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Land Resources Inventory for Assessment of Crop Suitability and Land Capability of Pannur North-3 Micro watershed Using RS and GIS

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A B S T R A C T

Pannur North-3 micro-watershed area of Manvi taluk, Raichur district, Karnataka, was studied for their land capability and crop suitability. Land capability subclasses in the study area were III and IV with limitations of texture, drainage, fertility and topography. Among all the five mapping units, HSRmB2, YADmC (A)1 and PNUmC2 were classified under capability class III and most of the crops like cotton, pigeonpea, greengram, sorghum, pearl millet and guava are moderately suitable. On other hand stream bank mapping units were classified into IV land capability class due to severe limitation of erosion. Majority of the crops were moderately to marginally suitable and few were currently and potentially unsuitable.

Introduction

Land and soil are the vital natural resources for the survival of life on the earth. The natural resources assessment is prerequisite for the assessment of productivity of land and sustainability of the ecosystem. Land is a limited resource having competing demands. The per capita availability of land is declining as a result of population explosion. In addition to this, there is a significant diversion of farmlands to non- agricultural uses, exerting further strain on the already shrinking land and water resources, affecting not only the productivity but also the sustainability of the resources. Apart from the above, wrong choice of crops, faulty agricultural practices, imbalance in use of fertilizer, lack of appropriate cropping pattern and choice of land use to exploit the full potentials of the resources by the farmer have greatly affected the productivity of land resources. The problems of ever-increasing population and increased competition for a variety of demands have induced tremendous pressure on shrinking land resources. It is, therefore, essential to assess the potential of available land in terms of its capability for proper land use planning (Kharche and Gaikawad 1993). In view of this, an attempt

has been made to assess land capability for land use adjustment according to FAO (1990), as well as suggesting soil conservation measures in parts of Pannur North -3 micro watershed for efficient land utilization. Keeping these considerations in view, land capability and crop suitability exercise was undertaken in the Pannur north-3 micro-watershed of North Eastern Dry zone of Karnataka.

Materials and Methods

Pannur North-3 microwatershed was located in Manvi taluk of Raichur district, Karnataka. The microwatershed with a total area of 640.78 ha lies between 16° 12′ N latitude and 77° 22′ E longitudes. The microwatershed is surrounded by Pannuur, Chikalparvi, hosur and mustur village. The location map of the study area is depicted in Figure 1.

Semi-arid climate prevails on Pannur north-3 microwatershed and it belongs to North Eastern Dry zone of Karnataka state. The average annual rainfall is 707.16 mm. Mean maximum and minimum temperatures are 33.82°C and 21.16°C, respectively. The highest rainfall was received during the month of September (164.90 mm). The length of growing period, which indicates the availability of water for plant growth, is about 150 to 180 days in a year. It starts from the middle July and continues up to the end of December. The area qualifies for *hyperthermic* temperature regime.

The detailed survey of the entire village was carried out with the help of cadastral map (Fig. 2) and IRS imagery of the village through rapid traversing to cover up the soils at varying physiographic position. During the traverse, based on geology, drainage pattern, surface features, slope characteristics and land use, landforms and physiographic units were identified. The pedons were exposed and studied for their morphological properties following the standard procedure outlined (Anon., 1999). Surface samples were collected from farmer's fields for fertility status (major and &micro nutrients) and physicochemical properties (horizon-wise) were estimated following standard procedures (Table 1).

Based on these soil–site characteristics Pannur North-3 micro watershed area was divided into different homogeneous units known as mapping/management units. Mapping units under study were YADmC(A)1, PNUmC2, HSRmB2 and MASmC2 & MASmC3 under Yadavalli, Pannur, Hosur and Maskihalla series, respectively (Fig. 3). Among five mapping units obtained three different landforms *viz.*, upland, midland and stream revealed the slope varying from very gentle sloping (1-3%) to gentle sloping (3-5%).

The extent of area and distribution of these management units are marked with boundary on Pannur North-3 cadastral map. The high intensity survey (at 1:8,000 scale) was carried out in 640.78 ha area of the Pannur North-3 during 2016.

Results and Discussion

Land capability classification

The classification is based on the FAO (1993), framework for land evaluation. The classification includes four categories: orders, classes, sub classes and units. There are two orders (S, N), which reflect the kind of suitability (S for suitable and N for not suitable). There are three classes (S1, S2 and S3) under the order S and two classes (N1 and N2) under the order N, reflecting degree of suitability within the order. The appraisal of the classes, within an order is done according to evaluation of land limitations. The sub

classes reflect the kinds of limitations or the main kinds of improvement measures required within a class. They are indicated by the symbol, using lower case letters following the arabic numeral used for the class. The land suitability unit suggests the relative importance of land improvement works. It is indicated by arabic numerals enclosed in parenthesis following the sub class symbol.

In Yadavalli series YADmC (A)1 mapping unit was classified into IIItesf land capability sub-class with moderate limitation of slope, erosion, texture and organic carbon (Table 3). Similarly, In Pannur series PNUmC2 mapping unit was classified into IIItesf capability sub class with moderate limitation of slope, erosion, texture and organic carbon. Similarly, In Hosur series HSRmB2 mapping unit classified in to IIIsf capability sub class with moderate limitation of texture and organic carbon. Whereas, In Maskihalla series MASmC2 and MASmC3 mapping units were classified into IVe capability sub class having severe limitation of erosion and other factors are moderate limitation of slope, erosion, texture and organic carbon (Fig. 4).

