Jurnal Ilmu Pertanian Indonesia (JIPI), April 2024
ISSN 0853-4217
EISSN 2443-3462

Vol. 29 (2): 305–314
http://journal.ipb.ac.id/index.php/JIPI
DOI: 10.18343/jipi.29.2.305

Land Suitability for Pepper in Tanggamus Regency, Lampung Province, Indonesia

Diah Puspita Hati[1], Mira Media Pratamaningsih[1]*, Rufaidah Qonita Muslim[1], Erwinda Erwinda[1], Adi Setiadi[1], Pronika Kricella[1], Dwi Oksanti Saparina[2]

(Received September 2023/Accepted February 2024)

ABSTRACT

Pepper is one of the local commodities developed in Indonesia and has become an export commodity. Improving the productivity of pepper can be done through sustainable land management based on the characteristics of soils and their potential. Therefore, land suitability evaluation is needed to maximize land potential and minimize inhibiting factors for pepper plant growth. This study evaluated the characteristics, potential, and distribution of suitable land for pepper plant development in Tanggamus Regency, Lampung Province, Indonesia. Land suitability was evaluated by matching land characteristics with land suitability criteria for pepper plants. This criterion consists of four classes, namely highly suitable (S1), moderately suitable (S2), marginally suitable (S3), and not suitable (N). The soil's climate and physical and chemical properties were the land characteristics data used. Potential land availability was arranged based on land suitability classes by considering existing land use and forest area status. Soil types in Tanggamus Regency are Inceptisols, Entisols, Alfisols, Andisols, Oxisols, and Ultisols, with the most extensive distribution of soil types being Oxisol (Typic Hapludox). The distribution of relief in Tanggamus Regency is dominated by mountainous areas with very steep slopes (slope >40%). Land suitability classes are moderately suitable (S2), marginally suitable (S3), and not suitable (N) with limiting factors, namely drainage, texture, soil pH, and erosion hazard/slope. Improvement can be made by planting according to contours, planting cover crops, applying lime and organic matter, and ensuring balanced fertilization. The development of pepper plants in Tanggamus Regency can be achieved through diversification and extensification, with a total area of potential land that can be developed of 73,995 ha.

Keywords: land potential, land evaluation, limiting factor, pepper, soil characteristics

INTRODUCTION

Pepper (*Piper nigrum* L.) is a plantation commodity crop with high economic value (Maryani *et al.* 2018). Pepper has become the export commodity for destination countries such as Malaysia, Singapore, Vietnam, Japan, Taiwan, the United States, the Netherlands, Germany, and France. The amount of pepper export demand in the last three years has increased by 9,399.4 tons. Based on data from BPS-Statistic Indonesia (2020), 2016 pepper exports were recorded at 20,292.5 tons, which increased to 29,691.9 tons in 2019. Along with increasing domestic and foreign demand, intensification and extensification efforts must be carried out to increase pepper plants' productivity. In addition, efficient and appropriate handling of cultivation in the field needs to be done to strengthen competitiveness in the face of increasingly sharp market competition (Pitono 2019). It can be done by collecting information on the potential and suitability of land around the area or center of pepper plants.

[1] Research Organization for Agriculture and Food, National Research and Innovation Agency, Bogor 16915
[2] Indonesian Center for Agricultural Land Resources Standardization, Agency for Standardization of Agricultural Instruments, Ministry of Agriculture, Bogor 16124
* Corresponding Author:
E-mail: mira.media.pratamaningsih@brin.go.id

Lampung is Indonesia's second-largest pepper-producing province after the Bangka Belitung Islands. Pepper production in Lampung Province in 2019 reached 14,436 tons, decreased to 14,415 tons in 2020, and increased to 15,229 tons in 2021 (Directorate General of Plantations 2020 2023). Pepper is one of the leading plantations of black pepper and cloves (Lampung Provincial Communication, Information, and Statistics Service 2022). Therefore, pepper plantations in Tanggamus Regency continue to grow, so efforts need to be made to maintain the quality and yield of pepper plants, one of which is by utilizing land suitability information. Commodities in Lampung Province, especially in Tanggamus Regency, which is the second largest pepper-producing center in Lampung Province, amounting to 3,678 tons or 24.15% of the total pepper production in Lampung Province (Sudarsono *et al*. 2019, BPS-Statistics of Lampung Province 2023). The Lampung Provincial Plantation Service has even targeted increased production and productivity for superior varieties.

Land evaluation is an assessment process that aims to develop plants to increase plant productivity. Several studies have evaluated land suitability for pepper plants in other areas. Iqbal *et al*. (2018) studied land evaluation and suitability for pepper in Tompobulu District, Bantaeng Regency, South Sulawesi Province. They recommended >6,000 ha of potential land for improvement in the form of lime and dolomite applications. Research by Zainudin *et al*.

(2020) showed the potential of three villages (Purwajaya, Tani Bakti, and Batuah) in Loa Janan District, Kutai Kartanegara Regency, East Kalimantan Province that are moderately suitable for pepper plant development. However, no similar reference presents the land evaluation and suitability for pepper plant development in Tanggamus Regency, Lampung Province. Therefore, data and information on land characteristics are needed to determine the potential and estimate land improvement efforts. Addharu *et al*. (2021) stated that the analysis of land suitability and capability can facilitate the preparation of directions and the application of innovative technologies to increase crop productivity. These improvement efforts can be recommended by considering the growing conditions of pepper plants with actual land suitability conditions.

