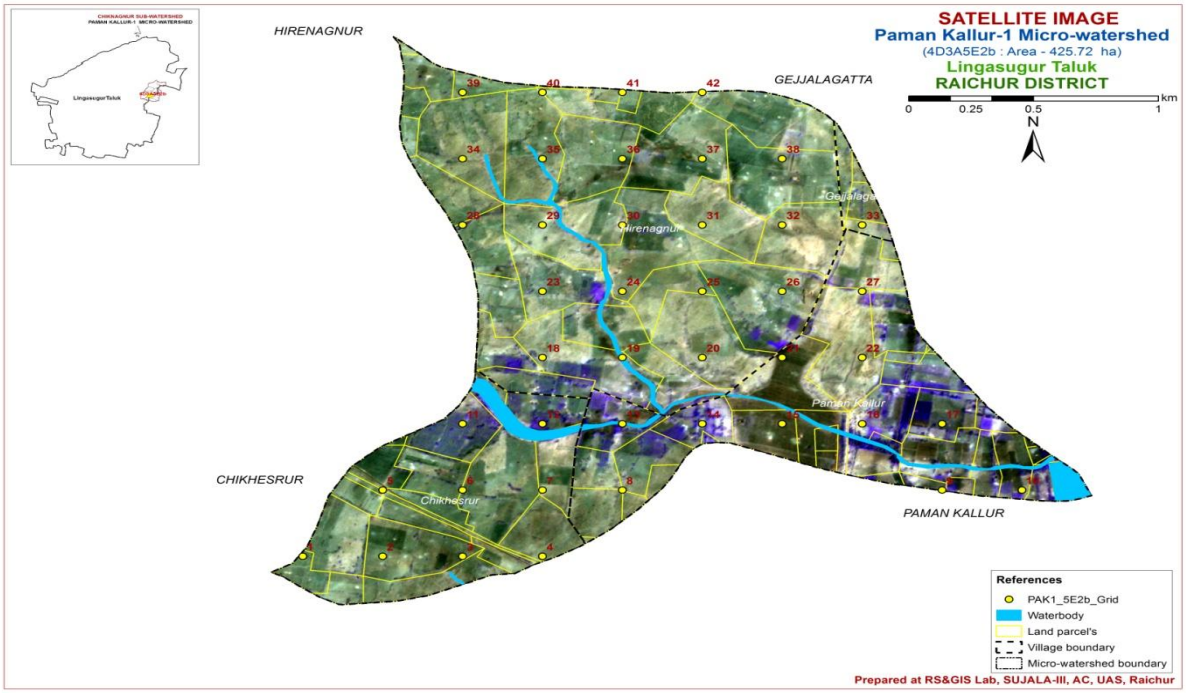


Fig.3 Soil map of Paman kallur-1 micro-watershed

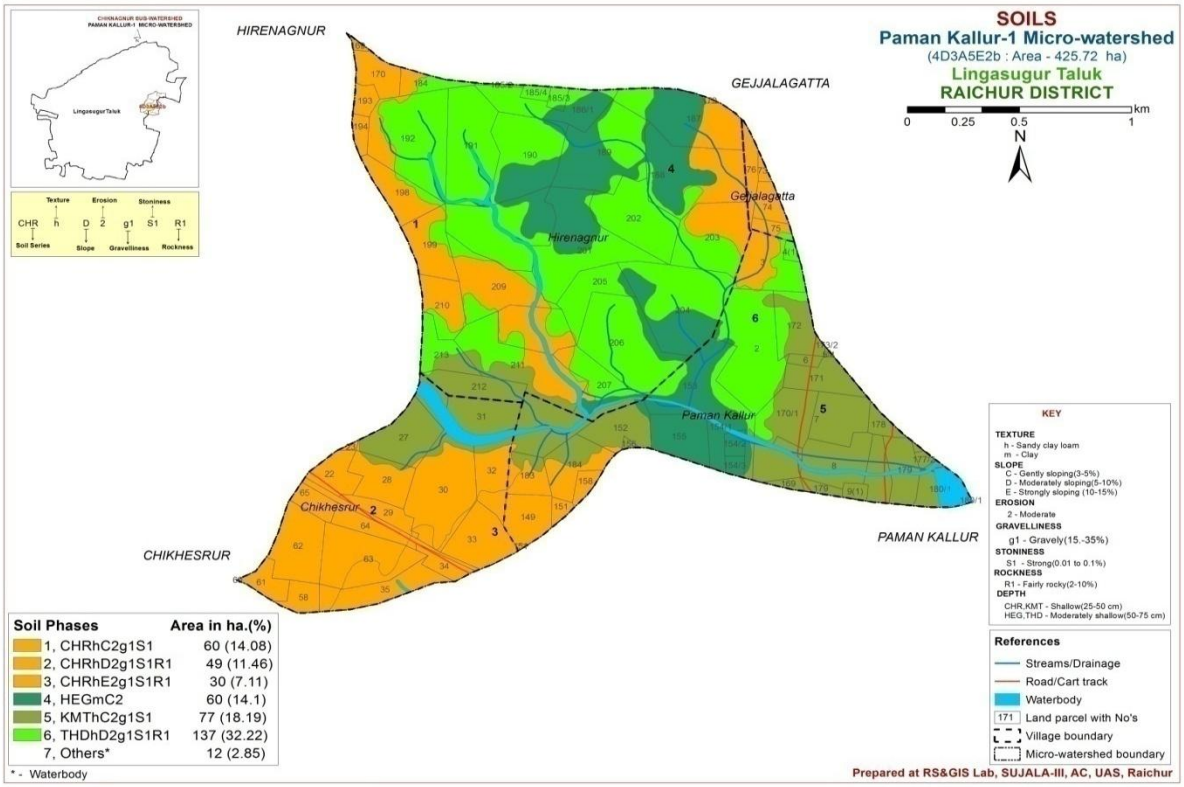


Fig.4 Land capability map of Paman kallur-1 micro-watershed

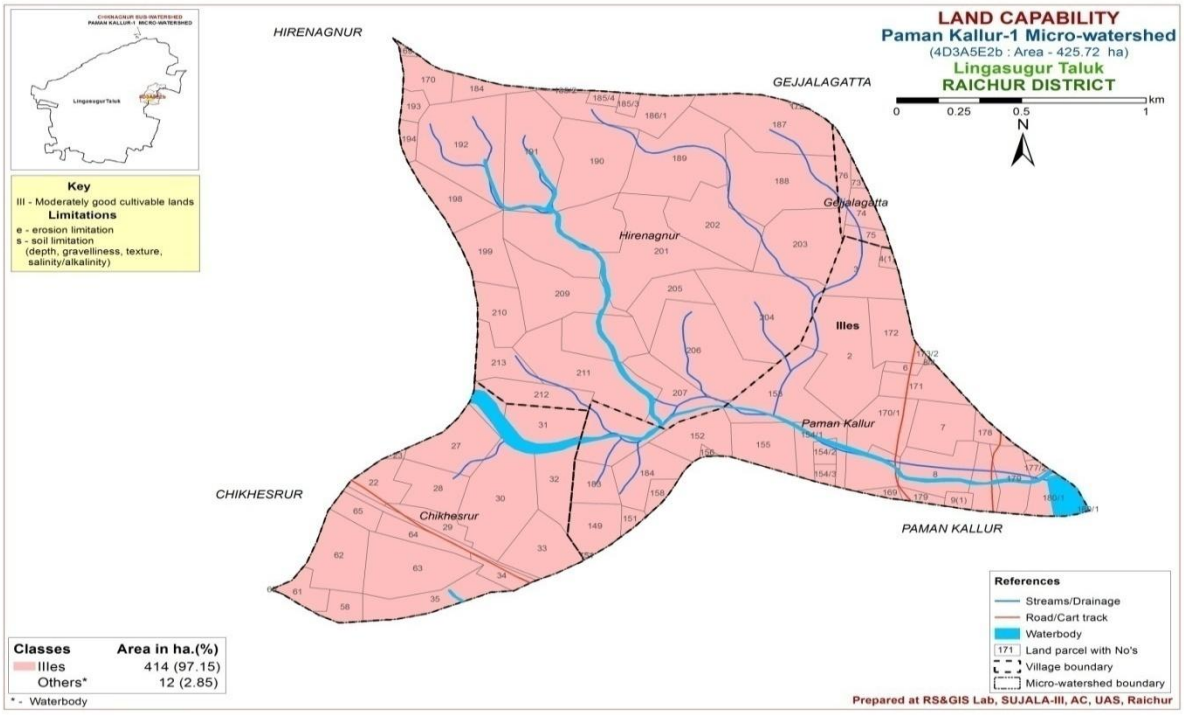


Fig.5 Land suitability map for Ground nut in Paman kallur-1 micro-watershed