The performance of any crop is largely dependent on soil parameters (depth, texture, drainage *etc*.) as conditioned by climate and topography. The study of crop suitability characterization for predicting the crop performance of an area forms land evaluations. According to Van Wambeke and Rossiter (1987) land evaluation is the rating of soil optimum returns per unit area.

The yield influencing factors for important crops have to be evaluated and the results obtained may be applied for higher production of these crops though proper utilization of similar soils occurring elsewhere in same agro-climatic sub region under scientific management practices (Khadse and Gaikwad, 1995). The soil site characteristics of the mapping units from the study area were matched with crop suitability criteria for a few important crops. The kind and degree of limitation and suitability class were determined and evaluated.

Crop suitability classification

Based on degree of limitations of soil fertility, climatic regime and land quality the soil site suitability criteria of Pannur north 3 microwatershed classified for field crops and horticultural crops.

The optimum requirements of a crop are always region specific. Climate and soil-site parameters play significant role in maximizing the crop yields (Table 2).

Cotton

It is deep rooted crop and it require 100 to 200 cm depth, and more than 80 per cent base saturation was optimum for cotton cultivation. YADmC (A)1 and PNUmC2 mapping units were moderately suitable for cotton crop having moderate limitation of slope, erosion, $CaCO_3$, pH and organic carbon. HSRmB2 mapping unit was found to be moderately suitable for cotton, due to moderate limitations of $CaCO_3$, pH and organic carbon. MASmC2 and MASmC3 mapping units were marginally suitable because severe limitation of erosion and organic carbon (Fig. 5).

Sorghum

The mapping units of the study area were moderately to marginally suitable for growing sorghum. The YADmC(A)1 and PNUmC2 mapping units were found to be moderately suitable for sorghum cultivation with moderate limitations of slope, erosion and soil reaction. The HSRmB2 mapping unit was also moderately suitable for sorghum with only one moderate limitation of soil reaction.