Based on the above, land characteristics in Tanggamus Regency must be evaluated for their suitability for pepper plant development. Therefore, this study aimed to evaluate and optimize the potential of available land for pepper plant development. In addition, suggestions for improvement were also obtained based on land limiting factors for pepper plant growth to achieve good and sustainable production and productivity in Tanggamus Regency, Lampung Province.

MATERIALS AND METHODS

Study Area

The research location was in Tanggamus Regency, Lampung Province, Indonesia, which is astronomically located between 5°05' North Latitude and 5°56' South Latitude and between 104°18'–105°12' East Longitude and is traversed by the equator or the equator with a total area of 4654.96 km^2, which consists of a land area of 2855.46 km^2 and a sea area of 1799.5 km^2 (BPS Tanggamus 2021) (Figure 1).

Materials

The data used for the evaluation analysis of land suitability for pepper plants was obtained from soil mapping activities in 2016 and secondary data including the Indonesian earth map (RBI) (BIG-Geospatial Information Agency Indonesia 2010), administrative boundary map (BPS-Statistics Indonesia 2017), land cover map of Indonesia, and forest area status map (KLHK-Ministry of Environment and Forestry 2018). In addition, data from field surveys, such as soil surveys, were also used to add information on land characteristics.

Methods

In the initial stage, tabular and spatial data on land resources were collected. Thus, land characteristics data (climate data, soil physical and chemical properties) were ready for further processing and land suitability assessment. Land suitability evaluation was conducted using SPKL software version 2.01 (Bachri *et al*. 2015) by matching the land characteristics with Land Suitability Criteria for Pepper (Ritung *et al*. 2011) to determine the land suitability classes. This classification method for land suitability referred to the framework of land evaluation by FAO (1976) using four land suitability classes: highly suitable (S1), moderately suitable (S2), marginally suitable (S3), and not-suitable (N), which were then derived by data and information

Figure 1 The study site in Tanggamus Regency, Lampung Province, Indonesia.

on land resources from soil surveys and mapping to evaluate agricultural commodities commonly grown in Indonesia (Ritung *et al*. 2011). The land suitability classes above were determined based on land limiting factors. FAO (1976) explains that land class S2 (moderately suitable) has limiting factors that are moderately severe for sustained application. In comparison, class S3 (marginally suitable) has limiting factors that, in the aggregate, are severe for sustained application. The limiting factors (in class S2 and S3) will reduce benefits (productivity) and increase required inputs. Class N has limiting factors that may be surmountable in time but cannot be overcome with current knowledge, and the costs are too significant. The flowchart for making land suitability and crop recommendation map is shown in Figure 2.

Field potential land availability was arranged based on land suitability class by considering current land use and area status. Potential land availability was arranged on dry land, mixed gardens, shrubs, and open land, with the status of non-forest estate (area penggunaan lain; APL). APL is a top priority land for development in the form of agricultural land or other uses other than forest and paddy fields.

RESULTS AND DISCUSSION

Land Characteristics

According to the soil mapping (BBSDLP 2016), soil types in Tanggamus Regency include Alfisols (Typic Hapludalfs), Andisols (Typic Hapludands and Typic Udivitrands), Entisols (Typic Endoaquents). Inceptisols (Typic Endoaquepts, Typic Epiaaquepts, Typic Eutrudepts, Andic Dystrudepts, Aquic Dystrudepts, Fluventic Dystrudepts, and Typic Dystrudepts), Oxisols (Typic Hapludands), and Ultisols (Typic Hapludands, Typic Kanhapludults, and Typic Udipsamments. The distribution of each soil type is presented in Table 1 and Figure 3.

Based on data on the distribution of soil types in Tanggamus Regency, the most extensive soil type distribution is Oxisols (Typic Hapludox), with an area of 123,919 ha or 45.15% of the total area. Oxisols are soils that have undergone advanced weathering and are characterized by deep solum, high iron and aluminum oxide content, including acid soils, and low nutrient availability for plants (Hardjowigeno 2003). Because of these characteristics, an effort is needed to support the community's ability to utilize Oxyisols properly in meeting their needs. Research by Hevianti *et al*. (2012) on Oxisols in Padang Siantar stated that increasing the fertility of acidic soils such as Oxisols can be done by applying humic materials extracted from compost and P fertilizer.

Based on the results of land suitability analysis, suitable soils for pepper plants include Alfisols, Andisols, Inceptisols, Oxisols, and Ultisols. The dominant soil suitable for pepper plants is Inceptisols (Typic Dystrudepts). Inceptisols are formed from the weathering of sedimentary and metamorphic rocks. Inceptisols have a high clay content (>60%) with a loose texture that is suitable for agriculture (Subardja *et al*. 2018). The disadvantages of Inceptisols are usually characterized by acidic pH, low organic matter, and low nutrient content (Saptiningsih 2015), so liming and providing organic matter and fertilization are needed to support plant growth properly.

