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

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Abstract
In the present study five soil series were tentatively identified and mapped into seven mapping units using GIS technique in Bharatnur-3 micro-watershed of Kalaburagi district of Karnataka. These mapping units varied from very shallow (<25 cm) to deep (100-150 cm) in depth, clay in texture, very gently (1-3 %) to gently sloping (3-5 %), moderate erosion and non gravelly (<15 %) in nature. These seven mapping units were grouped into land capability class II and III with limitations of soil characteristics and erosion. Soil-site suitability evaluation for twenty major agricultural and horticultural crops showed that Nima Hosahalli series was highly suitable (S1) for all crops except jackfruit and cashew. Chimmanboda series (CMBmC2g0) was moderately suitable (S2) with limitation of texture for all agricultural crops. Chincholi and Kalgi series were not suitable (N) for growing of agricultural and horticultural crop due to severe limitations of rooting depth, texture and topography.

Keywords: soil series, mapping unit, land capability classification, suitability for crops

Introduction
Land has been a means of survival for many years and it will continue its role as a major resource on this planet. Soil is one of the most important natural resources and proper understanding of its properties is necessary for judicious, beneficial and optimal use on suitable basis. Soils provide food, fodder and fuel for meeting the basic human and animal needs. With the growth in human and animal population, demand on soils for more food production will also increase. However, the capacity of a soil resource to produce is limited and the limits to production are set by intrinsic characteristics, agro-ecological settings, use and management. This demands systematic appraisal of our soil resources with respect to their extent, distribution, characteristics, behaviour and potential use, which is very important for developing an effective land use system for augmenting agricultural production on a sustainable basis. 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. 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 variety suitable for the area. In carrying out this assessment, the specific requirements of a crop (compiled from the existing literature) are compared with the characteristics of land and based on the extent of matching; the suitability of the area for the crop is arrived (Sys *et al*, 1991) [5]. Then by comparing the relative suitability of the resources for different uses, an ideal combination of crops suitable for a particular farm within the micro watershed area can be selected.
The sustainable crop production system depends on developing and adaptation of ideal land use plan based on soil quality and its constraints for plant growth. Considering the above points, the land evaluation exercise was undertaken in Bharatnur-3 micro watershed at 1:8000 scale, under World Bank funded, Sujala-III project at Chitapur taluk Kalaburagi district, Karnataka state.

Material and Method
Bharatnur-3 micro watershed is located in Chitapur taluk of Kalaburagi district, Karnataka state and having total area of 498.26 hectares lies between 77^0 19' - 17^0 28' North latitude and 77^0 21' - 17^0 27' East longitude of 379 m above mean sea level (MSL). The average rainfall of this region is 730.87 mm with a large spatial and temporal variability.

The location of the study area furnished in Fig.1. Study area is characterized by Basalt, granites and gneiss complex.

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). Five soil series were tentatively identified in the study area and mapped into seven mapping units as phases of soil series (Fig. 2; 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) [2]. The land capability classification of mapping units and their extent in watershed is presented in Fig. 3.

Based on soil properties, the soils of Bharatnur-3 micro-watershed of Kalaburagi taluk have been classified into two land capability classes viz., II and III (Fig 3). The Nimahosahalli, Kalgi, Chincholi, Chimmanboda (CMBmB2g0), and Thajalapur (TJPmC2g0) soil series were grouped under land capability sub-class IIIes. These soils were marginally cultivable lands due to severe limitations of erosion and soil limitations (depth, gravelliness, texture, salinity and alkalinity). Whereas, Thajalapur (TJPmB2g0) and Chimmanboda (CMBmC2g0) were classified into IIes which are moderately cultivable lands with limitations of erosion and soil limitations (depth, gravelliness, texture, salinity and alkalinity). The area under IIIes and IIes was 236 (47.39 %) and 242 ha (48.48 %), respectively (Fig. 3). Major proportion of the area belongs to class IIes and least portion of the area belongs to class IIIes. Similar findings were also reported by (Patil *et al*., 2011) [6].

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) [2].

Land suitability of horticultural crops

The sustainability assessment for horticultural crops in Bharatnur-3 MWS showed that an area of 427 ha (85.63 %) was highly suitable (S1) for growing mango, sapota, jamun, guava and custard apple and an area of 26 ha (5.22 %) found to be moderately suitable (S2t) for growing mango, sapota, jamun, guava and custard apple with limitations of topography. And an area of 25 ha (5.03 %) was found to be not suitable (N) for mango, sapota, jamun, guava and custard apple due to limitations of depth, texture and topography. Sonali *et al.*, (2013) reported that the physiographic units P12, P22 and H12 of watershed of Dehradun district, Uttarakhand state, India were moderately suitable for mango cultivation with a limitation of steep slopes and piedmont plains. (Fig. 4,5,6,7 and 8).

The suitability assessment for jackfruit and cashew in Bharatnur-3 MWS showed that about 453 ha (90.84 %) area is moderately suitable (S2lt) with limitation to topography and texture and an area of about 25 ha (5.03 %) of micro-watershed found not suitable for jackfruit and cashew production with limitation of rooting depth and topography. (Fig. 9 and 12).

The suitability assessment for musambi, lime, amla and tamarind in Bharatnur-3 MWS showed that an area of about 386 ha (77.47 %) was highly suitable (S1). An area of about 67 ha (13.38 %) was moderately suitable (S2lt) with limitation to texture and topography and an area of about 25 ha (5.03 %) found to be not suitable with limitation of rooting depth and topography. (Fig, 10, 11, 13 and 14).

Land suitability of agricultural crops

The factors that influence sorghum and maize yield are rainfall, temperature, slope, and texture (Sehgal, 1996). Redgram is long duration crop with deep root system. The suitability assessment for agricultural crops in Bharatnur-3 MWS showed that about 386 ha (77.47 %) area is highly suitable (S1), an area of about 67 ha (13.38 %) of micro-watershed found moderately suitable (S2l) with limitations of texture and an area of 25 ha (5.03 %) was not suitable due to severe limitations of texture and rooting depth for sorghum, maize, redgram, bengalgram, blackgram, sunflower, soybean and sugarcane production. For Cotton the yield was significantly influenced by rainfall and soil depth, an ideal depth of 100 to 200 cm soil depth and moisture storage capacity of 220 mm (Patil *et al.,* 2011) [6]. An area of about 386 ha (77.47 %) was highly suitable (S1), 41 ha (8.16 %) was moderately suitable (S2l) and 26 ha (5.22 %) was marginally suitable (S3l) with limitation of texture and an area of 25 ha (5.03 %) was not suitable due to limitations of depth and topography. Similar findings were also reported by (Fig. 15, 16, 17, 18, 19, 20, 21, 22, 23).

Conclusion

In conclusion, the GIS tool was effectively utilized at the study area for land capability and crop suitability classifications. The land capability classification of the study area placed under class II (48.48 %) and III (47.39 %). The land suitability for different agriculture and horticulture crops were matched with the land characteristics, Thajalapur and Chimmanboda series were highly suitable for most of the crops except jackfruit and cashew. Chincholi and Kalgi series were not suitable for most of the crops. The mapping units restricted for different crops can be managed by adapting the suitable soil and water conservation practices. Hence, it can be concluded that the cadastral level detailed LRI based crop suitability and land capability classification assessment at micro watershed level will help in improved planning at parcel level.