Fig.1 Location of the Pannur North-3 MWS

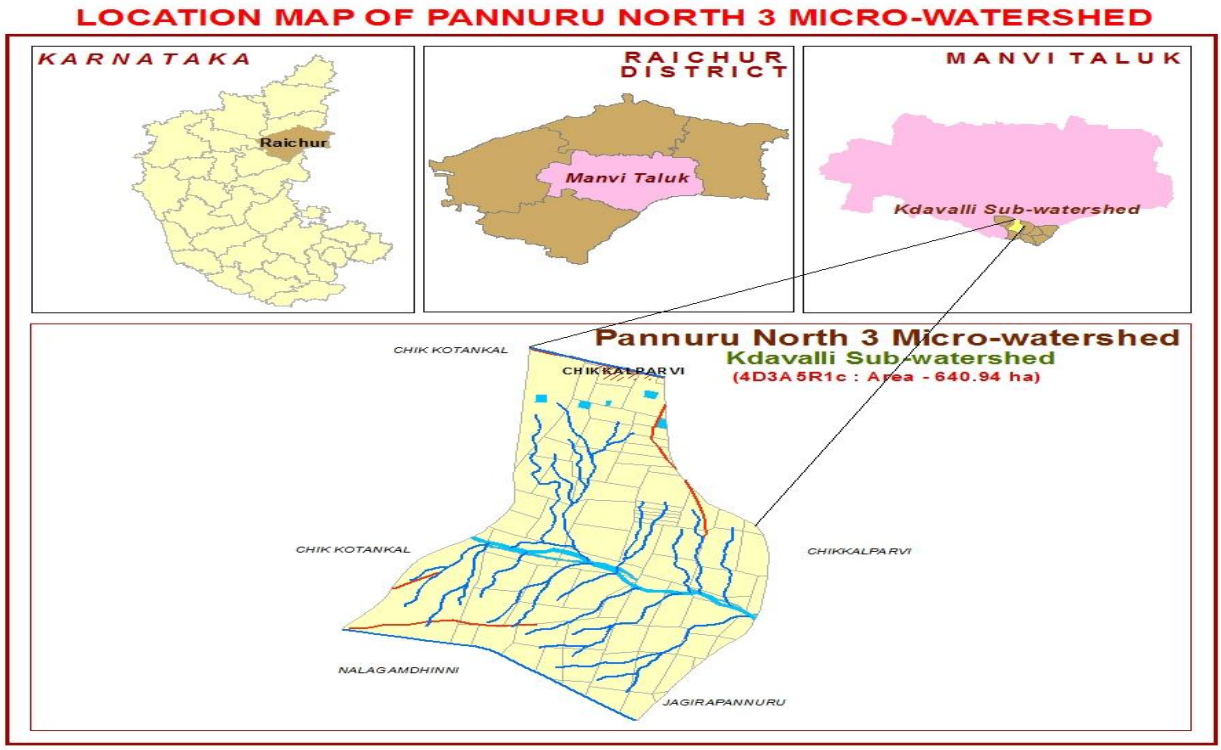

Fig.2 Cadastral map of Pannur North-3 MWS

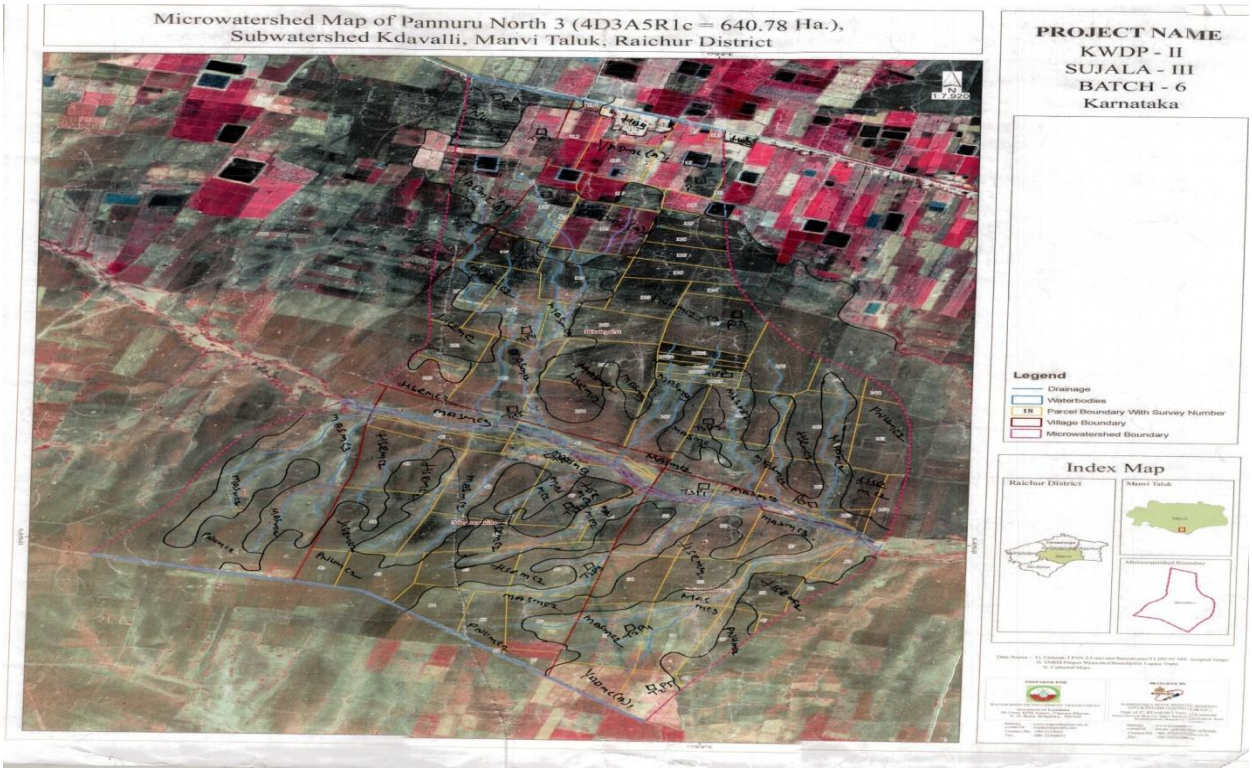

Fig.3 Soil mapping units of Pannur North-3 MWS

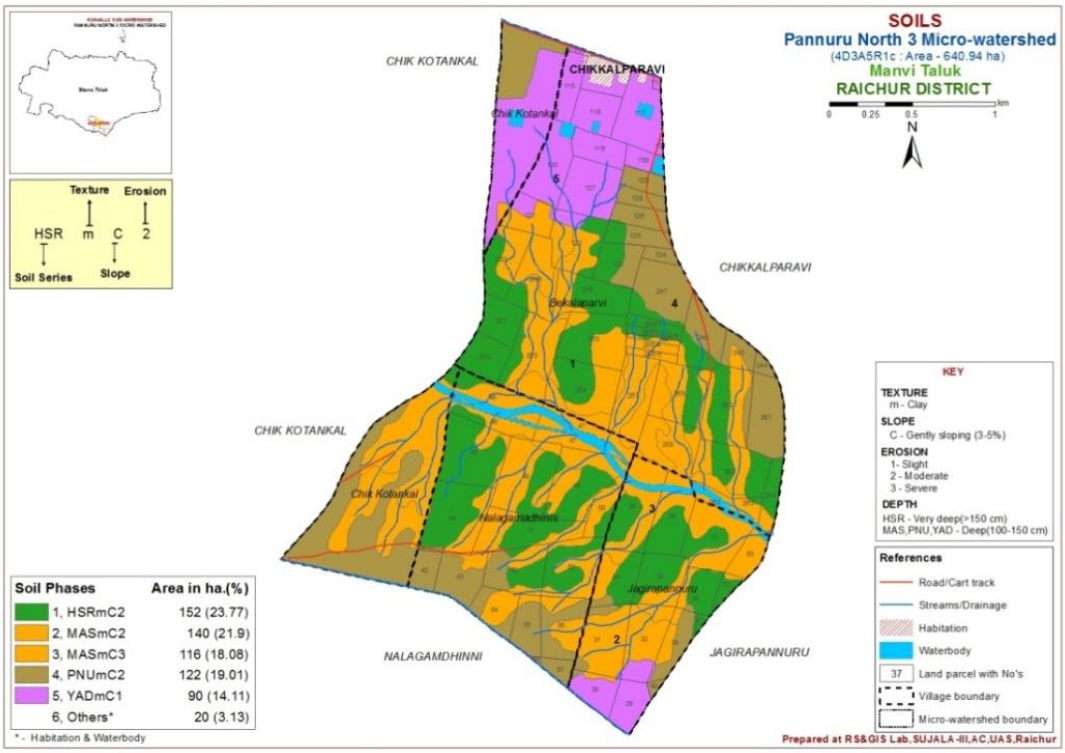

Fig.4 Land capability classification of soils in Pannur North-3 MWS

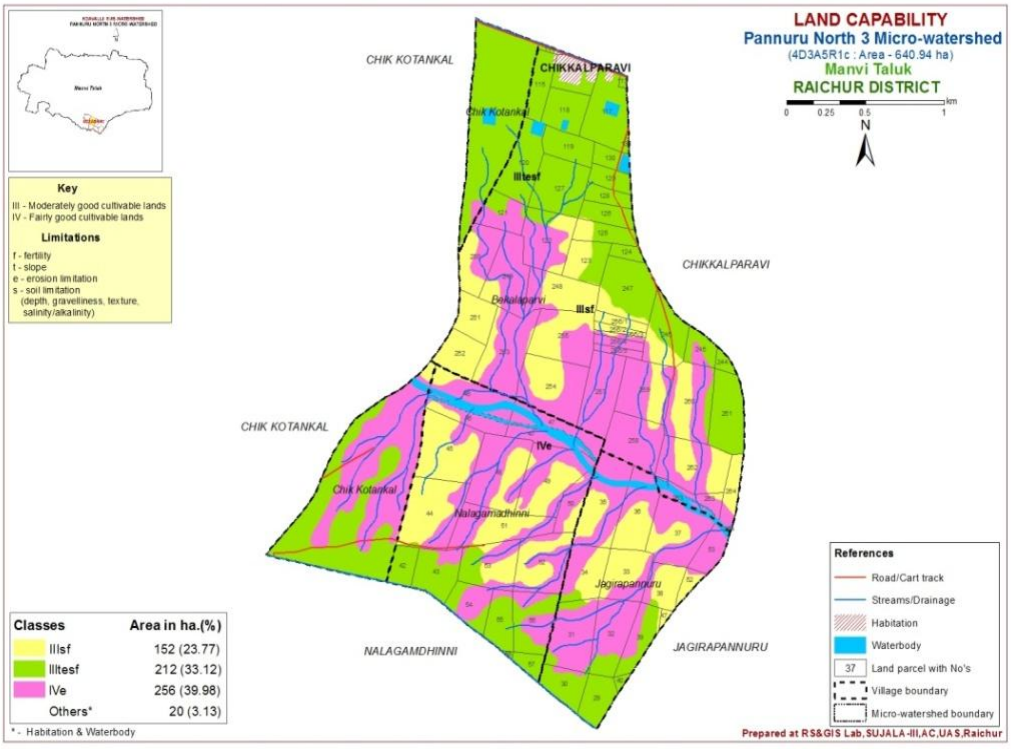

Fig.5 Crop suitability for cotton in Pannur North-3 MW

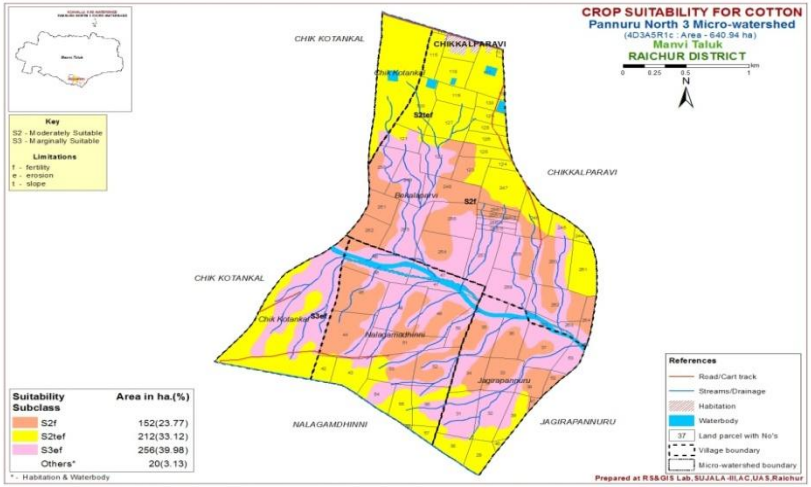

Fig.6 Crop suitability for sorghum in Pannur North-3 MWS

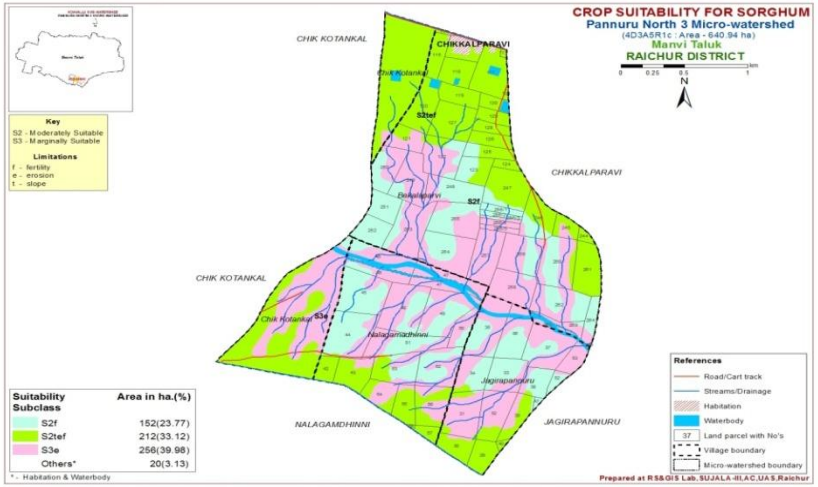

Fig.7 Crop suitability for pigeonpea in Pannur North-3 MW

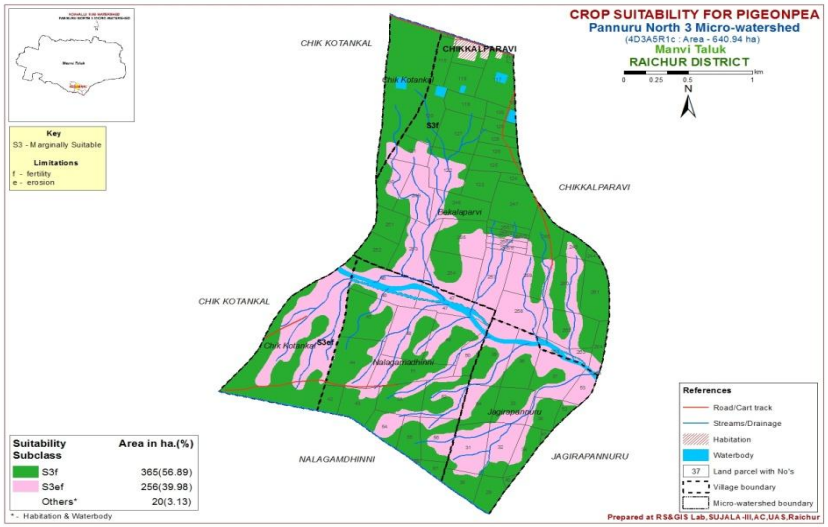

Fig.8 Crop suitability for groundnut in Pannur North-3 MWS