The distribution of relief in Tanggamus Regency is dominated by mountainous areas with very steep slopes (slopes >40%), about 24.64% of the regency area, followed by hillocky areas with moderately steep slopes (slopes 15-25%), about 18.91% of the regency area. Other reliefs are hilly with an area of 44,372 ha,

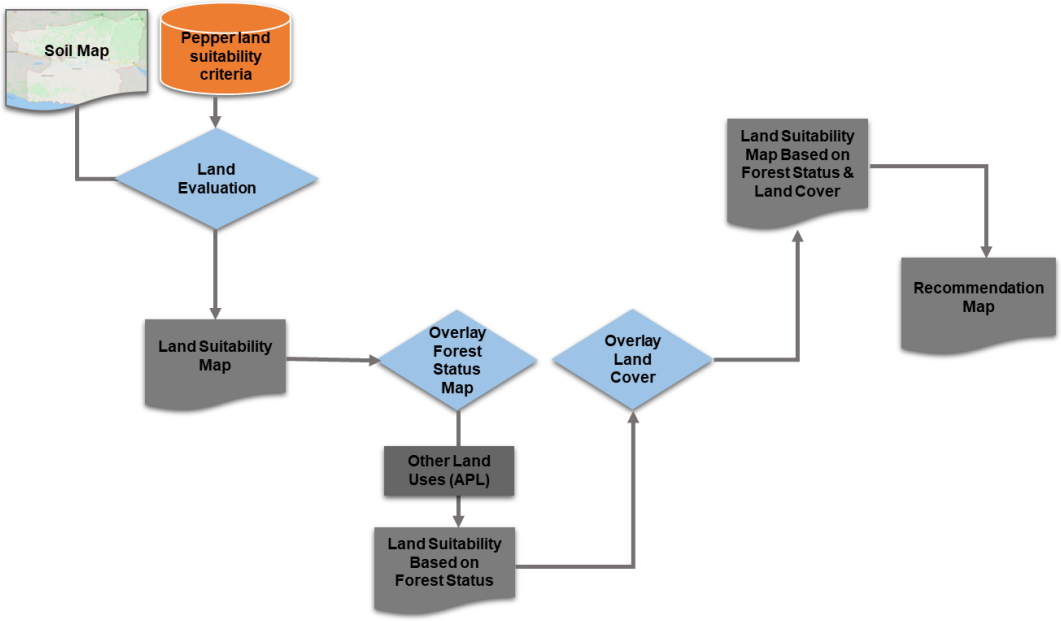

Figure 2 Method flowchart.

Table 1 Distribution of soil types in Tanggamus Regency, Lampung Province

Order	Soil Type National Soil Classification (Subardja *et al.* 2016)	Subgroup Soil Taxonomy (Soil Survey Staff 2022)	Area	
			Hectare (ha)s	Percentage (%)
Andisols	Andosol Haplik	Typic Hapludands	19,242	7.01
	Andosol Vitrik	Typic Udivitrands	1,052	0.38
Inceptisols	Gleisol Distrik	Typic Endoaquepts	18,167	6.62
		Typic Epiaquepts	5,964	2.17
	Gleisol Eutrik	Typic Endoaquepts	1,773	0.65
	Kambisol Distrik	Andic Dystrudepts	34,862	12.70
		Fluventic Dystrudepts	4,102	1.49
		Typic Dystrudepts	18,785	6.84
	Kambisol Distrik	Typic Dystrudepts	3,185	1.16
	Kambisol Eutrik	Typic Eutrudepts	2,719	0.99
	Kambisol Gleik	Aquic Dystrudepts	164	0.06
	Latosol Haplik	Typic Dystrudepts	22,678	8.26
Entisols	Aluvial Distrik	Typic Endoaquents	131	0.05
Alfisols	Mediteran Haplik	Typic Hapludalfs	3,171	1.16
Oxisols	Oksisol Haplik	Typic Hapludox	123,919	45.15
Ultisols	Podsolik Haplik	Typic Hapludults	3,373	1.23
	Podsolik Kandik	Typic Kanhapludults	4,227	1.54
	Regosol Eutrik	Typic Udipsamments	1,254	0.46
Others*			5,721	2.08
Total			274,491	100.00

Source: BBSDLP 2016.
Description: *others consist of escarpments, settlements, small islands, and water bodies.

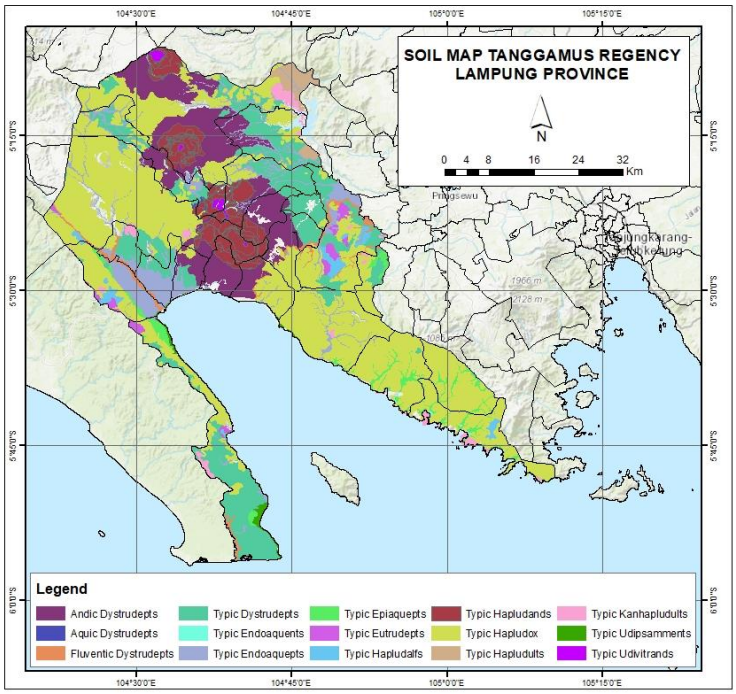

Figure 3 Soil map of Tanggamus Regency, Lampung Province. scale 1:50,000 (BBSDLP 2016).

