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GIS-Based Land Suitability Assessment for Sustainable Dragon Fruit Cultivation in Meghalaya, India

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Abstract— *The identification of suitable land resources is critical for promoting sustainable horticulture in ecologically fragile regions such as Meghalaya, India. This study presents a GIS-based land suitability assessment for dragon fruit cultivation by integrating soil, climatic, and topographic parameters within the FAO Land Evaluation Framework. Key variables, including slope, elevation, rainfall, temperature, soil pH, drainage, texture, stoniness, and soil depth, were analyzed using geospatial techniques. Thematic layers were generated from multiple data sources, including digital soil maps, Soil Health Card data, India Meteorological Department rainfall records, and MODIS-derived temperature datasets, and were standardized and integrated in a GIS environment for spatial analysis.*

A parametric evaluation approach was employed, wherein each land characteristic was assigned a limitation score (0–4) based on its deviation from optimal crop requirements. The overall suitability was determined using the most limiting factor method. The results reveal that 17.14% of the total assessed area is highly suitable (S1), 16.37% moderately suitable (S2), and 66.49% marginally suitable (S3) for dragon fruit cultivation. The predominance of marginally suitable land is mainly attributed to steep slopes and higher elevations prevalent across the state.

District-level analysis indicates that West Khasi Hills, East Khasi Hills, East Jaintia Hills, and Ri-Bhoi offer the most favorable conditions for cultivation, while several other districts are constrained by terrain and soil limitations. At the block level, Mairang, Umsning, Jirang, Kharkutta, and Umling emerge as priority areas for expansion. The study highlights that a substantial extent of culturable wastelands and fallow lands can be effectively utilized for dragon fruit cultivation with appropriate management interventions. Overall, the findings provide a scientific basis for sustainable land-use planning, horticultural diversification, and improved livelihood opportunities in Meghalaya.

Keywords— Dragon fruit, FAO framework, Geospatial analysis, Land suitability, Soil parameters.

I. INTRODUCTION

Soil degradation poses a significant threat to agricultural sustainability, particularly in the hilly regions of South and Southeast Asia, where steep terrain, intense rainfall, and shallow soils accelerate surface runoff and erosion, resulting in substantial topsoil loss. In India's North Eastern Region, approximately 17.91% of the land is affected by degradation, primarily due to soil acidification and water-induced erosion. The state of Meghalaya is especially vulnerable owing to its rugged topography and high monsoonal rainfall, which intensify soil erosion and nutrient depletion. The predominance of shallow soils further limits natural recovery processes, making restoration slow and challenging. Additionally, traditional agricultural practices such as shifting cultivation (jhum) exacerbate soil degradation, with soil loss rates far exceeding natural soil formation rates [1].

Dragon fruit (commonly known as Kamalam), scientifically classified under *Hylocereus* spp. and *Selenicereus* spp., has emerged as a high-value fruit crop globally due to its nutritional and medicinal properties. Also referred to as pitaya or strawberry pear, it belongs to the climbing cactus family and originates from Central and South America. The crop is well

known for its tolerance to abiotic stresses, pests, and diseases, making it suitable for marginal and degraded lands. Dragon fruit can be cultivated up to an altitude of about 1700 m, with an annual rainfall requirement ranging from 1145 to 2540 mm. It thrives best in well-drained, slightly acidic loamy soils (pH 5.5–6.5) and optimal temperature conditions between 20°C and 30°C. Commercially, four major types are cultivated: red skin with white flesh (*Hylocereus undatus*), red skin with red flesh (*Hylocereus polyrhizus*), red skin with purple flesh (*Hylocereus costaricensis*), and yellow skin with white flesh (*Hylocereus megalanthus*) [2].

The crop is typically planted during July to August using 20-25 cm long stem cuttings, spaced at 3 m × 3 m under a single post system. Plants begin bearing fruits within 12-15 months after planting, with harvesting occurring between June and September, often in multiple cycles within a month [4].

Dragon fruit was introduced in India during the 1990s and has since gained popularity due to its low maintenance requirements, drought tolerance, and resilience to extreme weather conditions. It is increasingly recognized as a promising crop for the utilization of degraded lands. Currently, the crop is cultivated over more than 3000 hectares in India, with Gujarat contributing approximately 34% of the total production (2020). Other states engaged in its cultivation include Karnataka, Kerala, Tamil Nadu, Maharashtra, Chhattisgarh, Odisha, West Bengal, Andhra Pradesh, the Andaman and Nicobar Islands, Mizoram, and Nagaland [5]. Despite this expansion, a substantial proportion of dragon fruit available in Indian markets is still imported from countries such as Vietnam, Thailand, Malaysia, and Sri Lanka. The productivity of the crop is often influenced by nutrient management practices, particularly the use of inorganic fertilizers [6].

In Northeast India, dragon fruit cultivation has been reported in states such as Mizoram, Assam, Manipur, and Meghalaya [7]. In Meghalaya, the crop covers an area of approximately 174 hectares, with a total production of 786.6 metric tons as of 2020 [8].

Despite its growing importance and favorable agro-climatic conditions, systematic studies assessing land suitability for dragon fruit cultivation in Meghalaya remain limited. The absence of comprehensive spatial evaluations restricts the identification of potential areas for its expansion. Therefore, the present study aims to assess the spatial suitability for dragon fruit cultivation across the entire state of Meghalaya using geospatial techniques integrated with soil-site evaluation methods.

II. MATERIALS AND METHODS

2.1 Study Area

Meghalaya is situated in Northeast India between 25°13′06″ and 25°17′45″ North latitude and 89°49′52″ and 92°48′17″ East longitude. It is bordered by Assam to the north and east and Bangladesh to the south and west. The state is distinguished by its rugged hilly landscape, substantial rainfall, and varied agro-climatic conditions (Fig. 1).

