Plant Archives Vol. 26, Supplement 1, 2026 pp. 1019-1029 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org
DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2026.v26.supplement-1.136

EVALUATION OF SOIL-SITE SUITABILITY FOR MAJOR HORTICULTURE CROPS IN THE HOLIHOSUR SUB-WATERSHED, KARNATAKA, INDIA, THROUGH REMOTE SENSING AND GIS

Mounika Vemula[1*], V.B. Kuligod[1], S.S. Gundulur[1], Manjunatha M.V.[2], Raja Kumar G.R.[1] and Milind P. Podtar[3]
[1]Department of Soil Science and Agricultural Chemistry, University of Agricultural Sciences, Dharwad-580 005, Karnataka, India.
[2]Department of Agricultural Engineering, University of Agricultural Sciences, Dharwad-580 005, Karnataka, India.
[3]Department of Agricultural Meteorology, University of Agricultural Sciences, Dharwad-580 005, Karnataka, India.
*Corresponding author E-mail: mounikavemula86@gmail.com
(Date of Receiving : 10-09-2025; Date of Acceptance : 11-11-2025)

ABSTRACT

A comprehensive evaluation was conducted to assess the soil resources of the Holihosur sub-watershed, situated in the Belagavi district within the Northern Transition Zone of Karnataka, with the aim of promoting sustainable land use planning. The investigation focused on twenty-four distinct soil series, namely SRL (Shirol), KKD (Kurakunda), GKP (Gaddikarvinkoppa), BLD (Beladadi), NBP (Nabhapur), MUK (Mudanakodu), ADG (Aladageri), NYN (Nayanagar), CKR (Chekkerur), ATT (Attikatti Tanda), SGB (Shiragambi), BDT (Beladaditanda), SKB (Sunakalabidhar), JLG (Jelligeri), VRV (Varavi), BTK (Betakerur), MVD (Mevundi), KLP (Kalasapur), RNR (Ranebennur), LDK (Lingadevarakoppa), CPT (Channapura Tanda), BTP (Bettadapura), MGR (Megur) and GPH (Gopanahal). Each soil series was characterized based on key site and soil parameters including texture, effective soil depth, slope gradient, erosion status, gravel content and stoniness. These attributes formed the basis for delineating the soils into sixty-one distinct mapping units using ArcGIS software (version 10.8). The mapping units were subsequently subjected to a detailed soil-site suitability assessment for four major fruit crops cultivated in the region: grapes (*Vitis vinifera* L.), sapota (*Manilkara achras*), guava (*Psidium guajava* L.) and lime (*Citrus aurantiifolia* L.).The analysis revealed that certain soil series, namely SRL, KKD, GKP, BLD, ADG, MUK and NBP, were classified as currently not suitable for the cultivation of all four fruit crops. This unsuitability was primarily attributed to very severe limitations in effective soil depth coupled with steep slope gradients, which significantly impede root development, moisture retention, and field operations. Conversely, the remaining soil series demonstrated moderate (S2) to marginal (S3) suitability, with constraints varying in type and severity depending on the crop requirements and local site conditions.
Keywords: *Arc* GIS, crop-suitability, horticultural crops, soil depth and thematic mapping.

Introduction

Ensuring sustainable food security in the coming decades hinges on the efficient management of natural resources. By the year 2050, the global population is projected to reach approximately 9.73 billion, necessitating a 50% increase in food and feed production compared to 2012 levels to meet growing demand (FAO, 2017). Modern intensive agriculture, while significantly boosting crop yields and contributing to food security, has also resulted in the overexploitation and degradation of key natural resources such as soil, air and water particularly in India. Given the dual challenge of declining soil health and escalating food requirements, the optimal and sustainable utilization of farmland has become imperative. A critical first step toward sustainable agricultural use is the assessment of land suitability, which determines whether specific parcels of land can support particular crops under prevailing conditions. The FAO (1976) defines land suitability as "a function of crop requirements and land characteristics, and a measure of how well the qualities of a land unit match the requirements of a specific type of land use". This assessment not only identifies limiting factors that may hinder crop productivity but also aids decision-makers in formulating targeted management strategies to enhance agricultural output. From a sustainability perspective, aligning available land resources with their most appropriate uses is vital to balance societal food demands with the conservation of fragile ecosystems (FAO, 1993). This process increasingly relies on advanced geospatial technologies.

Geographic Information Systems (GIS) have emerged as essential tools for handling, analysing, and interpreting large volumes of spatial data, offering solutions to complex geographic and hydrological challenges (Amara *et al*., 2016). GIS technology facilitates the collection, storage, management, and retrieval of geographically referenced data from diverse sources, enabling more informed and data-driven land management decisions (Aronoff, 1991). In recent years, the integration of **Remote Sensing (RS)** with GIS has revolutionized land evaluation and natural resource management. These technologies have gained substantial traction over the past decade in large-scale spatial applications related to agriculture (Green, 1995; Hinton, 1996). Decision support systems that combine GIS and RS offer rapid access to relevant, high-resolution datasets, enhancing both the efficiency and precision of planning processes. Numerous studies have highlighted the potential of integrating RS and GIS for quantitative land evaluation (Walke *et al*., 2012; Gangopadhyay *et al*., 2018). Such integrated approaches enable spatial mapping of land properties, detection of limiting factors, and generation of suitability classes for different crops, thereby facilitating location-specific agricultural planning. The present investigation builds upon this integrated methodology, employing RS and GIS technologies in conjunction with soil profile data to evaluate soil-site suitability for selected fruit crops namely guava, pomegranate, sapota, lime and grapes in the Holihosur sub-watershed.

Materials and Methods

Study area

The Holihosur sub-watershed (4D5B8q), the designated study area, is situated in Bailhongal taluk of Belagavi district (Fig. 1), within the northern transitional zone of Karnataka. It is geographically positioned at 15^{o} 44′ 1.8″ north latitude and 74^{o} 44′ 50.5″ east longitude, covering a total area of 5,493.37 hectares. The region experiences a semi-arid to sub-humid climate, with average maximum temperatures ranging between 28°C and 38°C, and minimum temperatures between 16°C and 23°C. The average annual rainfall typically varies from 620 mm to 1,025 mm (Anon, 2025).