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

Name of the series	Mapping units	Area(ha)	Area cover (%)
Chimmanboda	CMBmB2g0	45	8.95
	CMBmC2g0	41	8.16
Chincholi	CNLmC2g0	4	0.84
Kalgi	KALmC2g0	21	4.19
NIimhosahalli	NMHmB2g0	140	28.19
Thajalapur	TJPmB2g0	201	40.32
	TJPmC2g0	26	5.22
Others*	Waterbody and Habitation	21	4.12
Total area		498.26	100.00

Table 2: Soil-site characteristics of Bharatnur-3 micro-watershed for land evaluation

Mapping unit	Climate (c)				Land form characteristics			Physico- chemical characteristics (f)				
	Rainfall (mm)	Max. Temp (^{0}C)	Min. Temp (^{0}C)	RH (%)	Slope (t)	Erosion (e)	Drainage (w)	Depth (cm)	Texture	pH (1:2.5) (soil: water)	EC (dS/m)	OC (Per Cent)
CMBmB2g0	730.87	40.91	29.6	74.1	1-3	Moderate	Moderately well	100-150	clay	Moderately alkaline	Non saline	Medium
CMBmC2g0	730.87	40.91	29.6	74.1	1-3	Moderate	Moderately well	100-150	clay	Strongly alkaline	Non saline	Medium
CNLmC2g0	730.87	40.91	29.6	74.1	3-5	Moderate	Moderately well	25-50	clay	Slightly alkaline	Non saline	High
KALmC2g0	730.87	40.91	29.6	74.1	1-3	Moderate	Moderately well	<25	clay	Neutral	Non saline	High
NMHmB2g0	730.87	40.91	29.6	74.1	1-3	Moderate	Moderately well	75-100	clay	Slightly alkaline	Non saline	Medium
TJPmB2g0	730.87	40.91	29.6	74.1	1-3	Moderate	Moderately well	100-150	clay	Slightly alkaline	Non saline	Medium
TJPmC2g0	730.87	40.91	29.6	74.1	3.5	Moderate	Moderately well	100-150	clay	Moderately alkaline	Non saline	Medium

