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Land evaluation of rastampur-3 micro-watershed in north eastern transition zone of Karnataka for sustainable land use planning

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Abstract
A study was undertaken to evaluate ten soil series belonging to Rastampur-3 micro watershed (Kalaburagi district) in North Eastern Transition Zone of Karnataka for sustainable land use planning. Ten soil series were tentatively identified and mapped into ten mapping units using GIS technique. These mapping units were grouped into land capability class III, IV and VI with the limitations of slope, erosion, drainage, depth, texture and soil chemical properties. Soil-site suitability evaluation for pigeonpea, green-gram, black-gram, bengal-gram, sorghum, soya bean, mango, guava, custard apple, sapota and jamun showed that Maulani hani and Rummanaguda series were not suitable (N) for most of the selected crops due to very severe limitations of slope and erosion. The remaining soil series of the study area were moderately and marginally suitable for pigeonpea, green-gram, black-gram, bengal-gram, sorghum and soya bean crops. However, Chimmanchod, Maulani hani, Rummanaguda, Dotikola and Naranal series were not suitable for horticultural crops due to severe limitations of slope, erosion and rooting depth. Ranapur and Thajalapur series were highly suitable for all horticultural crops except mango due to marginal limitations of slope and rooting depth.

Keywords: Land capability classification, Land forms, Suitability for crops

Introduction
Soil is a surface covering on most of the earth's land area, an aggregation of unconsolidated mineral and organic particles produced by the combined action of wind, water and organic decay. It is having three dimensional body with length, breadth and depth and it is hidden below the land surface.

Watershed is a “geo-hydrological” entity or piece of land that drains at a common outlet. This natural unit is evolved through the interaction of the rainwater and land mass and normally comprises of arable and non-arable lands along with drainage lines. Thus, the watershed area is delineated based on distribution and flow of rainwater, which facilitates scientific developments of natural resources like soil, water and vegetation.

In the recent past, concept of watershed based holistic development has emerged as one of the potential approaches in rain-fed areas, which can lead to higher productivity and sustainability in agricultural production. Land resource inventory helps in improving land productivity, planning and development of watershed for a particular locality. Land resource inventory is a science and technology adopted for inventing natural resources by surveying an area and mapping the surveyed data. This is helpful for planning and development of the geographical locality on sustainable basis. Land resource inventory and soil fertility analysis helps to generate thematic maps that include soil maps, soil fertility maps, land capability maps, crop suitability and soil-water conservation intervention maps.

Keeping these considerations in view, a detailed soil resource inventory at 1:8,000 scale will be carried out for Rastampur-3 micro-watershed in Kalaburagi district to evaluate the lands for its suitability and capability for different crops.

Materials and Methods
The Rastampur-3 micro-watershed of Nima hosahalli sub watershed is located in Chincholi Taluk of Kalaburgi District, Karnataka and having total area of 933.91 hectares lies between 17^0 28' East longitudes and 77^o15' North latitude.

The adjacent black and red soils are seen in this area, which is also feature of sub-watershed. The elevation of the area ranges from 405 to 556 m above MSL. Semi-arid climate prevails on Rastampur-3 micro-watershed and it belongs to north eastern transition zone of Karnataka state. Mean maximum and minimum temperature were 32.36 °C and 19.75 °C, respectively. The average annual rainfall is 795.11 mm.

The detailed soil survey was carried out using IRS P6 data. The pedons were exposed and studied for their geomorphological features (slope, surface stoniness, erosion, drainage, gravels *etc*.,) of landscape and morphological features (soil depth, texture, colour, structure, consistency, coarse fragments, porosity, soil reaction *etc*.,) of the pedons. The physico-chemical properties (horizon-wise) were estimated by following the standard procedures (Soil Survey Staff 1999) [3]. Ten soil series were tentatively identified in the study area and mapped into ten mapping units as phases of soil series (Fig. 1; Table 1). Weighted mean of each property was calculated and soil-site characteristics of different soil units were obtained as shown in table 2. These weighted average data have been used to evaluate the land capability classification and soil-site suitability. Land capability map and soil- site suitability maps were prepared from ArcGIS 10.3 software.

Results and Discussion

Land capability classification: Land capability classification is an interpretive grouping of soils mainly based on the inherent soil characteristics, external land features and environmental factors that limits the use of the land. Soil site characteristics of soil units (Table 2) are matched with the criteria for land capability classification (Sehgal 1996) [1]. The land capability classification of mapping units and their extent in watershed is presented in table 3.

The micro-watershed area represented by Dotikola and Chimmanachod series were classified into IVesf and IVs land capability sub-class due to the limitations of erosion, texture, soil depth, organic carbon and soil depth, respectively. The Chincholi series and Hasiragundagi series were classified into IIItesf land capability sub-class due to the limitations of slope, erosion, Texture, depth and organic carbon. Ranapur series and Thajalapura series were classified into IIIesf land capability sub-class due to the limitations of erosion, Texture and organic carbon. Moga series classified into IVef land capability sub-class due to the limitations of erosion and organic carbon. Naranal series was classified into VIs land capability sub-class due to the limitation of soil depth. Maulani hani series and Rummanaguda series are classified into VIte and VItes land capability sub-class due to the limitations of slope, erosion and Slope, erosion and soil depth, respectively (Fig. 2). (Sharma *et al.*, 2004) [2].