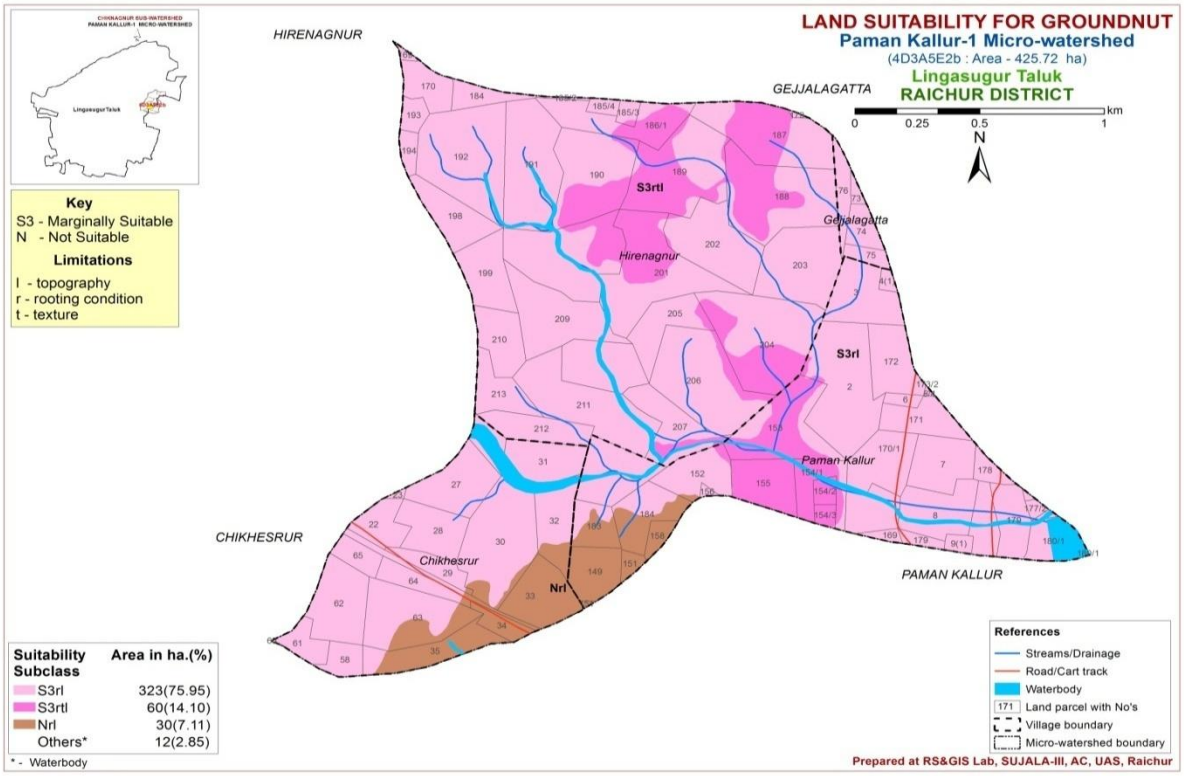


Fig.6 Land suitability map for Green gram in Paman kallur-1 micro-watershed

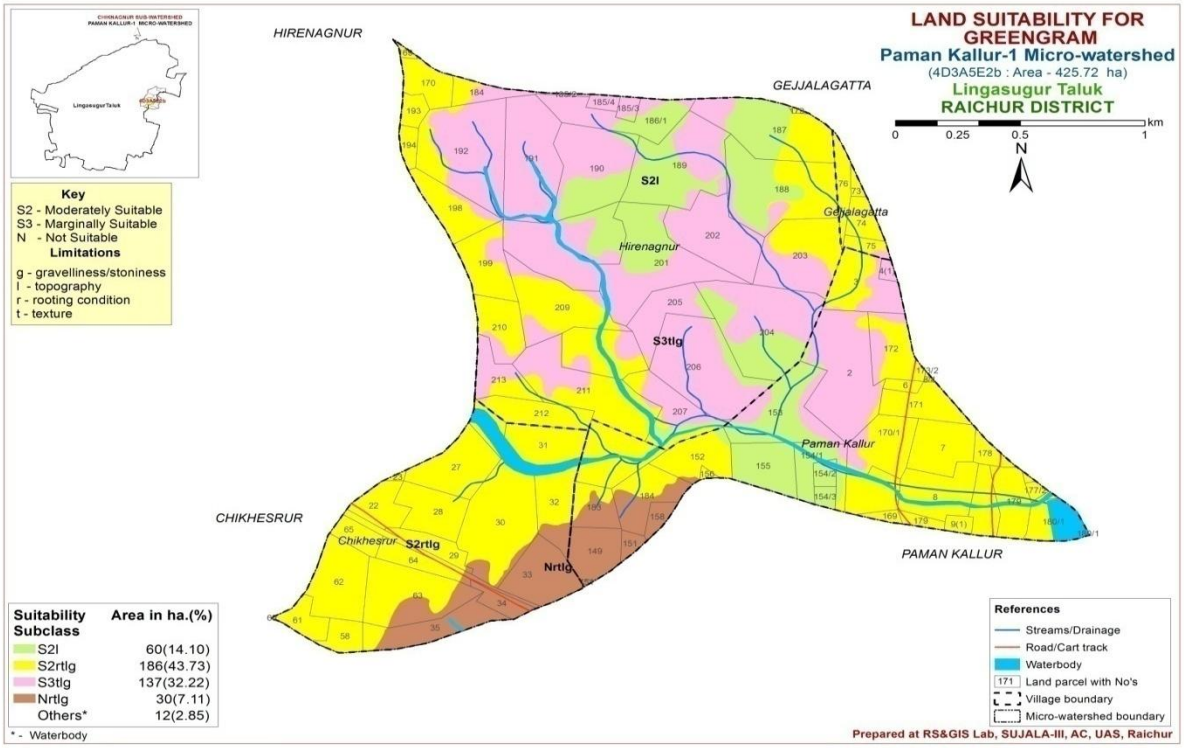


Fig.7 Land suitability map for Bengal gram in Paman kallur-1 micro-watershed