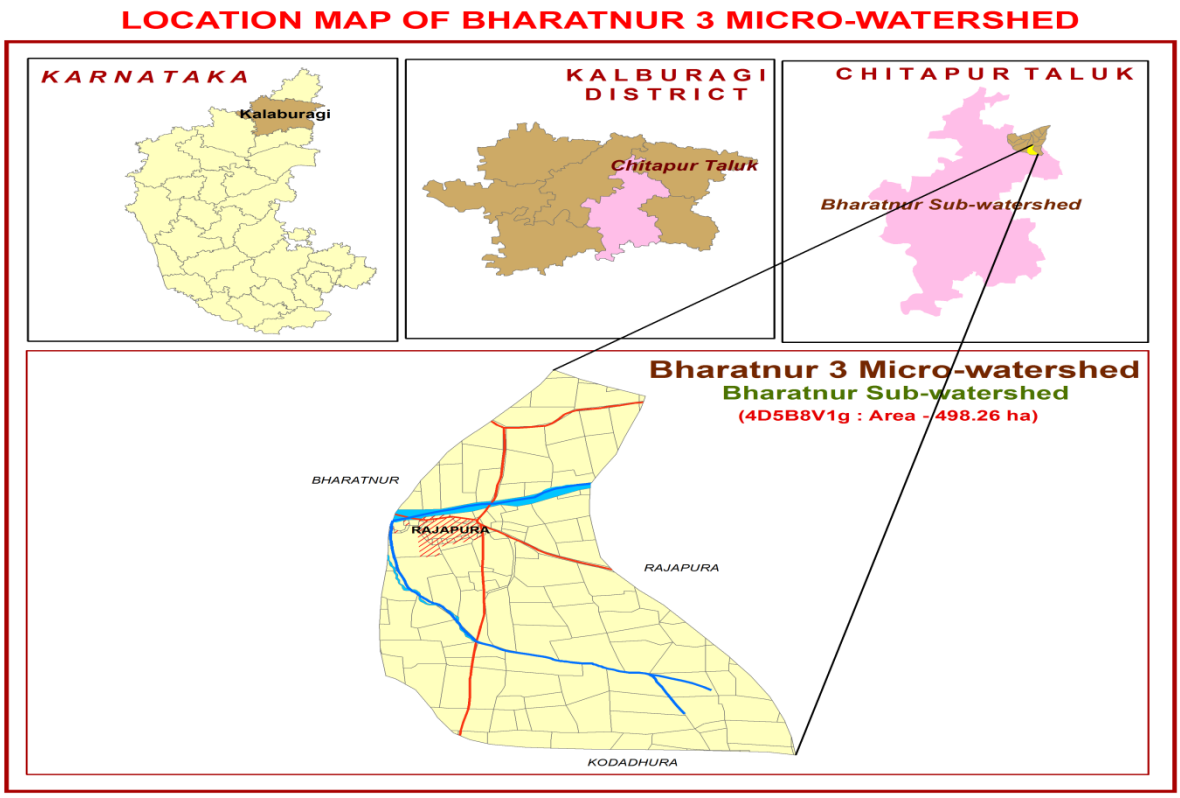

Fig 1: Location map of Bharatnur-3 micro watershed

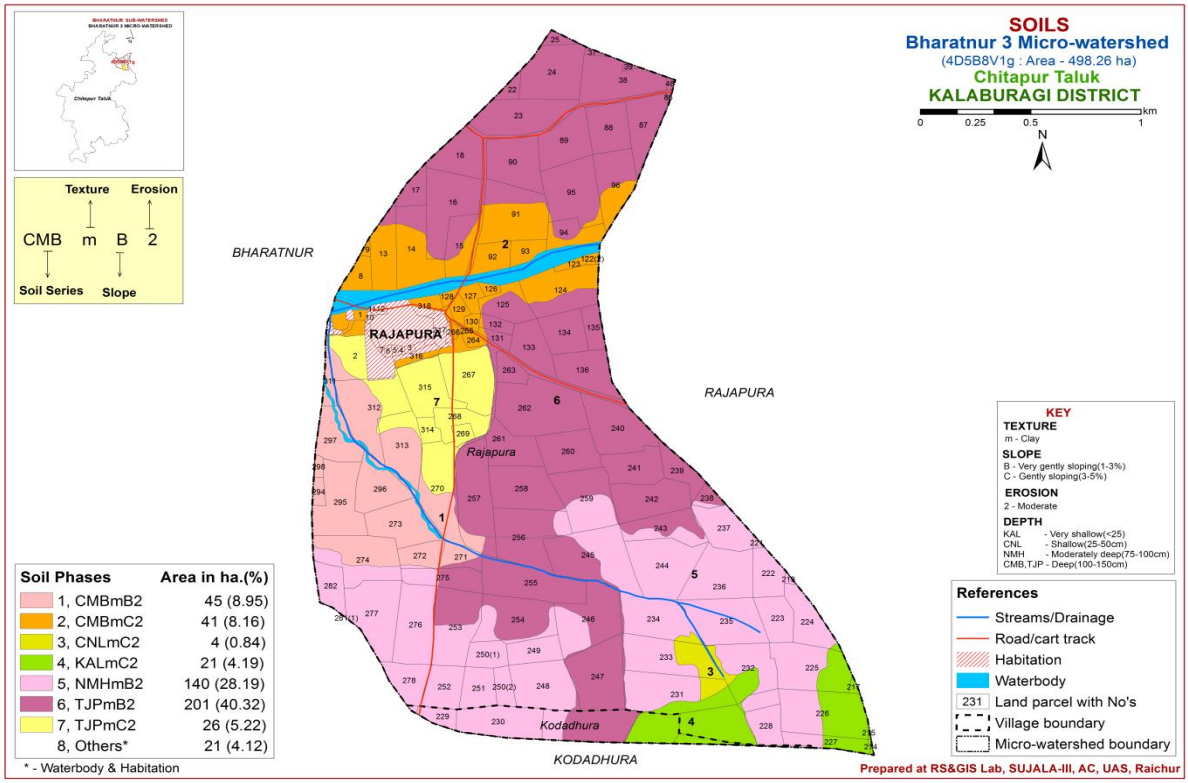

Fig 2: Soil series mapping unit of Bharatnur-3 micro watershed

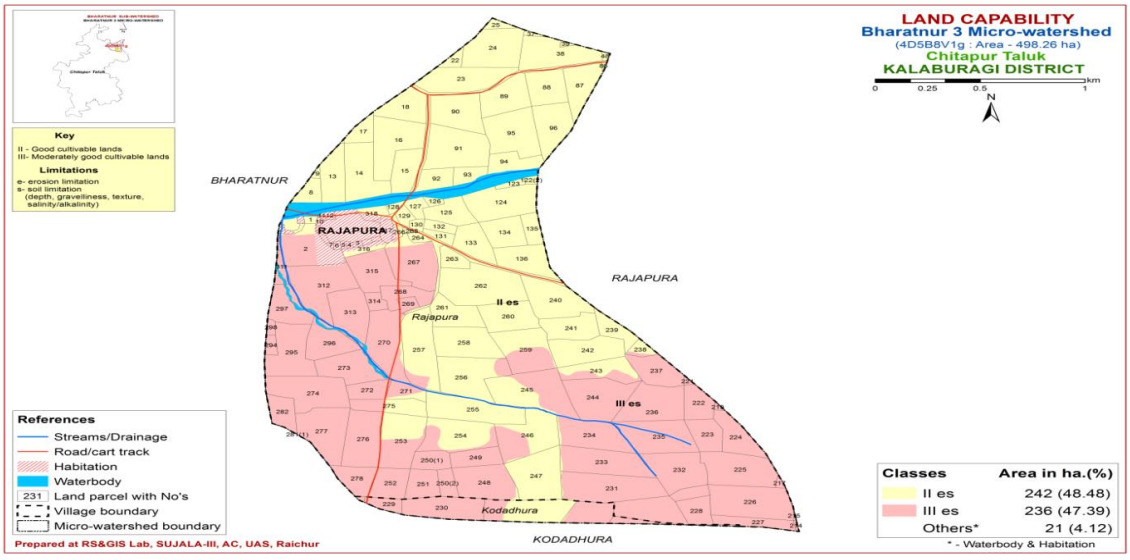

Fig 3: Land capability classification map of Bharatnur-3 micro watershed

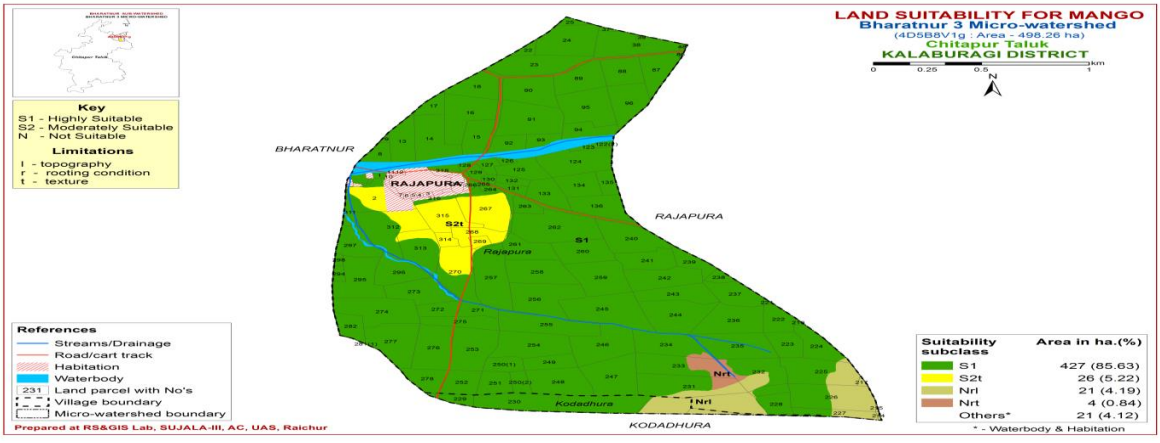

Fig. 4. Land suitability map for Mango in Bharatnur-3 MWS