Soil-site suitability evaluation for crops: The optimum requirements of a crop are always region specific. Climate and soil-site parameters play significant role to maximize the crop yields. The soil-site properties from the study area (Table 2) were matched with soil-site suitability criteria for different crops (Sehgal 1966) [1].

As it is long duration crop with deep roots, the rainfall, texture, erosion, soil depth and base saturation of soils significantly influence the yield of pigeonpea. Chincholi and Hasiragundagi series were moderately suitable because of moderate limitations of rainfall, slope, erosion and soil depth in addition to this exchangeable sodium percentage is also moderate limitation in Chincholi series. Similarly, Ranapur and Thajalapura series were moderately suitable because of moderate limitations of rainfall, erosion, soil depth and rainfall and erosion, respectively. Moga series was marginally suitable for pigeonpea because of severe limitations of slope and erosion. Dotikola and Chimmanchod series were marginally suitable for pigeonpea because of severe limitations of slope, erosion, soil depth and soil depth, respectively. The study area represented by Maulanihani, Rummanaguda and Naranal series were not suitable for pigeonpea due to the severe limitations of slope, erosion and soil depth (Fig. 3).

The suitability of study area for green-gram shows that majority of the area was moderately suitable for green-gram. Chincholi, Ranapur, Thajalapura and Hasiragundagi series were moderately suitable for green-gram due to moderate limitation of texture, in addition to the texture soil depth is also moderate limitation in Chincholi series. Similarly, Moga series was also moderately suitable for green-gram because of moderate limitation of slope. Dotikola and Chimmanchod series were marginally suitable for green-gram due to severe limitation of soil depth. Rummanaguda and Maulanihani series were not suitable for green-gram due to severe limitation of Slope, depth and slope, respectively. Naranal series was not suitable for green-gram due to severe limitation of soil depth (Fig. 4).

The suitability of study area for bengal-gram shows that majority of the area was marginally suitable for bengal-gram due to the major limitation of temperature. Chimmanachod series was marginally suitable for bengal-gram due to severe limitations of temperature and depth. Similarly, Chincholi, Ranapur, Hasiragundagi and Thajalapura series were marginally suitable due to the severe limitation of temperature. Moga and Dotikola series were marginally suitable for Bengal-gram due to the severe limitation of temperature, slope, erosion and temperature, slope, erosion and soil depth, respectively. The Maulanihani, Rummanaguda and Naranal series were not suitable for bengalgram because of severe limitation of Slope, erosion; slope, erosion, soil depth and soil depth, respectively (Fig. 5).

The suitability of study area for black-gram shows that majority of the area was moderately suitable for black-gram. Chincholi, Ranapur, Thajalapura and Hasiragundagi series were moderately suitable for black-gram because of moderate limitation of texture, in addition to the texture soil depth is also moderate limitation in Chincholi series. Similarly, Moga series was also moderately suitable for black-gram because of moderate limitation of slope. Dotikola and Chimmanchod series were marginally suitable for black-gram due to severe limitation of soil depth. Rummanaguda and Maulanihani series were not suitable for black-gram due to severe limitations of Slope, depth and slope, respectively. Naranal series was not suitable for black-gram due to severe limitation of soil depth (Fig. 6).

The factors that influence the soya bean yield are rainfall, temperature, slope, erosion and soil depth. Chincholi and Hasiragundagi series were moderately suitable due to moderate limitations of rainfall, temperature, relative humidity, erosion, soil depth and texture. Similarly, Ranapur and Thajalapura series were also moderately suitable for soya bean due to moderate limitations of rain fall, temperature, relative humidity and erosion. Moga and Chimmanachod series were marginally suitable for soya bean due to severe limitations of slope, erosion and soil depth, respectively. Similarly, Dotikola and Naranal series were also marginally

suitable for soya bean due to severe limitations of erosion and depth. Whereas, Maulanihani and Rummanaguda series were not suitable due to severe limitations of slope and erosion (Fig. 7).

The factors that influencing sorghum yield are rainfall, temperature, slope, BS, $CaCO_3$, CEC and texture. The suitability of study area for sorghum shows that majority of the area was moderately suitable for sorghum. Chincholi and Hasiragundagi series were moderately suitable with the moderate limitations of slope and erosion. Chimmanchod series was moderately suitable with the moderate limitations of slope, erosion and soil depth. Similarly, Ranapur and Thajalapura series were also moderately suitable due to moderate limitation of erosion. Whereas, Moga and Dotikola series were marginally suitable due to severe limitations of slope and erosion.Naranal series was marginally suitable due to severe limitation of erosion. Maulanihani and Rummanaguda, series were not suitable due to severe limitations of slope, erosion and depth (Fig. 8).

Majority of the study are indicates that most of the area was not suitable for growing of mango (Chincholi, Chimmanachod, Maulanihani, Moga, Rummanaguda, Hasiragundagi, Dotikola and Naranal series) due to severe limitations of slope, erosion and rooting depth. Whereas, the soils of Ranapur and Thajalapura series are moderately suitable for growing of mango due to moderate limitations of rooting depth and erosion (Fig. 9).