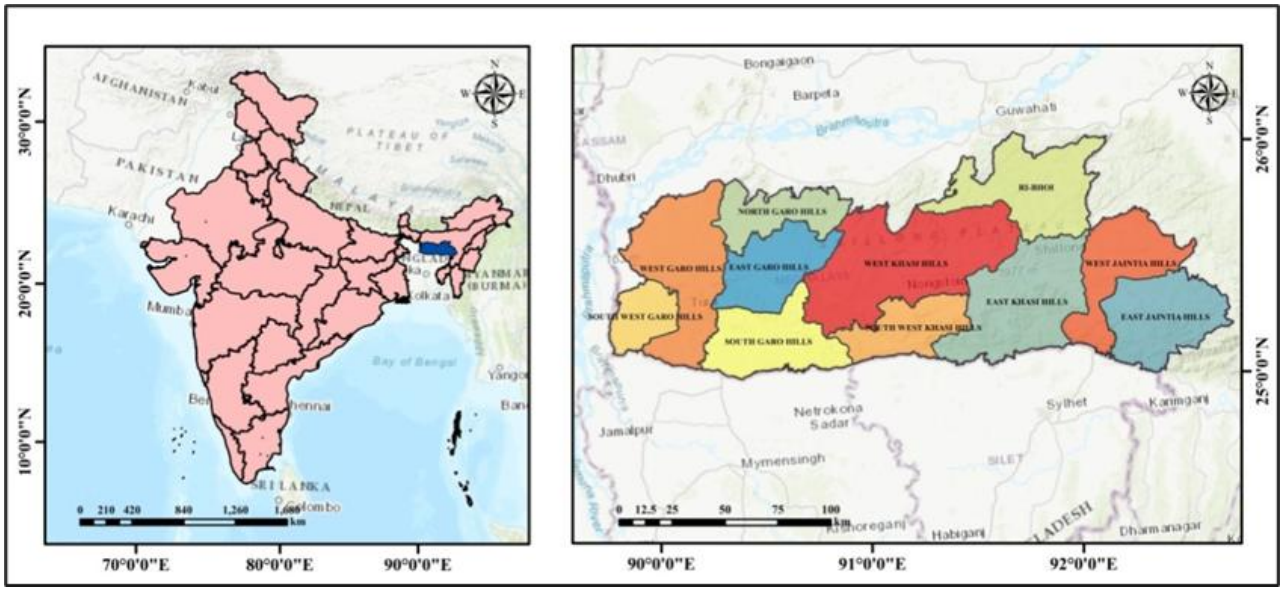

FIGURE 1: Location of the study area

2.2 Data Sources and Thematic Map Preparation

In this study, nine key factors—slope, elevation, rainfall, temperature, soil pH, drainage, stoniness, texture, and depth—were considered to identify the most suitable areas for dragon fruit cultivation. The suitable areas for dragon fruit cultivation were determined through a soil-site suitability evaluation based on the FAO Land Evaluation Framework (1983). Topographic, soil, and climatic parameters were integrated within a GIS environment to assess land suitability. The total cultivable land area in Meghalaya was estimated using 2024 Land Use Land Cover (LULC) data. Thematic layers representing slope, elevation, rainfall, and soil pH were generated and overlaid using ArcGIS 10.8.2 to delineate potential zones for dragon fruit cultivation.

A seamless digital soil map was developed by integrating district-wise soil maps at 1:50,000 scales, originally prepared by the North Eastern Space Applications Centre and the Soil and Land Use Survey of India. The map was further refined to incorporate key soil fertility parameters, including soil pH (acidity), organic carbon (OC), and available phosphorus (P) and potassium (K) [9]. Based on this updated soil dataset, multiple thematic layers were generated, such as soil texture, depth, drainage, pH, organic carbon (OC), and available nutrients (P and K), for subsequent analysis. Soil fertility maps, including parameters such as pH, were prepared using soil health data obtained from the Soil Health Card (SHC) portal (http://soilhealth.dac.gov.in).

Grid-wise soil health data were downloaded from the SHC dashboard and subsequently processed to ensure compatibility with the GIS environment. A point layer was generated using soil sample location coordinates (latitude and longitude) within the GIS framework using ArcGIS 10.3 software, and the point-based soil pH values were spatially interpolated using standard GIS techniques to produce a continuous soil pH map of the study area, which served as an important indicator for evaluating soil health conditions [10].

High spatial resolution gridded rainfall data with a resolution of 0.25° × 0.25°, developed by the India Meteorological Department (IMD), were obtained from the official IMD data portal (https://www.imdpune.gov.in/lrfindex.php). Monthly rainfall datasets covering a 27-year period (1997–2023) were used in this study. The mean annual temperature map for Meghalaya was generated using 16 years (2007-2023) of MODIS Land Surface Temperature data at a spatial resolution of 1 km, with daily observations processed to derive annual averages.

2.3 Suitability Criteria and Limitation Scoring

The suitability assessment was carried out using the FAO parametric framework, in which each land quality parameter was assigned a limitation score ranging from 0 (no limitation) to 4 (very severe limitation), based on its deviation from the optimum requirements of the crop. The threshold values for different suitability classes (S1 to N) are presented in Table 1 and were established through scientific consultations with officials from the Horticulture Department, Government of Meghalaya. These criteria and ratings were formulated by integrating field experiment results, farmers' feedback, and the prevailing climatic, soil, and terrain conditions of the state. The detailed scoring scheme is provided in Table 1 to ensure transparency and reproducibility.