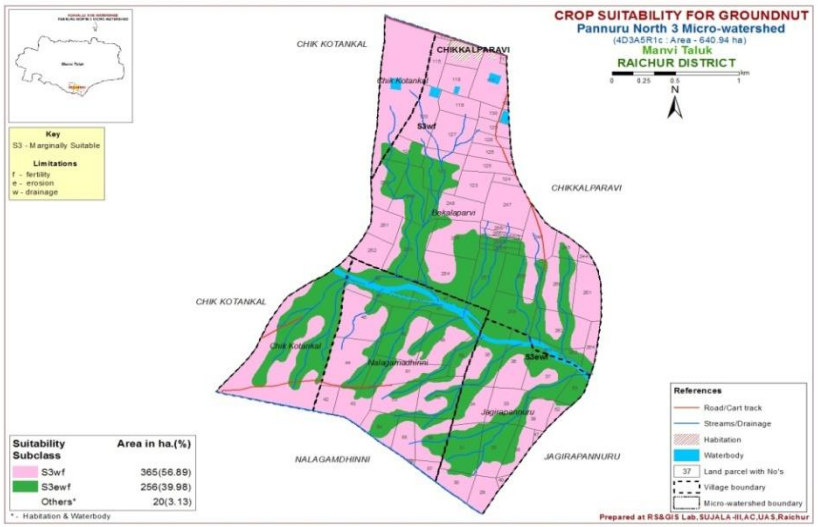

Fig.9 Crop suitability for sunflower in Pannur North-3 MWS

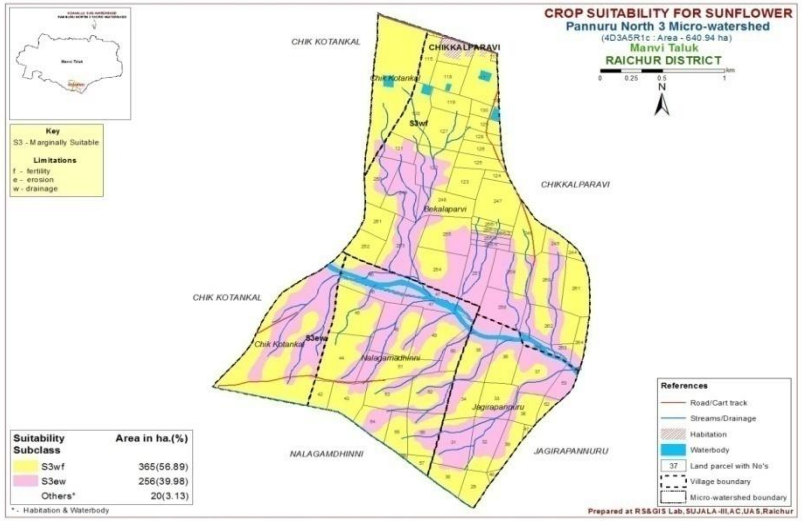

Fig.10 Crop suitability for Bengal gram in Pannur North-3 MWS

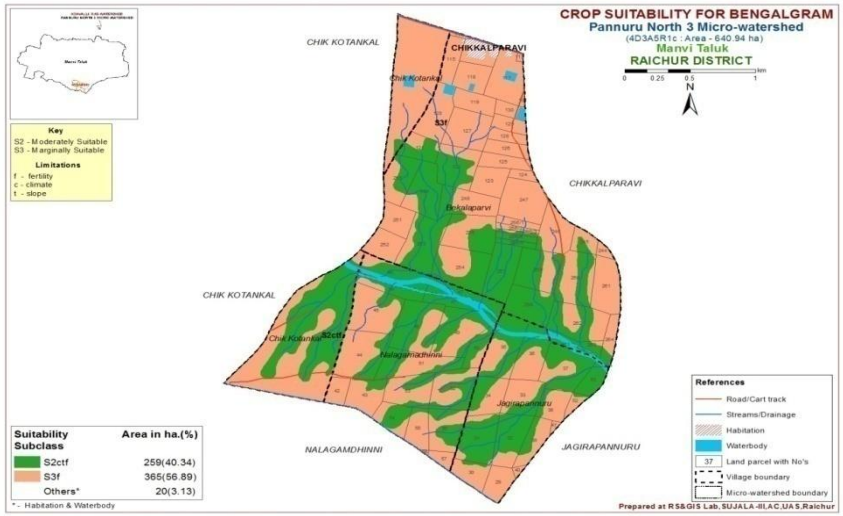

Fig.11 Crop suitability for greengram in Pannur North-3 MWS

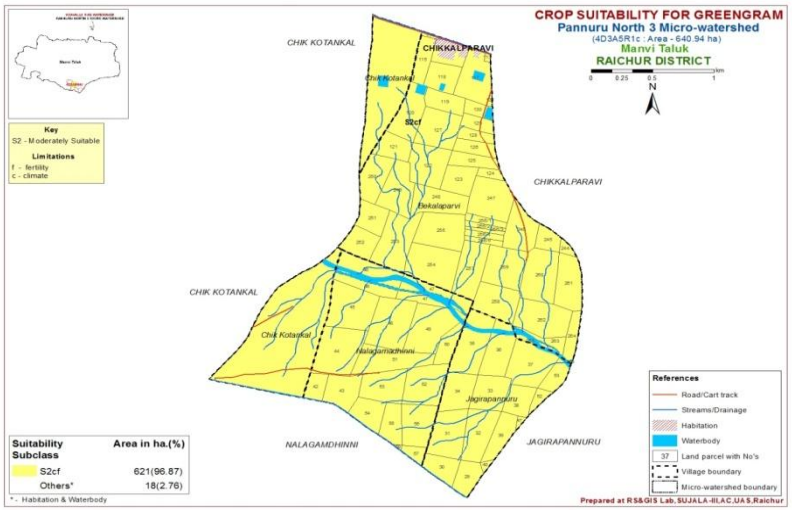

Fig.12 Crop suitability for Bajra in Pannur North-3 MWS

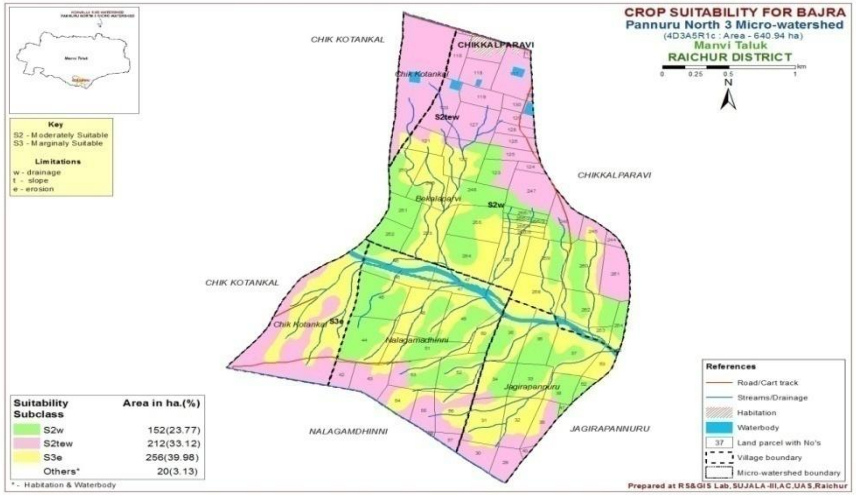

Fig.13 Crop suitability for mango in Pannur North-3 MWS

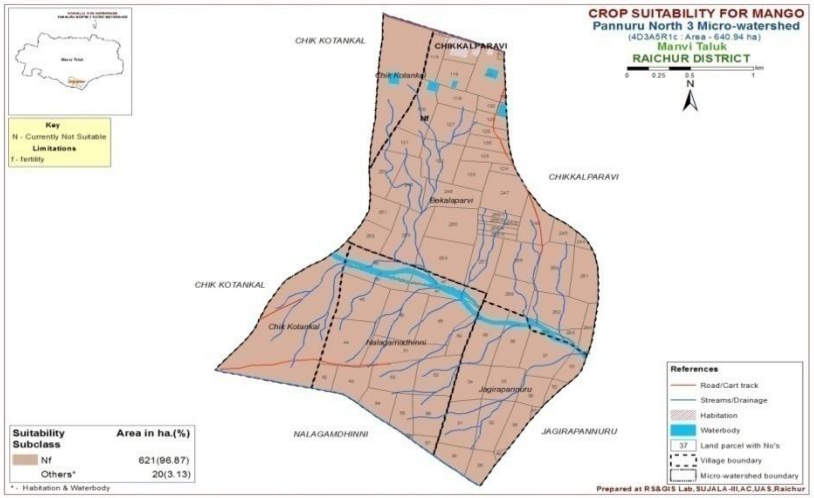

Fig.14 Crop suitability for sapota in Pannur North-3 MWS

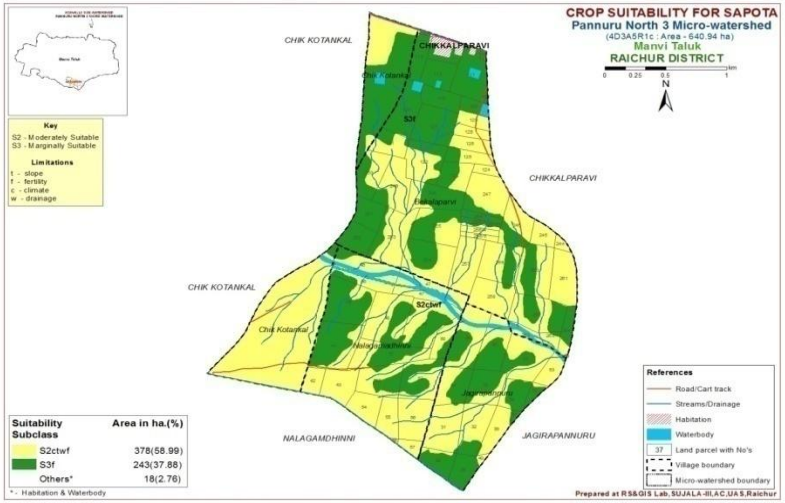

Fig.15 Crop suitability for guava in Pannur North-3 MWS