Soil series like Chimmanachod, Maulanihani, Rummanaguda, Dotikola and Naranal series were potentially unsuitable for growing of sapota in study area with the severe limitations of rooting depth, erosion and slope. The soils of Chincholi, Moga and Hasiragundagi series were marginally suitable for growing of sapota due to severe limitation of rooting depth. Whereas, the soils of Ranapur and Thajalapura series are highly suitable for growing of sapota due to slight limitation of erosion (Fig. 10).

Majority of the study area indicates that most of the area is not suitable for growing of Jamun (Chincholi, Chimmanachod, Maulanihani, Moga, Rummanaguda, Hasiragundagi, Dotikola and Naranal series) due to limitations of rooting depth, erosion and slope. Whereas, the soils of Ranapur and Thajalapura series were moderately suitable for growing of jamun due to moderate limitations of depth, slope and erosion (Fig. 11).

The soils of Ranapur and Thajalapura series are highly suitable for growing of custard apple in study area. The soils of Chincholi, Moga and Hasiragundagi series are marginally suitable for growing of custard apple due to severe limitations of erosion, slope and rooting depth. Whereas, Maulanihani, Chimmanachod, Rummanaguda, Dotikola and Naranal series were not suitable for growing of custard apple due to severe limitations of slope, erosion and rooting depth (Fig. 12).

The soils of Ranapur and Thajalapura series are highly suitable for growing of guava in study area. The soils of Chincholi, Moga and Hasiragundagi series are marginally suitable for growing of guava due to severe limitations of erosion, slope and rooting depth. Whereas, Maulanihani, Chimmanachod, Rummanaguda, Dotikola and Naranal series were not suitable for growing of guava due to severe limitation of slope, erosion and rooting depth (Fig. 13).

Conclusion

Soil productivity constraints were identified in the study area irrespective of soil type and stage of crop. The productivity class of Chimmanachoda, Rummanaguda and Naranal series were extremely poor due to the major constraints like depth, soil moisture and soluble salts. Whereas, Chincholi, Maulanihani, Moga, Hasiragundagi and Dotikola series were observed poor in productivity class. However, the average productivity of the crops observed in the Thajalupara and Ranapur series. In the study area soil moisture was the major constraint as majority of farmers depends mainly on the rainfall. Apart from soil physico-chemical constraints, under fertilization of crops and less / non- application of organic manures and micronutrients were considered as prime reasons for low productivity of crops in the study area. The low productivity of crops was also attributed to growing of local varieties in the study area.

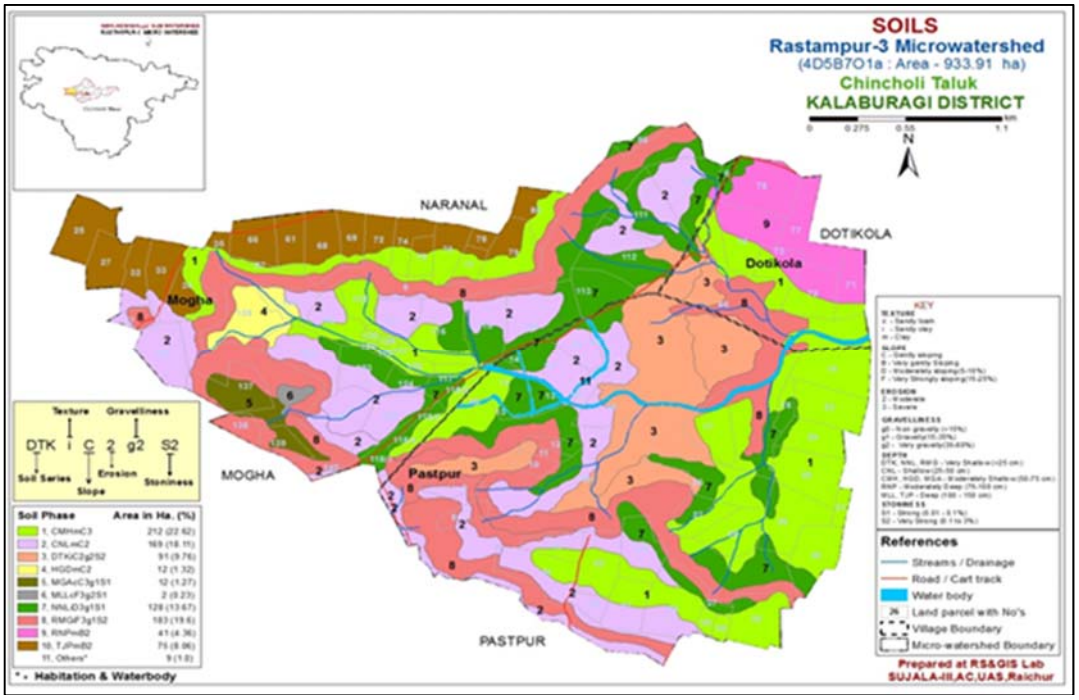

Fig 1: Soil phase map of Rastampur-3 microwatershed

Table 1: Area distribution of Soil mapping units of Rastampur-3 micro-watershed

Name of the series	Mapping units	Area (ha)	Area cover (%)
Chincholi Series	CNLmC2	169	18.11
Chimmanchod Series	CMHmC3	212	22.62
Maulanihani Series	MLLcF3g2S1	2	0.23
Moga Series	MGAcC3g1S1	12	1.27
Ranapur Series	RNPmB2	41	4.36
Thajalapura Series	TJPmB2	75	8.06
Rummanaguda Series	RMGiF3g1S2	183	19.60
Hasiragundagi Series	HGDmC2	12	1.32
Dotikola Series	DTKiC2g2S2	91	9.76
Naranal Series	NNLiD3g1S1	128	13.67
Total		925	99.00