The overall suitability of each mapping unit was determined using the most limiting factor approach, whereby a unit could not be classified as highly suitable if any critical parameter exceeded the acceptable threshold, in accordance with FAO (1984) guidelines. Prior to spatial analysis, all thematic layers were standardized to a common coordinate reference system and integrated through overlay analysis in ArcGIS Pro.

Suitability classes were then assigned based on the degree and combination of limitations. Land units classified as Highly Suitable (S1) exhibit no limitations or only a few slight limitations (up to four), indicating minimal constraints for crop growth. Moderately Suitable (S2) units are characterized by more than four slight limitations and/or up to three moderate limitations, reflecting manageable constraints that may influence productivity. Marginally Suitable (S3) units include those with more than three moderate limitations and/or at least one severe limitation, indicating substantial constraints that restrict optimal crop performance. Land categorized as Not Suitable (N) comprises units with very severe limitations, rendering them unsuitable for the intended crop under existing conditions (Table 2).

TABLE 1

CRITERIA AND LIMITATION RATING FOR EVALUATION OF SOIL-SITE SUITABILITY FOR DRAGON FRUIT

Parameter	S1 (Highly Suitable)	S2 (Moderately Suitable)	S3 (Marginally Suitable)	N (Not Suitable)
Slope (%)	0-40	40-50	50-60	>60
Elevation (m)	<1700	-	-	>1700
Rainfall (mm)	1145-2540	-	-	<1145 or >2540
Temperature (°C)	20-30	15-20 or 30-35	<15 or >35	-
pH	5.5-6.5	6.5-7.5	7.5-8.0	<5.5 or >8.0
Drainage	Well drained	Moderately drained	Poorly drained	Very poorly drained
Stoniness (%)	<10	Oct-25	25-50	>50
Texture	Loamy	Clay loam/Sandy loam	Clay/Sand	Heavy clay
Depth (cm)	>100	50-100	25-50	<25

TABLE 2

CRITERIA FOR DETERMINATION OF LAND SUITABILITY CLASSES

Land classes	Criteria
S1: Highly suitable	Land units with no or only 4 slight limitations
S2: Moderately suitable	Land units with more than 4 slight limitations and/or no more than 3 moderate limitations
S3: Marginally suitable	Land units with more than 3 moderate limitations and/or one or more severe limitations
N: Not suitable	Land units with very severe limitations

