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Land Suitability Evaluation on Pepper Plant in Bireuen Regency, Aceh Province

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ABSTRACT

Pepper plant development requires data and information on land potential and land suitability class assessment based on the physical and chemical properties criteria so that the land can be productive. The study aimed to determine the land suitability class for pepper plants in Bireuen Regency. The research was conducted in Bireuen Regency. The unit land map (*Satuan Peta Lahan, SPL*) resulting from the overlay of the slope map, land use map, and soil type map was used in this study. The method used is a survey method with a land unit approach consisting of four stages: (1) preparation stage, (2) preliminary survey, (3) main survey, and (4) presentation of results. The results showed that the land had good to poor drainage, soil depth >75 cm, flat to steep slopes, mild to very heavy erosion hazard, dusty clay texture, low to high cation exchange capacity (CEC), slightly acidic to slightly alkaline pH, low organic C, Base Saturation (BS) is low to high, N total is low to very low, P_2O_5 is very low, and K_2O is very low. Land suitability class for pepper plants in Bireuen Regency includes marginal suitability (S3) with limiting factors in the form of drainage, texture, CEC, BS, N-total, P_2O_5, K_2O, slope, and erosion hazard. Improvements include making rorak, planting contours, drainage systems, applying manure or compost, and planting cover crops.

Keywords: Land evaluation, land suitability, pepper, suitable marginal

INTRODUCTION

The land evaluation uses a proven method to assess land resources for a specific purpose. Information and instruction for land use following land needs will be available. Land suitability is the degree of suitability of a plot for a particular use. The land suitability can be rated for the current condition (actual land suitability) or after improvement (potential land suitability). Actual land suitability is based on soil biophysical properties data or land resources before being given the required inputs to resolve the land constraint. Land suitability potential describes the achieved land suitability if improvement efforts are made (Ritung *et al.* 2007).

Careful planning and appropriate decisions based on plant suitability are necessary to achieve optimal production. Plant development needs to consider the potential land suitability so that land use can produce maximum production. Likewise, the pepper commodity is needed data and information on potential land. Therefore, it is necessary to evaluate the land suitability class based on the soil's physical and chemical properties criteria to achieve productive land.

Indonesia is the second biggest pepper-producing country in the world. During six years (2015-2021) average production of Indonesia's pepper is 71,583 tons or 9.04% of Vietnam's pepper which is the first country in the world that contribute 27.39% of world pepper production (Direktorat Jenderal Perkebunan 2021). Prospects of pepper cultivation in the future will continue to be a significant concern. Many factors, including land quality, determine the success of pepper development. If the production of plant pepper is high, food enhancement in Indonesia will also increase so that the national income will improve (Yusra *et al*. 2020).

Aceh Province is one area that has enormous potential for pepper development. Besides Aceh Province having vast land of 258,067 ha, which is not yet used, pepper plants are also commonly cultivated by the community. The pepper planting area in Aceh Province has reached 1,239 ha, with production reaching 366 tons/year (Direktorat Jenderal Perkebunan 2021). Bireuen Regency is one of the districts in Aceh Province with potential plant pepper development. Subdistricts in Bireuen Regency as producer pepper are Peudada with an area of 6.50 ha, Kuta Blang with 3.50 ha, Juli with 3 ha, and Jeunieb with 1 ha; however, production in each sub-district is different (BPS 2020). Currently, pepper development in several districts in Bireuen Regency still has not yet noticed land characteristics and quality suitable for the plant. Therefore, the obtained pepper production is still low. They are considering the potential land in Bireuen Regency, which is very good for plant pepper development and for knowing input that must be given to increase pepper production.

The research aimed to study land suitability class on the plant pepper development in Bireuen Regency. Recently, the pepper development in Bireuen is still done simply without considering land aspects and other biophysical factors. Then, this research is vital to apply land suitability assessment techniques to overcome the obstacles so that Bireuen Regency becomes a region with the potential pepper development with high production.

MATERIALS AND METHODS

Research Site

This research was carried out in Bireuen Regency, Aceh Province, covering the Districts of Kuta Blang, Peudada, and Juli. Geographically, the research location is located in Bireuen Regency at coordinates 5° 49'00" N North Latitude (LU) and 96° 49'00" E East Longitude (BT).

Method

A survey method was used in this study using a land unit approach consisting of four stages that are (1) preparation stage, (2) preliminary survey, (3) main survey, (4) data analysis and presenting results.