Table 2: Soil-site characteristics of Rastampur-3 microwatershed for land evaluation

Mapping units	Climate (c)				Land form characteristics			Physico - chemical characteristics (f)							
	Rain-fall	Max. Temp.	Min. Temp.	RH	Slope (t)	Erosion (e)	Drainage (w)	Depth	$CaCO_3$	Texture	pH	OC	CEC	BS	ESP
Chincholi series	795.11	32.36	19.75	69.38	3-5	Moderate	Well drained	50-75	4.56	c	7.19	5.20	49.94	93.58	5.91
Chimmanchod series	795.11	32.36	19.75	69.38	3-5	Moderate	Well drained	25-50	5.42	c	7.74	5.50	50.8	93.9	4.91
Maulanihani series	795.11	32.36	19.75	69.38	15-25	Very severe	Well drained	100-150	3.60	sl	6.94	4.90	25.0	87.4	4.07
Moga series	795.11	32.36	19.75	69.38	3-5	Severe	Well drained	50-75	3.92	sl	7.07	4.80	28.2	88.6	3.96
Ranapur series	795.11	32.36	19.75	69.38	1-3	Moderate	Well drained	75-100	5.19	c	7.27	6.10	43.2	92.8	5.47
Thajalapura series	795.11	32.36	19.75	69.38	1-3	Moderate	Well drained	100-150	5.09	c	7.46	5.90	43.7	92.9	4.96
Rummanaguda series	795.11	32.36	19.75	69.38	10-25	Very severe	Well drained	0-25	3.90	sc	7.09	4.10	40.3	92.3	3.15
Hasiragundagi series	795.11	32.36	19.75	69.38	3-5	Moderate	Mod. Well drained	50-75	5.09	c	7.64	5.30	52.4	94.1	3.99
Dotikola series	795.11	32.36	19.75	69.38	3-5	Severe	Well drained	25-50	4.43	sc	7.19	4.60	45.1	93.1	3.15
Naranal series	795.11	32.36	19.75	69.38	5-10	Severe	Well drained	0-25	4.15	sc	7.78	5.50	46.4	93.3	4.36

Table 3: Land capability classification of Rastampur-3 microwatershed

Mapping units	Land form characteristics			Physical characteristics (s)			Chemical characteristics (f)			LCC
	Slope (t)	Erosion (e)	Drainage (w)	Texture	Soil depth	Pedon Development	CEC	OC	BS	
Chincholi series										
CNLmC2	III	III	I	III	III	II	I	III	I	IIItesf
Chimmanchod series										
CMHmC3	III	III	I	III	IV	II	I	III	I	IVs
Maulanihani series										
MLLcF3g2S1	VI	VI	I	III	II	II	I	IV	I	VIte
Moga series										
MGAcC3g1S1	III	IV	I	III	III	II	I	IV	I	IVef
Ranapur series										
RNPmB2	II	III	I	III	III	II	I	III	I	IIIesf
Thajalapura series										
TJPmB2	II	III	I	III	II	II	I	III	I	IIIesf
Rummanaguda series										
RMGiF3g1S2	VI	VI	I	IV	VI	III	I	IV	I	VItes
Hasiragundagi series										
HGDmC2	III	III	II	III	III	II	I	III	I	IIItesf
Dotikola series										
DTKiC2g2S2	III	IV	I	IV	IV	III	I	IV	I	IVesf
Naranal series										
NNLiD3g1S1	III	IV	I	IV	VI	III	I	III	I	VIs

