Original Research Article

SOIL SUITABILITY FOR GROWING HORTICULTURAL CROPS IN KANAMADI SOUTH SUB-WATERSHED OF KARNATAKA

Abstract:

An investigation was carried to assess land suitability for growing horticultural crops in Kanamadi South sub-watershed of Vijayapura district of Karnataka. The soil survey was conducted using 1:7920 scale, LISS IV satellite imagery. The soils were shallow to deep with clay loam to clay in texture. The soils were low in nitrogen and organic carbon, low to medium in phosphorus and sulphur, medium to high in potassium. Iron, copper, zinc and manganese were sufficient. Land suitability evaluation revealed that soils were moderately suitable for growing fruits such as guava (73.75 % TGA), pomegranate (70.73 % TGA), sapota (85.65 % TGA). In case of flowers, major part of the study area was marginally suitable for crops such asrose (65.26 % TGA) and jasmine (91.72 % TGA). Around 11.55 per cent of the area was evaluated as unsuitable for growing fruit crops.The consideration of depth and nutrient status of soil in sub-watershed area is ideal to grow the horticultural crops like fruit crops with soil conservation measures to obtain food sustainability and nutrition level of people living the study area.

Key words: Kanamadi, Land suitability, sub-watershed, sustainablility.

Introduction:

Soil survey constitutes a valuable resource inventory linked with the survival of life on the earth. It provides an accurate and scientific inventory of different soils, their kind and nature and extent of distribution so that one can predict their characteristics and potentialities. It also provides adequate information in terms of landform, slope, land use as well as characteristics of soils (*viz.,* texture, depth, structure, stoniness, drainage, acidity, salinity, *etc*.) which can be utilized for planning and development (Nagendra and Patil, 2015).

Kanamadi South sub-watershed is located in Tikota hobli of Vijayapura taluk of Vijayapura district in Karnataka and was selected as study area. This area is well known for pomegranate and grapes production. The sub-watershed with a total area of 4170.17 ha lies between 75^0 21’ and 75^0 26’30" East longitudes and 16^0 51’ and 16^0 55’30" North latitudes.

Land suitability assessment is a prerequisite for achieving optimum utilization of available land resources for agricultural production in a sustainable manner. FAO (1976) defined land suitability as ‘a function of crop requirements and land characteristics as well as a measure of how well the qualities of a land unit matches the requirements of a particular form of land use’. Land suitability assessment allows identifying the main limiting factors of a piece of land for particular crop production and enables decision-makers to develop a crop management system for increasing land productivity (Denis *et al*.,2016).

Horticultural crops, particularly the fruit crops areimportant for ensuring nutritional security andemployment opportunity and thus, vital for livelihoodsecurity. Horticulture production

system (fruit cropbased) is economically viable and more adoptable(Chundawat, 1993; Chadha, 2002). Integration ofannual field crops with fruit crops results in high yieldand income (Osman, 2003). Now a day's horticulturesystem is becoming more important to arrest landdegradation and improving the income, and thus holdsgreat promise for diversification of marginal land.

The mainpurpose of agricultural land suitability evaluation is topredict the potential and limitation of the land for cropproduction (Pan and Pan, 2012; AbdelRahman *et al.*,2016). Besides, to achieve the goal of sustainableagriculture it is also important to emphasize on properland categorization and its utilization based upon theirdifferent uses (FAO, 1993). Better delineation of soiland land suitability for optimum soil and landmanagement requires information on soil and relatedproperties which can be obtained from proper soilsurvey and soil classification.

This case study was initiated from the concern that farmers in Vijayapura district of Karnataka continue to grow cereal crop on unsuitable soils despite state efforts to dissuade. Therefore the study aimed at quantification of area suited to grow potential horticultural crops and recently vanished fruit and flower crop at soil series level.

Materials and Methods:

Soil Survey: A detailed soil survey of the Kanamadi south sub-watershed was carried out using IRS P6 LISS-IV image and Vijayapura district Toposheet. The image and scanned Toposheet were geocoded and a subset was created in ArcGIS 10.2 on a 1: 12,500 scale. The area was then intensively traversed and 19 pedon locations were fixed on soil heterogeneity. At each pedon location, a fresh profile was opened and detailed morphological studies as described by the USDA Soil Survey Manual (2000) and horizon-wise samples were collected and analyzed for Physico-chemical parameters.

Soil mapping

Based on soil heterogeneity as revealed by laboratory analysis and visual interpretation of the IRS P6 LISS-IV image, soil mapping units were delineated following the USDA Soil Survey manual (2000) and evaluated for the land capability and soil site suitability for crops.