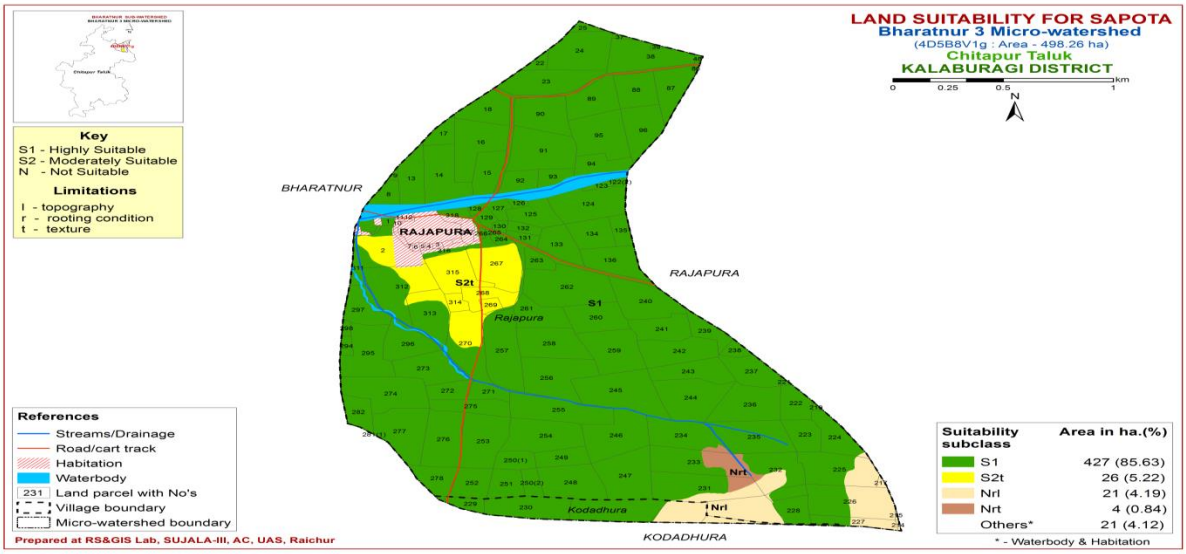

Fig 5: Land suitability map for Sapota in Bharatnur-3 MWS

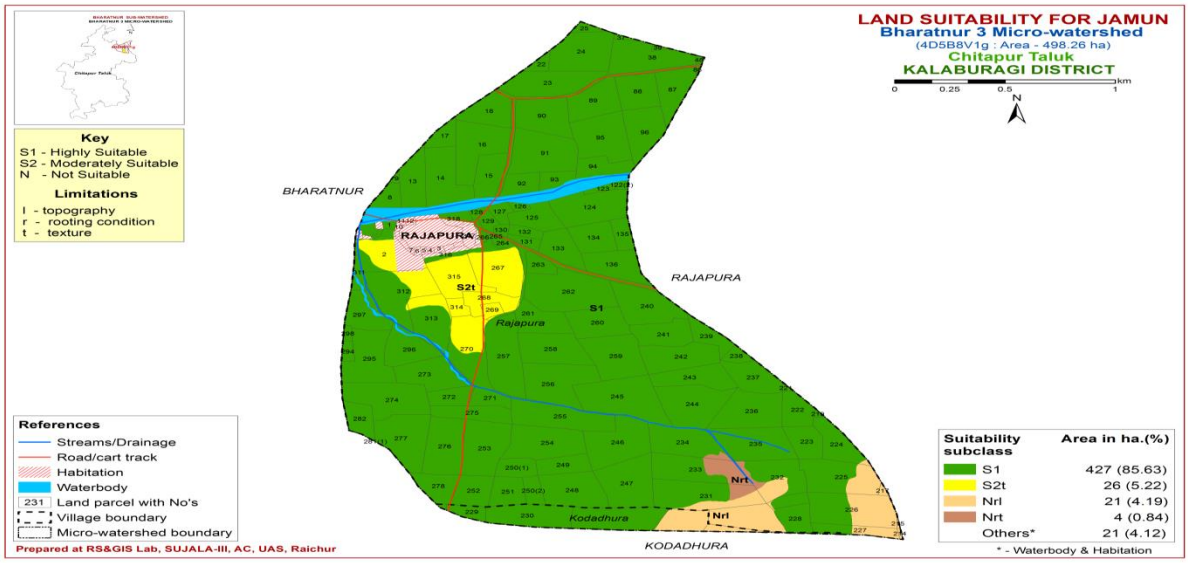

Fig 6: Land suitability map for Jamun in Bharatnur-3 MWS

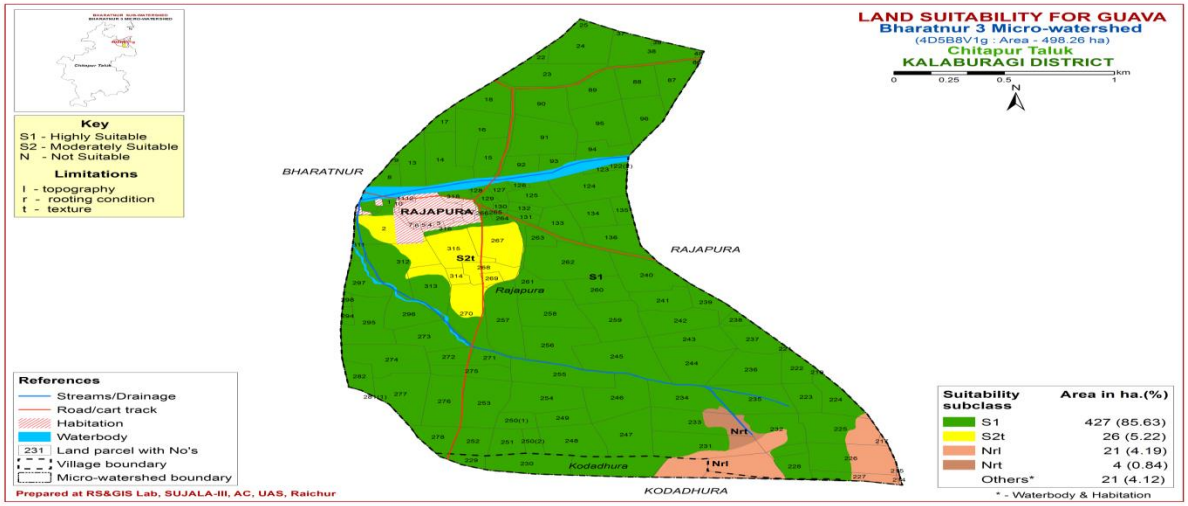

Fig 7: Land suitability map for Guava in Bharatnur-3 MWS

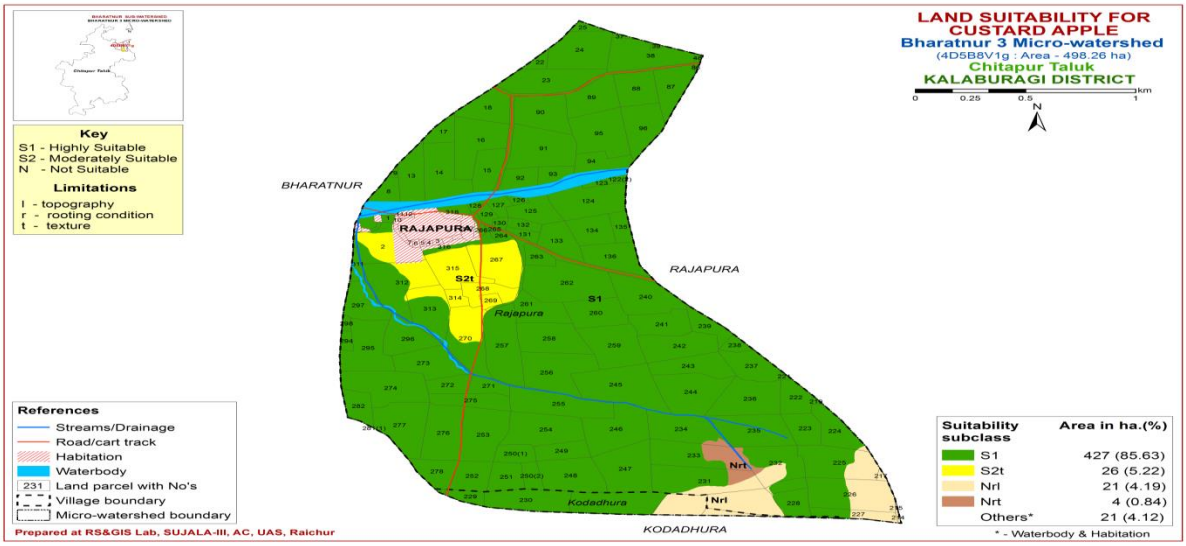

Fig 8: Land suitability map for Custard Apple in Bharatnur-3 MWS