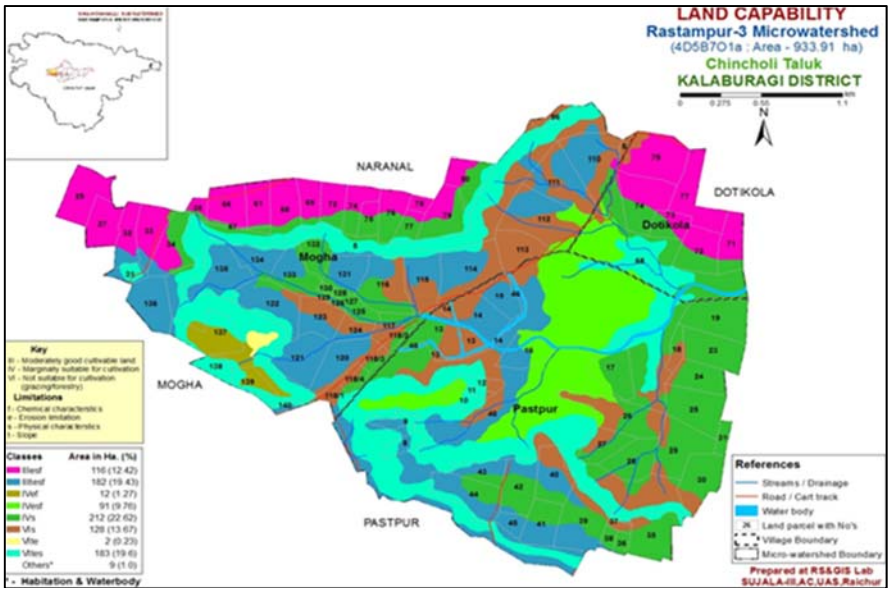

Fig 2: Land capability classification of soils in Rastampur-3 microwatershed

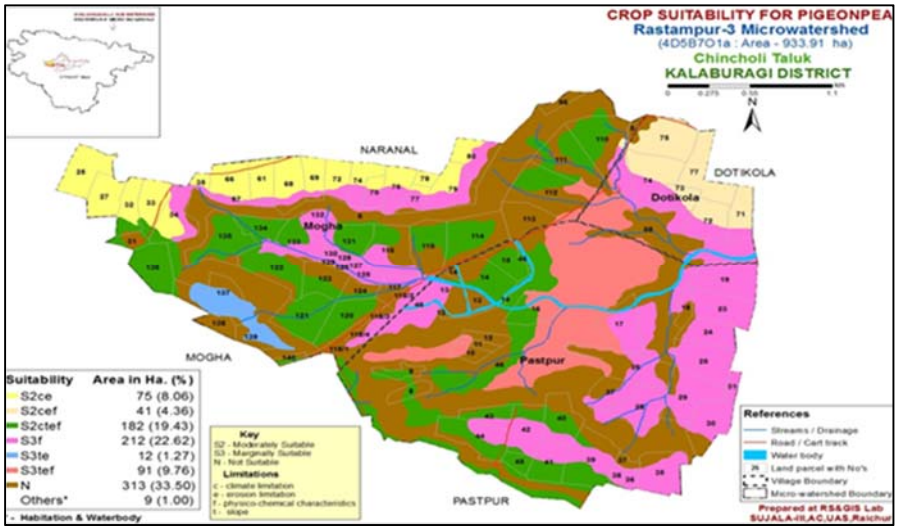

Fig 3: crop suitability of pigeonpea in Rastampur-3 microwatershed

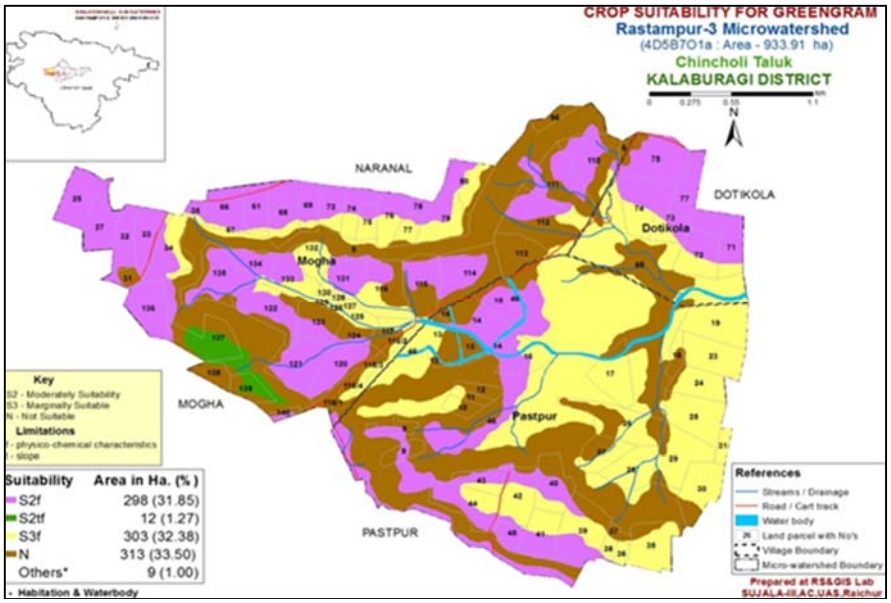

Fig 4: crop suitability for greengram in Rastampur-3 microwatershed