or 16.00% of the regency area; rolling with an area of 40,131 ha, or 14.62% of the regency area; flat area of 32,774 ha, or 11.94% of the regency area; undulating with an area of 20,213 ha or 7.36% of the regency area; and nearly flat with an area of 10,245 ha, or 3.73% of the regency area (BBSDLP 2016). The distribution of relief in Tanggamus Regency can be seen in Table 2.

Flat relief is spread over the Alluvial, Marin, partially Tectonic, and partially Volcanic landform groups. In contrast, nearly flat and undulating reliefs are spread over the volcanic and partially tectonic landforms (BBSDLP 2016). These three reliefs generally have moderate potential for agriculture if the limiting factors for plant growth, such as low soil fertility and soil acidity, can be addressed appropriately.

Climatic Characteristics

Based on climate data, Tanggamus Regency has an annual average temperature ranging from 19.2 to

32.5°C, an average humidity of 85%, and an annual rainfall of 2,614 mm year^{-1}. The highest rainfall occurs in December, and the lowest is in August. The monthly rainfall distribution is presented in Figure 4.

Based on the data on climate characteristics, the regency is a suitable area for pepper cultivation. It is in line with the statement of Ritung *et al*. (2011) that pepper plants are very suitable for planting in areas with rainfall of 2,000 to 3,000 mm year^{-1}, humidity of 60 to 80% in the rainy season, with a maximum temperature of 32°C and a minimum temperature of 23°C. Rosman (2014) also stated that pepper cultivation is very suitable in areas with rainfall of 2,000 to 3000 mm year^{-1}. Water requirements for pepper growth can be fulfilled well during the rainy season. However, groundwater availability around the pepper roots will gradually decrease as the dry season progresses. Water availability can be addressed through conservation measures. It is done by increasing the storage capacity of groundwater through the enrichment of organic matter content and increasing water infiltration in the soil, especially towards the end of the rainy season (Pitono 2019).

Land Use in Tanggamus Regency

According to the land cover map data from the Ministry of Environment and Forestry (2018), land use in Tanggamus Regency is dominated by dryland agriculture (moorland and mixed gardens), which accounts for 78.69% of the regency area. Meanwhile, the most extensive non-agricultural land is forest, which accounts for 10% of the regency area. Pepper is a creeping perennial plant, so to grow normally, it requires living or dead stands (Yudiyanto 2013). In addition, pepper plants are tropical plants that can grow well in the altitude range from sea level to 1,500 masl (Sivaramaw *et al*. 1999). Therefore, from land use data in the regency, pepper plants can be planted and developed on agricultural land such as dry dryland, plantations, and non-agricultural land such as shrubs or uncultivated land. Based on data from BPS-Statistics of Tanggamus Regency (2023), the total area of pepper plantations in 2021 was 7,929 ha. It spread in almost all districts except Kota Agung and Kota Agung Barat. The complete data on land use distribution in the regency can be seen in Table 3.

Land Suitability for Pepper Plantation

The results of the land suitability assessment at the study site can be seen in Table 4 and Figure 5. The map of land suitability for pepper consists of moderately suitable (S2) with green color, marginally suitable (S3) with yellow color, and not-suitable (N) with pink color. The map is confirmed by Table 4; the largest area of suitable land for pepper is moderately suitable (S2), covering 76,073 ha; marginally suitable

Table 2 Relief/slope distribution lands in Tanggamus Regency, Lampung Province

Symbol	Relief	Slope (%)	Area	
			Hectare (ha)s	Percentage (%)
n	Flat	0–1	32,774	11.94
f	Nearly flat	1–3	10,245	3.73
u/B	Undulating/Gentle Sloping	3–8	20,213	7.36
r/C	Rolling/Sloping	8–15	40,131	14.62
c/D	Hillocky/Moderately steep	15–25	51,894	18.91
h/E	Hilly/Steep	25–40	44,372	16.00
m	Mountainous/very steep	>40	67,627	24.64
x	Settlement, islands, river, mining	-	7,235	2.64
Total			274,491	100.00

Source: BBSDLP 2016.