The preparation stage consists of a literature study, collecting rainfall data from BMKG North Aceh and base maps in the form of soil type maps, slope maps, and land usage maps from BAPPEDA Aceh Province. The three base maps are overlaid into a functioning land map unit (*Satuan Peta Lahan, SPL*) that functions as a map of determination taking soil sample points. An overall total of as many as 26 *SPL*.

At the preliminary stage survey, activities included evaluating *SPL* boundaries, determining research location points, managing letter permission for study, and observing all the study places, making it easy to do research and take samples.

The main survey was an activity to observe/ measure biophysical data on a land map unit supported by data on climate and soil samples. Taking soil samples were carried out on 14 *SPL* from a total of 26 *SPL*, while the soil samples of 12 *SPL* were not taken because the land consists of water body (*SPL* 1, 9, and 19), swamps and ponds (*SPL* 7, 8 and 17), rice fields (*SPL* 6 and 14), secondary dry

Table 1. The land map unit (*Satuan Peta Lahan, SPL*) observed in the Bireuen Regency.

SPL	Land Usage	Soil Type	Slope	District / Village
				Kuta Blang :
3	Dry Land Agriculture Mixture	alluvial	0-3%	Paya Embrace
4	Dry Land Agriculture Mixture	Grumusol	8-15%	Blang Me
5	Dry Land Agriculture Mixture	Podsolik	0-3%	Parang Sikureng
				Peudada :
11	Dry Land Agriculture Mixture	alluvial	0-3%	Meunasah
12	Dry Land Agriculture Mixture	Grumusol	0-3%	Teungoh
13	Dry Land Agriculture Mixture	Mediterranean	0-3%	Blang Embrace
15	Bush Scrub	alluvial	0-3%	Hagu
16	Bush Scrub	Grumusol	8-15%	Mace
18	Open Land	alluvial	8-15%	Blang Beururu
				Neubok Naleng
				Juli :
22	Dry Land Agriculture Mixture	alluvial	0-3%	Ranto Panyang
23	Dry Land Agriculture Mixture	Grumusol	5-15%	Ranto Panyang
24	Dry Land Agriculture Mixture	Podsolik	0-3%	Paya Ru
25	Bush Scrub	alluvial	8-15%	Ranto Panyang
26	Open Land	Mediterranean	25-40%	Mane Meujingki

land forest (*SPL* 10 and 20), and settlements (*SPL* 2 and 21). The land map unit on the third District of Bireuen Regency is presented in Table 1.

Soil samples were randomly taken using a soil drill at a depth of 0-30 cm at five observation points (subsamples) and then composited to become one sample land for each *SPL*. Soil samples were put into plastic bags and given several labels or descriptions date, the place SPL, with whole total sample soil were 14 samples.

This soil drilling represented the main soil character in the study area. The soil samples were analyzed in the laboratory, and the soil properties were studied. The analysis consisted of soil texture, pH (H_2O), cation exchange capacity (CEC), organic C, base saturation (BS), total N, P_2O_5, and K_2O. The soil Analysis method is presented in Table 2.

Direct observation activities in the field were slope (measured by *the Abney level* tool), soil drainage (by seeing how much standing water is in each *SPL*), and soil color on the drill profile. Soil erosion (by looking at the percentage of the land lost) and paying attention to surface eroded soil compared to the non-eroded soil surface, characterized by the presence of horizon A.

Soil observation was done by drilling to a depth of 120 cm. Observation of surface rocks and outcrop rock were by measuring the area in every *SPL* which has rock surface and outcrop rock then data from results measurement were calculated by using formula:

$$\text{Surface rock (\%)} = \frac{\text{surface rock area}}{SPL\ \text{area}} \times 100\%$$

$$\text{Outcrop rock (\%)} = \frac{\text{outcrop rock area}}{SPL\ \text{area}} \times 100\%$$

Analysis Data and Results Presentation

Land evaluation suitability was carried out by the *matching* method between the results of land biophysical data analysis with land suitability criteria for pepper plants (Ritung *et al*. 2011) which was presented in the form of a suitability land map for pepper plants in the Subdistricts of Kuta Blang, Peudada, and Juli at Bireuen Regency, Aceh Province.