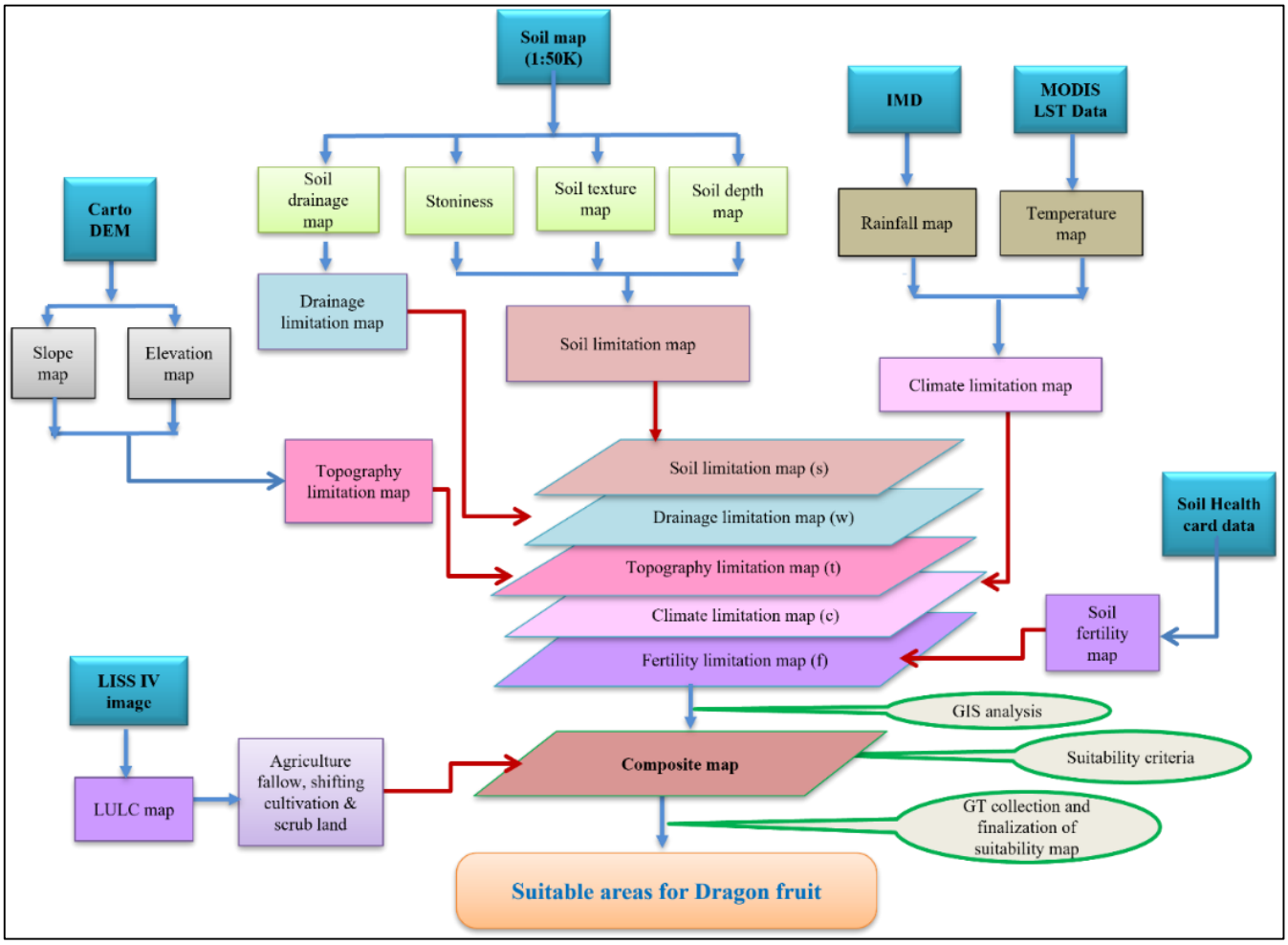

FIGURE 2: Flowchart of the methodology

III. RESULTS AND DISCUSSION

3.1 Climate and Topographic Parameters

3.1.1 Slope

Slope, as influenced by elevation, results in spatial variations in soil moisture, which are essential for agricultural productivity [12]. To evaluate slope suitability for dragon fruit cultivation, the study area was classified into four categories (Table 1): highly suitable (0-40%), moderately suitable (40-50%), marginally suitable (50-60%), and not suitable (>60%). This classification helps to identify areas that are most favorable for cultivation, thereby supporting optimal agricultural planning. Figure 3a illustrates the spatial distribution of slope classes and their suitability across the study area.

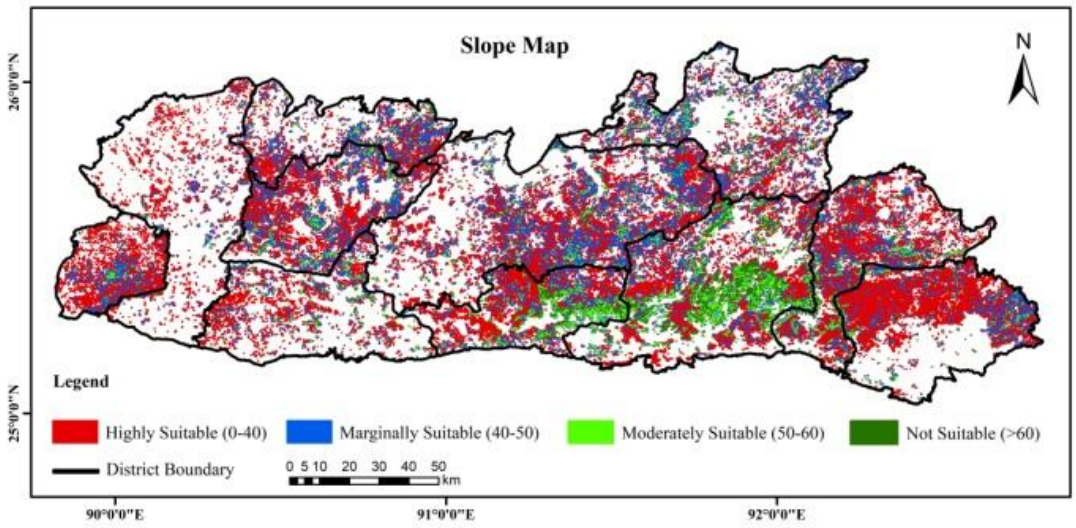

FIGURE 3 a): Spatial distribution of slope classes and their suitability for dragon fruit cultivation in Meghalaya

3.1.2 Elevation

Elevation across the study area in Meghalaya exhibits substantial variability, reaching up to 1968.09 m above mean sea level. However, the present analysis primarily focuses on areas below 1700 m, as recommended by the Horticulture Department of Meghalaya. In this context, regions situated below 1700 m are considered highly suitable for dragon fruit cultivation, while areas above this threshold are regarded as less suitable due to suboptimal growing conditions [9].

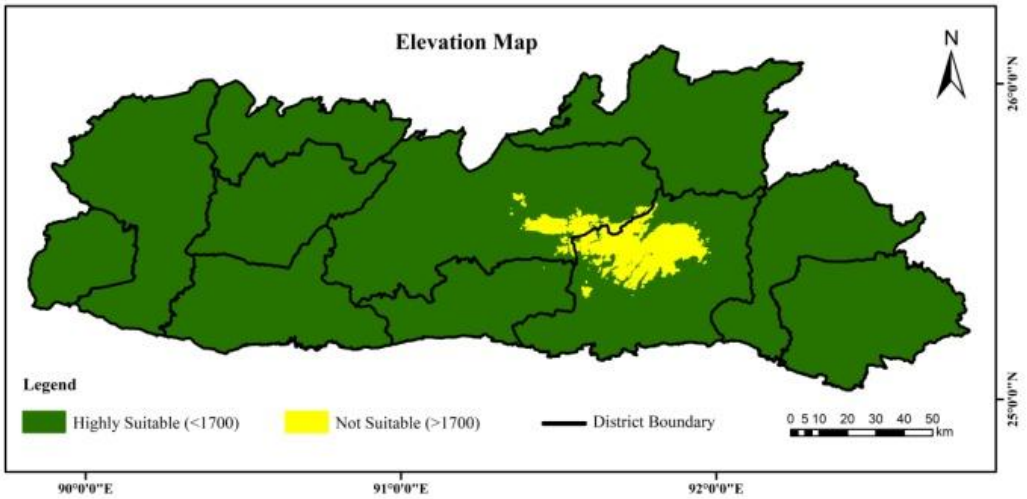

FIGURE 3 b): Spatial delineation of elevation-based suitability zones for dragon fruit cultivation in Meghalaya

Figure 3b illustrates the spatial delineation of suitability zones based on elevation, highlighting its influence on crop suitability across the study area. Such elevation-based classification provides a critical basis for informed agricultural planning and land-use decision-making, particularly for the expansion and sustainable cultivation of dragon fruit in Meghalaya.