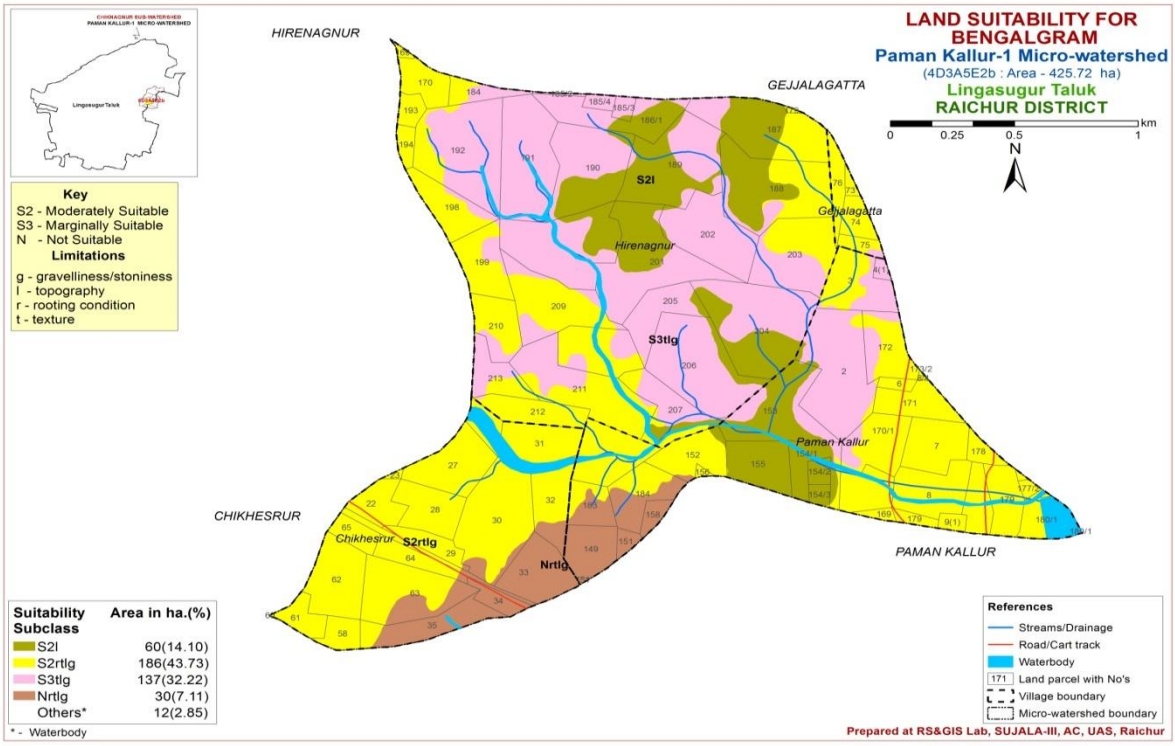


Fig.8 Land suitability map for Black gram in Paman kallur-1 micro-watershed

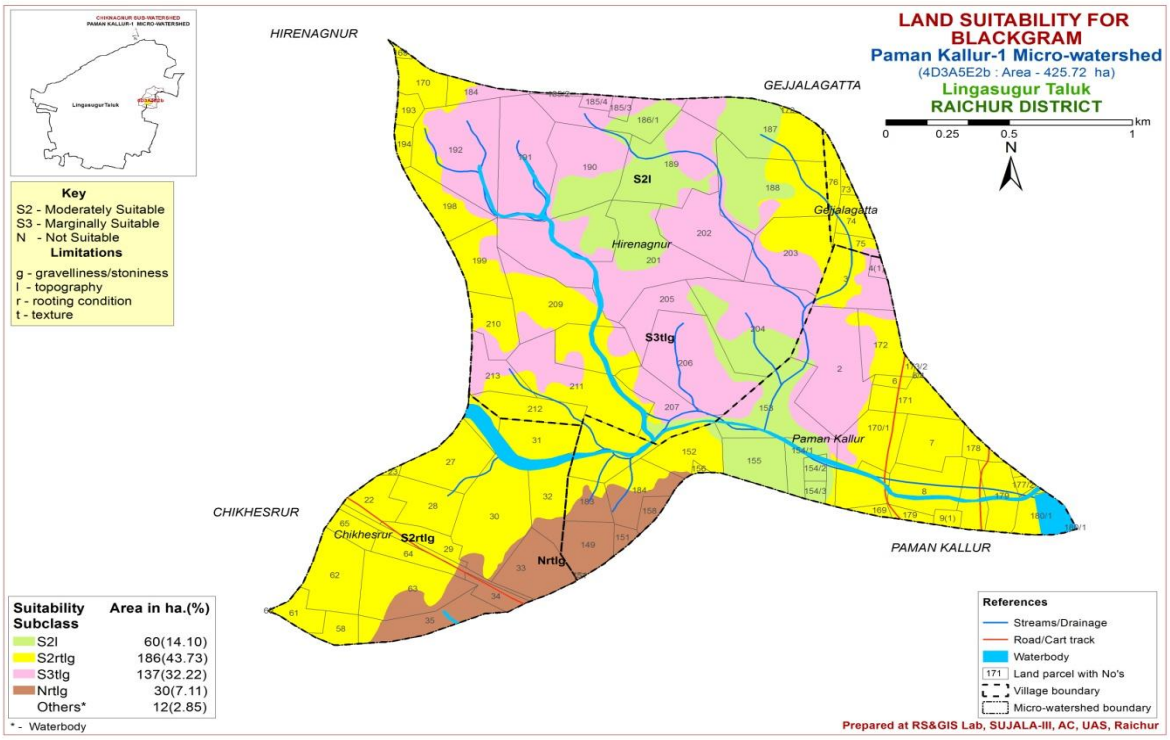


Fig.9 Land suitability map for Redgram in Paman kallur-1 micro-watershed

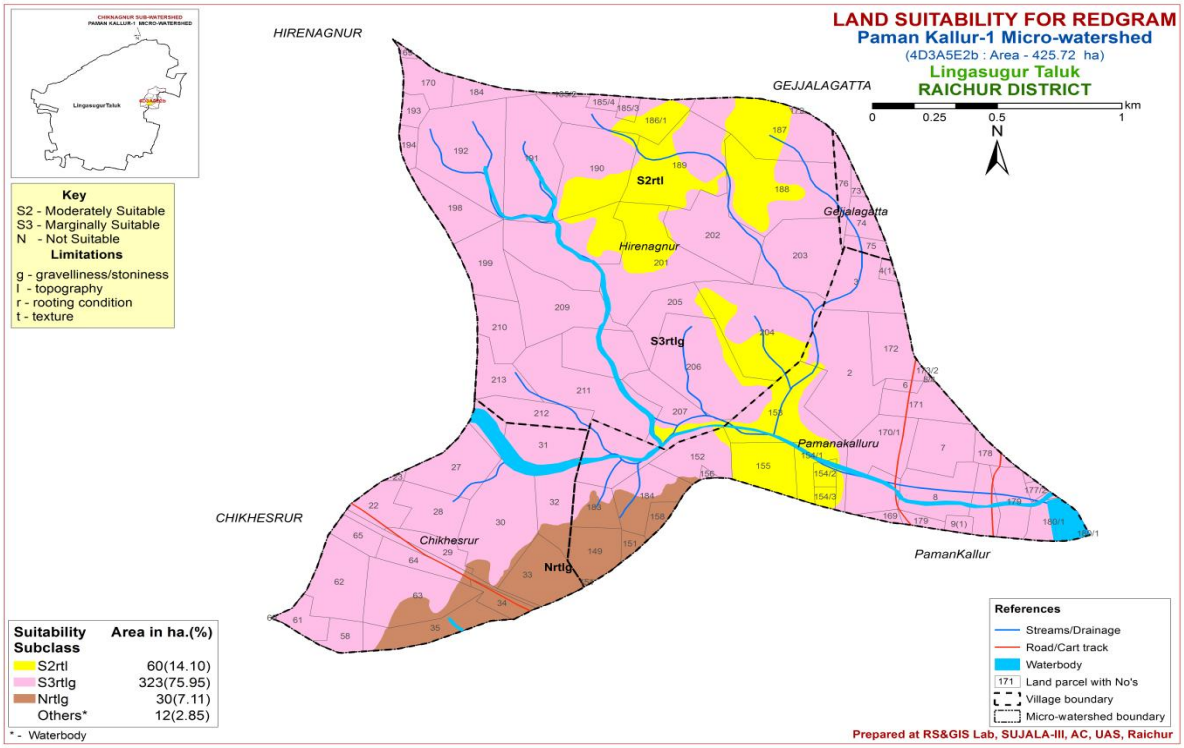