Methodology

A comprehensive survey of the Holihosur sub-watershed was undertaken using a 1:7,920 scale base map and satellite imagery to analyze geology, drainage patterns, surface features, slope gradients, land use, landforms and physiographic divisions. Based on these observations, twenty-four representative soil profiles were selected for morphometric analysis, with their physical and chemical properties determined using standard laboratory procedures. The detailed soil resource inventory identified 24 soil series, further subdivided into 61 mapping units according to surface characteristics. Soil-phase-level suitability maps were prepared for major fruit crops grown in the region guava, sapota, grapes and lime using ArcGIS 10.8. Suitability assessment followed the limitation method outlined by Naidu *et al*. (2006), taking into account both the type and severity of land constraints.

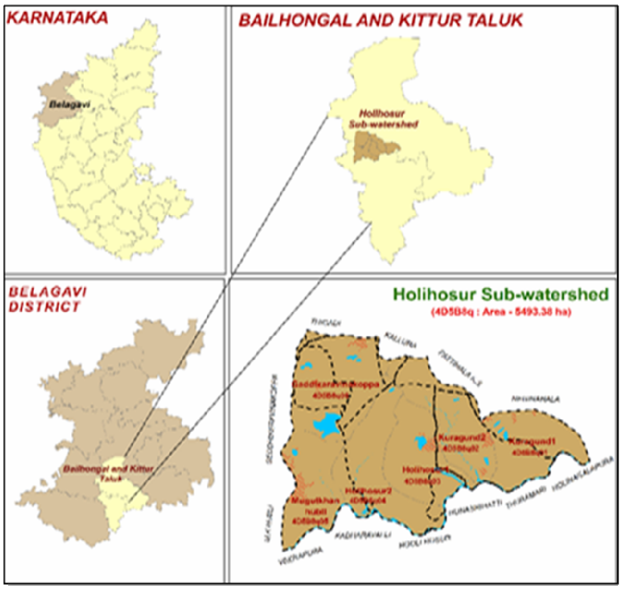

Fig.1. Location of study area

The evaluation was conducted in three phases. Phase I involved collecting land and soil characteristics (Table 1) in accordance with FAO (1976) guidelines. Phase II utilized landscape and soil requirements for the four crops, as specified by Naidu *et al*. (2006) and described by Sehgal (2005). Phase III applied a fourtier classification system, comprising orders, classes, subclasses and units. Two orders were defined: **S** (Suitable) and **N** (Not suitable). Order S included three classes **S1** (Highly suitable), with negligible or minor limitations; **S2** (Moderately suitable), with up to three moderate limitations that could slightly reduce productivity; and **S3** (Marginally suitable), where severe limitations substantially affect yield yet allow marginally viable cultivation. Order N contained two classes **N1 or N** (Currently not suitable), where existing constraints hinder profitable use under present technology and economic conditions and **N2** (Permanently not suitable), where limitations are too severe for sustainable use in the future. Subclasses denoted the nature of limitations or required improvements using lowercase letters after the class numeral, while units shown as numerals in parentheses indicated the relative priority for land improvement measures. The final suitability classification for each soil series was determined by comparing observed land characteristics with crop-specific limitation thresholds provided by Naidu *et al.* (2006), as described by Sehgal (2005), in line with FAO (1976) guidelines.

Results and Discussion

The soil characteristics of the study area were evaluated against established soil-site suitability criteria for key fruit crops commonly cultivated in northern Karnataka. The resulting assessment of land suitability for major horticultural crops is summarized in Table 2.

Soil-site suitability evaluation for grapes

Grape cultivation thrives best in regions receiving over 100 cm of annual rainfall, with deep, fertile soils producing higher yields. Optimal soils are sandy loam, silt loam, clay loam, or loam in texture, 100–150 cm deep, well-drained, and free from salinity, alkalinity and toxic salt accumulation. Extremely sandy or heavy clay soils, as well as those with high concentrations of alkali metal salts or other harmful substances, are unsuitable. For guava cultivation, the ideal temperature range is 25–30 °C, with mean relative humidity between 50–60%. In the Holihosur sub-watershed, soil-phase-level evaluation for grape production revealed suitability classes ranging from moderately suitable (S2) and marginally suitable (S3) to currently not suitable (N), with key limitations including rooting depth, nutrient availability, topography and texture illustrated in table 2 and fig. 2.

Within the moderately suitable category, the **S2gn** subclass covered 45 ha (BTKiB2g1), limited by gravelliness and nutrient availability. The **S2gnt** subclass comprising SKBiB2, SKBiB2g1, SKBmB2, SKBmB2g1, SKBfB2 and SKBfB2g1 spanned 304 ha, constrained by excessive gravel, nutrient deficiencies and suboptimal texture. The **S2gt** subclass, including RNRfB2, RNRiB2g1, and RNRmB2 (105 ha), was constrained by both gravel content and texture. The largest group, **S2nt** (930 ha), encompassed mapping units such as BTPmB2, BTPmB2g1, JLGfB2, JLGiB2g1, JLGmB2, KPRfB2, KPRiB2, KPRmB2, KPRmB2g1 and VRVmB2g1, where nutrient limitations and texture issues were predominant. The **S2t** subclass CPTfB2, CPTmB2, GPHmB2, LDKcB2g1, LDKfB2, LDKmB2, LDKiB2g1 and MGRmB2 accounted for 1,523 ha, with moderate texture-related constraints. In the marginally suitable category, the **S3gn** subclass (254 ha) included BDThB2g1, BDTiB2, BDTiB2g1, BDTmB2g1, CKRfB2, CKRiB2g and CKRmB2g1, where high gravel content and nutrient deficiencies were limiting factors. The **S3gnl** subclass (CKRcC3g1, 54 ha) suffered from steep slopes in addition to gravel and nutrient issues. The **S3nt** subclass (NYNmB2Ca, 90 ha) was constrained by nutrient status and unfavorable texture. Units under **S3gt** SGBcB2g1, SGBfB2, SGBfB2g1, SGBiB2, SGBiB2g1 and SGBmB2g1 covered 230 ha and were affected by severe gravel and texture limitations. The **S3rt** subclass, comprising ATTfB2, ATTiB2g1, ATTmB2 and ATTmB2g1 (116 ha), had depth and texture constraints. Currently not suitable (N) areas constituted 559 ha (10.17%), primarily due to shallow effective soil depth. This group included ADGfB2g1, ADGiB2g1, ADGmB2, BLDcB2g1, BLDiB2g1, GKPcC3g1Ca, KKDhB2g1, MUKfB2, MUKfB2g1, MUKmB2 and SRLcB2g1. Despite otherwise favorable properties, severe depth limitations rendered these areas unfit for sustainable grape cultivation. These findings align with earlier research by Madhusadan (2019) and Manjunatha *et al.* (2017) in the Kanaginahala sub-watershed of the Chikamageri microwatershed, which also reported soil texture, depth, and pH constraints leading to suitability classes from moderately suitable to unsuitable for grapes