Soil Site Suitability evaluation for crops

The FAO (1976) framework for land evaluation was followed in the evaluation of soil-site suitability for maize, pearl millet and sorghum in the Kanamadi south sub-watershed. This classification recognizes two orders of land suitability, order 'S' (suitable) and order 'N' (not suitable) which are further subdivided into land suitability classes.

The classification includes four categories: orders, classes, subclasses, and units. There are two orders (S, N) that reflect the kind of suitability(S for suitable and N for unsuitable).

There are three classes (S-1 to 3) under the suitable order S and two classes (N-1 and 2) under the order N, reflecting the degree of suitability within the order. The appraisal of the classes, within an order, is done according to the evaluation of land limitations. The subclasses 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 subclass symbol. The criteria for evaluation of soil suitability for gauva , pomegranate, sapota, rose and jasmine are given in tables 1, 2, 3, 4 and 5.

Table 1: Soil site suitability criteria (crop requirements) for guava

Soil site characteristics		Unit	Rating			
			Highly suitable (S1)	**Moderately suitable (S2)**	**Marginally suitable (S3)**	**Not suitable (N)**
Climatic regime	Mean temp. in growing season	°C	28-32	33-36 & 24-27	37-42 & 20-23	-
Land quality	**Land characteristics**					
Moisture availability	Length of growing period	Days	>150	120-150	90-120	90
Oxygen availability to roots	Soil drainage	Class	Well drained	Moderately to imperfectly	Poorly	Very poorly
Nutrient availability	Texture	Class	Scl, l, cl, sil	Sl, sicl, sic, sc, c (m/k)	C (<60)	C (>60) s, ls
	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
	Available nutrient status (NPK)	Fertility rating class	High	Medium	Low	-
Rooting conditions	Effective soil depth	cm	>100	75-100	50-75	<50
	Presence of gravel	%	Non gravelly	<15	15-35	<35
	Coarse fragments	Vol %				-
Soil toxicity	Salinity (ECe)	dS/m	<2.0	2.0-4.0	4.0-6.0	>6.0
	Sodicity (ESP)	%	Non sodic	10-15	15-25	>25
Erosion hazard	Slope	%	<3	3-5	5-10	>10

Table 2: Soil site suitability criteria (crop requirements) for pomegranate

Soil site characteristics		Unit	Rating			
			Highly suitable (S1)	**Moderately suitable (S2)**	**Marginally suitable (S3)**	**Not suitable (N)**
Climatic regime	Mean temp. in growing season	°C	30-34	35-38 25-29	39-40 15-24	-
Land quality	**Land characteristics**					
Moisture availability	Length of growing period	Days	>150	120-150	90-120	<90
Oxygen availability to roots	Soil drainage	Class	Well drained	Moderately well drained	Poorly drained	V. poorly drained
Nutrient availability	Texture	Class	scl, l, sil, cl	c, sic, sicl	cl, s, ls	-
	pH	1:2.5	5.5-7.5	7.6-8.5	8.6-9.0	-
Rooting conditions	Effective soil depth	cm	>100	75-100	50-75	<50
	Presence of gravel	%	Non gravelly	15-35	>35	-
Soil toxicity	Salinity (ECe)	dS/m	Non saline	<9	>9	<50
Erosion hazard	Slope	%	<3	3-5	5-10	-

(Source; Naidu *et al*., 2006)

Table 3 : Soil site suitability criteria (crop requirements) for sapota

Soil site characteristics		Unit	Rating			
			Highly suitable (S1)	**Moderately suitable (S2)**	**Marginally suitable (S3)**	**Not suitable (N)**
Climatic regime	Mean temp. in growing season	°C	28-32	33-36 24-27	37-42 18-23	>42 <18
Land quality	**Land characteristics**					
Moisture availability	Length of growing period	Days	>150	120-150	90-120	<120
Oxygen availability to roots	Soil drainage	Class	Well drained	Moderately well drained	Imperfectly drained	Poorly drained
Nutrient availability	Texture	Class	scl, l, sil, cl	sl, sc, sicl, c(m/k)	c (s>60)	ls, s, c (s>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
Rooting conditions	Effective soil depth	cm	>150	75-150	50-75	<50
	Presence of gravel	%	Non gravelly	<15	15-35	<35
Soil toxicity	Salinity (ECe)	dS/m	Non saline	Upto 1.0	1.0-2.0	2.0-4.0
	Sodicity (ESP)	%	Non sodic	10-15	15-25	>25
Erosion hazard	Slope	%	<3	3-5	5-10	-