3.1.3 Rainfall

Dragon fruit cultivation requires a well-defined range of annual rainfall for optimal growth and productivity. In the study area, annual precipitation exhibited considerable variability, ranging from 995.801 to 11,420.5 mm. To assess its suitability for dragon fruit cultivation, the rainfall data were classified into two categories (Table 1): highly suitable (1145-2540 mm) and not suitable (<1145 mm or >2540 mm), based on their potential to support optimal crop growth. The classification of precipitation levels plays a crucial role in identifying the most suitable areas for dragon fruit cultivation. Regions categorized as highly suitable are expected to offer optimal growing conditions, whereas areas with very low suitability may present significant constraints to successful cultivation. This understanding of precipitation variability supports improved land-use planning and agricultural decision-making. The spatial distribution of suitable zones based on precipitation analysis is presented in Figure 3c.

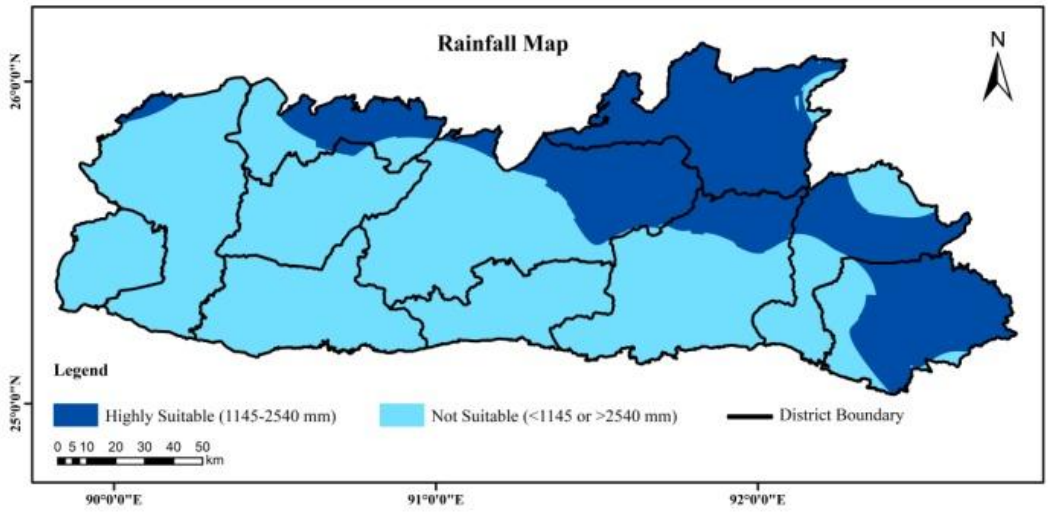

FIGURE 3 c): Spatial distribution of rainfall-based suitability zones for dragon fruit cultivation in Meghalaya

3.1.4 Temperature

Dragon fruit cultivation is well suited to tropical and subtropical regions, ranging from high humid to relatively dry areas. The optimal temperature range for its growth is 20-30°C, with tolerance from 15°C to 35°C [13]. These temperature conditions are prevalent across Meghalaya, indicating that the entire state is suitable for dragon fruit cultivation.

3.2 Soil Characteristics

Soil characteristics in Meghalaya, including drainage, stoniness, texture, and depth, collectively provide favorable conditions for agricultural development. The soils are generally well to moderately well-drained, exhibit minimal stoniness, possess suitable textural classes, and are predominantly deep to very deep in nature. These combined attributes create an optimal soil environment, indicating that all four parameters are highly suitable for dragon fruit cultivation in the region.

Soil pH is a critical factor in dragon fruit cultivation, as it significantly affects nutrient availability and overall plant growth. The crop thrives best in slightly acidic soils (pH 5.5-6.5), where essential nutrients such as phosphorus, iron, and manganese are more easily accessible [12]. To evaluate land suitability for dragon fruit cultivation based on soil pH, the pH map was classified into four categories: highly suitable (5.5-6.5), moderately suitable (6.5-7.5), marginally suitable (7.5-8.0), and not suitable (<5.5 or >8.0) [12]. This classification supports targeted land-use planning by identifying areas that may require soil management interventions. Figure 3d illustrates the spatial distribution of pH-based suitability across the study area.

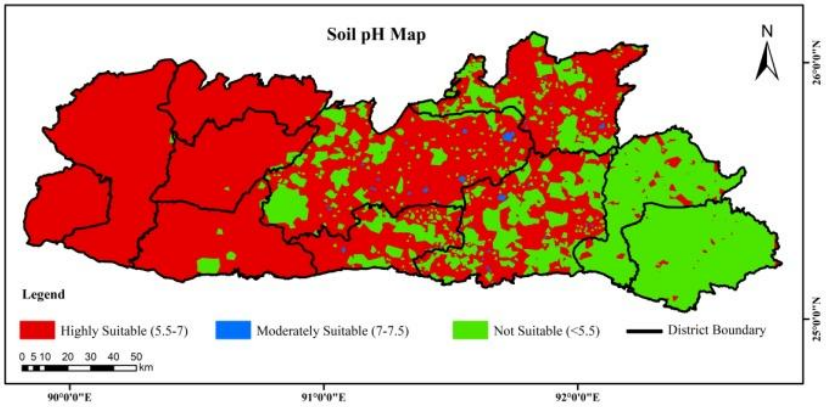

FIGURE 3 d): Spatial distribution of pH-based suitability zones for dragon fruit cultivation in Meghalaya

3.3 Land Use Land Cover (LULC)

Land use within the study area was assessed using Land Use Land Cover (LULC) data, which offers a comprehensive representation of different land categories in the region. Analysis of 2024 LISS IV imagery indicates that Meghalaya is predominantly covered by sparse scrubland (10.23%) and dense scrubland (4.48%), with smaller areas of shifting cultivation (0.87%), grassland/grazing land (0.012%), and fallow land (0.004%). Figure 3e presents the LULC classification map of the study area, depicting the spatial distribution of different land cover types and facilitating the identification of potential zones for dragon fruit cultivation.