Table 1 : Soil-site characteristics of soil mapping units of Holihosur sub-watershed for evaluation of crop suitability

Sl. No.	Soil phases	Physical conditions of soil				Nutrient availability				Salinity/ alkalinity		Topography
		Texture	Depth (cm)	Gravelliness (%)	$CaCO_3$ (%)	pH (1:2.5)	OC (g kg^{-1})	CEC [cmol (p+) kg^{-1})	BS (%)	EC (1:2.5) dSm^{-1}	ESP	Slope
1.	SRLcB2g1	Sandy loam	18	15-35%	0.95	6.79	5.3	21.85	78.35	0.14	1.30	1-3%
2.	SRLiB2g1	Sandy clay	18	15-35%	0.95	6.79	5.3	21.85	78.35	0.14	1.30	1-3%
3.	KKDhB2g1	Sandy clay loam	28	15-35%	1.21	6.89	4.8	23.03	81.15	0.12	2.46	1-3%
4.	GKPcC3g1Ca	Sandy loam	28	15-35%	9.95	8.06	5.89	27.05	91.06	0.17	3.61	3-5%
5.	BLDcB2g1	Sandy loam	40	15-35%	3.03	7.87	4.90	24.76	91.80	0.24	3.16	1-3%
6.	BLDiB2g1	Sandy clay	40	15-35%	3.03	7.87	4.90	24.76	91.80	0.24	3.16	1-3%
7.	NBPfB2g1	Clay loam	47	15-35%	2.28	7.92	4.00	28.28	92.29	0.19	1.70	1-3%
8.	MUKfB2	Clay loam	38	<15%	3.67	7.69	5.88	46.22	92.68	0.22	0.65	1-3%
9.	MUKfB2g1	Clay loam	38	15-35%	3.67	7.69	5.88	46.22	92.68	0.22	0.65	1-3%
10.	MUKmB2	clay	38	<15%	3.67	7.69	5.88	46.22	92.68	0.22	0.65	1-3%
11.	ADGfB2g1	Clay loam	39	15-35%	3.00	7.90	0.46	27.21	91.05	0.21	1.77	1-3%
12.	ADGiB2g1	Sandy clay	39	15-35%	3.00	7.90	0.46	27.21	91.05	0.21	1.77	1-3%
13.	ADGmB2	clay	39	<15%	3.00	7.90	0.46	27.21	91.05	0.21	1.77	1-3%
14.	NYNmB2Ca	Clay	71	<15%	11.47	8.36	2.35	41.07	95.77	0.28	4.49	1-3%
15.	CKRcC3g1	Sandy loam	57	15-35%	1.18	6.36	5.25	21.80	79.99	0.30	1.97	3-5%
16.	CKRfB2	Clay loam	57	<15%	1.18	6.36	5.25	21.80	79.99	0.30	1.97	1-3%
17.	CKRiB2g1	Sandy clay	57	15-35%	1.18	6.36	5.25	21.80	79.99	0.30	1.97	1-3%
18.	CKRmB2g1	clay	57	15-35%	1.18	6.36	5.25	21.80	79.99	0.30	1.97	1-3%
19.	ATTfB2	Clay loam	62	<15%	3.00	7.14	4.21	27.31	91.38	0.28	1.11	1-3%
20.	ATTiB2g1	Sandy clay	62	15-35%	3.00	7.14	4.21	27.31	91.38	0.28	1.11	1-3%
21.	ATTmB2	clay	62	<15%	3.00	7.14	4.21	27.31	91.38	0.28	1.11	1-3%
22.	ATTmB2g1	clay	62	15-35%	3.00	7.14	4.21	27.31	91.38	0.28	1.11	1-3%
23.	SGBcB2g1	Sandy loam	54	15-35%	0.26	7.24	4.52	29.29	88.44	0.24	5.92	1-3%
24.	SGBfB2	Clay loam	54	<15%	0.26	7.24	4.52	29.29	88.44	0.24	5.92	1-3%
25.	SGBfB2g1	Clay loam	54	15-35%	0.26	7.24	4.52	29.29	88.44	0.24	5.92	1-3%
26.	SGBiB2	Sandy clay	54	<15%	0.26	7.24	4.52	29.29	88.44	0.24	5.92	1-3%
27.	SGBiB2g1	Sandy clay	54	15-35%	0.26	7.24	4.52	29.29	88.44	0.24	5.92	1-3%
28.	SGBmB2g1	clay	54	15-35%	0.26	7.24	4.52	29.29	88.44	0.24	5.92	1-3%
29.	BDTiB2	Sandy clay	53	<15%	0.44	6.38	4.28	23.37	82.97	0.17	2.12	1-3%
30.	BDTiB2g1	Sandy clay	53	15-35%	0.44	6.38	4.28	23.37	82.97	0.17	2.12	1-3%
31.	BDThB2g1	Sandy clay loam	53	15-35%	0.44	6.38	4.28	23. 37	82.97	0.17	2.12	1-3%
32.	BDTmB2g1	clay	53	15-35%	0.44	6.38	4.28	23.37	82.97	0.17	2.12	1-3%
33.	SKBfB2	Clay loam	89	<15%	1.63	6.26	4.44	23.04	79.52	0.21	0.71	1-3%
34.	SKBfB2g1	Clay loam	89	15-35%	1.63	6.26	4.44	23.04	79.52	0.21	0.71	1-3%
35.	SKBiB2	Sandy clay	89	<15%	1.63	6.26	4.44	23.04	79.52	0.21	0.71	1-3%
36.	SKBiB2g1	Sandy clay	89	15-35%	1.63	6.26	4.44	23.04	79.52	0.21	0.71	1-3%
37.	SKBmB2	Clay	89		1.63	6.26	4.44	23.04	79.52	0.21	0.71	1-3%
38.	SKBmB2g1	Clay	89	15-35%	1.63	6.26	4.44	23.04	79.52	0.21	0.71	1-3%
39.	JLGfB2	Clay loam	81	<15%	2.32	7.85	5.06	43.26	92.06	0.27	0.59	1-3%
40.	JLGiB2g1	Sandy clay	81	15-35%	2.32	7.85	5.06	43.26	92.06	0.27	0.59	1-3%