(Source; Naidu *et al*., 2006)

Table 4: Soil site suitability criteria (crop requirements) for rose

Soil site characteristics		Unit	Rating			
			Highly suitable (S1)	**Moderately suitable (S2)**	**Marginally suitable (S3)**	**Not suitable (N)**
Climatic regime	Mean temp. in growing season	°C	25-30	31-32 20-24	32-36 15-19	
Land quality	**Land characteristics**					
Oxygen availability to roots	Soil drainage	Class	Well drained	Moderate	Imperfect	Poor
Nutrient availability	Texture	Class	sl, l, scl, cl, sil	sic, sicl, sc, c (m/k)	c (ss)	s, sl
	pH	1:2.5	6.0-7.5	67.6-8.5 5.0-5.9	<5 >8.5	
	CEC	c mol $(P^+)kg^{-1}$	>15	10-15	<10	
	$CaCO_3$ in root zone	%	Non-calcareous	Slightly calcareous	Strong calcareous	
Rooting conditions	Effective soil depth	cm	>100	75-100	50-75	<50
	Coarse fragments	%	<15	1535	>35	
Soil toxicity	Salinity (ECe)	dS m^{-1}	Non-saline	Slight	Strongly	
	Sodicity (ESP)	%	Non-sodic	Slight	Strongly	
Erosion hazard	Slope	%	1-5	5-10	10-20	>20

(Source; Naidu *et al*., 2006)

Table 5: Soil site suitability criteria (crop requirements) for jasmine

Soil site characteristics		Unit	Rating			
			Highly suitable (S1)	**Moderately suitable (S2)**	**Marginally suitable (S3)**	**Not suitable (N)**
Climatic regime	Mean temp. in growing season	°C	18-23	17-15 24-35	35-40 10-14	-
Land quality	**Land characteristics**					
Oxygen availability to roots	Soil drainage	Class	Well drained	Moderate	Imperfect	Poor
Nutrient availability	Texture	Class	sl, 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	-
	CEC	cmol (p^+) kg^{-1}	>25	10-15	<10	-
	$CaCO_3$ in root zone	%	Non calcareous	Slightly calcareous	Strong calcareous	-
Rooting conditions	Effective soil depth	cm	>75	50-75	25-50	<25
	Coarse fragments	%	<15	15-35	>35	-
Soil toxicity	Salinity (ECe)	dS m^{-1}	Non-saline	Slight	Strongly	-
	Sodicity (ESP)	%	Non-sodic	Slight	Strongly	-
Erosion hazard	Slope	%	1-3	3-5	5-10	>10

(Source; Naidu *et al*., 2006)

Table 6: Soil-site suitability classification of mapping units for major horticultural crops

Mapping unit	Guava	Pomegranate	Sapota	Rose	Jasmine
DMTmB2g1	N	N	N	S2crts	S3s
DMTmB2g1Ca	N	N	N	S2crts	S3s
DMTmB2g2Ca	N	N	N	S3s	S3ts
KGRmB2	S3r	S3r	S3r	S3s	S3ts
KGRmB2g1	S3r	S3r	S3r	S3s	S3ts
NHLmB2	S3r	S3r	S3r	S2crts	S3s
THLmB2	S2rs	S2rs	S2rs	S2crts	S2crts
THLmB2g1Ca	S2rts	S2rts	S2rts	S3s	S3s
THLmB2g2Ca	S2rs	S2rs	S2rs	S3s	S3s
RPRmB2	S2ts	S2ts	S2rs	S3s	S3ts
BBLmB2	S2ts	S2ts	S2ts	S2ts	S2crts
NDNmB2	S3ts	S2ts	S2ts	S2ts	S3s
NDNmB2g1Ca	S2ts	S2ts	S2ts	S3s	S3ts
TSLmB2g1Ca	S2ts	S2ts	S2ts	S3s	S3ts
SRDmB2	S2ts	S2ts	S2ts	S3s	S3ts
SRDmB2g1Ca	S2ts	S2ts	S2ts	S3s	S3ts
KRJmB2	S2ts	S2ts	S2ts	S3s	S3ts
KRJmB2g1Ca	S2ts	S2ts	S2ts	S3s	S3s
HNTmB2g1Ca	S2ts	S2ts	S2ts	S2crts	S2crts

Results and Discussion:

The soil properties of the study area were matched with the soil site suitability criteria for a few important crops grown in north Karnataka. The soil suitability for major horticultural crops is presented in Table 6.

Fruit crops

Pomegranate

The mapping units of the study area were moderately suitable to not suitable for pomegranate cultivation because of limitations of climate, soil physico-chemical properties and land form characteristics.