RESULTS AND DISCUSSION

Characteristics of Morphology and Physics Soil

Soil morphology and physics Characteristics observed in all *SPL*s in Bireuen Regency were soil drainage, effective depth, slope length, erosion danger level, surface rock, outcrop rock, and soil texture. Based on results identification, morphology, and physics soil obtained soil drainage with good until obstructed criteria, effective depth (>75cm), slope length of 1.3-25.5%, erosion danger level very light until weight, soil texture consisted of loam, clay, silty loam, silty clay loam, and silt. Identification results of soil morphology and physics characteristics are presented in Table 3, which is part of soil characteristic data on the land map unit in the Bireuen Regency. Evaluation criteria of soil morphology and physics characteristics based on Calculate *et al.* (2011).

Hampered drainage soils could influence land management for agriculture development, specifically plants that need good drainage (Sumarauw and Tanudjaja 2015). Based on Table 3, soil drainages belonging to good are in *SPL* 11, 12, 16, 18, 23, and 26, where the soil has no yellow, gray, or chocolate spots in soil surface layers. Rather hampered drainages found in *SPL* 3, and 5, have no yellow, gray, or chocolate spots in soil surface layers. Hampered drainages in *SPL* 4, 12, 13, 15, and 24 have gray spotting color on the soil.

Effective soil depth is the depth until how far the soil could overgrow roots, and save enough water and nutrients, generally restricted by the existence of gravel and materials parent or another hard layer, so it can not penetrate plants root (Hardjowigeno 2015). Deep soil depth was found in *SPL* 11 (105 cm). Shallow soil depths were found in *SPL* 15, 16, 23, and 26 ($\leq$ 75 cm).

Flat slopes class (0-8%) were found in *SPL* 3, 4, 5, 11, 12, 13, 15, 22, and 24, gentle slope class (8-15%) were found in *SPL* 16, and 18, and steeply slope class (15-25%) was found at *SPL* 26. Slope length, steepness, and shape influence significant erosion and soil surface flow (Hardjowigeno and Widiatmaka 2001).

Erosion hazard would affect the amount of runoff rate of soil surface runoff. The greater the

Table 2. Soil analysis method.

No	Soil Properties	Method
1	Soil texture	Pipetting
2	pH (H_2O)	PH meter
3	CEC	NH_4OA_c (pH 7.0)
4	Organic C	Walkey and Black
5	Base Saturation	NH_4OA_c (pH 7.0)
6	Total N	Kjeldahl
7	P_2O_5	Bray II
8	K_2O	Morgan

Source: Balai Penelitian Tanah [PPT] (2009)

Table 3. Land characteristics data in land map Units (*SPL*) in Bireuen Regency.

Land Characteristics	*SPL* 3	*SPL* 4	*SPL* 5	*SPL* 11	*SPL* 12	*SPL* 13	*SPL* 15	*SPL* 16	*SPL* 18	*SPL* 22	*SPL* 23	*SPL* 24	*SPL* 25	*SPL* 26
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Temperature (tc)														
mean temperature (°c)	26.8	26.8	26.8	26.8	26.8	26.8	26.8	26.8	26.8	26.8	26.8	26.8	26.8	26.8
Availability (wa)														
Rainfall (mm)	1532.1	1532.1	1532.1	1532.1	1532.1	1532.1	1532.1	1532.1	1532.1	1532.1	1532.1	1532.1	1532.1	1532.1
Air humidity (%)	82.5	82.5	82.5	82.5	82.5	82.5	82.5	82.5	82.5	82.5	82.5	82.5	82.5	82.5
Dry month length (month)	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3
Oxygen availability (o)														
Drainage	at	t	at	b	t	t	t	b	b	at	b	t	b	b
Rooting media (rc)														
Texture	s	h	s	s	s	s	s	s	i	s	s	s	s	s
Soil depth (cm)	82	85	80	105	90	95	75	75	76	78	75	80	82	75
retention (nr)														
Soil CEC (cmol)	18,80	14.80	13.20	42.00	39,20	27.60	28,40	16.00	8.40	11.20	13.60	15,20	11.60	17,20
Base Saturation (%)	86.60	44.39	35.68	66.10	76.73	59.60	27.75	70.38	37.96	28,48	31.84	67.96	27.39	17.03
pH (H_2O)	7.2	5.6	6.0	6.4	6.9	6.0	6.3	5.1	5.9	5.8	5.8	6.4	5.9	6.3
Organic C (%)	0.89	0.94	0.93	1.01	0.99	0.93	0.98	0.95	0.86	0.98	0.96	1.03	0.97	1.03
available nutrients (na)														
Total N (%)	0.16	0.08	0.12	0.17	0.20	0.17	0.14	0.14	0.06	0.11	0.13	0.30	0.22	0.19
P_2O_5 (mg 100 g^{-1})	0.08	0.01	0.02	0.05	0.03	0.02	0.01	0.02	0.10	0.04	0.02	0.01	0.01	0.05
K_2O (mg 100g^{-1})	0.04	0.03	0.04	0.08	0.07	0.06	0.08	0.04	0.04	0.01	0.02	0.02	0.01	0.07
Erosion hazard (uh)														
Slope (%)	1.3	2.3	1.3	1.3	2.3	1.3	1.3	8.8	11.1	3.3	14.4	2.3	8.8	25.5
Danger erosion	sr	sr	sr	sr	sr	sr	sr	r	r	sr	r	sr	r	sb
Land setup (lp)														
Assistance on the surface (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Outcrop rock (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Description: Drainage (b = good; at = somewhat obstructed; t = inhibited), Texture (h = smooth; s = moderate), Danger erosion (sr = very light; r = light; sb = very weight).