Sl. No.	Soil phases	Physical conditions of soil				Nutrient availability				Salinity/ alkalinity		Topography
		Texture	Depth (cm)	Gravelliness (%)	$CaCO_3$ (%)	pH (1:2.5)	OC (g kg^{-1})	CEC [cmol (p+) kg^{-1})	BS (%)	EC (1:2.5) dSm^{-1}	ESP	Slope
41.	JLGmB2	Clay	81	<15%	2.32	7.85	5.06	43.26	92.06	0.27	0.59	1-3%
42.	VRVmB2g1	Clay	101	15-35%	6.09	7.98	5.20	45.04	94.42	0.26	1.92	1-3%
43.	BTKiB2g1	Sandy clay	89	15-35%	2.47	6.92	4.86	26.68	87.76	0.23	2.91	1-3%
44.	MVDmB2g1	Clay	145	15-35%	8.18	7.61	6.90	41.40	92.71	0.20	2.49	1-3%
45.	KPRfB2	Clay loam	142	<15%	5.67	8.00	3.97	37.63	93.61	0.24	1.13	1-3%
46.	KPRiB2	Sandy clay	142	<15%	5.67	8.00	3.97	37.63	93.61	0.24	1.13	1-3%
47.	KPRmB2	Clay	142	<15%	5.67	8.00	3.97	37.63	93.61	0.24	1.13	1-3%
48.	KPRmB2g1	Clay	142	15-35%	5.67	8.00	3.97	37.63	93.61	0.24	1.13	1-3%
49.	RNRfB2	Clay loam	104	<15%	1.65	7.80	5.64	25.39	92.31	0.25	5.87	1-3%
50.	RNRiB2g1	Sandy clay	104	15-35%	1.65	7.80	5.64	25.39	92.31	0.25	5.87	1-3%
51.	RNRmB2	clay	104	<15%	1.65	7.80	5.64	25.39	92.31	0.25	5.87	1-3%
52.	LDKcB2g1	Sandy loam	114	15-35%	1.98	7.20	5.10	36.08	89.77	0.31	0.95	1-3%
53.	LDKfB2	Clay loam	114	<15%	1.98	7.20	5.10	36.08	89.77	0.31	0.95	1-3%
54.	LDKiB2g1	Sandy clay	114	15-35%	1.98	7.20	5.10	36.08	89.77	0.31	0.95	1-3%
55.	LDKmB2	clay	114	<15%	1.98	7.20	5.10	36.08	89.77	0.31	0.95	1-3%
56.	CPTfB2	Clay loam	191	<15%	10.93	8.26	3.12	55.26	95.49	0.25	7.50	1-3%
57.	CPTmB2	Clay	191	<15%	10.93	8.26	3.12	55.26	95.49	0.25	7.50	1-3%
58.	BTPmB2	Clay	175	<15%	2.32	8.05	7.16	63.25	96.63	0.25	2.36	1-3%
59.	BTPmB2g1	Clay	175	15-35%	2.32	8.05	7.16	63.25	96.63	0.25	2.36	1-3%
60.	MGRmB2	Clay	200	<15%	4.71	8.50	3.58	60.90	96.93	0.23	3.39	1-3%
61.	GPHmB2	clay	197	<15%	3.43	8.26	5.78	62.69	96.81	0.32	0.91	1-3%

Table 2 : Soil-site suitability classification of soil mapping units of Holihosur sub-watershed for major Horticulture crops

Sl. No	Soil phases	Grape	Sapota	Guava	Lime
1.	SRLcB2g1	N	N	N	N
2.	SRLiB2g1	N	N	N	N
3.	KKDhB2g1	N	N	N	N
4.	GKPcC3g1Ca	N	N	N	N
5.	BLDcB2g1	N	N	N	N
6.	BLDiB2g1	N	N	N	N
7.	NBPfB2g1	N	N	N	N
8.	MUKfB2	N	N	N	N
9.	MUKfB2g1	N	N	N	N
10.	MUKmB2	N	N	N	N
11.	ADGfB2g1	N	N	N	N
12.	ADGiB2g1	N	N	N	N
13.	ADGmB2	N	N	N	N
14.	NYNmB2Ca	S3nt	S3nt	S3nt	S3rn
15.	CKRcC3g1	S3gn	S3gnl	S3gnl	S3gnl
16.	CKRfB2	S3gn	S3gn	S3gn	S3gn
17.	CKRiB2g1	S3gn	S3gn	S3gn	S3gn
18.	CKRmB2g1	S3gn	S3gn	S3gn	S3gn