The area of 2 ha (0.04 % TGA) had moderate to severe limitation of soil drainage and grouped as S2r. Moderate to marginal limitation of drainage, texture, soil depth and pH was observed in the mapping units RPRmB2, BBLmB2, NDNmB2, NDNmB2g1Ca, TSLmB2g1Ca, SRDmB2, SRDmB2g1Ca, KRJmB2, KRJmB2g1Ca, HNTmB2g1Ca (S2ts) covering 2948 ha (70.69 % of TGA). Moderate to marginal limitation of stoniness and soil depth was observed in KGRmB2, KGRmB2g1, NHLmB2 covering 117 ha (2.8 % of TGA) and grouped as S3r.

The mapping units such as THLmB2, THLmB2g2Ca exhibited moderate to marginal limitation of stoniness, soil depth and pH and grouped under the subclass S2rs. THLmB2g1Ca exhibited severe limitation of stoniness, soil depth, pH and texture and grouped under suitability sub class S2rts. In the study area, 241ha (5.78% TGA) and 333 ha (7.98 % of TGA) were found to have moderate to marginal limitations of stoniness-soil depth-pH (S2rs) and stoniness-soil depth- pH-texture (S2rts), respectively.

Due to severe limitation of soil depth alone, an area of 482 ha (11.55 % of TGA)observed in mapping unit DMTmB2g1, DMTmB2g1Ca, DMTmB2g2Ca was grouped under non suitability sub class N2r. (Fig.1). Similar results were obtained by Manjunata *et al.* (2017).

Sapota

The soil suitability for sapota in Kanamadi South sub-watershed was moderate to temporarily not suitable with climate, soil physico-chemical properties and land form characteristics.

The area of 2 ha (0.04 % TGA) had moderate to severe limitation of soil drainage and grouped as S2r.The 2890 ha (69.3% TGA) area covering the mapping units such, BBLmB2, NDNmB2, NDNmB2g1Ca, TSLmB2g1Ca, SRDmB2, SRDmB2g1Ca, KRJmB2, KRJmB2g1Ca, HNTmB2g1Ca had moderate to severe limitations of texture, drainage, pH and organic carbon and grouped under the suitability subclass S2ts.In the area of 299 ha (7.16% TGA) pH, organic carbon, drainage, texture and soil depth were the limiting factors having mapping units RPRmB2, THLmB2, THLmB2g2Ca grouped under suitability sub class S2rs. The mapping unit THLmB2g1Ca had moderate to severe limitation stoniness, soil depth, pH and texture and grouped under suitability sub class S2rts having333 ha (7.98% TGA).

Moderate to marginal limitation of stoniness and soil depth was observed in 117 ha (2.8% TGA) grouped as S3r covering KGRmB2, KGRmB2g1, NHLmB2 mapping units.

The severe limitation of soil depth was observed in area 482 ha (11.55% TGA) having mapping unit 482 DMTmB2g1, DMTmB2g1Ca, DMTmB2g2Ca were grouped under non suitability subclass N2r (Fig. 2).Similar results of limitation of rooting conditions and texture was reported by Madhusudan (2019) and Prathibha *et al.* (2019).

Gauva

All the mapping units of the study area were marginally suitable to non-suitable for guava due to limitations of climate and soil physico-chemical properties.

The area of 2 ha (0.04 % TGA) had moderate to severe limitation of soil drainage and grouped as S2r. The mapping units such as BBLmB2, RPRmB2, NDNmB2g1Ca, TSLmB2g1Ca, SRDmB2, SRDmB2g1Ca, KRJmB2, KRJmB2g1Ca, HNTmB2g1Ca had moderate to severe limitations of texture, drainage, pH and organic carbon and grouped under the suitability subclass S2ts having 2451 ha (58.78% TGA) (Fig. 3). pH, organic carbon, drainage, texture and soil depth were the limiting factors in THLmB2, THLmB2g2Ca mapping units were grouped under suitability sub class S2rs having an area of 241 ha (5.78% TGA). The area of 333 ha (7.98% TGA)consisting of mapping unit THLmB2g1Ca had moderate to severe limitation stoniness, soil depth, pH and texture and grouped under suitability sub class S2rts.

Moderate to marginal limitation of stoniness and soil depth was observed in KGRmB2, KGRmB2g1, NHLmB2 covering 117 ha (2.8% TGA). and grouped as S3r. The severe limitations of texture, drainage, pH and organic carbon was observed in NDNmB2in area of 496 ha (11.9% TGA) and grouped under the suitability subclass S3ts.