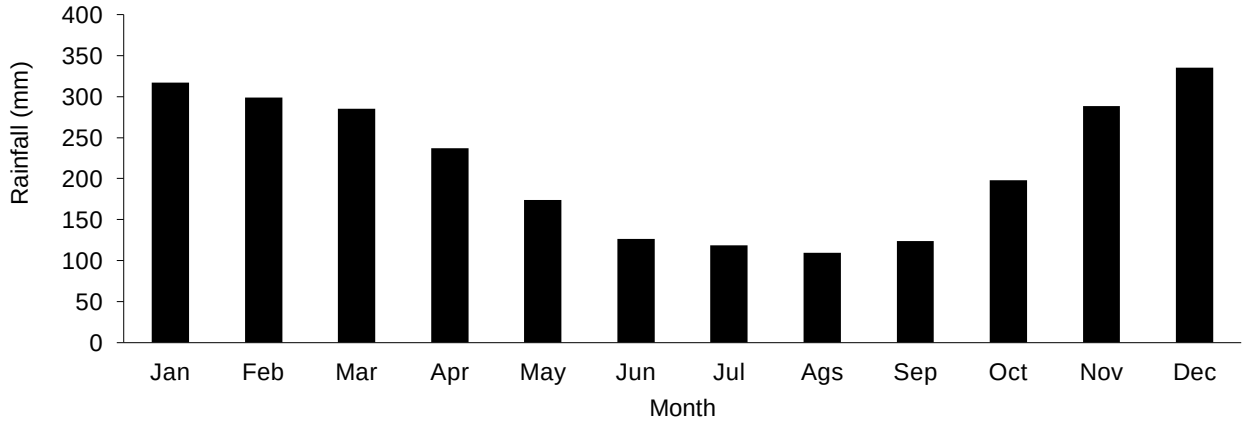

Figure 4 Distribution of monthly rainfall in Tanggamus Regency, Lampung Province.
Source: http://id.climate-data.org/continent/asia/.

Table 3 Existing land use in Tanggamus Regency, Lampung Province.

Land use	Area	
	Hectare (ha)s	Percentage (%)
Agricultural land		
Rice fields	14,800	5.39
Dryland farming	216,000	78.69
Plantation	462	0.17
Subtotal	231,262	84.25
Non-agricultural land		
Water bodies	584	0.21
shrubs	5,997	2.18
Forest	28,205	10.28
Settlement	7,954	2.90
Mining	28	0.01
Pond	351	0.13
Open Land	103	0.04
Other	5	0.00
Subtotal	43,228	15.75
Total	274,491	100.00

Source: KLHK-Ministry of Environment and Forestry 2018.

(S3), covering 79,313 ha; and not-suitable (N), covering 119,105 ha. Suitable land for pepper is found on almost all soil types, such as Typic Hapludalfs, Typic Hapludands, Typic Udivitrands, Typic Endoaquepts, Typic Epiaquepts, Typic Eutrudepts, Andic Dystrudepts, Aquic Dystrudepts, Fluventic Dystrudepts, Typic Dystrudepts, Typic Hapludox, Typic Hapludults, and Typic Kanhapludults. These soils are spread across all districts in Tanggamus Regency. The most suitable lands for pepper, consisting of S2 and S3, are in the Hutan, Pematang Sawa, Pugung, and Air Naningan districts. Meanwhile, the least suitable land is in Gunung Alip and Talang Padang District.

The limiting factors for land suitability of pepper plantations are drainage (oa), texture (rc1), soil pH (nr3), and erosion hazard/slope (eh1). Limiting factors in class S2 are mainly caused by soil pH (nr3), slope (eh1), and a combination of both factors. Other factors are drainage (oa) and texture (rc1), which are associated with pH (nr3) and slope (eh1) (see Table 5).

The limiting factor of soil pH (nr3) is most prevalent because the soils in the study site are dominated by acidic soils (pH 4.5 to 5.5). It is related to high rainfall, which causes cation leaching so that H+ ions dominate soil absorption. The primary soil type with this condition is Typic Dystrudepts. A slope (eh1) of 8-15% is the most dominant limiting factor for class S2 after soil pH (nr3). This slope condition can be found on the lower and middle slopes of the landforms of volcanic mountains. Pepper cultivation on sloping land is one of the problems in pepper farming in Lampung Province, which causes soil erosion (Karmawati *et a*l. 2020).

The limiting drainage factor (oa) is caused by the rather poor drainage conditions in the Aquic Dystrudepts soil type. This condition causes plant roots not to get optimal oxygen. Meanwhile, the soil texture (rc1) limiting factor in class S2 is rather coarse. The rather coarse texture is sandy loam on Typic Udivitrands soil. Kumar et al. (2021) explained that black pepper grows well on soils with heavy clay to light sandy clay texture with high contents of exchangeable bases, organic carbon, and micronutrients, especially zinc, to support pepper plant growth. Several land improvement efforts that can be done to overcome these limiting factors include planting according to contours, planting cover crops, applying lime and organic matter, and balanced fertilization. The land improvement efforts are expected to support the optimal growth of pepper plants.

Not-suitable land (N) for pepper is mainly caused by slope (eh1) (Table 5). Other factors are drainage (oa) and texture (rc1). As much as 40% (Table 2) of the study area is covered by tectonic and volcanic hills and mountains with slopes >25%. These conditions are not suitable for pepper plants. In the study area, these lands are found mainly in Kelumbayan District. Meanwhile, drainage and texture limiting factors are found on sandy coastal landforms in Typic Udipsamments. Not-suitable land (N) tends not to be recommended because it is impossible to make physical improvements, avoid land degradation, and preserve the environment. FAO (1976) stated that unsuitable land had limiting factors that might be overcome but required intolerable costs and unknown knowledge.