Sl. No	Soil phases	Grape	Sapota	Guava	Lime
19.	ATTfB2	S3rt	S3rt	S3rt	S3r
20.	ATTiB2g1	S3rt	S3rt	S3rt	S3r
21.	ATTmB2	S3rt	S3rt	S3rt	S3r
22.	ATTmB2g1	S3rt	S3rt	S3rt	S3r
23.	SGBcB2g1	S3gt	S3nt	S3rt	S3r
24.	SGBfB2	S3gt	S3nt	S3rt	S3r
25.	SGBfB2g1	S3gt	S3nt	S3rt	S3r
26.	SGBiB2	S3gt	S3nt	S3rt	S3r
27.	SGBiB2g1	S3gt	S3nt	S3rt	S3r
28.	SGBmB2g1	S3gt	S3nt	S3rt	S3r
29.	BDTiB2	S3gr	S3r	S3r	S3r
30.	BDTiB2g1	S3gr	S3r	S3r	S3r
31.	BDThB2g1	S3gr	S3r	S3r	S3r
32.	BDTmB2g1	S3gr	S3r	S3r	S3r
33.	SKBfB2	S2gnt	S2rn	S2rn	S2rn
34.	SKBfB2g1	S2gnt	S2rn	S2rn	S2rn
35.	SKBiB2	S2gnt	S2rn	S2rn	S2rn
36.	SKBiB2g1	S2gnt	S2rn	S2rn	S2rn
37.	SKBmB2	S2gnt	S2rn	S2rn	S2rn
38.	SKBmB2g1	S2gnt	S2rn	S2rn	S2rn
39.	JLGfB2	S2nt	S2nt	S2nt	S2rn
40.	JLGiB2g1	S2nt	S2nt	S2nt	S2rn
41.	JLGmB2	S2nt	S2nt	S2nt	S2rn
42.	VRVmB2g1	S2nt	S2nt	S2nt	S2rn
43.	BTKiB2g1	S2gn	S2gn	S2gn	S2gn
44.	MVDmB2g1	S2nt	S2nt	S2nt	S2n
45.	KPRfB2	S2nt	S2nt	S2nt	S2n
46.	KPRiB2	S2nt	S2nt	S2nt	S2n
47.	KPRmB2	S2nt	S2nt	S2nt	S2n
48.	KPRmB2g1	S2nt	S2nt	S2nt	S2n
49.	RNRfB2	S2gt	S2gt	S2gt	S2g
50.	RNRiB2g1	S2gt	S2gt	S2gt	S2g
51.	RNRmB2	S2gt	S2gt	S2gt	S2g
52.	LDKcB2g1	S2t	S2t	S2t	S2t
53.	LDKfB2	S2t	S2t	S2t	S2t
54.	LDKiB2g1	S2t	S2t	S2t	S2t
55.	LDKmB2	S2t	S2t	S2t	S2t
56.	CPTfB2	S2t	S2t	S2t	S2t
57.	CPTmB2	S2t	S2t	S2t	S2t
58.	BTPmB2	S2nt	S2nt	S2t	S2t
59.	BTPmB2g1	S2nt	S2nt	S2t	S2t
60.	MGRmB2	S2t	S2t	S2t	S2t
61.	GPHmB2	S2t	S2t	S2t	S2t

Soil-site suitability evaluation for sapota

Sapota (*Manilkara zapota* L.), commonly known as chiku, is a tropical fruit native to Central America and now widely cultivated under diverse agro-climatic conditions. It thrives in warm climates with well-drained sandy loam soils, and the optimal pH range for its growth lies between 6.0 and 8.0. In the Holihosur sub-watershed, land suitability assessment for sapota revealed three primary classes were moderately suitable (S2), marginally suitable (S3) and currently not suitable (N) (Table 2 and Fig. 3).

Moderately suitable areas accounted for 2,907 ha (52.92% of the total area), where productivity was mainly constrained by gravelliness, poor texture and nutrient limitations. The **S2gn** subclass included the mapping unit BTKiB2g1, affected by excessive gravel and nutrient deficiency. The **S2gnt** subclass included mapping units of SKBiB2, SKBiB2g1, SKBmB2, SKBmB2g1, SKBfB2 and SKBfB2g1 covered 304 ha and displayed similar constraints with additional textural issues. The **S2gt** subclass (RNRfB2, RNRiB2g1 and RNRmB2) occupied 105 ha (1.92%) and was jointly limited by gravelliness and texture. A major portion of moderately suitable land (1,247 ha; 22.71%) fell under the **S2nt** subclass, which included mapping units of JLGmB2, JLGfB2, JLGiB2g1, KPRfB2, KPRiB2, KPRmB2, KPRmB2g1, BTPmB2, BTPmB2g1, VRVmB2g1 and MGRmB2, where nutrient deficiencies and unsuitable texture restricted suitability.