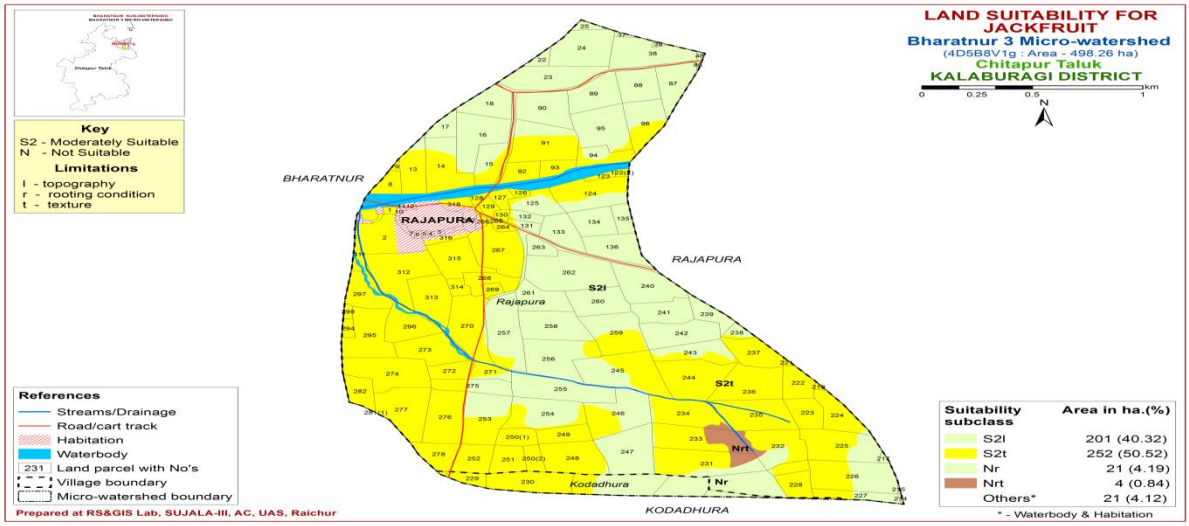

Fig 9: Land suitability map for Jackfruit in Bharatnur-3 MWS

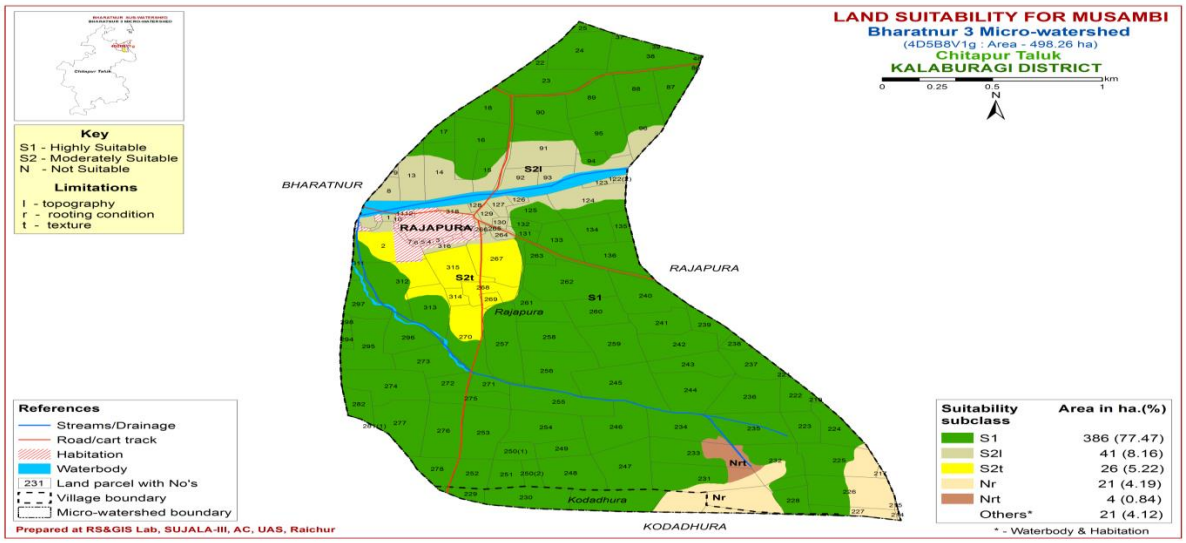

Fig 10: Land suitability map for musambi in Bharatnur-3 MWS

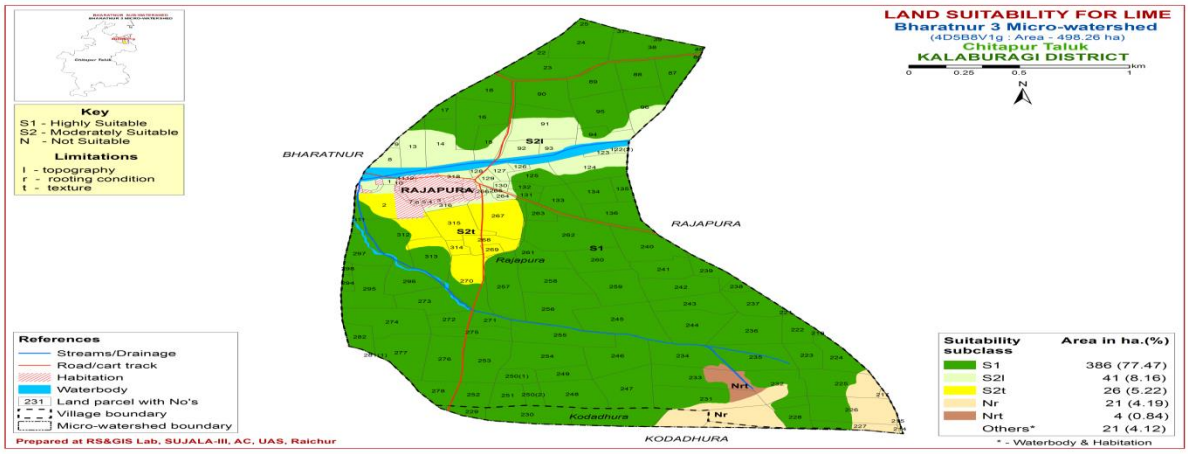

Fig 11: Land suitability map for lime in Bharatnur-3 MWS

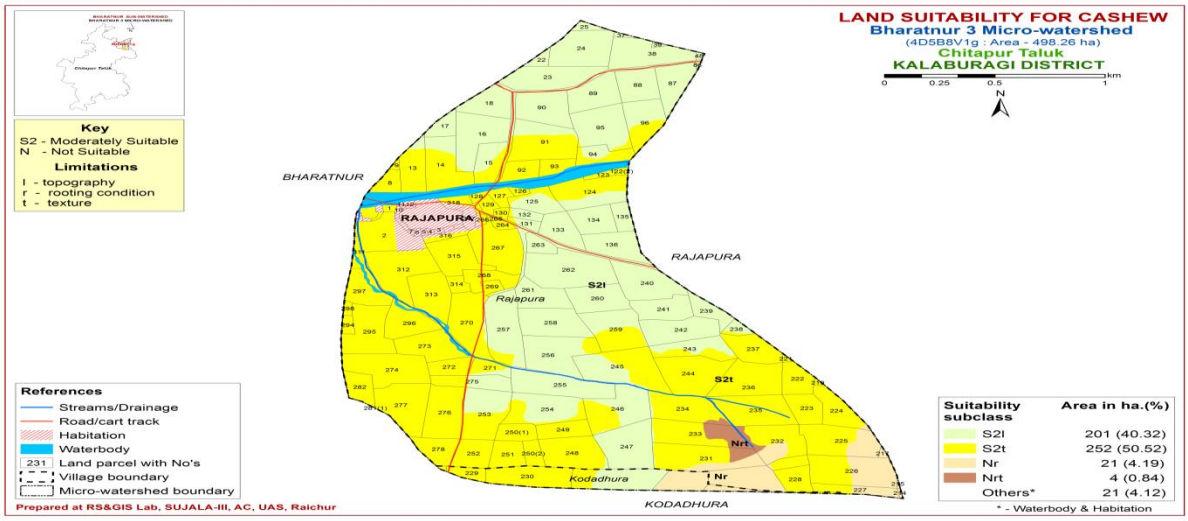

Fig 12: Land suitability map for cashew in Bharatnur-3 MWS