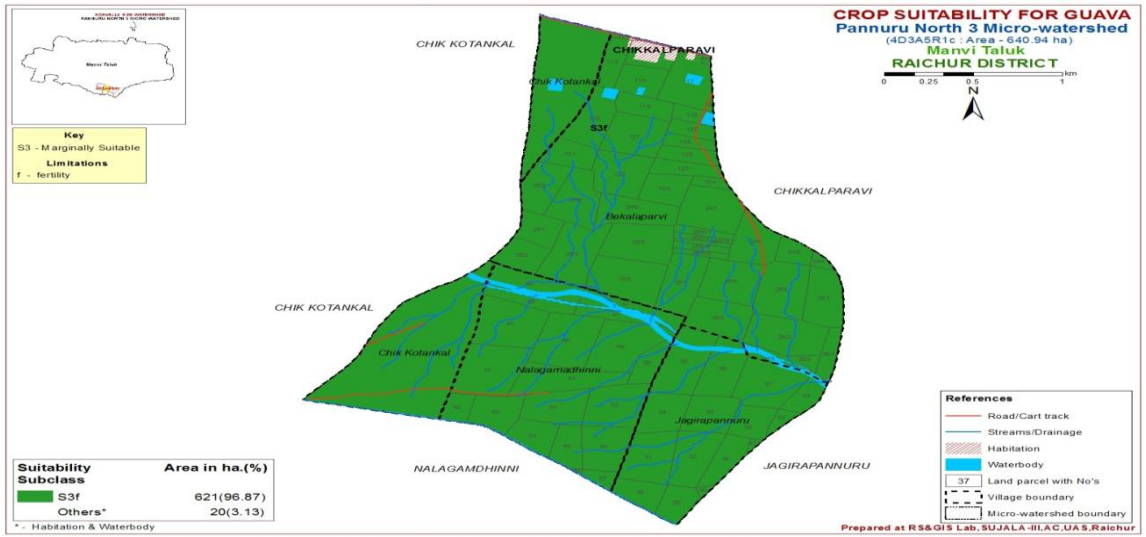

Table.1 Morphological features of the soils of Pannur North -3 MWS

Name of Soil series	Mapping unit	Geology	Colour		Soil depth (cm)		Slope (%)	Landform	Texture		Structure		Consistency	
			Surface	Subsurface	Surface	Sub surface			Surface	Sub surface	Surface	Sub surface	Surface	Sub-surface
Yadavalli	YADmC (A)1	Schist	10YR 3/2 (D) & 3/1(M)	10YR 3/1(D) & 3/1(M)	0-11	95-130	3-5	Upland	C	C	2 msbk	3 mabk	sh, fr, ss, sp	vh, fi, vs, vp
Pannur	PNUmC 2	Granite	10YR 3/2(D) & 3/1(M)	10 YR 3/1 (D) & 3/1 (M)	0-12	120-140	3-5	Upland	C	C	2 msbk	3 mabk	sh, fr, ss, sp	h, fr, vs, vp
Hosur	HSRmB 2	Granite	10YR 3/1(D) & 3/1(M)	10 YR 2/1 (D) & 2/1(M)	0-11	120-160	1-3	Midland	C	C	2 msbk	3 mabk	sh, fr, ss, sp	vh, fr, vs, vp