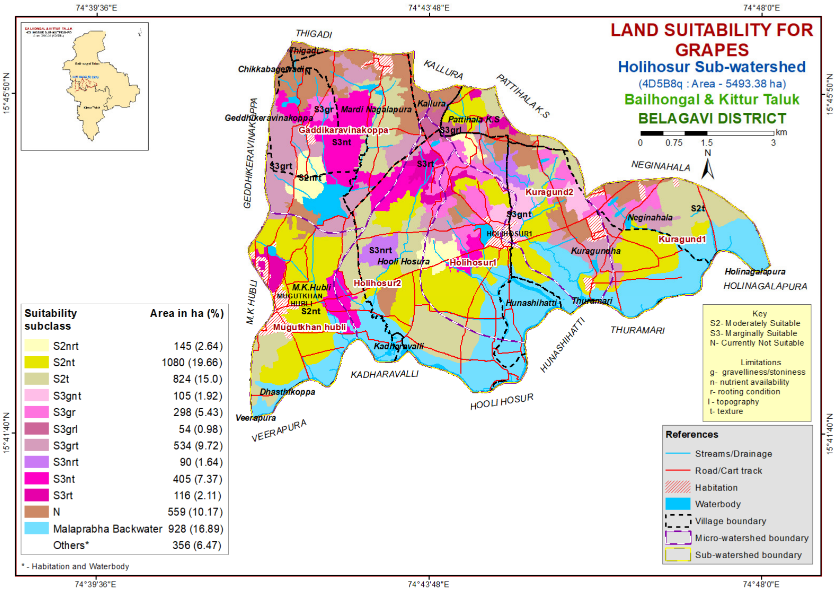

Fig. 2 : Soil site suitability map for grapes crop in Holihosur Sub-watershed

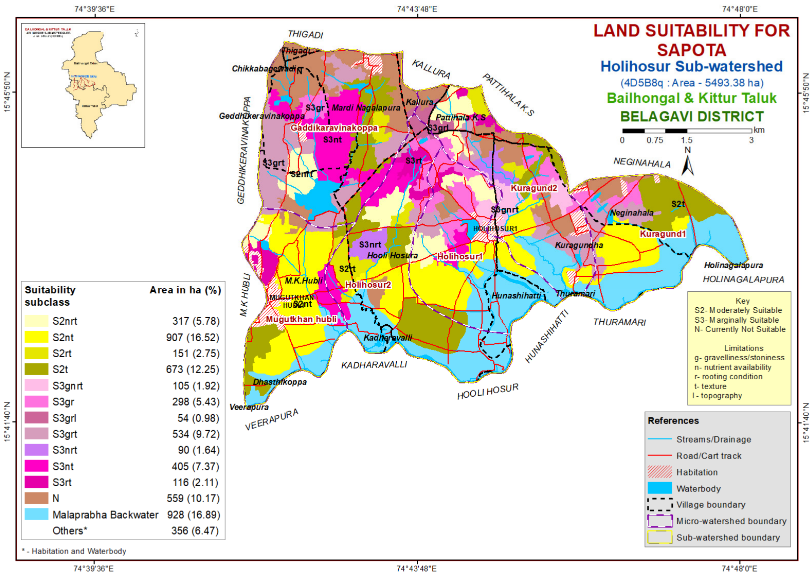

Fig. 3 : Soil site suitability map for sapota crop in Holihosur Sub-watershed

The **S2t** subclass, comprising GPHmB2, LDKcB2g1, LDKfB2, LDKiB2g1, LDKmB2, CPTfB2 and CPTmB2, covered 1,206 ha and was primarily affected by adverse texture. Marginally suitable land constituted 744 ha (13.54%) and exhibited more severe constraints. The **S3gn** subclass BDThB2g1, BDTiB2, BDTiB2g1, BDTmB2g1, CKRmB2g1, CKRiB2g1 and CKRfB2 spanned 254 ha, with excessive gravel and low nutrient availability as primary limitations. The **S3gnl** subclass (CKRcC3g1) was additionally constrained by slope. The **S3nt** subclass, mapping units were SGBfB2, SGBfB2g1, SGBiB2, SGBiB2g1, SGBcB2g1, SGBmB2g1 and NYNmB2Ca covered 320 ha and faced nutrient and texture-related limitations. The **S3rt** subclass, including ATTfB2, ATTmB2, ATTmB2g1 and ATTiB2g1, was restricted by shallow depth and unfavorable texture, making it marginally suitable for sapota's deep-rooting habit. Currently not suitable lands included units such as ADGmB2, BLDcB2g1, BLDiB2g1, GKPcC3g1Ca, KKDhB2g1, MUKfB2, MUKmB2 and SRLcB2g1, where shallow soil depth failed to meet the rooting requirements for sustainable production. Comparable findings were reported by Basavaraj *et al*. (2022) in the Dabarbad sub-watershed, Kalaburagi district, where 71.01% of soils were unsuitable for sapota cultivation due to severe limitations in rooting depth, texture and terrain.

Soil-site suitability evaluation for guava

Guava (*Psidium guajava* L.) thrives in tropical and subtropical climates, growing successfully from sea level to altitudes of about 500 m above MSL. In regions with distinct winters, both yield and fruit quality tend to improve. Ideal conditions for guava include deep soils (>100 cm) with sandy loam, silt loam, clay loam, or loam texture, free from salinity and alkalinity, and well-drained. The optimum temperature range is 28–32 °C, with a growing period exceeding 150 days for maximum productivity. In the Holihosur sub-watershed, soil-phase-level evaluation indicated that guava suitability ranged from moderately suitable (S2) to marginally suitable (S3) and currently not suitable (N), with limitations arising from soil physical properties and landform characteristics.

Moderately suitable areas covered 2,908 ha (52.92% of TGA), marginal suitability was noted over 744 ha (13.54%) and 559 ha (10.17%) were classified as not suitable (Fig. 4).Within the moderately suitable category, **S2gn** (BTKiB2g1; 45 ha, 0.81%) was constrained by gravelliness and low nutrient availability. **S2gt** (RNRfB2, RNRiB2g1, RNRmB2; 105 ha, 1.92%) was limited by coarse fragments and adverse texture. The **S2nr** subclass included SKBfB2, SKBfB2g1, SKBiB2, SKBiB2g1, SKBmB2, SKBmB2g1 mapping units which spanned 304 ha (5.53%) of an area, with nutrient and textural constraints. The **S2nt** subclass, including JLGfB2, JLGiB2g1, JLGmB2, KPRfB2, KPRiB2, KPRmB2 and KPRmB2g1, accounted for 340 ha (6.19%), where nutrient deficiency and texture were limiting. The largest share of moderately suitable land (**S2t**) BTPmB2, BTPmB2g1, CPTfB2, CPTmB2, GPHmB2, LDKcB2g1, LDKfB2, LDKiB2g1, and LDKmB2 occupied 2,114 ha (38.48%), primarily restricted by soil texture. Marginal suitability (**S3**) reflected more severe constraints. **S3gn** (BDThB2g1, BDTiB2, BDTiB2g1, BDTmB2g1, CKRfB2, CKRiB2g1, CKRmB2g1) covered 254 ha (4.62%) with limitations from gravelliness and nutrient shortages. **S3gnl** (CKRcC3g1) spanned 54 ha (0.98%) of an area, affected by slope, gravelliness and nutrient constraints. **S3nt** (NYNmB2Ca) occupied 90 ha (1.64%) with nutrient and texture issues. The **S3rt** subclass ATTfB2, ATTiB2g1, ATTmB2, ATTmB2g1, SGBcB2g1, SGBfB2, SGBfB2g1, SGBiB2, SGBiB2g1, SGBmB2g1 accounted for 346 ha (6.30%), restricted by rooting depth and texture. Currently not suitable (**N**) areas ADGfB2g1, ADGiB2g1, ADGmB2, BLDcB2g1, BLDiB2g1, GKPcC3g1Ca, KKDhB2g1, MUKfB2, MUKmB2 and SRLcB2g1 were limited by shallow effective depth and unsuitable structure for guava's root system. Similar constraints have been documented in the Chikkumbi-3 micro-watershed of Dharwad district, where Vyas *et al*. (2024) classified guava suitability as moderately to marginally suitable (S3cs) due to drainage, texture, pH and organic matter limitations. These findings are in agreement with Anilkumar *et al*. (2017), who also highlighted the influence of such soil-related constraints on the spatial variability of guava cultivation potential.

Soil-site suitability evaluation for lime

Lime cultivation thrives in soils with a depth exceeding 150 cm, having sandy loam, silt loam, clay loam, or loam textures, free from salinity and alkalinity and with good drainage. The optimal temperature range for lime cultivation is between 28 °C and 30 °C and the ideal growing period for achieving maximum productivity spans 240–265 days. In the Holihosur sub-watershed, evaluation of soil phases for lime production revealed that the mapping units predominantly fell into moderately suitable (S2) to currently not suitable (N) classes, constrained by moderate to very severe limitations. Land suitability varied from moderately favorable to unsuitable conditions illustrated in table 2 and fig. 5.