The severe limitation of soil depth was observed in area of 482 ha (11.55% TGA), were grouped under non suitability subclass N2r. Similar results were reported by Denis *et al.* (2014) in Singhanhalli- bogur micro-watershed and Anilkumar *et al.* (2019) in Haradanahalli microwatershed.

Flower crops

Rose

Mapping units of the Kanamadi South sub-watershed were moderately to marginally suitable for rose cultivation due to soil physico-chemical constraints and none to slight limitations of land form characteristics.

The mapping units registered moderate to marginal limitations of rainfall, drainage, texture, pH and soil depth for rose cultivation and were grouped under suitability sub class S2crts, these included DMTmB2g1, DMTmB2g1Ca, NHLmB2, THLmB2 and HNTmB2g1Ca. and covered 522 ha (12.51% TGA). The mapping unit BBLmB2 and NDNmB2g1Ca had moderate to severe limitation of texture, pH and soil depth and grouped as S2ts and coveredthe area of 877.69 ha (21.04% TGA). Most of mapping unit were moderate to marginal limitations of pH which include DMTmB2g2Ca, KGRmB2, KGRmB2g1, THLmB2g1Ca, THLmB2g2Ca, RPRmB2, NDNmB2, TSLmB2g1Ca, SRDmB2, SRDmB2g1Ca, KRJmB2, KRJmB2g1Ca were grouped under suitability sub class S3s and covered 2721.81 ha (65.26% TGA) (Fig.4).

Similar observation of moderately suitable condition for rose was reported by Manjunatha *et al.* (2017) and Denis *et al.* (2014).

Jasmine

Mapping units of the Kanamadi South sub-watershed were moderately to marginally suitable for Jasmine cultivation due to soil physico-chemical constraints and none to slight limitations of land form characteristics.

The area of 296.46 ha (7.10% TGA) covering the mapping units THLmB2, BBLmB2 and HNTmB2g1Ca registered moderate to marginal limitations of mean temperature, drainage, texture, pH and soil depth for jasmine cultivation and were grouped under suitability sub class S2crts. The mapping unit which was moderate to marginal limitations of pH included DMTmB2g1, DMTmB2g1Ca, NHLmB2, THLmB2g1Ca, THLmB2g2Ca, NDNmB2 and KRJmB2g1Ca which was grouped under suitability sub class S3s with the area of 1812.41 ha (43.46% TGA).

The severe limitation of soil texture and pH was observed in mapping units of DMTmB2g2Ca, KGRmB2, KGRmB2g1, RPRmB2, NDNmB2g1Ca, TSLmB2g1Ca, SRDmB2, SRDmB2g1Ca and KRJmB2 were grouped under suitability sub class S3tswith the area 2012.63 ha (48.26% TGA).These mapping unit were marginally suitability for jasmine cultivation.Similar observation in the mapping units of Bastwad micro-watershed of Karnataka, which were moderately to marginally suitable for jasmine, was reported by Manojkumar (2011) (Fig. 5).

Conclusions:

The investigation on soil suitability of Kanamadi South sub-watershed with respect to morphological, physical and chemical properties showed among horticulture crops, major part of the study area was moderately suitable for growing fruits such as guava (S2, 73.75 % TGA), pomegranate (S2, 70.73 % TGA), sapota (S2, 85.65 % TGA), In case of flowers, major part of the study area was marginally suitable for crops such as rose (65.26 % TGA) and jasmine (91.72 % TGA). Around 11.55 per cent of the area was evaluated as unsuitable for growing fruit cropsSoil suitability assessment of horticultural crops helped in identifying the main limiting factors of Kanamadi south subwatershed for fruit and flower crop production and enables decision-makers to develop a crop management system for increasing land productivity.