Fig.10 Land suitability map for Custard apple in Paman kallur-1 micro-watershed

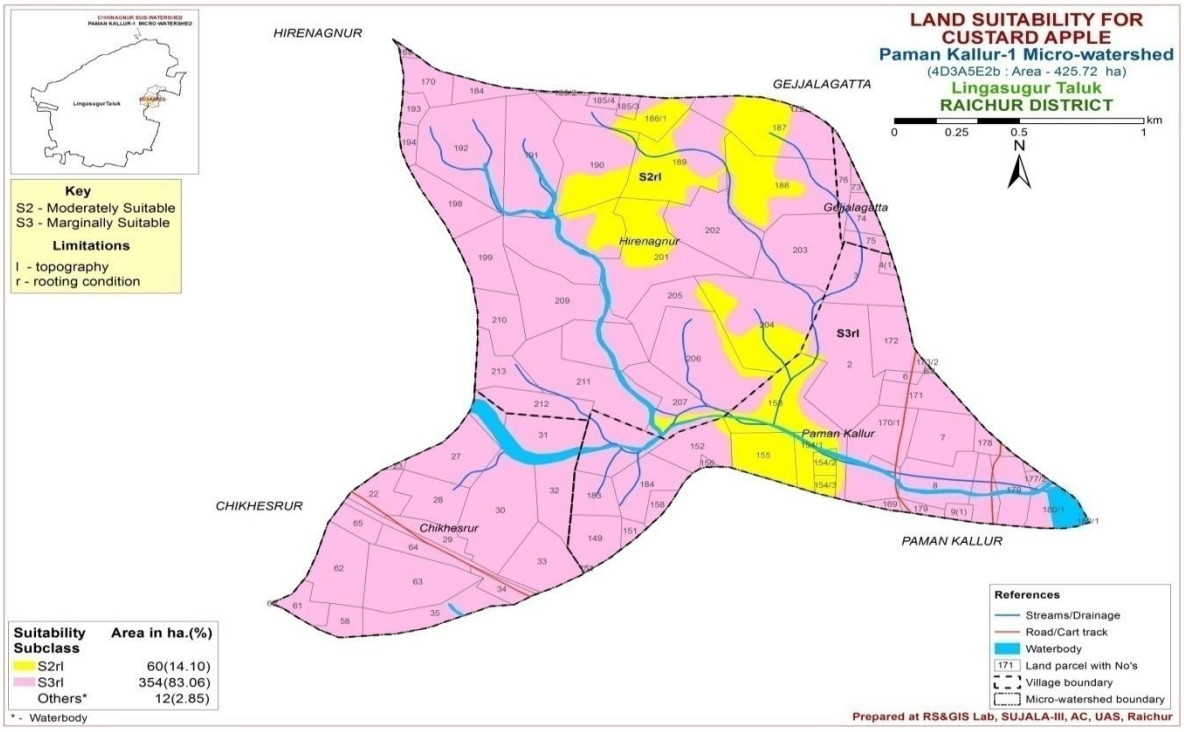


Fig.11 Land suitability map for Guava in Paman kallur-1 micro-watershed

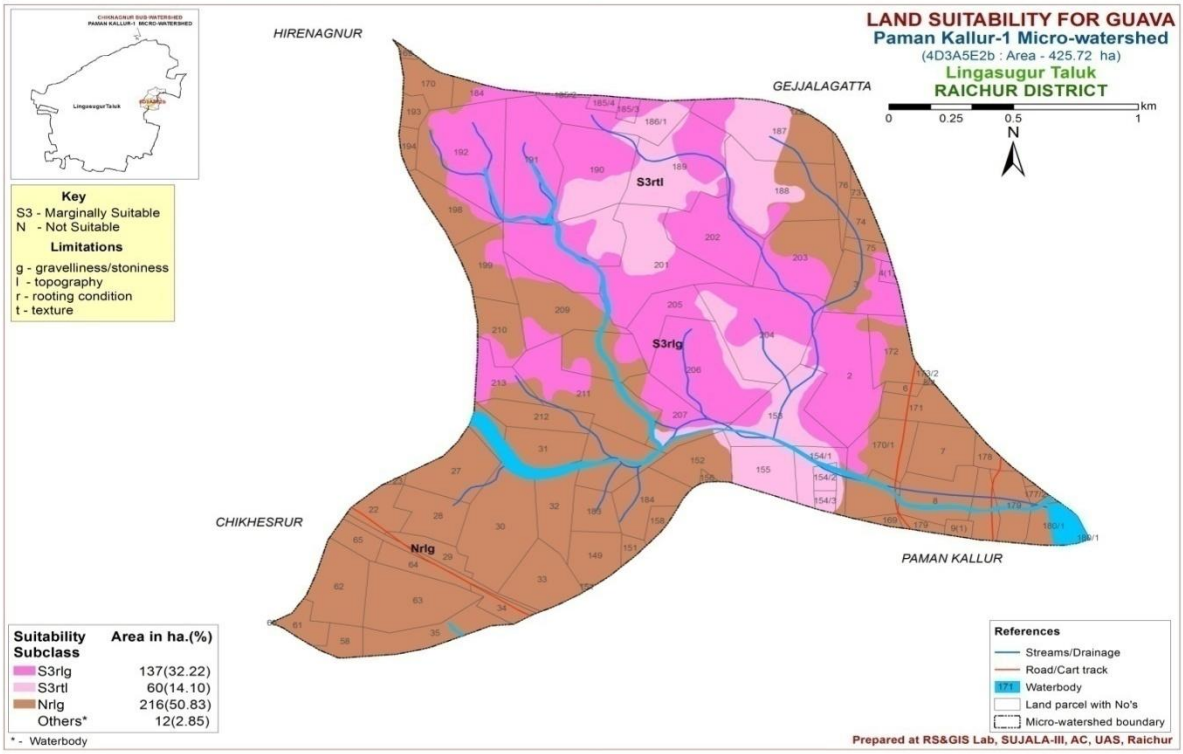


Fig.12 Land suitability map for Jamun in Paman kallur-1 micro-watershed