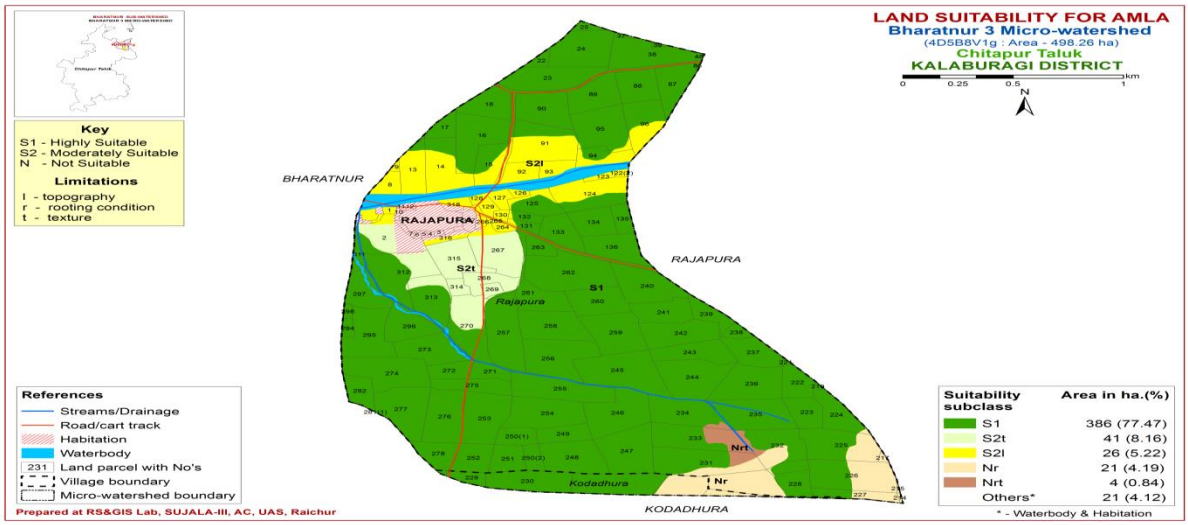

Fig 13: Land suitability map for amla in Bharatnur-3 MWS

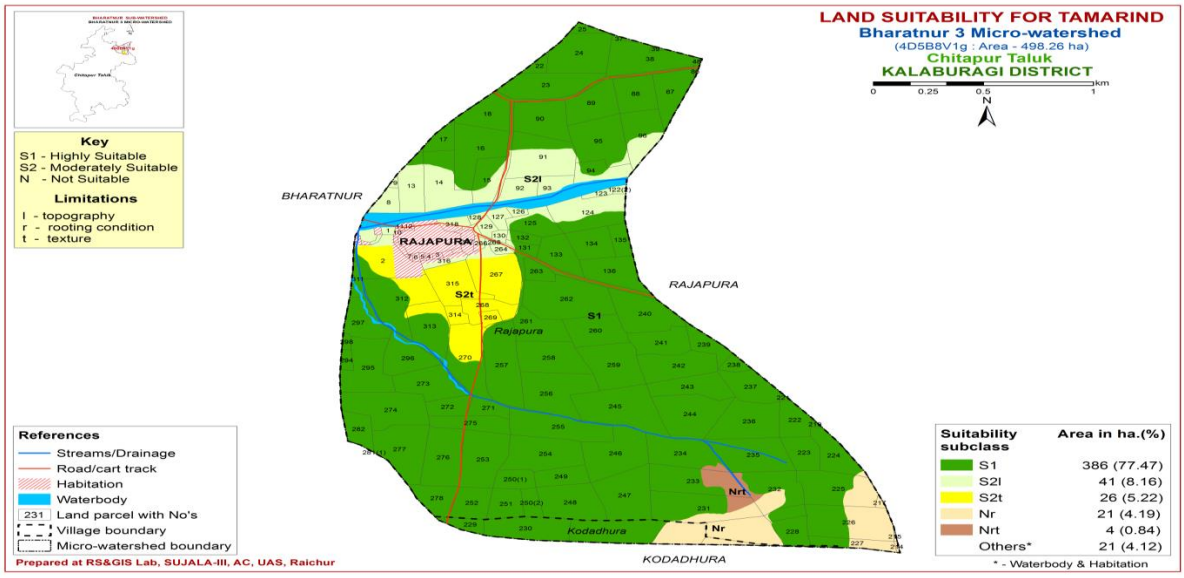

Fig 14: Land suitability map for tamarind in Bharatnur-3 MWS

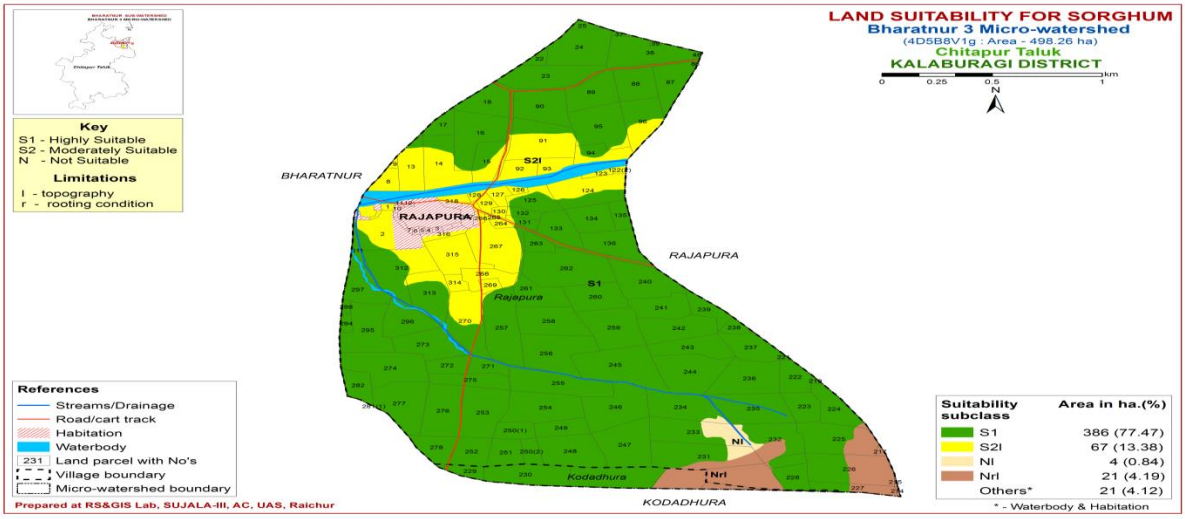

Fig 15: Land suitability map for sorghum in Bharatnur-3 MWS

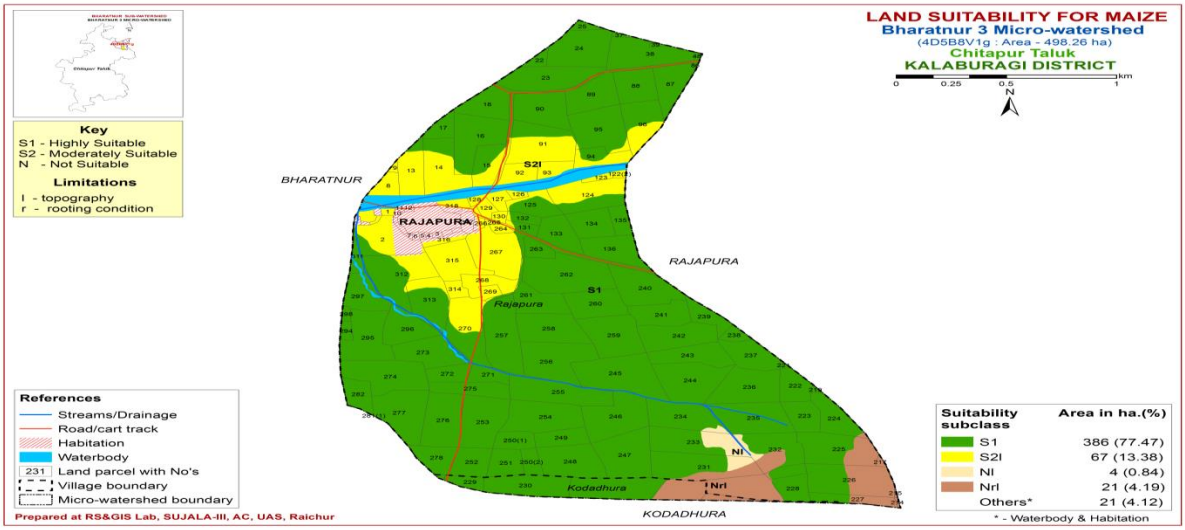

Fig 16: Land suitability map for maize in Bharatnur-3 MWS