Potential Land for Pepper Plantation

Potential land for pepper plant development results from overlaying land use with forest area status and land suitability class for pepper plants. Based on this, the research results show that of the total land area of 155,386 ha, which is moderately suitable (S2) and marginally suitable (S3), the recommended land area for potential pepper plant development in Tanggamus

Table 4 Land suitability class for pepper based on districts in Tanggamus Regency

Subdistrict	S2	S3	N	Area (ha)
Air Naningan	5,188	4,952	2,768	12,909
Bandar Negeri Semuong	2,097	1,583	361	4,040
Bulok	1,008	1,719	1,619	4,346
Cukuh Balak	79	2,845	9,821	12,746
Gisting	2,750	560	1,968	5,278
Gunung Alip	2,353	20	120	2,492
Hutan	15,449	26,394	45,737	87,581
Kelumbayan		3,012	8,270	11,281
Kelumbayan Barat		1,070	8,503	9,573
Kota Agung	2,193	855	1,811	4,859
Kota Agung Barat	2,091	1,422	594	4,107
Kota Agung Timur	2,266	978	3,644	6,888
Limau	760	3,277	13,712	17,749
Pematang Sawa	13,862	4,984	4,014	22,860
Pugung	7,730	6,081	4,898	18,708
Pulau Panggung	5,330	4,813	1,018	11,161
Semaka	1,237	5,504	4,086	10,827
Sumberejo	3,551	1,193	677	5,421
Talang Padang	2,416	181	265	2,863
Ulubelu	4,254	4,970	4,643	13,867
Wonosobo	1,460	2,899	576	4,934
Total	76,073	79,313	119,105	274,491

Description: S2 = Moderately suitable, S3 = Marginally suitable, and N = Not suitable.

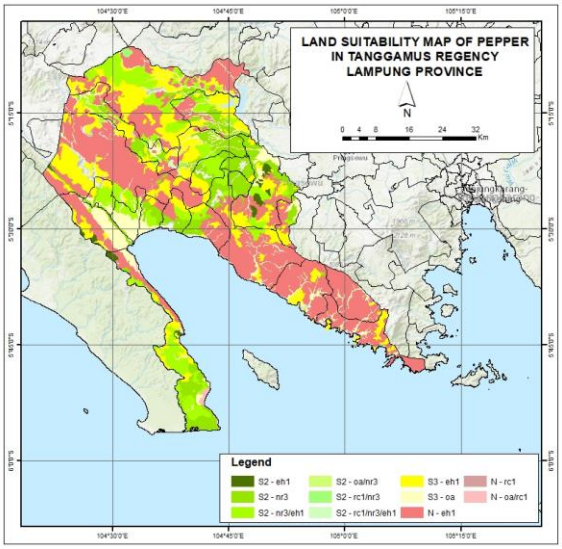

Figure 5 Land suitability map for pepper in Tanggamus Regency, Lampung Province.

Table 5 Class and limiting factors for pepper

Class	Class and limiting factors	Area (ha)
S2	S2 - eh1	2,719
	S2 - nr3	35,360
	S2 - nr3/eh1	37,027
	S2 - oa/nr3	164
	S2 - rc1/nr3	418
	S2 - rc1/nr3/eh1	385
S3	S3 - eh1	53,408
	S3 - oa	25,904
N	N - eh1	117,720
	N - oa/rc1	1,254
	N - rc1	131
Total		274,491

Description: oa = Drainage, rc1 = Texture, nr3 = Soil pH, and eh1 = Erosion hazard.

Regency is 73,995 ha, with a class S2 covering an area of 40.842 ha and class S3 area of 33.153 ha which is located in non-forest estate (area penggunaan lain; APL). Therefore, there are two criteria for developing pepper plants that can be applied, namely diversification on dry agricultural land, plantation, and mixed gardens with an area that can be developed of 72,841 ha, and extensification on scrub land with an area of 1,154 ha or 1.56% of the total recommended land. Detailed data and a map of the potential and availability of pepper plantations can be seen in Table 6 and Figure 6.

Agricultural diversification is a crop cultivation practice where different types of crops are grown on one farm to increase productivity and sustainability. One method of diversification is intercropping, where

Table 6 Recommendation land for pepper plant development based on the district in Tanggamus Regency, Lampung Province

District	APL		Area (ha)
	D	E	
Air Naningan	9,364		9,364
Bandar Negeri Semuong	2,697	116	2,814
Bulok	1,779		1,779
Cukuh Balak	2,056		2,056
Gisting	1,857	103	1,960
Gunung Alip	572		572
Hutan	6,958	26	6,984
Kelumbayan	1,565	101	1,666
Kelumbayan Barat	806		806
Kota Agung	1,680	11	1,691
Kota Agung Barat	2,351		2,351
Kota Agung Timur	1,436	15	1,451
Limau	1,608		1,608
Pematang Sawa	7,058	20	7,078
Pugung	8,826	117	8,943
Pulau Panggung	8,465		8,465
Semaka	1,459	32	1,490
Sumberejo	2,659	570	3,230
Talang Padang	1,471	0	1,471
Ulubelu	6,845		6,845
Wonosobo	1,329	42	1,371
Total	72,841	1,154	73,995

Description: APL = non-forest estate, D = Diversification, and E = Extensification.