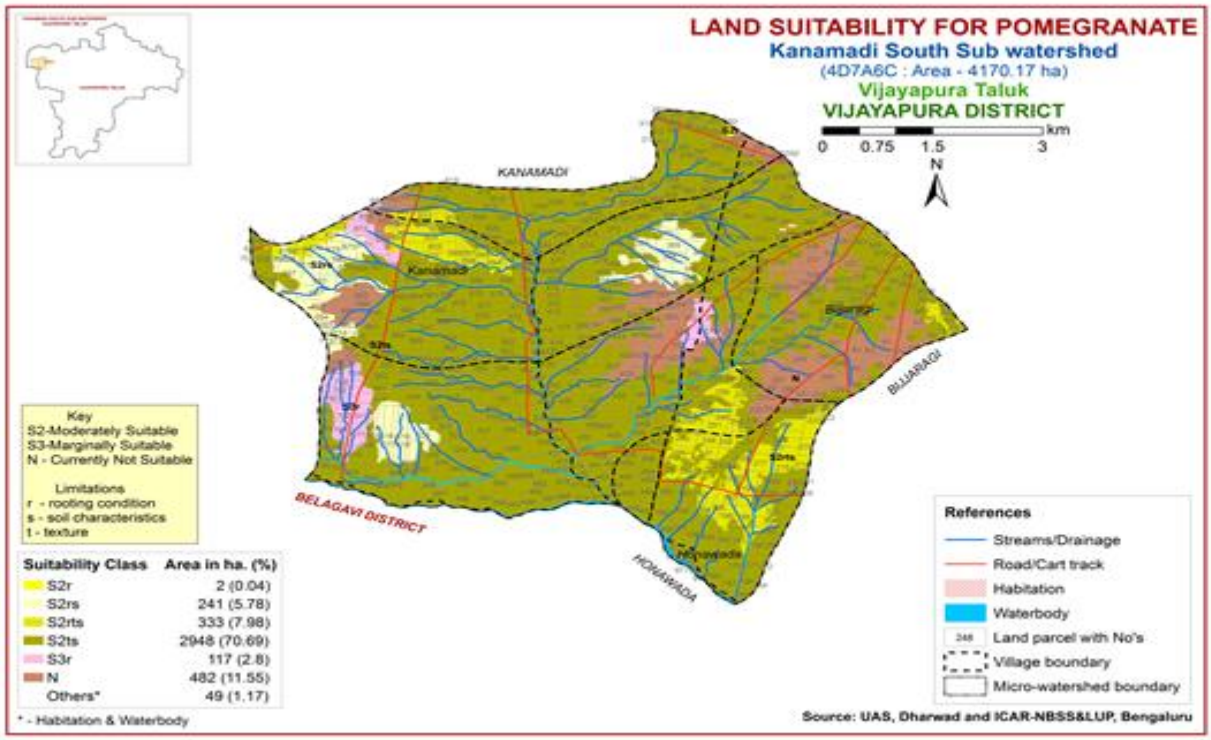

Fig. 1. Soil suitability of Kanamadi South sub-watershed for pomegranate.