slope, the greater the amount and runoff velocity (Tarigan and Mardiatno 2013). Erosion hazard belonging to very light was in *SPL* 3, 4, 5, 11, 12, 13, 15, 22, and 24; light erosion in *SPL* 16 and 18; and heavy erosion in *SPL* 26.

The amount of surface and outcrop rock at all *SPL* was 0%. Surface and outcrop rock could influence the soil preparation process, such as plant roots, and reduce the soil's ability (Hardjowigeno 2015). The storage capacity of water in the soil to meet the needs of plants can be influenced by the condition of outcrops rock (Tufaila and Alam 2014).

Soil texture in the Bireuen Regency is dominated by loamy textures, which play an essential role in determining the soil water system, especially the infiltration rate, penetration, and ability of the soil binding water (BPPTP 2008). According to Manohara *et al*. (2007), a loamy texture is a texture that stores nutrients and sufficient water content for soil air circulation compared to a coarse texture. Loamy soil texture is in *SPL* 3 and *SPL* 22, clay in *SPL* 4 and *SPL* 12, silty loam at *SPL* 5, 12, 13, 15, 16, 23, 24, 25, loamy clay silt at *SPL* 11, loamy sand at *SPL* 16, and silty at *SPL* 26.

Soil Chemical Characteristics

Soil chemical properties observed in all *SPL*s in Bireuen Regency are CEC, pH, Organic C, BS, N total, P_2O_5 and K_2O. Analysis results of the soil chemical properties are presented in Table 3, which is part of the soil characteristics data on the land map unit in Bireuen Regency. The criteria for assessing soil chemical properties are based on Ritung *et al*. (2011).

Based on Table 3, the soil CEC in all *SPL*s is 8.40-42.00 me $100g^{-1}$ with low to very high criteria. The CEC is very high (42.00 me $100g^{-1}$) at *SPL* 11 while low (8.40 me $100g^{-1}$) at *SPL* 18. For other *SPL*s that have low criteria (*SPL* 4, 5, 16, 22, 23, 24, and 25), medium criteria (*SPL* 3 and 26), and high criteria (*SPL* 12, 13, and 15). The difference in value is due to several factors, including organic matter or high clay content, so it has a higher CEC than soil with low organic matter content or sand texture (Zainuddin and Kesumaningwati 2021). Soil rich in organic matter can bind and store nutrient elements (cations) or metal elements, such as Ca, Mg, and K. If the CEC increases, the soil will contain more nutrients and release them for plant growth (Munawar 2013).

Soil acidity (pH) in all *SPL* was between 5.1 - 7.2. The lowest pH was at *SPL* 16, while the highest was at SPL 3. *SPL* with criteria of acid (*SPL* 16), slightly acidic (*SPL* 4, 5, 11, 13, 15, 18, 22, 23, 24, 25 and 26), and neutral (*SPL* 3 and 12). Soil acidity that is too high or too low will interfere with the absorption of nutrients from the soil to plants. Low soil acidity (pH) is related to high rainfall intensity because it causes the bases to be washed out. The rainfall factor causes weathering of organic matter, producing organic acids that can cause soil acidity (Liyanda *et al.* 2012).