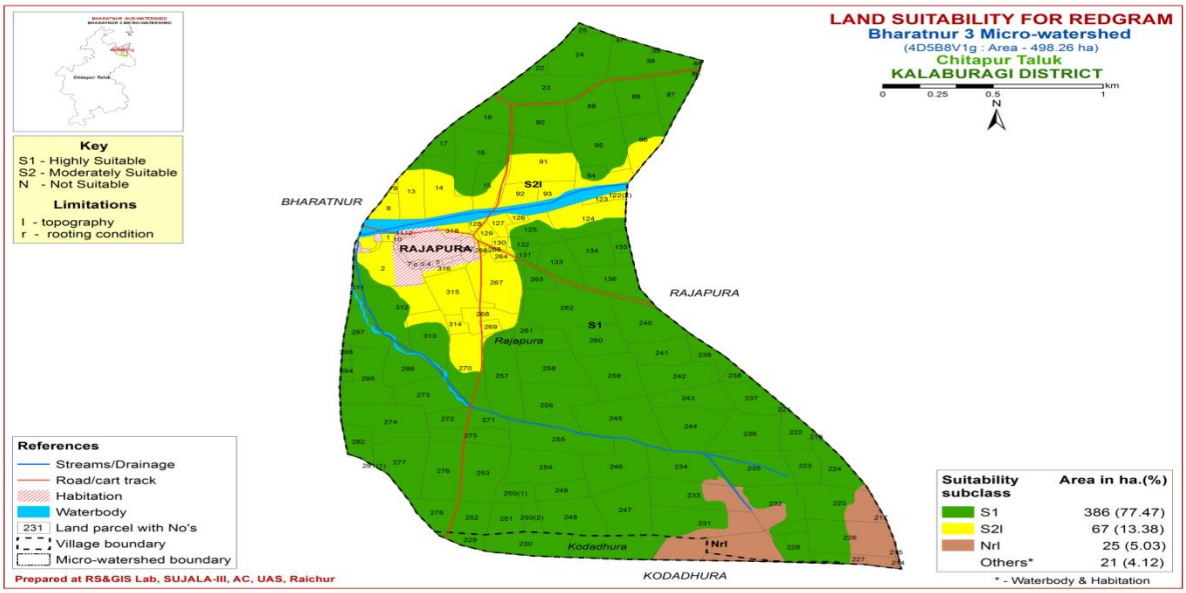

Fig 17: Land suitability map for redgram in Bharatnur-3 MWS

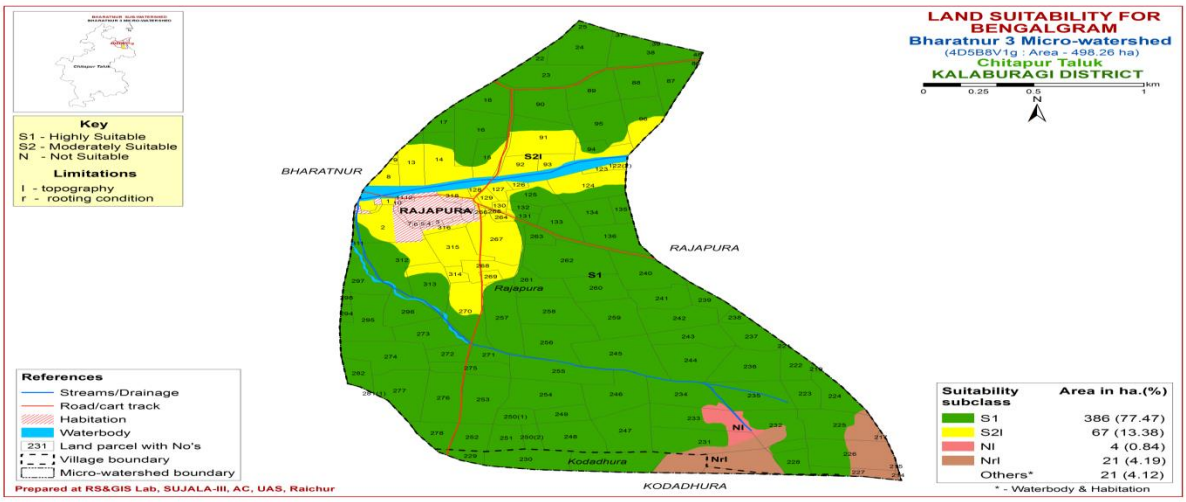

Fig 18: Land suitability map for bengalgram in Bharatnur-3 MWS

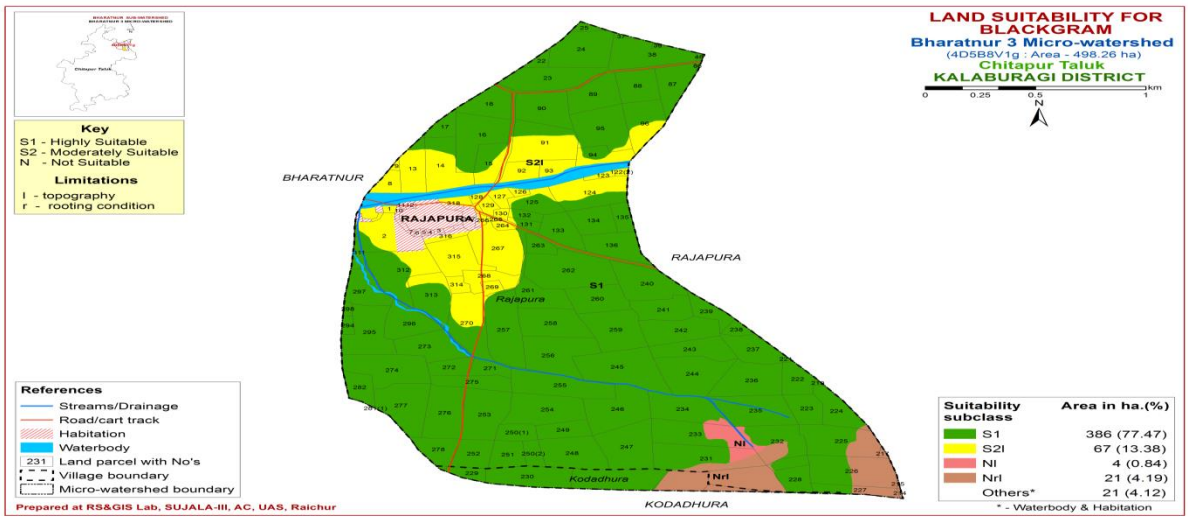

Fig 19: Land suitability map for blackgram in Bharatnur-3 MWS

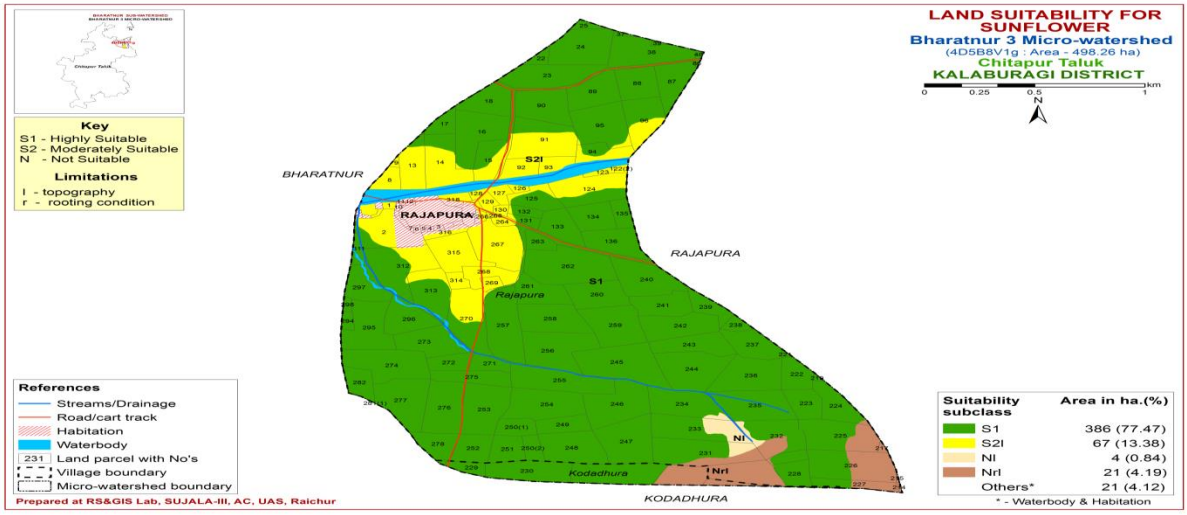