Maskihalla	MASmC 2	Granite	10YR 4/2(D) & 4/1(M)	10 YR 3/2(D) & 3/1M)	0-12	105-130	3-5	Stream bank	C	C	2 msbk	2 cabk	sh, fr, ss, sp	h, fr, vs, vp
	MASmC 3	Granite	10YR 4/2(D) & 4/1(M)	10 YR 3/2(D) & 3/1(M)	0-18	95-120	3-5	Stream bank	C	C	2 msbk	2 cabk	sh, fr, ss, sp	h, fr, s, vp

Note: sh – slighly hard, ss – slightly sticky, sp – slightly plastic, fr – friable, fi – firm, vs – very sticky, v p – very plastic, h – hard, m – medium, sbk – subangular blocky, abk-angular bloky, c – coarse

Table.2 Crop suitability characteristics of Pannur North -3 MWS for land evaluation

Mapping units	Climate (c)					Land form characteristics					Physico - chemical characteristics (f)				
	RF (mm)	Max. Temp. (^{0}C)	Min. Temp. (^{0}C)	RH (%)	Slope (t)	Erosion (e)	Drainage (w)	Depth (cm)	$CaCO_3$ (%)	Texture	pH	OC (g kg^{-1})	CEC cmol(p^+) kg^{-1}	BS (%)	ESP
YADmC(A)1	707.1	33.82	21.16	69.62	3-5	Moderate	Moderately well drained	95-125	13.0	Clay	8.11	5.5	56.0	93.33	8.83
PNUmC2	707.1	33.82	21.16	69.62	3-5	Moderate	Moderately well drained	120-140	12.8	Clay	8.07	5.6	54.8	92.79	7.64
HSRmB2	707.1	33.82	21.16	69.62	1-3	Slight	Moderately well drained	120-160	13.2	Clay	8.30	5.8	62.4	94.69	8.93
MASmC2	707.1	33.82	21.16	69.62	3-5	Severe	Moderately well drained	105-140	11.0	Clay	8.05	4.6	45.7	92.27	7.88
MASmC3	707.1	33.82	21.16	69.62	3-5	Severe	Moderately well drained	95-135	10.2	Clay	7.95	4.3	45.1	91.86	8.62