A considerable portion, covering 2,114 ha (38.48% of the total geographical area), was assessed as moderately suitable (S2), particularly in the S2t subclass, represented by mapping units CPTfB2, CPTmB2, GPHmB2, LDKcB2g1, LDKfB2, LDKiB2g1, LDKmB2 and MGRmB2, primarily affected by textural constraints. The S2g subclass, with an extent of 105 ha, comprised RNRfB2, RNRiB2g1, and RNRmB2, where moderate gravelliness was a key limiting factor. The BTKiB2g1 mapping unit (S2gn subclass), covering 45 ha, exhibited combined limitations of gravelliness and nutrient availability. The S2n subclass, represented by KPRfB2, KPRiB2, KPRmB2, KPRmB2g1 and MVDmB2g1, occupied 158 ha, where nutrient availability was the major constraint. The S2nr subclass covered 486 ha, encompassing mapping units SKBiB2g1, SKBiB2, SKBmB2g1, SKBmB2, SKBfB2g1, SKBfB2, JLGmB2, JLGfB2, JLGiB2g1 and VRVmB2g1, limited by both rooting depth and nutrient status. Marginally suitable (S3) areas extended over 744 ha (13.54%), primarily constrained by soil-related factors. The S3gn subclass, covering 254 ha (BDThB2g1, BDTiB2, BDTiB2g1, BDTmB2g1, CKRfB2, CKRiB2g1, CKRmB2g1), was affected by severe gravelliness and low nutrient levels. The S3gnl subclass, represented by CKRcC3g1 (54 ha), experienced a combination of steep slope, high gravel content, and fertility limitations. Nutrient and shallow rooting depth constraints were predominant in the S3nr category (NYNmB2Ca, 90 ha). Units under the S3r subclass, including ATTfB2, ATTiB2g1, ATTmB2, ATTmB2g1, SGBcB2g1, SGBfB2g1, SGBiB2g1, SGBfB2 and SGBiB2, covering 346 ha, were mainly limited by inadequate rooting depth, restricting root expansion and water uptake.

The currently not suitable (N) class accounted for 559 ha (10.17%), consisting of mapping units MUKfB2, MUKmB2, GKPcC3g1Ca, KKDhB2g1, SRLcB2g1, BLDcB2g1, and BLDiB2g1. These areas presented compounded limitations such as extreme gravelliness and shallow soil profiles, severely restricting lime establishment and productivity. These findings align with those of Rajesh *et al.* (2019), who reported the Adavibhavi micro-watershed as unsuitable for lime cultivation due to severe constraints in rooting depth, soil texture, slope and gravel content. Similarly, Mahesh *et al.* (2019) documented that in the Bharatnur-3 micro-watershed, lands were classified as moderately suitable (S2lt) where textural and topographic limitations existed, whereas other areas were deemed unsuitable due to restrictive rooting conditions.