Soil organic carbon in all *SPL* was between 0.86% - 1.03%, with all criteria very low. Munawar (2013) stated that soil organic matter comes from the remains of dead plants, plants, and animals that affect the soil's high or low organic content. Base saturation in all *SPL* was between 17.03 - 86.60% with very low to very high criteria. The lowest base saturation was at *SPL* 26 (17.03 %), while the highest was at *SPL* 3 (86.60 %). For other *SPL*s that had low criteria (*SPL* 5, 15, 18, 22, 23, and 25), moderate criteria (*SPL* 4 and 13), and high criteria (*SPL* 11, 12, 16, and 24). Base saturation is closely related to soil pH; the higher the base saturation, the higher the soil pH (Utomo *et al.* 2016). Hardjowigeno (2015) stated that the value of soil base saturation is a percentage of the total CEC supported by basic cations, namely, Ca^{++}, Mg^{++}, K^{+}, and Na^{+}.

Total soil nitrogen in all *SPL* ranged from 0.06 - 0.30% with very low to moderate criteria. Total nitrogen was very low at *SPL* 18 (0.06 %), while moderate criteria were at *SPL* 24 (0.30 %). For other *SPL*s that had very low criteria (*SPL* 4), low criteria (*SPL* 3, 5, 11, 12, 13, 15, 16, 22, 23, and 26), and moderate criteria (*SPL* 25). According to Supangat (2013), the amount of N-total soil depends on environmental conditions such as climate and vegetation types. Vegetation that grows above the soil and its decomposition process is one of the factors causing changes in the total N content in the soil sooner or later.

The P_2O_5 content (25% HCl) in all *SPL*s ranged from 0.01-0.08 mg $100g^{-1}$ with very low criteria. *SPL* has a P2O5 value with very low criteria, which is influenced by soil pH, which tends to be neutral. Soil acidity is one of the causes of increased Al levels, which can bind P, resulting in the formation of insoluble aluminum phosphate compounds. This situation can lead to low P elements in the soil (Gusnidar et al., 2019).

The K_2O content (25% HCl) in all *SPL*s ranged from 0.01 to 0.08 mg $100g^{-1}$ with very low criteria. K_2O values of 0.01 mg $100g^{-1}$ were found in *SPL* 22 and *SPL* 25 with very low criteria, while K_2O values of 0.08 mg $100g^{-1}$ were found in *SPL* 11 and *SPL* 15 with very low criteria. The limiting factors of available nutrients, such as N, P, and K, can be increased by adding organic matter and lime to increase soil acidity. As for the limiting factor of nutrient retention, it can be increased by giving N, P, and K fertilizers to increase the availability of nutrients under the lack of nutrients in the soil (Addharu *et al*. 2021).

Land Suitability Class Assessment

The land suitability class for pepper plants in Bireuen Regency was determined by matching the land characteristics in each SPL with the land suitability criteria for pepper plants. The suitability class assessment for pepper plants in the land map unit in Bireuen Regency is presented in Table 4, while the land suitability class for pepper plants at the Bireuen Regency unit level is presented in Table 5. Land suitability maps for pepper plants in Kutablang, Peudada, and July Districts in Bireuen Regency are presented in Figures 1, 2, and 3.

Based on Table 4, the land suitability class assessment in all *SPL*s in Bireuen Regency is included in the S3 class (marginally appropriate) with each limiting factor. The limiting factors for *SPL* 4 (rainfall, drainage, N total, P_2O_5, and K_2O), *SPL* 3, 5, 11, 16, (rainfall, P_2O_5, and K_2O), *SPL* 15 (rainfall, drainage, BS, P_2O_5, and K_2O), *SPL* 12, 13, 24 (rainfall, drainage, P_2O_5, and K_2O), *SPL* 18 (rainfall, N total, P_2O_5, and K_2O), *SPL* 22, 23, 25 (rainfall, BS, P_2O_5, and K_2O), and *SPL* 26 (rainfall, BS, P_2O_5, K_2O, slope, and erosion hazard).

Improvement Effort for Land Suitability Class

Based on the limiting factors, efforts are needed to improve the land suitability class. The efforts are divided into two, namely (1) limiting factors that can be repaired economically and not detrimentally by incorporating appropriate technologies such as drainage, nutrient retention, nutrient availability, erosion hazard, and (2) limiting factors that are permanent or not economically repaired such as altitude, temperature, and humidity (Hardjowigeno and Widiatmaka 2001).

Table 4. Assessment of land suitability class for pepper plants on land map units (*SPL*) in Bireuen Regency.