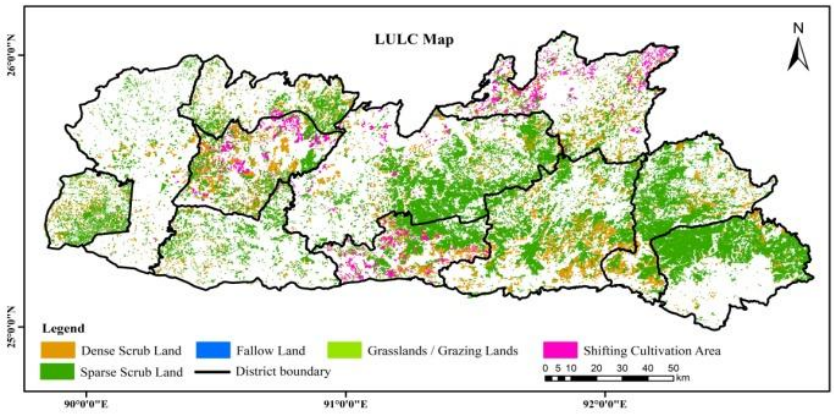

FIGURE 3 e): Land Use Land Cover (LULC) classification map of Meghalaya

3.4 Field Verification and Ground Truth (GT)

Ground truthing was carried out to validate the site suitability analysis for dragon fruit cultivation in Meghalaya. The survey encompassed a wide range of locations across the state, capturing variations in elevation, soil types, and climatic conditions relevant to the crop. A total of 1,700 GPS-referenced field points were collected to assess the accuracy of the generated suitability map. At each location, critical parameters including land use, soil properties, and terrain characteristics were systematically recorded. These field observations were then compared with the model-derived outputs to evaluate the reliability of the suitability classification. The ground validation exercise improved the overall accuracy of the analysis and confirmed that several areas in Meghalaya exhibit high suitability for dragon fruit cultivation.

3.5 Evaluation of Map Accuracy

To assess the accuracy of the suitability map, a stratified random sampling approach was employed, with 1,700 locations selected across all four suitability classes (S1, S2, S3, and N) throughout the state. The number of samples in each class was proportional to its spatial extent, with a minimum of 100 observations ensured per class. At each sampling point, key parameters were measured, including soil pH (using a field meter), soil depth (with an auger), soil texture (assessed in the field and validated through laboratory analysis for 20% of samples), and slope (measured using a clinometer).

Additionally, microclimatic data were recorded at 200 locations distributed along elevation gradients using temperature loggers. The observed field data were then compared with the model-generated predictions to evaluate consistency. Map accuracy was determined using a confusion matrix, which compared field-observed classes with model-predicted classes, and metrics such as overall accuracy and the Kappa coefficient were computed [11].

The results indicated an overall accuracy of 90% and a Kappa coefficient of 0.86, reflecting strong agreement between observed and predicted suitability classes. Most misclassifications occurred between S1 and S2 categories in transitional zones, which is consistent with known limitations of DEM-derived slope estimations in rugged terrain. Figure 3f presents the validated suitability map.

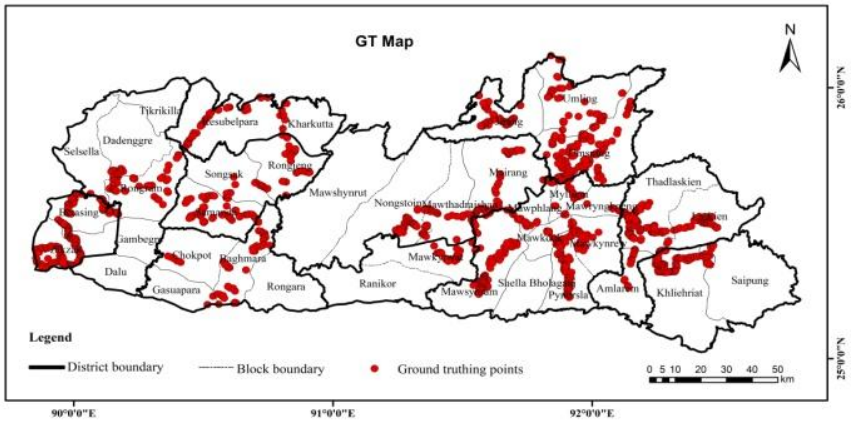

FIGURE 3 f): Validated suitability map for dragon fruit cultivation in Meghalaya

3.6 Assessment of Dragon Fruit Cultivation Suitability in Meghalaya

The land evaluation was carried out within culturable wastelands and agricultural fallow areas, and the study revealed that the state has significant potential for expanding dragon fruit cultivation across Meghalaya. Based on integrated analysis of climate, soil, topography, and landscape, the study revealed that 17.14% of the total assessed area is highly suitable, 16.37% moderately suitable, and 66.49% marginally suitable.

The high proportion of marginally suitable areas is largely attributed to steep slopes and higher elevations prevalent in many districts, limiting the growth of the crop. Despite these constraints, the availability of over 56,927 hectares of highly suitable land demonstrates strong potential for sustainable expansion of dragon fruit cultivation if planned appropriately (Fig. 4). The primary limiting factor for dragon fruit suitability is rainfall (S2c covers 146,114.69 ha), followed by soil pH (S3f covers 121,050.27 ha), as shown in Table 3.