Table.3 Land capability classification of Pannur North -3 MWS

Mapping units	Land form characteristics			Physical characteristics (s)			Chemical characteristics (f)			LCC
	Slope (%) (t)	Erosion (e)	Drainage (w)	Texture	Soil depth (cm)	Pedon Development	CEC cmol (p^+) kg^{-1}	OC (g kg^{-1})	BS (%)	
Yadavalli series										
YADmC(A)1	III	III	II	III	II	II	I	III	I	IIItesf
Pannur series										
PNUmC2	III	III	II	III	II	II	I	III	I	IIItesf
Hosur series										
HSRmB2	II	II	II	III	I	I	I	III	I	IIIsf
Maskihalla series										
MASmC2	III	IV	II	III	II	II	I	III	I	IVe
MASmC3	III	IV	II	III	II	II	I	III	I	IVe

Whereas MASmC2 and MASmC3 mapping units were marginally suitable due to severe limitation of erosion and other parameters were found to be moderate limitations for the sorghum cultivation (Fig. 6). Similarly, Satyavathi and Suryanarayan Reddy (2004) reported that Typic Haplustalfs in Telangana region were moderately suitable for growing groundnut as they exhibited similar limitations in soil fertility and physical characteristics.

Pigeonpea

The soil-site suitability assessment for pigeonpea revealed that the soils of the study area were marginally suitable (S3) due to marginal to severe limitations of erosion and exchangeable sodium percentage. YADmC(A), PNUmC2 and HSRmB2 mapping units were marginally suitable for pigeonpea crop with only one severe limitation of exchangeable sodium per cent and other parameters were found to be moderate limitations to the pigeonpea crop (Fig. 7). Similarly, MASmC2 and MASmC3 mapping units were also marginally suitable for pigeonpea cultivation with severe limitation of erosion and exchangeable sodium percentage.

Groundnut

Most of the Mapping units *viz.*, YADmC(A)1, PNUmC2 and HSRmB2 were marginally suitable for groundnut cultivation because severe limitations of texture and drainage. Similarly, MASmC2 and MASmC3 mapping units were also marginally suitable due to severe limitation of erosion, texture and drainage to the groundnut crop (Fig. 8).

Sunflower

It has been established that rainfall, temperature, slope, BS, $CaCO_3$, CEC and soil depth are the important factors which influence sunflower yield.

Pannur North -3 microwatershed area had severe limitations of texture and drainage and hence the mapping units YADmC(A)1, PNUmC2 and HSRmB2 mapping units belongs to marginally suitable class for sunflower cultivation. And other mapping units *viz*., MASmC2 and MASmC3 were also marginally suitable for sunflower having severe limitations of erosion, drainage (Fig. 9).

Bengal gram

In this study area PNUmC2, MASmC2 and MASmC3 mappings units were moderately suitable for cultivation of the bengalgram due to moderate limitations of climate, slope, texture and soil reaction. YADmC(A)1 and HSRmB2 mapping units were marginally suitable due to single severe limitation of soil reaction while other factors are moderate limitations for bengalgram cultivation shown in Figure 10.

Green gram

Soil reaction, depth, texture, exchangeable sodium per cent showed considerable impact on yield of green gram. All the five mapping units were found to be moderately suitable for Greengram cultivation in this study area because moderate limitations of texture and soil reaction (Fig. 11).

Pearl millet

In alfisols or vertisols yield have considerable impact on pearl millet with factors like rainfall, depth, texture and $CaCO_3$. YADmC(A)1 and PNUmc2 mapping units were found to be moderately suitable for pearl millet cultivation because moderate limitation of slope, erosion and drainage. The HSRmB2

mapping unit was also moderately suitable for pearl millet with moderate limitation of slope and drainage. MASmC2 and MASmC3 mapping units were marginally suitable are owing to single severe limitation of erosion (Fig. 12).

Mango

All the mapping units of the study area were found non suitable for mango plantation. Mango tree require more depth and neutral soil reaction for its better growth and development. In this study area all the mapping units were found to be non-suitable due to one severe limitation of calcium carbonate while other parameters were found to be moderate limitations (Fig. 13).

Sapota

Mapping units PNUmC2, MASmC2 and MASmC3 were moderately suitable for sapota cultivation due to moderate limitations of climate, slope, drainage, depth, texture, soil reaction and base saturation. Whereas, YADmC(A)1 and HSRmB2 mapping units were marginally suitable due to severe limitation of soil reaction and other factors are moderate limitation (Fig. 14).

Guava

All horticulture crops need more depth compared to field crops and require neutral soil reaction. Mapping units *viz.*, YADmc (A)1, PNUmC2 and HSRmB2, were marginally suitable for guava cultivation having severe limitations of calcium carbonate and soil reaction Whereas, MASmC2 MASmC3 mapping units were also marginally suitable are owing to single limitation of calcium carbonate (Fig. 15).

In pannur north 3 micro watershed all the mapping units were classified as vertisols, having very fine montmorillite type of soil. Among all the five mapping units, HSRmB2, YADmC(A)1 and PNUmC2 covered 364 ha of total study area (640 ha). These mapping units were classified under capability class III and most of the crops like cotton, pigeonpea, greengram, sorghum, pearl millet and guava are moderately suitable. On other hand stream bank mapping units covered 258 ha of total study area were classified into IV land capability class due to severe limitation of erosion. Therefore suitability of different crops was restricted. Hence such parcel of land can be managed by adapting good soil and water conservation measures and also land suitability evaluation puts alternative possibilities for change in land use, predicts the consequence of such changes and it provides full evidence contributing to planning, management and investment decision and it should be remain useful for several decades.

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