Fig 20: Land suitability map for sunflower in Bharatnur-3 MWS

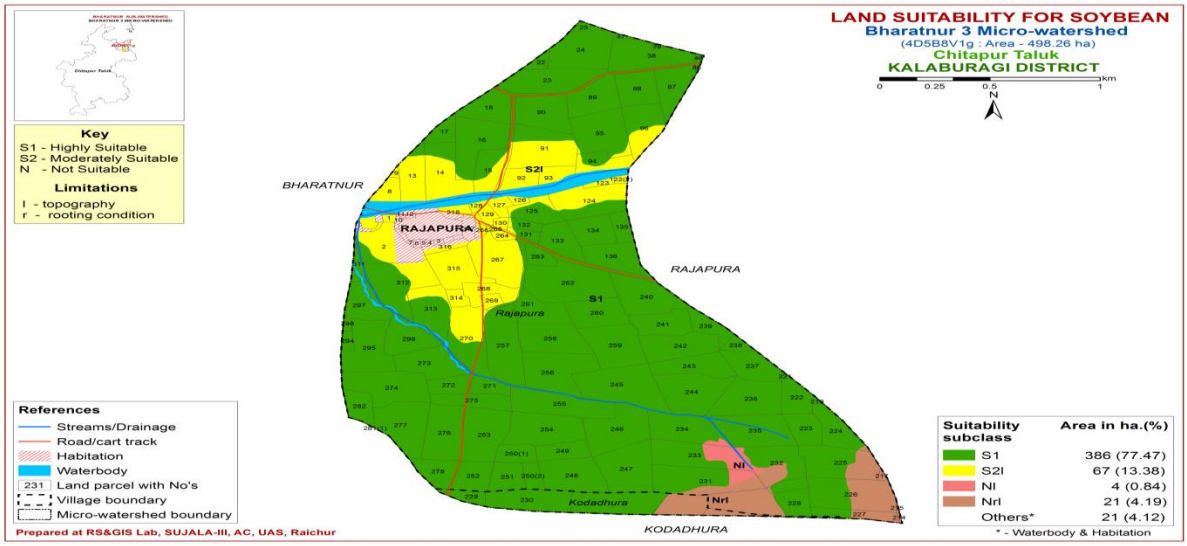

Fig 21: Land suitability map for soybean in Bharatnur-3 MWS

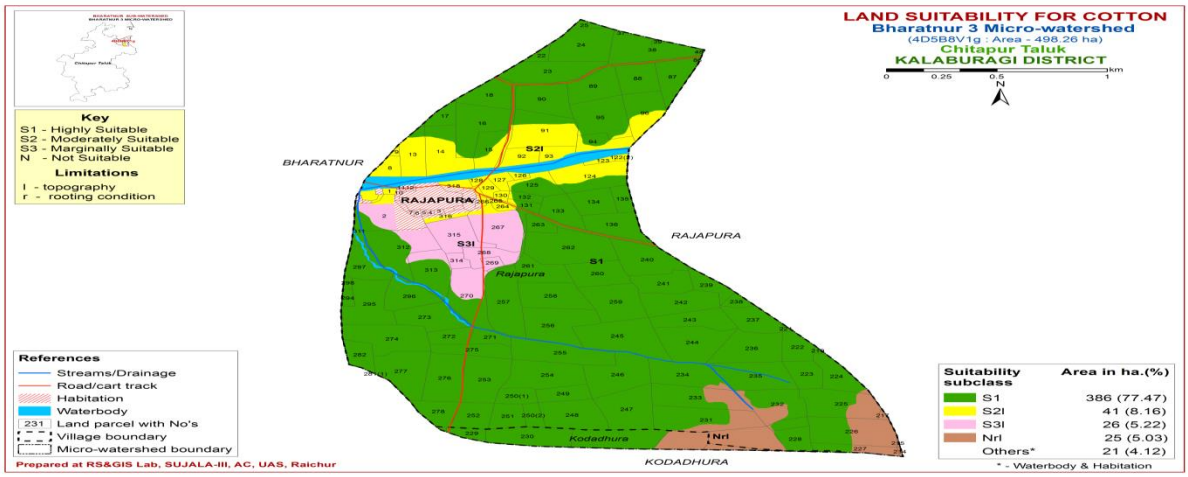

Fig 22: Land suitability map for cotton in Bharatnur-3 MWS

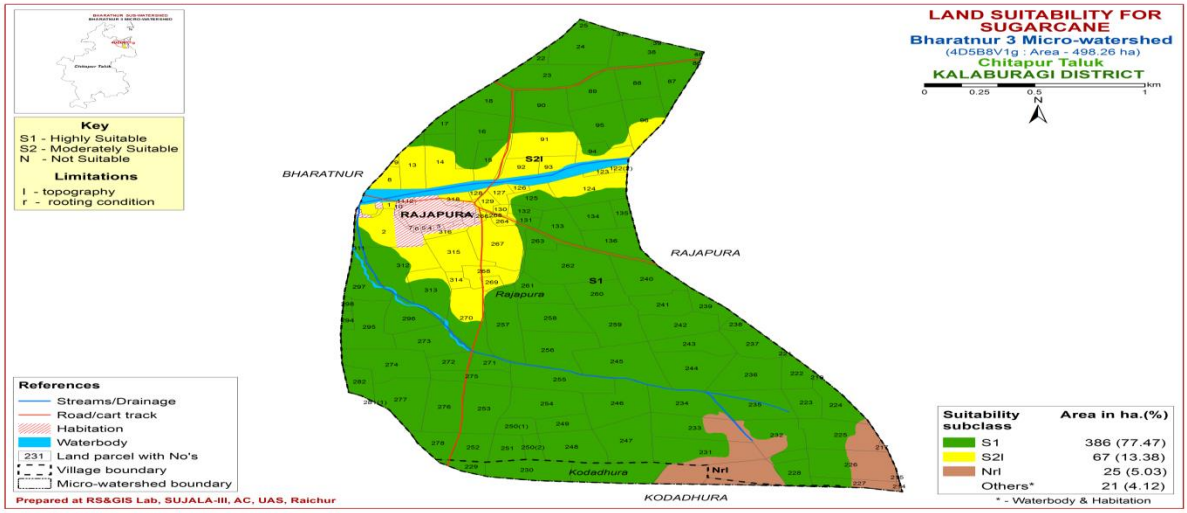

Fig 23: Land suitability map for sugarcane in Bharatnur-3 MWS

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