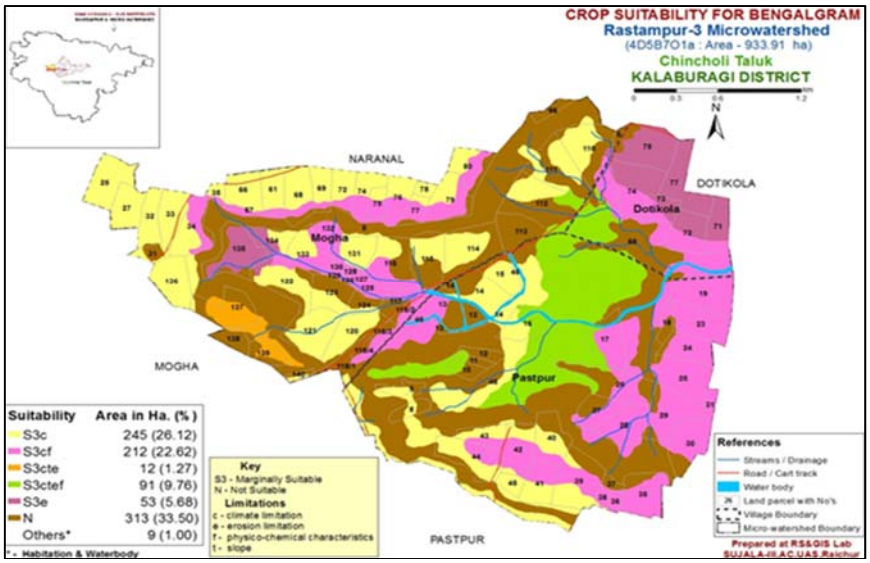

Fig 5: Soil-site suitability for bengal gram in Rastampur-3 microwatershed

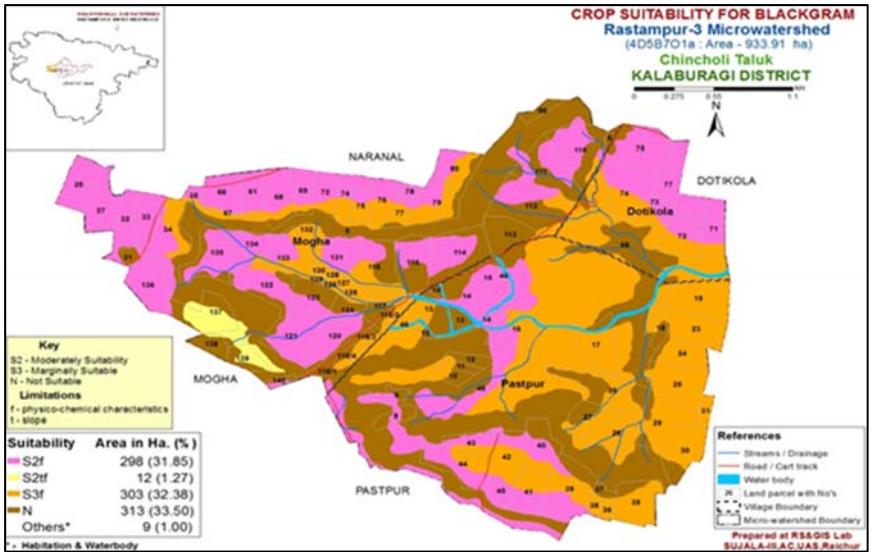

Fig 6: crop suitability for black-gram in Rastampur-3 microwatershed

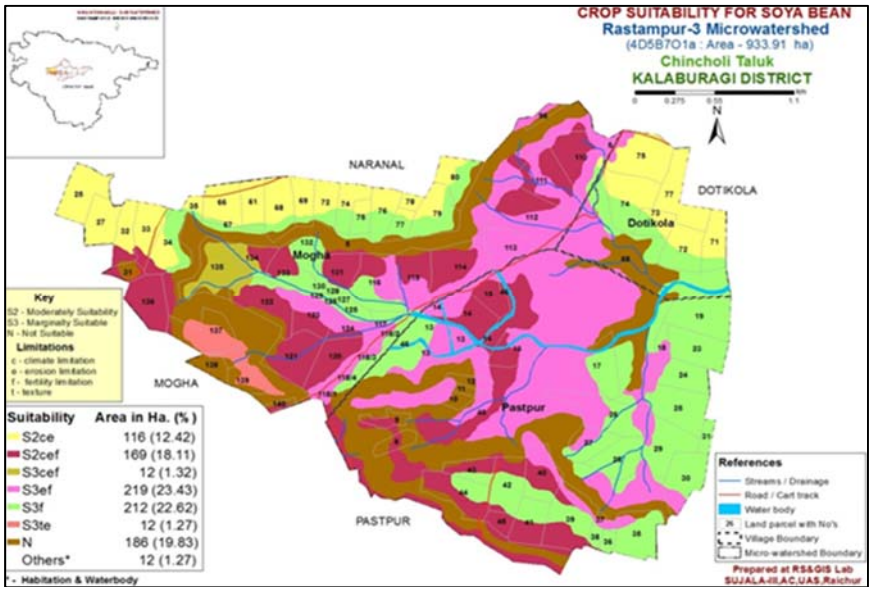

Fig 7: crop suitability for soya bean in Rastampur-3 microwatershed