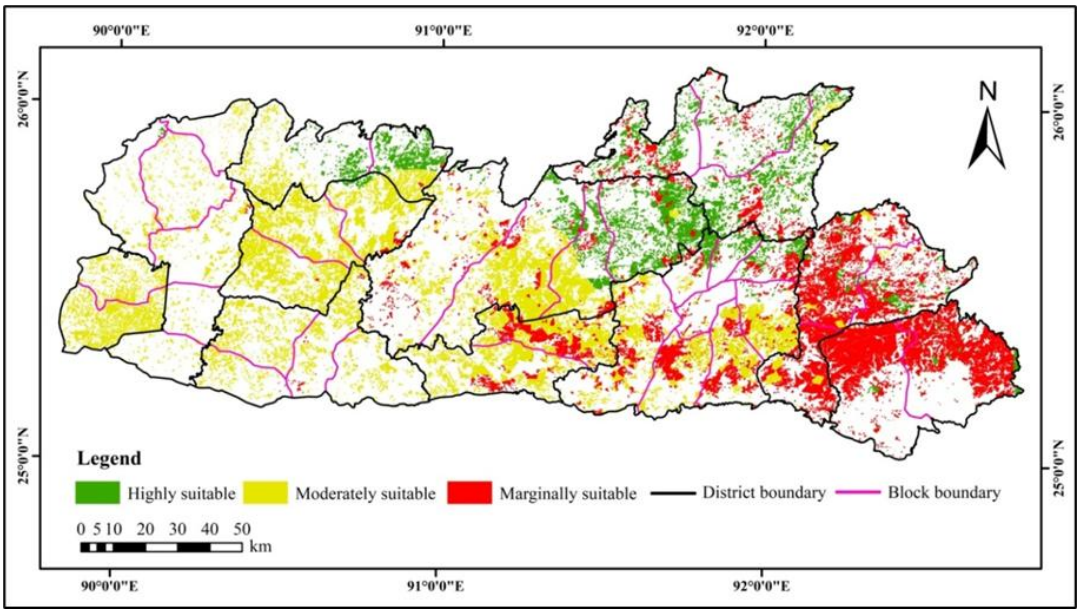

FIGURE 4: Suitable areas for dragon fruit cultivation in Meghalaya

TABLE 3

AREA UNDER SUITABILITY SUBCLASS

Suitability Class	Suitability Subclass	Area (ha)	Area (%)	Limitation/Improvement
S2	S2c	1,46,114.69	56.33	Rainfall
S2	S2ct	384.06	0.12	Rainfall and slope
S2	S2cf	166.73	0.05	Rainfall and soil pH
S2	S2t	89.14	0.03	Slope
S2	S2f	388.7	0.13	Soil pH
S3	S3t	58.31	0.02	Slope
S3	S3f	1,33,701.63	43.32	Soil pH
S3	S3ft	11.26	-	Soil pH and slope

Note: "-" indicates negligible area (<0.01%)

3.6.1 District-wise Suitable Areas for Dragon Fruit

The district-wise land suitability analysis for dragon fruit cultivation in Meghalaya reveals considerable spatial variability across different suitability classes (Table 4). West Khasi Hills recorded the highest total suitable area (71,575.36 ha), with a substantial proportion under the moderately suitable class (43,441.41 ha), followed by East Khasi Hills (54,642.66 ha) and East Jaintia Hills (51,219.18 ha). Ri-Bhoi and East Khasi Hills exhibited a relatively higher proportion of highly suitable land in relation to their total suitable area, indicating favorable agro-climatic and edaphic conditions for dragon fruit cultivation.

In contrast, East Jaintia Hills and West Jaintia Hills were predominantly characterized by marginally suitable land, accounting for 49,179.03 ha and 39,689.29 ha, respectively, suggesting the presence of significant environmental and terrain-related constraints. The districts of South Garo Hills, South West Garo Hills, and South West Khasi Hills did not record any area under the highly suitable class and were largely confined to moderate and marginal suitability categories.

From a planning perspective, the dominance of moderately suitable land in key districts highlights substantial scope for horizontal expansion through appropriate agronomic interventions, while the presence of extensive marginal areas underscores the need for targeted resource management strategies. These findings suggest that while West Khasi Hills and East Khasi Hills offer immediate opportunities for large-scale expansion, districts with higher marginal suitability require site-specific improvements in soil fertility, drainage, and microclimatic conditions to enhance productivity.

To further refine these district-level insights and support localized planning, a block-wise suitability assessment was undertaken, which is discussed in the following section.

TABLE 4

DISTRICT-WISE SUITABLE AREA FOR DRAGON FRUIT CULTIVATION IN MEGHALAYA

District	Areas (ha) under different suitability class			Total (ha)
	High	Moderate	Marginal	
East Garo Hills	975.51	35,396.97	719.31	37,113.65
East Jaintia Hills	1,916.55	120.32	49,179.03	51,219.18
East Khasi Hills	8,395.31	26,761.84	19,456.14	54,642.66
North Garo Hills	6,375.88	7,777.33	87.23	14,255.57
Ri-Bhoi	18,865.72	1,108.98	7,427.67	27,434.61
South Garo Hills	-	12,774.50	213.22	12,995.03
South West Garo Hills	-	8,993.39	-	8,998.54
South West Khasi Hills	-	23,961.53	8,493.93	32,469.16
West Garo Hills	142.19	10,908.70	72.88	11,130.24
West Jaintia Hills	3,368.59	3,629.76	39,689.29	46,695.36
West Khasi Hills	19,643.67	43,441.41	8,432.52	71,575.36

3.6.2 Block-wise Suitable Areas for Dragon Fruit

The block-wise suitability analysis for dragon fruit cultivation in Meghalaya reveals pronounced spatial variability across the state (Table 5). Several blocks, notably Mairang, Umsning, Jirang, Kharkutta, and Umling, exhibit extensive areas under high suitability, indicating strong potential for large-scale cultivation. Among these, Mairang alone accounts for 13,347.64 ha of

highly suitable land, followed by Umsning (10,493.50 ha) and Jirang (4,861.07 ha), thereby emerging as priority blocks for immediate expansion.