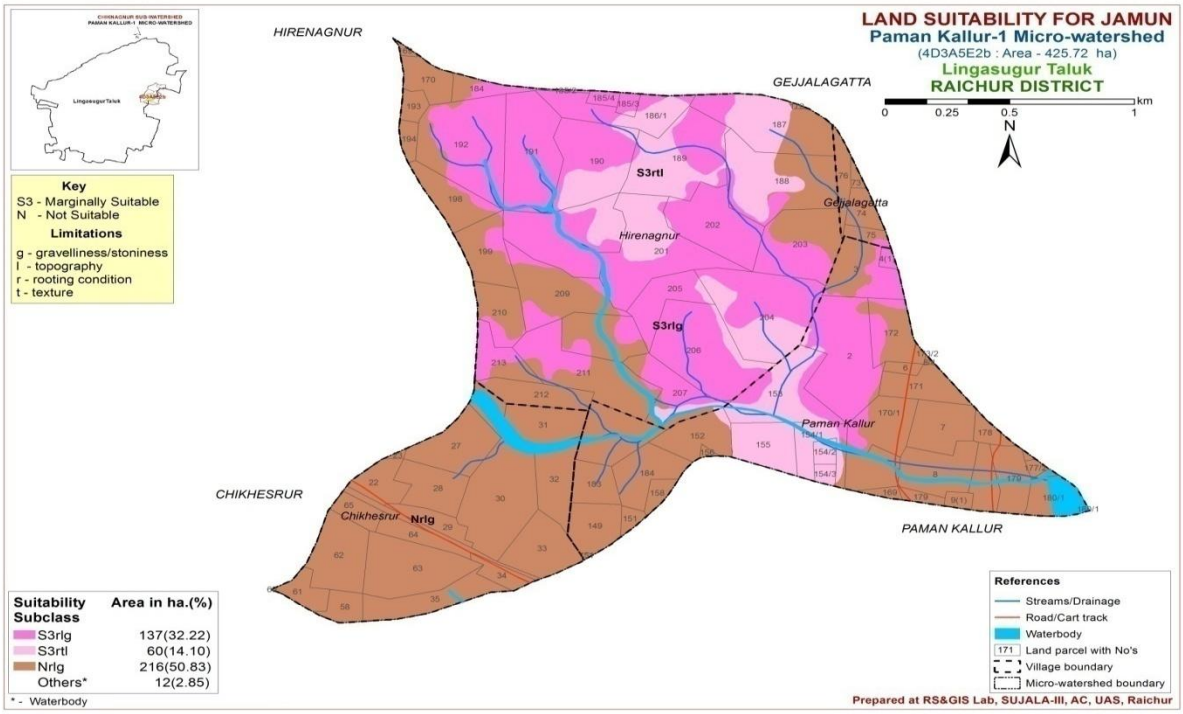


Fig.13 Land suitability map for Mango in Paman kallur-1 micro-watershed

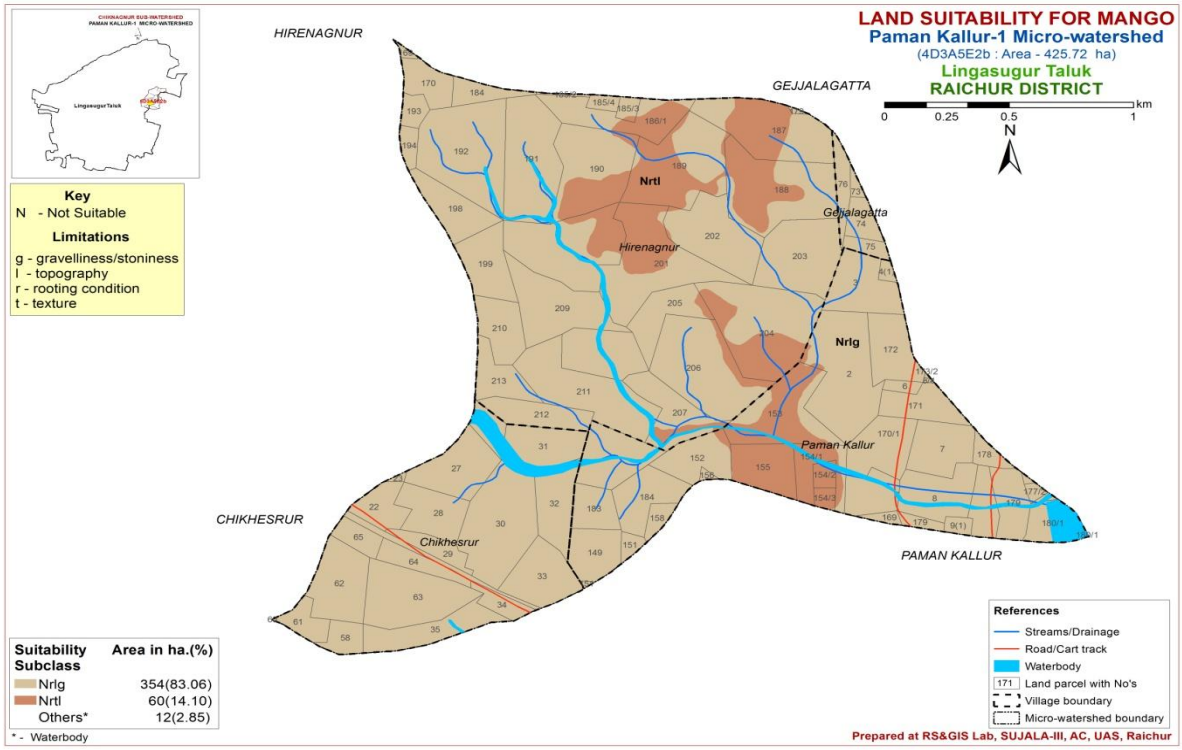


Fig.14 Land suitability map for Sapota in Paman kallur-1 micro-watershed

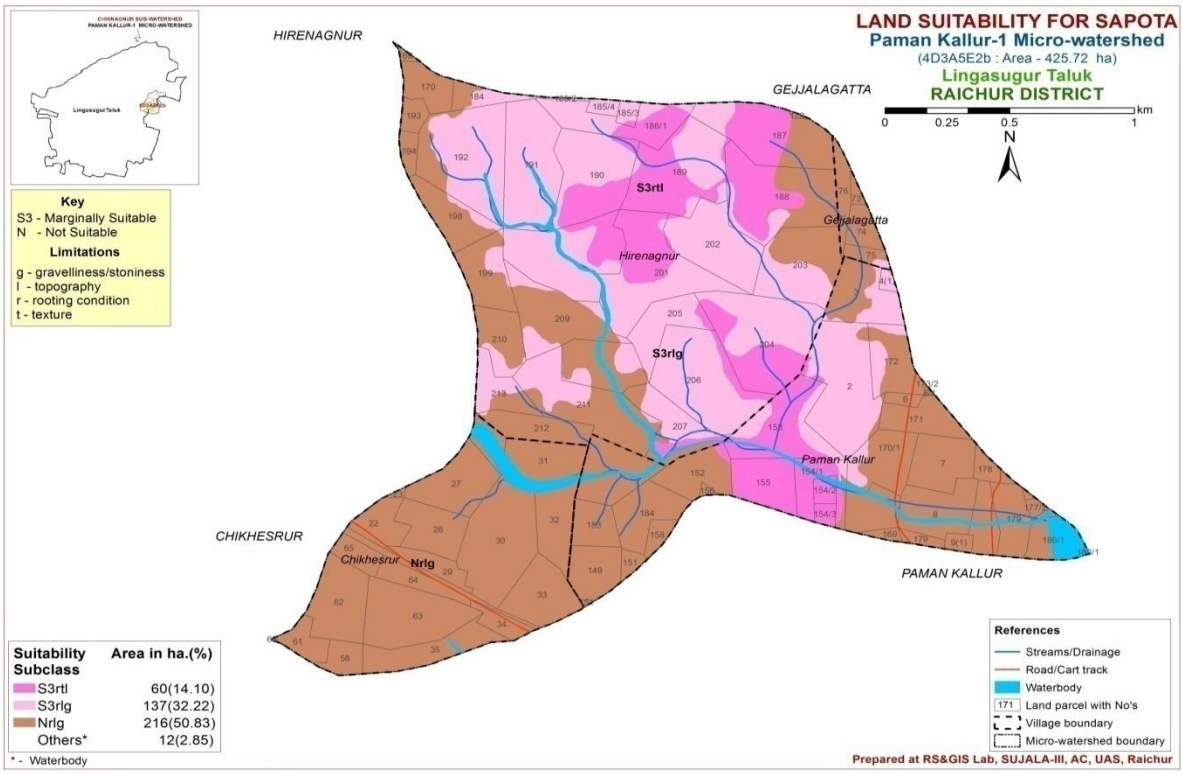