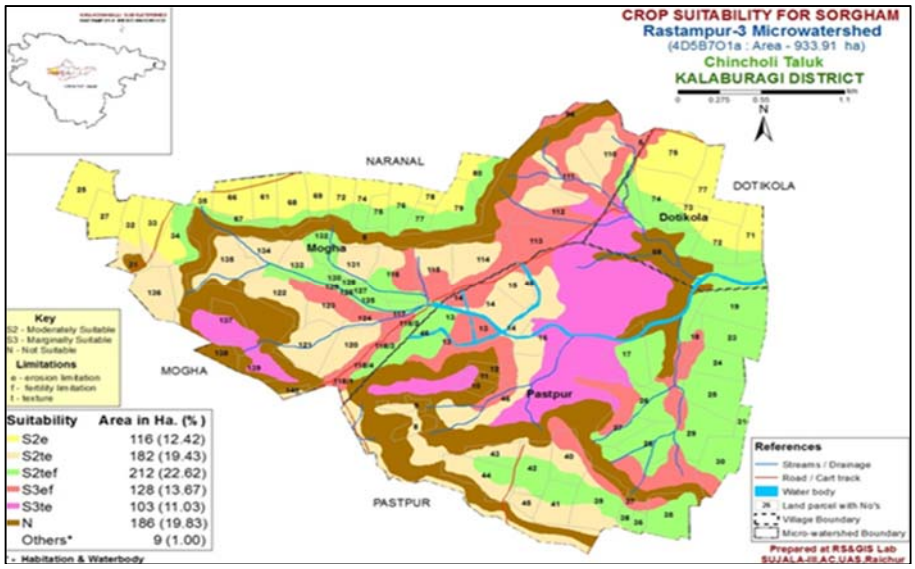

Fig 8: crop suitability for sorghum in Rastampur-3 microwatershed

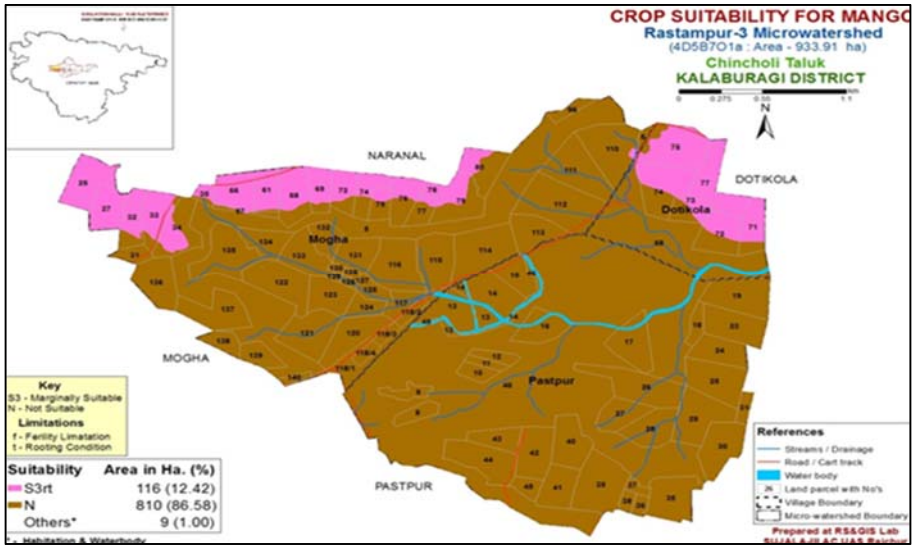

Fig 9: crop suitability for mango in Rastampur-3 microwatershed

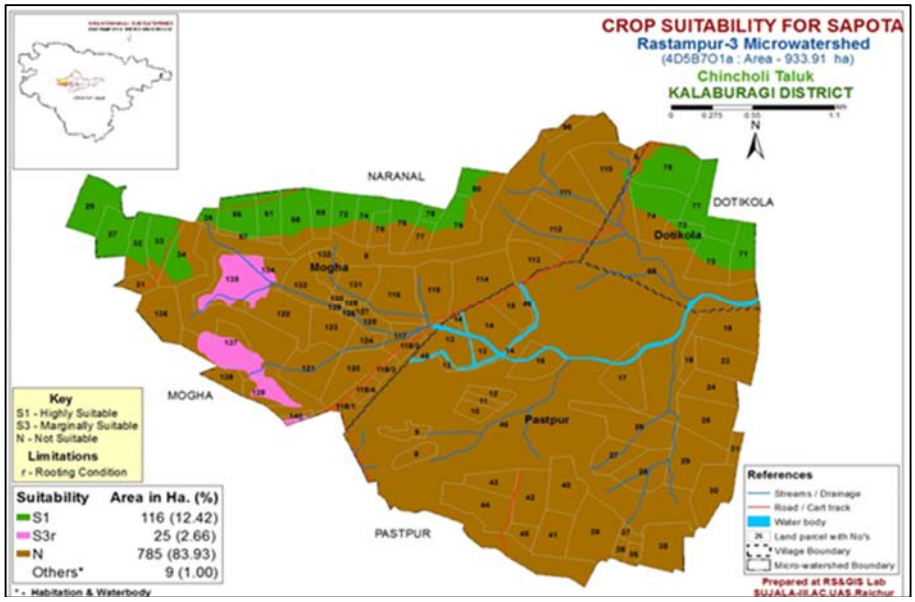

Fig 10: crop suitability for sapota in Rastampur-3 microwatershed

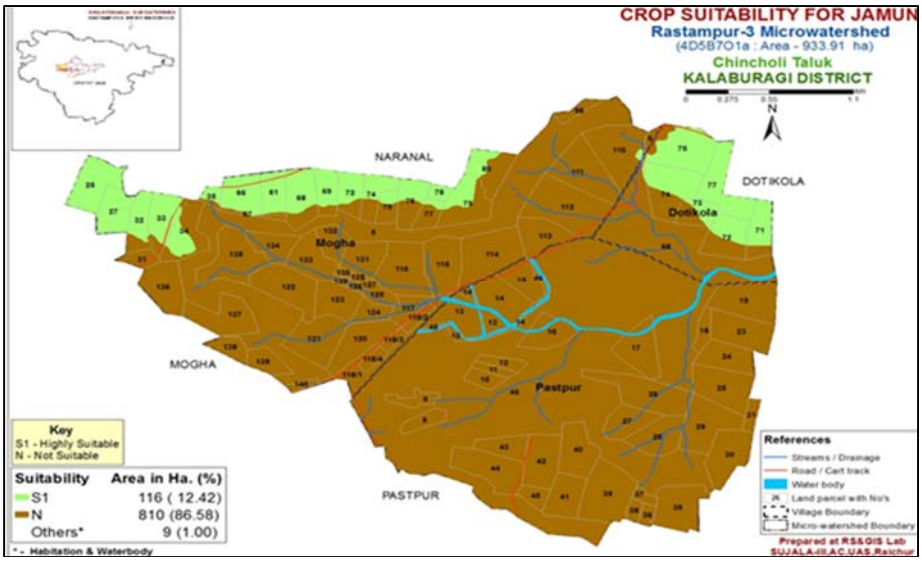