Moderately suitable areas are dominant in a number of blocks, including Nongstoin (22,300.86 ha), Mawkyrwat (14,616.24 ha), Samanda (13,850.90 ha), Mawthadraishan (13,234.59 ha), and Rongjeng (10,939.02 ha). These regions collectively contribute substantial land resources that can be effectively utilized for cultivation with appropriate agronomic and management interventions. In contrast, blocks such as Khliehriat, Saipung, Thadlaskien, and Amlarem are characterized by extensive tracts of marginally suitable land, ranging from approximately 12,000 to over 24,000 ha, where environmental constraints may limit productivity.

Overall, the analysis highlights that blocks with high suitability offer immediate opportunities for the expansion of dragon fruit cultivation, whereas areas classified as moderately and marginally suitable require targeted interventions related to soil management, microclimatic optimization, and terrain modification to enhance their production potential.

TABLE 5

DISTRICT/BLOCK-WISE SUITABLE AREA FOR DRAGON FRUIT CULTIVATION IN MEGHALAYA

District	Block	Areas (ha) under different suitability class			Total (ha)
		High	Moderate	Marginal	
East Garo Hills	Rongjeng	975.51	10,939.02	677.1	12,591.63
	Samanda	-	13,850.90	42.2	13,893.09
	Songsak	-	10,607.05	-	10,607.05
East Jaintia Hills	Khliehriat	346.36	120.32	24,288.52	24,755.20
	Saipung	1,570.20	-	24,890.50	26,460.70
East Khasi Hills	Mawkdok	-	366.14	385.29	751.44
	Mawkynrew	173.12	7,371.55	2,182.18	9,726.84
	Mawphlang	3,176.39	338.47	606.58	4,121.44
	Mawryngkneng	2,416.66	3.53	2,528.52	4,948.70
	Mawsynram	114.95	8,044.91	4,645.26	12,805.12
	Mylliem	2,514.20	24.31	415.69	2,954.19
	Pynursla	-	6,018.04	4,027.27	10,045.31
	Shella Bholaganj	-	4,594.90	4,665.35	9,260.25
North Garo Hills	Kharkutta	4,312.48	4,143.08	87.16	8,542.73
	Resubelpara	2,063.40	3,634.25	0.06	5,697.71
Ri-Bhoi	Jirang	4,861.07	0.27	2,876.18	7,737.51
	Umling	3,511.16	0.89	898.2	4,410.25
	Umsning	10,493.50	1,107.82	3,653.29	15,254.61
South Garo Hills	Baghmara	-	3,920.73	203.67	4,124.39
	Chokpot	-	4,338.19	0.05	4,338.23
	Gasuapara	-	1,807.95	9.18	1,817.13
	Rongara	-	2,707.64	0.33	2,707.97
South West Garo Hills	Betasing	-	3,003.80	-	3,003.80
	Zikzak	-	5,989.59	-	5,989.59
South West Khasi Hills	Mawkyrwat	-	14,616.24	6,901.30	21,517.54
	Ranikor	-	9,345.29	1,592.63	10,937.92
West Garo Hills	Dadenggre	14.44	2,356.31	-	2,370.74
	Dalu	-	864.13	-	864.13
	Gambegre	-	759.94	-	759.94
	Rongram	-	4,740.39	72.88	4,813.27
	Selsella	113.73	1,823.83	-	1,937.55
	Tikrikilla	14.02	364.1	-	378.13
West Jaintia Hills	Amlarem	-	1,997.60	12,525.21	14,522.82
	Laskien	1,831.39	189.15	7,262.89	9,283.44
	Thadlaskien	1,537.20	1,443.01	19,901.18	22,881.39
West Khasi Hills	Mairang	13,347.64	805.45	2,026.26	16,179.36
	Mawshynrut	200.67	7,100.51	2,814.04	10,115.22
	Mawthadraishan	3,403.21	13,234.59	1,337.49	17,975.29
	Nongstoin	2,692.15	22,300.86	2,254.72	27,247.74

IV. CONCLUSION

The present study highlights the significant potential of Meghalaya for the expansion of dragon fruit cultivation based on a soil-site suitability evaluation using the Food and Agriculture Organization Land Evaluation Framework integrated within a GIS environment. By incorporating topographic, climatic, and soil parameters such as slope, elevation, rainfall, and soil pH, the analysis revealed that 17.14% of the assessed area is highly suitable, 16.37% moderately suitable, and 66.49% marginally suitable for dragon fruit cultivation. The predominance of marginally suitable land is largely due to the steep slopes and higher elevations characteristic of many parts of the state. Despite these limitations, the presence of more than 56,927 hectares of highly suitable land indicates strong potential for the expansion of dragon fruit cultivation in Meghalaya. District-wise analysis showed that West Khasi Hills, Ri-Bhoi, East Khasi Hills, and North Garo Hills possess the most favorable agro-ecological conditions, while East Jaintia Hills, West Jaintia Hills, South Garo Hills, South West Garo Hills, and South West Khasi Hills are dominated by moderate and marginal suitability classes due to environmental constraints. At the block level, Mairang, Umsning, Mawthadraishan, Nongstoin, and Jirang emerged as the most promising areas for large-scale cultivation, particularly Mairang and Umsning, which contain the largest extent of highly suitable land. Overall, the findings suggest that with proper land management practices, soil improvement measures, and strategic planning, Meghalaya holds considerable potential for sustainable expansion of dragon fruit cultivation, contributing to horticultural diversification and improved livelihood opportunities for farmers in the region.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this research paper.

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