Fig.15 Land suitability map for Musambi in Paman kallur-1 micro-watershed

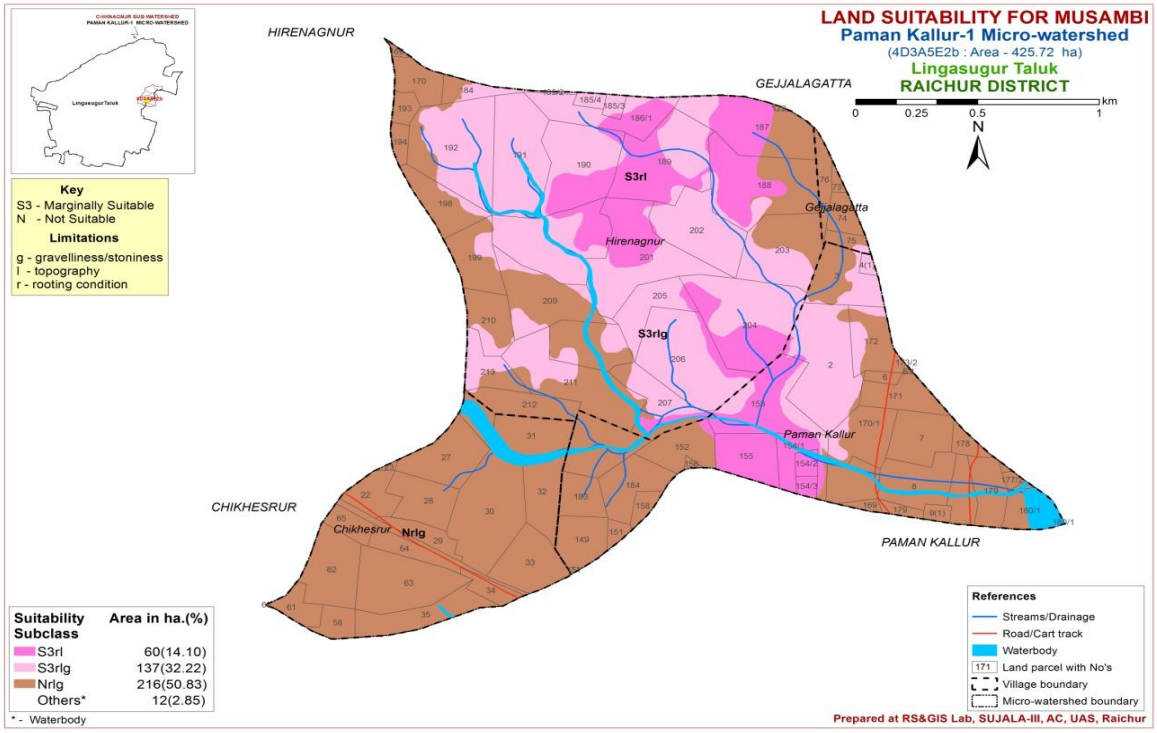


Fig.16 Land suitability map for Tamarind in Paman kallur-1 micro-watershed

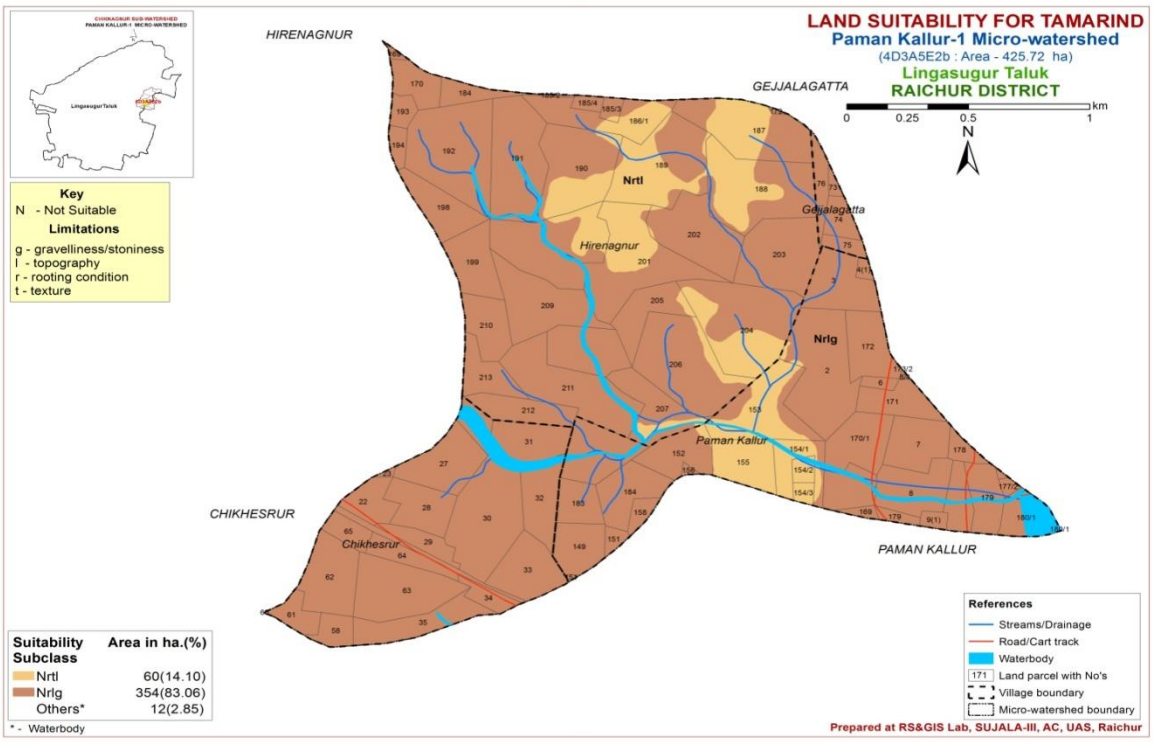


Fig.17 Land suitability map for Jackfruit in Paman kallur-1 micro-watershed