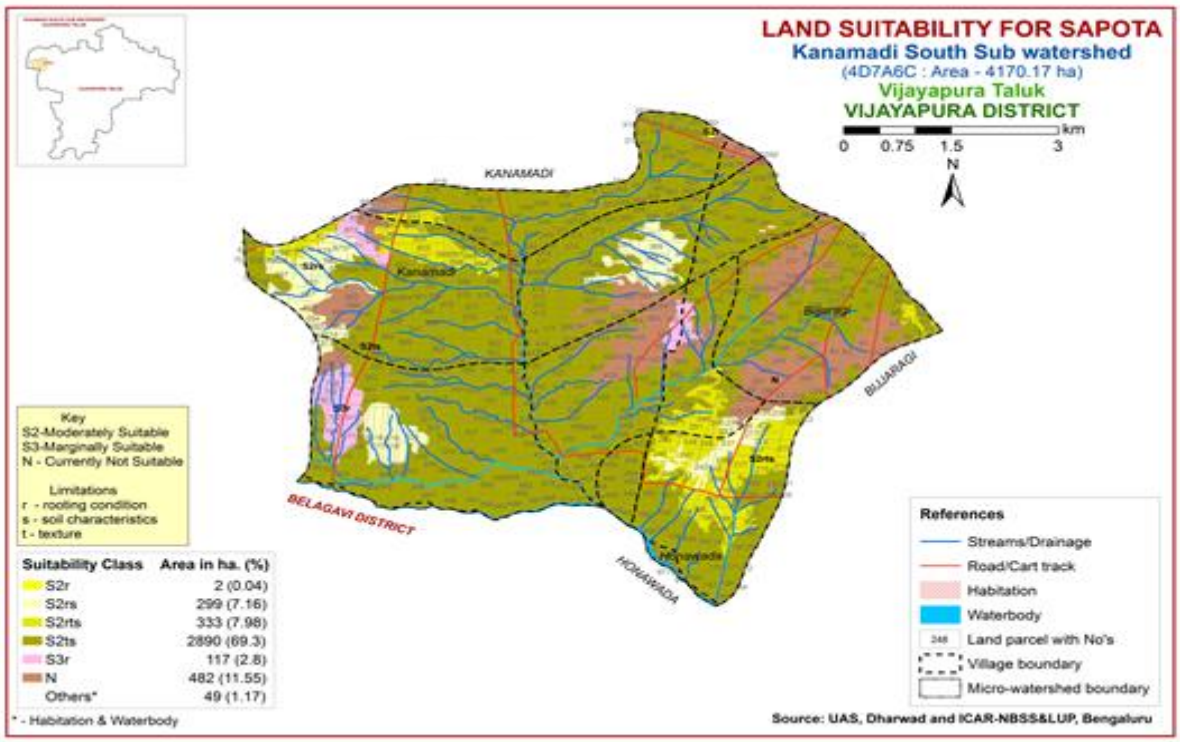

Fig. 2. Soil suitability of Kanamadi South sub-watershed for sapota.

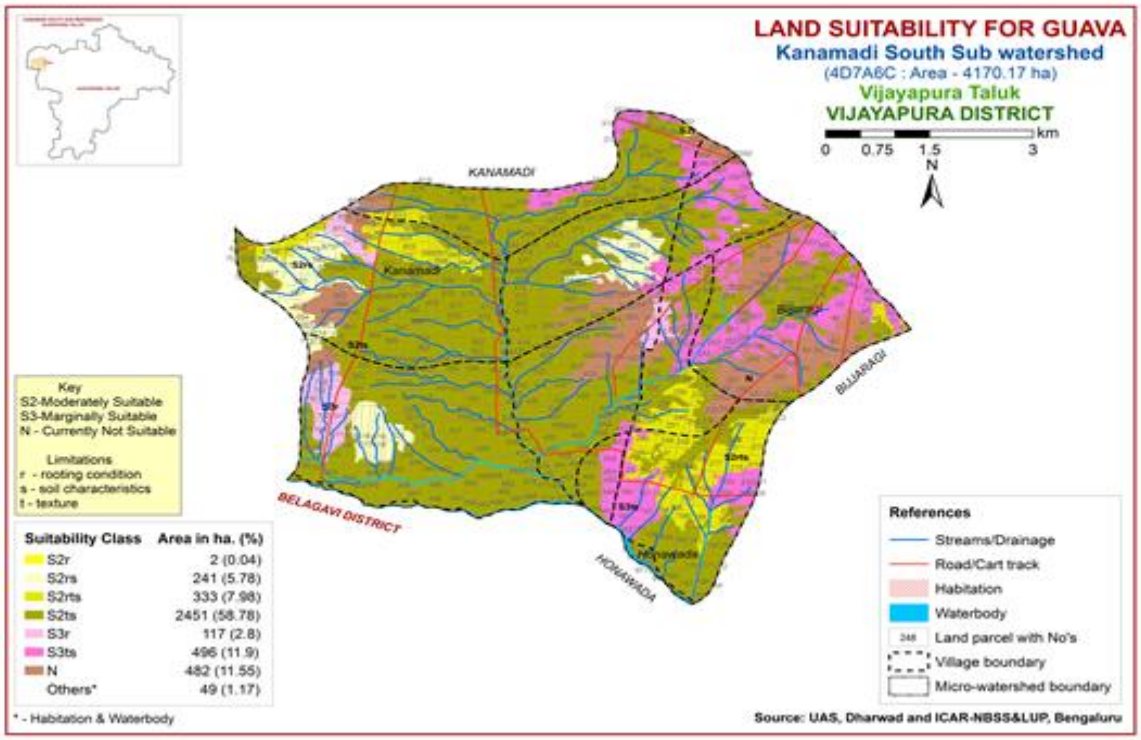

Fig. 3. Soil suitability of Kanamadi South sub-watershed for gauva.