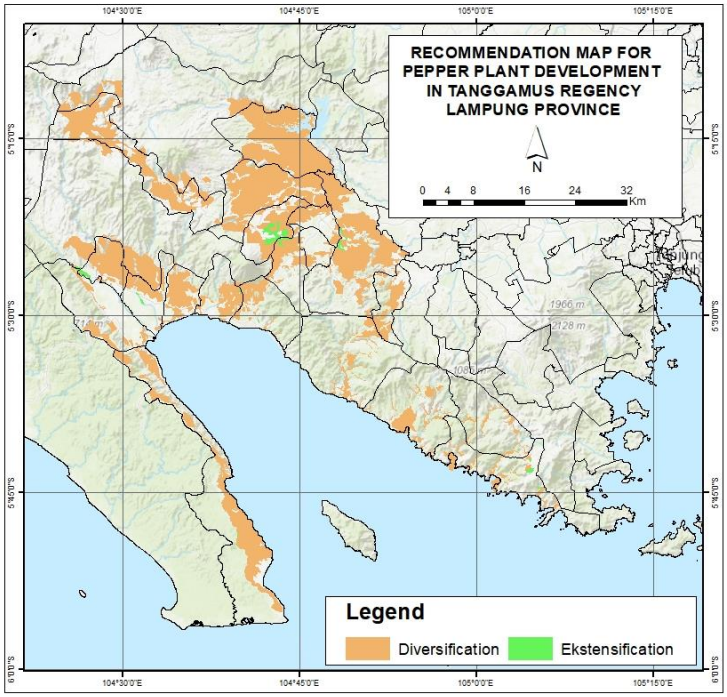

Figure 6 Map of potential and land availability for pepper plants in Tanggamus Regency.

different crops are grown together. For example, pepper is often intercropped with coffee plants, with the ratio of coffee to pepper plants around 4:1. In addition, land expansion for pepper plantations can be done by extending land by opening new land to plant pepper. However , it should be noted that most pepper plants, both in intercropping and extensification systems, require supporting plants such as Dadap trees (*Erythrina variegate*) or Gamal trees (*Gliricidia sepium*) as "living trees" to support pepper growth and production. There are various methods of pepper cultivation, and apart from intercropping, pepper plants can also be developed using the monoculture method. This diversification approach can potentially increase agricultural yields and land resilience to various environmental challenges and maintain the balance of agricultural ecosystems (Addharu 2021).

CONCLUSIONS

Based on the characteristics of soil and climate, Tanggamus Regency has the potential to develop pepper plants. Several suitable soil types with the potential for pepper cultivation are distributed across almost all regions in the regency. The land suitability for pepper plantations is classified as moderately suitable (S2), marginally suitable (S3), and unsuitable (N). Several limiting factors include texture (rc1), drainage (oa), soil pH (nr3), and erosion hazard/slope (eh1). The total area of land available for developing pepper plants is 155,385 ha. However, the potential land for pepper plants with non-forest estate (APL) status is 73,995 ha, with class S2 covering 40,842 ha and class S3 covering 33,153 ha. Land improvement efforts to overcome limiting factors include contour planting, cover cropping, lime and organic matter application, and balanced fertilization. There are two patterns of pepper plant development applicable in Tanggamus Regency, namely diversification with an area of 72,841 ha and extensification with an area of 1,154 ha.

ACKNOWLEDGEMENTS

The authors are very grateful to the Indonesian Center for Agricultural Land Resources Standardization (ICALRS), the Agency for Standardization of Agricultural Instruments, Ministry of Agriculture, for the data support provided.

REFERENCES

Addharu E, Barus B, Kinseng RA. 2021. March land suitability evaluation for pepper (*Piper nigrum* L.) in West Lampung Regency. *In IOP Conference Series: Earth and Environmental Science* (Vol. 694, No. 1, p. 012055) IOP Publishing. https://doi.org/10.1088/1755-1315/694/1/012055

Bachri S, Sulaeman Y, Ropik, Hidayat H, Mulyani A. 2015. Sistem Penilaian Kesesuaian Lahan version 2.01 (Software). Bogor: Indonesian Center for Agricultural Land Resources Research and Development.

BBSDLP-Indonesian Center for Agricultural Land Resources Research and Development. 2016. Atlas Peta Tanah Skala 1:50,000 Kabupaten Tanggamus, Provinsi Lampung (digital). Bogor (ID): Indonesian Center for Agricultural Land Resources Research and Development.

BIG - Geospatial Information Agency Indonesia. 2010. Indonesian earth map (digital). Jakarta: Geospatial Information Agency Indonesia.

BPS-Statistics Indonesia. 2017. Administrative boundary map (digital). Jakarta (ID): Statistic Indonesia.

BPS-Statistics Indonesia. 2020. Statistik Indonesia 2020. Jakarta (ID): Statistic Indonesia.

BPS-Statistics of Lampung Province. 2023. Provinsi Lampung Dalam Angka 2023. Bandar Lampung (ID): Statistic of Lampung Province.

BPS-Statistics of Tanggamus Regency. 2021. Kabupaten Tanggamus Dalam Angka 2021. Tanggamus (ID): Statistic of Tanggamus Regency.

Directorate General of Plantations. 2020. Statistik Perkebunan Indonesia Edisi: Lada. Jakarta (ID): Secretariat of the Directorate General of Plantations, Directorate General of Plantations, Ministry of Agriculture.

Directorate General of Plantations. 2023. Statistik Perkebunan Unggulan Nasional Tahun 2021–2023. Jakarta (ID): Secretariat of the Directorate General of Plantations, Directorate General of Plantations, Ministry of Agriculture.