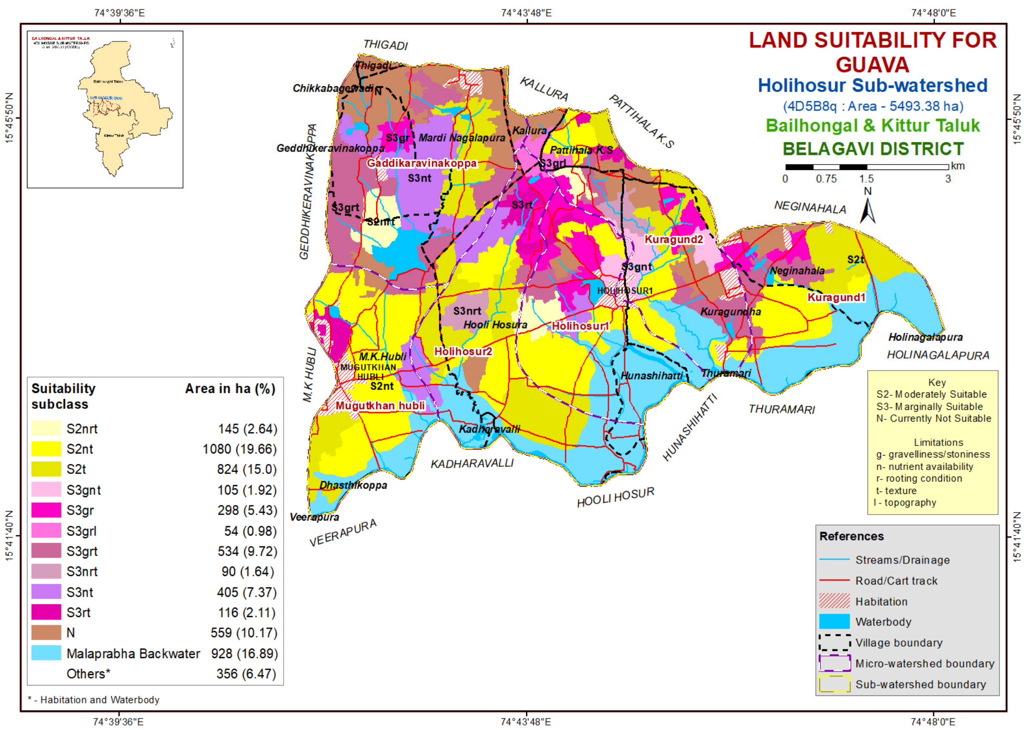

Fig. 4 : Soil site suitability map for guava crop in Holihosur Sub-watershed

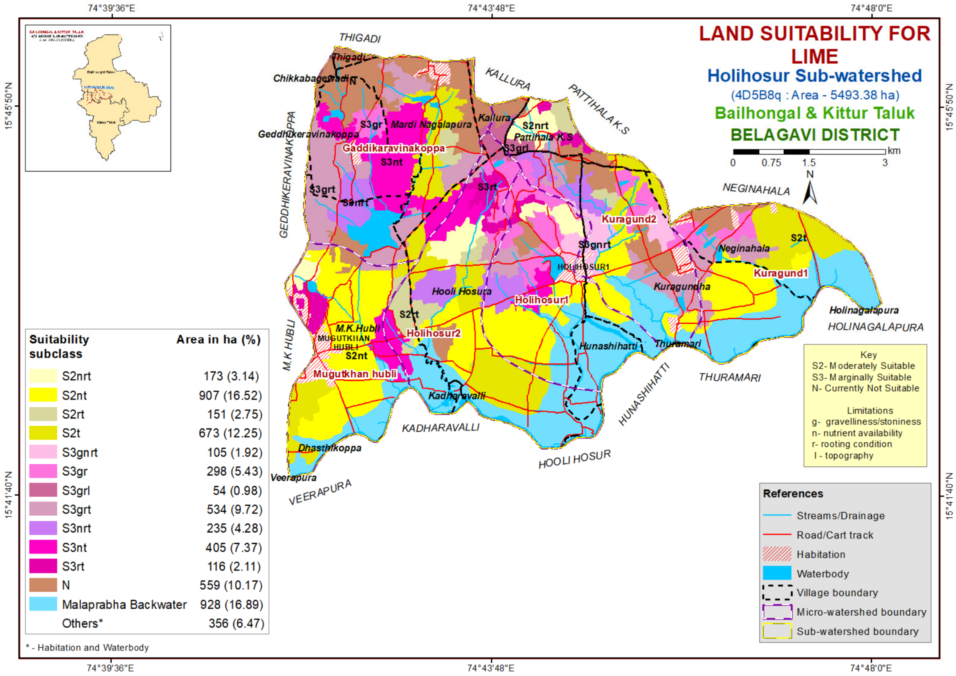

Fig. 5 : Soil site suitability map for lime crop in Holihosur Sub-watershed

Conclusion

The soil-site suitability assessment clearly indicates that a substantial portion of the Holihosur sub-watershed possesses inherent physical limitations particularly shallow effective soil depth and steep slopes that restrict the cultivation potential of major fruit crops such as grapes, sapota, guava, and lime. While a considerable proportion of the area retains moderate to marginal suitability, provided that site-specific management interventions are adopted. Addressing nutrient deficiencies, improving organic matter content and implementing soil and water conservation measures can enhance crop performance even in moderately constrained soils. Such targeted and sustainable land-use planning can contribute significantly to improving crop yields and enhancing farmers' income in the region.

Acknowledgements

This Study was part of the REWARD project (UAS Dharwad) funded by the World Bank and Government of Karnataka and Centre of Excellence on Watershed Management, GKVK, Bangalore. The authors duly acknowledged the technical and financial support.

References

Amara, D.M.K., Kamanda, P.J., Patil, P.L. and Augustine, M. (2016). Land Suitability Assessment for Maize and Paddy Production in Bogur Microwatershed Using Remote Sensing and GIS Techniques. *International Journal of Environment, Agriculture and Biotechnology*, **3**(1), 505–516.

Anilkumar, S.N., Chikkaramappa, T., Gopala, Y.M., Arunkumar, J.S. and Veerendra, P.G.M. (2019). Soil resource inventory, land capability and crop suitability assessment of Haradanahalli micro- watershed using Remote Sensing and GIS. *Acta Scientific Agriculture*, **3**(3):129-137.

Aronoff, S. (1991). Geographic Information System. A Management Perspective. WLD Publications Ottawa, ON, Canada.

Basavaraj, K., Reddy, B.S., Maheshkumar, R.N., Satishkumar, U. and Desai, B.K. (2022). Soil suitability of some major crops for sustainable production in the North Eastern dry zone of Dabarbad sub-watershed of Kalaburagi district, Karnataka. *The Pharma Innovation Journal*, **11**(4): 782-789.

FAO (1976). A framework for land evaluation. Soils Bull 32. Food and Agriculture Organization of the United Nations, Rome, Italy, p. 72.

FAO (1993). Guidelines: Land Evaluation for Rainfed Agriculture. Soils Bulletin No.52 Rome: 237.

FAO (2017). The future of food and agriculture – Trends and challenges. Food and Agriculture Organization of the United Nations, Rome, Italy.

Gangopadhyay, S.K., Reddy, G.P.O., Nayak, D.C. and Singh, S.K. (2018). Land Resource Inventory and Mapping: Tools and Techniques. In: Mapping, Monitoring and Management, Geotechnologies and the Environment 21 (Ed. Reddy GPO and Singh SK), *Springer Nature* Switzerland AG, Switzerland, p. 297-322.

Green, K. (1995). Using GIS to predict fire behaviour. *J Forestry*, 93:21–25.

Hinton, J.C. (1996). GIS and RS integration for environmental applications. *Intern J Geo Info Sys*, **10**: 877-890.

Madhusudhan (2019). Studies on morphological, physical, chemical and mineralogical characteristics of Kanaginahala sub-watershed (4D7C3B) in northern dry zone of Karnataka., *Ph.D Thesis*, University of Agricultural Sciences Dharwad, Karnataka (India).

Mahesh, K., Basavaraj, K., Rajesh, N.L. and Chittapur, B.M. (2019). Land evaluation of Bharatnur-3 micro- watershed in North Eastern dry zone of Karnataka for sustainable land use planning. *International Journal of Chemical Studies*, **7**(1):801-811.

Manjunatha, C.K., Manjunatha, H., Patil, P.L., Dasog, G.S. and Vishwanath, S. (2017). Soil resource assessment of watershed towards land use planning using satellite remote sensing and GIS techniques in Northern Karnataka, India. *International Journal of Chemical Studies*, **5**(6):1631-1635.

Naidu, L.G.K., Ramamurthy, V., Challa, O., Rajendra, H. and Krishnan, P. (2006). Manual: soil-site suitability criteria for major crops. *NBSS publication*, No. **129**, NBSS & LUP Nagpur; p. 1-118.

Rajesh, N.L., Rajesh, V., Meenakshi, R.B., Sathishkumar, U., Bhat, S.N. and Rudramurthy, H.V. (2019). Land resource inventory of Kalmali North-1 micro watershed to derive land capability and suitability for field crops. *International Journal of Chemical Studies*, **7**(1): 245-249.

Sehgal, J.L. (2005). Pedology–*Concepts and Applications*. Second Revised and Expanded Edition. Kalyani Publishers, New Delhi, p. 176-185.

Vyas, R., Patil, P.L. and Hebbara, M. (2024). Soil-site suitability assessment for major fruit crops in Chikkumbi-3 micro-watershed (4D7C5O2f), Karnataka using remote sensing and GIS Techniques. *International Journal of Plant and Soil Science*, **36**(3): 99- 110.

Walke, N., Reddy, G.P.O., Maji, A.K. and Thayalan, S. (2012). GIS-based multi-criteria overlay analysis in soil-suitability evaluation for cotton (*Gossypium* spp.): a case study in the black soil region of Central India. *Computers and Geosciences*, **41**: 108–118.