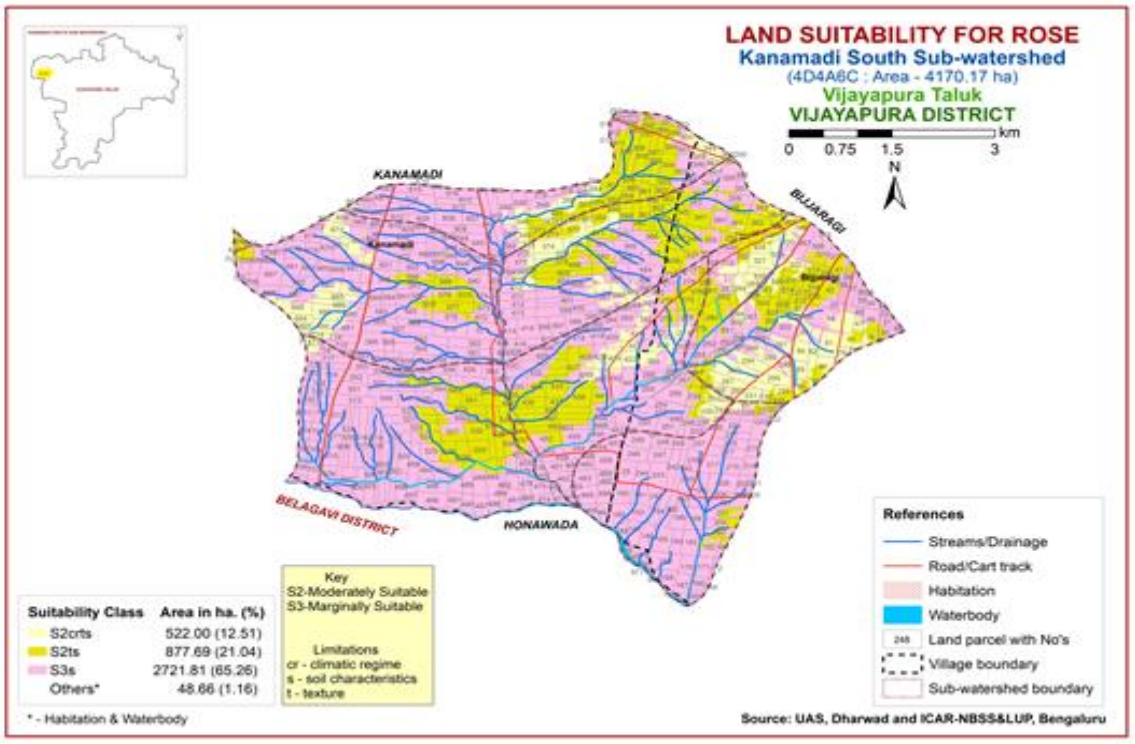

Fig. 4. Soil suitability of Kanamadi South sub-watershed for rose.

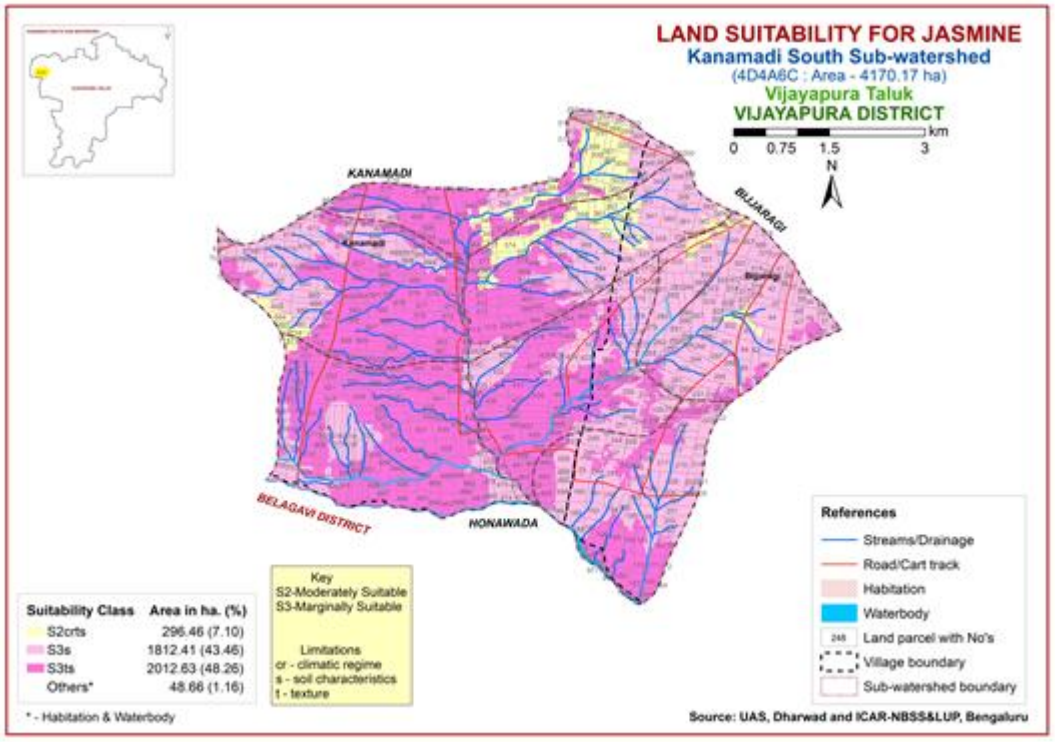

Fig. 5. Soil suitability of Kanamadi South sub-watershed forjasmine.

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