Fig 11: crop suitability for jamun in Rastampur-3 micro-watershed

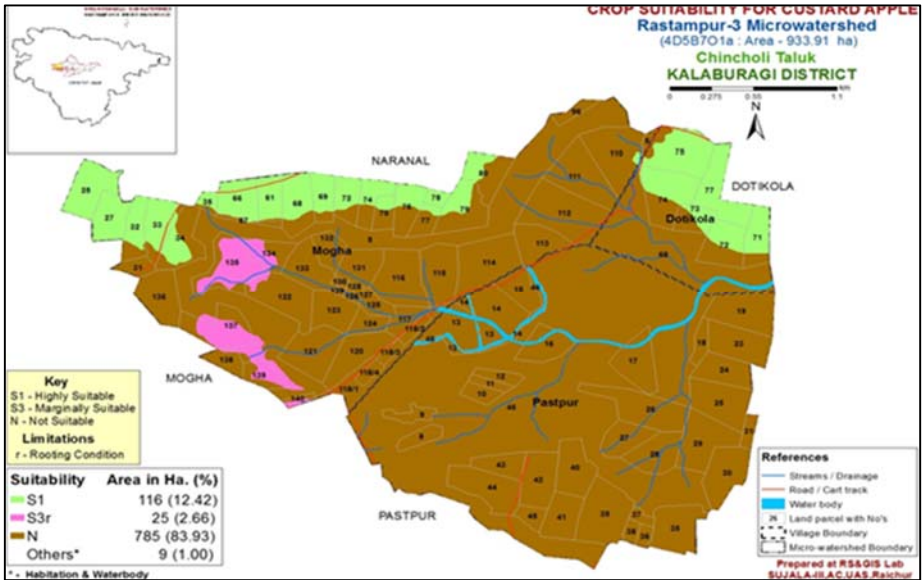

Fig 12: crop suitability for custard apple in Rastampur-3 micro-watershed

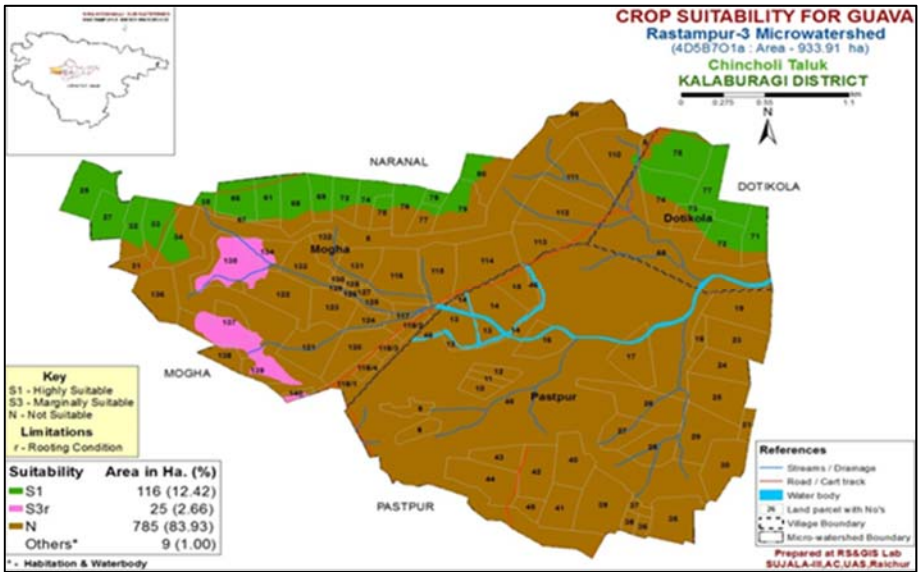

Fig 13: crop suitability for guava in Rastampur-3 micro-watershed

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