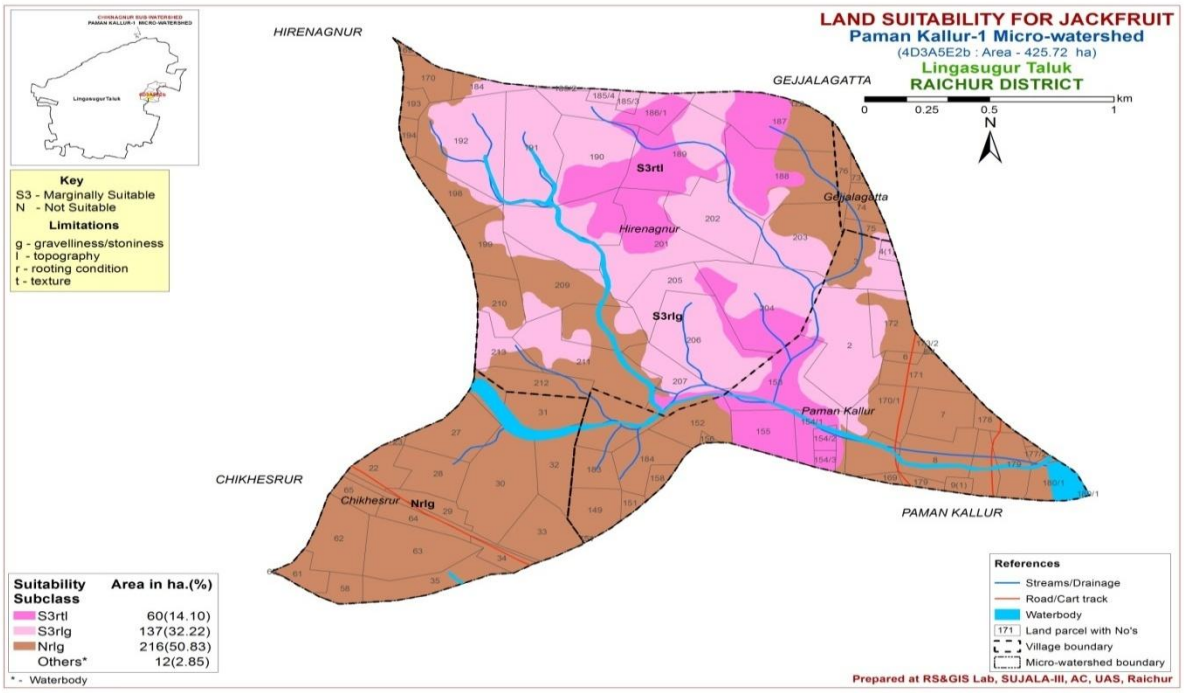
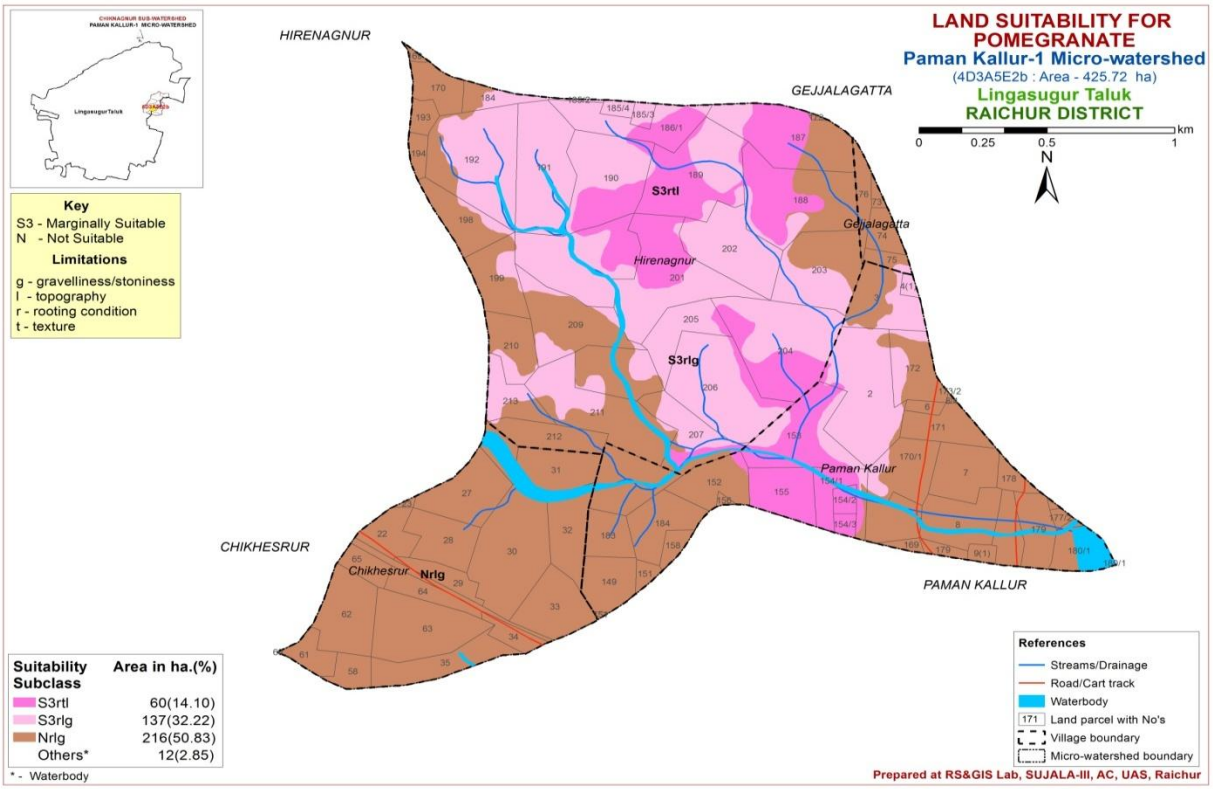


Fig.18 Land suitability map for Pomegranate in Paman kallur-1 micro-watershed



Whereas, CHRhC2g1S1, CHRhD2g1S1R1, CHRhE2g1S1R1, KMThC2g1S1 and THDhD2g1S1R1 soil phase units has interventions like deep and wider size pit for fruit crops, drip irrigation with suitable soil and water conservation measures and cultivation on raised beds with mulches and drip irrigation for vegetables (Table 4).

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