FAO-Food and Agriculture Organization. 1976. *A Framework for Land Evaluation.* Rome: Food and Agriculture Organization of the United Nations, Via delle Terme di Caracalla.

Hardjowigeno S. 2003. *Ilmu Tanah*. Jakarta (ID): Akademi Presindo.

Herviyanti H, Anche C, Gusnidar G, Darfis I. 2012. Perbaikan sifat kimia Oxisol dengan pemberian bahan humat dan pupuk p untuk meningkatkan serapan hara dan produksi tanaman jagung (*Zea mays* L.). *Jurnal Solum.* 9(2): 51–60. https://doi.org/10.25077/js.9.2.51-60.2012

Hikmatullah H. 2010. Sifat-sifat tanah yang berkembang dari bahan volkan di Halmahera Barat, Maluku Utara. *Jurnal Ilmu-Ilmu Pertanian Indonesia.* 12(1): 40–48. https://doi.org/10.31186/jipi.12.1.40-48

Iqbal M, Zubair H, Rismaneswati R. 2018. Evaluasi kesesuaian lahan Kecamatan Tompobulu Kabupaten Bantaeng untuk pengembangan tanaman lada (*Piper nigrum* L). *Jurnal Ecosolum.* 7(1): 7–23. https://doi.org/10.20956/ecosolum.v7i1.5211

Lampung Provincial Communication, Information, and Statistics Service. 2022. “Pemprov Programkan Kebangkitan Rempah Lampung”. [internet]. Available on: https://lampungprov.go.id/detail-post/pemprov-programkan-kebangkitan-rempah-lampung. [Accessed on 7 July 2023].

Karmawati E, Ardana IK, Siswanto, Soetopo D. 2020. Factors affecting pepper production and quality in several production centers. *IOP Conf Series: Earth and Environmental Science.* 418(2020): 012051 IOP Publishing. https://doi.org/10.1088/1755-1315/418/1/012051

KLHK-Ministry of Environment and Forestry. 2018. Forest area status map (digital). Jakarta (ID): Ministry of Environment and Forestry.

KLHK-Ministry of Environment and Forestry. 2018. Land cover map of Indonesia (digital). Jakarta (ID): Ministry of Environment and Forestry.

Kumar BM, Sasikumar B, Kunhamu TK. 2021. Agroecological aspects of black pepper (*Piper nigrum* L.) cultivation in Kerala: a review *Agrivita Journal of Agricultural Science*. 43(3): 648–664. https://doi.org/10.17503/agrivita.v43i3.3005

Maryani AT, Hermawati T, Mulyati S. 2018. Pemberdayaan ekonomi kelompok tani Desa Nyogan Kabupaten Muaro Jambi melalui pemanfaatan lahan tidak produktif dengan penanaman tanaman lada perdu (*Piper nigrum*). *Wikrama Parahita: Jurnal Pengabdian Masyarakat*. 2(2): 89–95. https://doi.org/10.30656/jpmwp.v2i2.732

Pitono J. 2019. Pertanian presisi dalam budi daya lada. *Perspektif*. 18(2): 99−111.

Ritung S, Nugroho K, Mulyani A, Suryani E. 2011. *Petunjuk Teknis Evaluasi Lahan untuk Komoditas Pertanian Edisi Revisi 2011.* Bogor (ID): Balai Besar Penelitian dan Pengembangan Sumberdaya Lahan Pertanian.

Rosman R. 2014. Model simulasi kelayakan lahan pengembangan lada organik. *In: Prosiding Seminar Nasional Pertanian Organik.* 200(3): 77–82.

Saptiningsih E. 2015. Kandungan selulosa dan lignin berbagai sumber bahan organik setelah dekomposisi pada tanah Latosol. *Buletin Anatomi dan Fisiologi Dh Sellula*. 23(2): 34–42.

Sivaraman K, Kandiannan K, Peter KV, Thankamani CK. 1999. Agronomy of black pepper (*Piper nigrum* L. A review *J Spices and Aromatic Crops*. 8(1): 1–18.

Soil Survey Staff. 2022. *Keys to Soil Taxonomy*. 13th ed. Washington DC: United States Department of Agriculture, Natural Resources Conservation Services.

Subardja D, Ritung S, Anda M, Sukarman, Suryani E, Subandiono RE. 2016. *Petunjuk Teknis Klasifikasi Tanah Nasional Edisi Ke-2.* Bogor (ID): Balai Besar Penelitian dan Pengembangan Sumberdaya Lahan Pertanian.

Sudarsono H. 2019. Lada sebagai Komoditas Warisan Lampung: Pengantar. Dalam *Revitalisasi Lada Lampung sebagai Komoditas Warisan,* hal. 1–8. Bandar Lampung (ID): Aura Publishing.

Yudiyanto. 2013. *Tanaman Lada dalam Perspektif Autekologi*. Bandar Lampung (ID): Aura Publiser.

Zainudin Z, Noor RB, Triantoro A. 2020. Evaluasi Kesesuaian Lahan untuk Pengembangan Tanaman Lada (Piper nigrum L) di Kecamatan Loa Janan Kabupaten Kutai Kartanegara. *Jurnal Agroekoteknologi Tropika*. 3(1): 6–11.