Land Characteristics	*SPL* 3	*SPL* 4	*SP* *L* 5	*SPL* 11	*SPL* 12	*SPL* 13	*SPL* 15	*SPL* 16	*SPL* 18	*SPL* 22	*SPL* 23	*SPL* 24	*SPL* 25	*SPL* 26
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Temperature (tc)														
temperature mean (°c)	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1
Availability (wa)														
Rainfall (mm)	S3	S3	S3	S3	S3	S3	S3	S3	S3	S3	S3	S3	S3	S3
Air humidity (%)	S1	S1	S1	S	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1
Dry month length (month)	S2	S2	S2	S2	S2	S2	S2	S2	S2	S2	S2	S2	S2	S2
Oxygen availability (o)														
Drainage	S2	S3	S2	S1	S3	S3	S3	S1	S1	S2	S1	S3	S1	S1
Rooting media (rc)														
Texture	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1
Depth ground (cm)	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1
retention (nr)														
Soil CEC (cmol)	S1	S2	S2	S1	S1	S1	S1	S2	S2	S2	S2	S2	S2	S1
Saturation base (%)	S1	S2	S2	S1	S1	S1	S3	S1	S2	S3	S3	S1	S3	S3
pH (H_2O)	S2	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1
Organic C (%)	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1
available nutrients (na)														
Total N (%)	S2	S3	S2	S2	S2	S2	S2	S2	S3	S2	S2	S1	S1	S2
P_2O_5 (mg $100g^{-1}$)	S3	S3	S3	S3	S3	S3	S3	S3	S3	S3	S3	S3	S3	S3
K_2O (mg $100g^{-1}$)	S3	S3	S3	S3	S3	S3	S3	S3	S3	S3	S3	S3	S3	S3
Erosion hazard (uh)														
Slope (%)	S1	S1	S1	S1	S1	S1	S1	S2	S2	S1	S2	S1	S2	S3
Danger erosion	S1	S1	S1	S1	S1	S1	S1	S2	S2	S1	S2	S1	S2	S3
Land setup (lp)														
Assistance on the surface (%)	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1
Outcrop rock (%)	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1	S1

Description: S1 = Very appropriate; S2 = Enough appropriate; S3 = Marginal Appropriate

Table 5. Level Conformity Land Class Unit for Pepper Plants in Bireuen Regency.

SPL	Conformity Land Class Unit	Barrier Factor	Repair Effort
(1)	(2)	(3)	(4)
3	S3wa-1; na-2,3	Precipitation, P_2O_5, K_2O	P and K fertilization
4	S3wa-1; oa-1; na-2,3	Rainfall, Drainage, N total, P_2O_5, K_2O	ditch drainage, P and K fertilization
5	S3wa-1; na-2,3	Precipitation, P_2O_5, K_2O	P, and K fertilization
11	S3wa-1; na-2,3	Precipitation, P_2O_5, K_2O	P, and K fertilization
12	S3wa-1; oa-1; na-,2,3	Rainfall, Drainage, P_2O_5, K_2O	ditch drainage, P and K fertilization
13	S3wa-1; oa-1; na-,2,3	Rainfall, Drainage, P_2O_5, K_2O	ditch drainage, P and K fertilization
15	S3wa-1; oa-1; na-2,3	Rainfall, Drainage, BS, P_2O_5, K_2O	ditch drainage, materials organic, P and K fertilization
16	S3wa-1; na-,2,3	Precipitation, P_2O_5, K_2O	P and K fertilization
18	S3wa-1; na-1,2,3	Precipitation, N total, P_2O_5, K_2O	P and K fertilization
22	S3wa-1; nr-2; na-2,3	Rainfall, BS, P_2O_5, K_2O	organic materials, P and K fertilization
23	S3wa-1; nr-2; na-2,3	Rainfall, BS, P_2O_5, K_2O	organic materials, P and K fertilization
24	S3wa-1; oa-1; na-,2,3	Rainfall, Drainage, P_2O_5, K_2O	ditch drainage, P and K fertilization
25	S3wa-1; na-2,3	Rainfall, BS, P_2O_5, K_2O	organic materials, P and K fertilization
26	S3wa-1; na-2,3; uh-1,2	Rainfall, BS, P_2O_5, K_2O, Slope, Erosion hazard	organic materials, rorak, P and K fertilization

Description: S3 = Appropriate Marginal. na-1 = N total, na-2 = P_2O_5, na-3 = K_2O, eh-1= Slope , eh-2= Erosion Hazard, oa-1= Drainage, wa-1= Bulk Rain

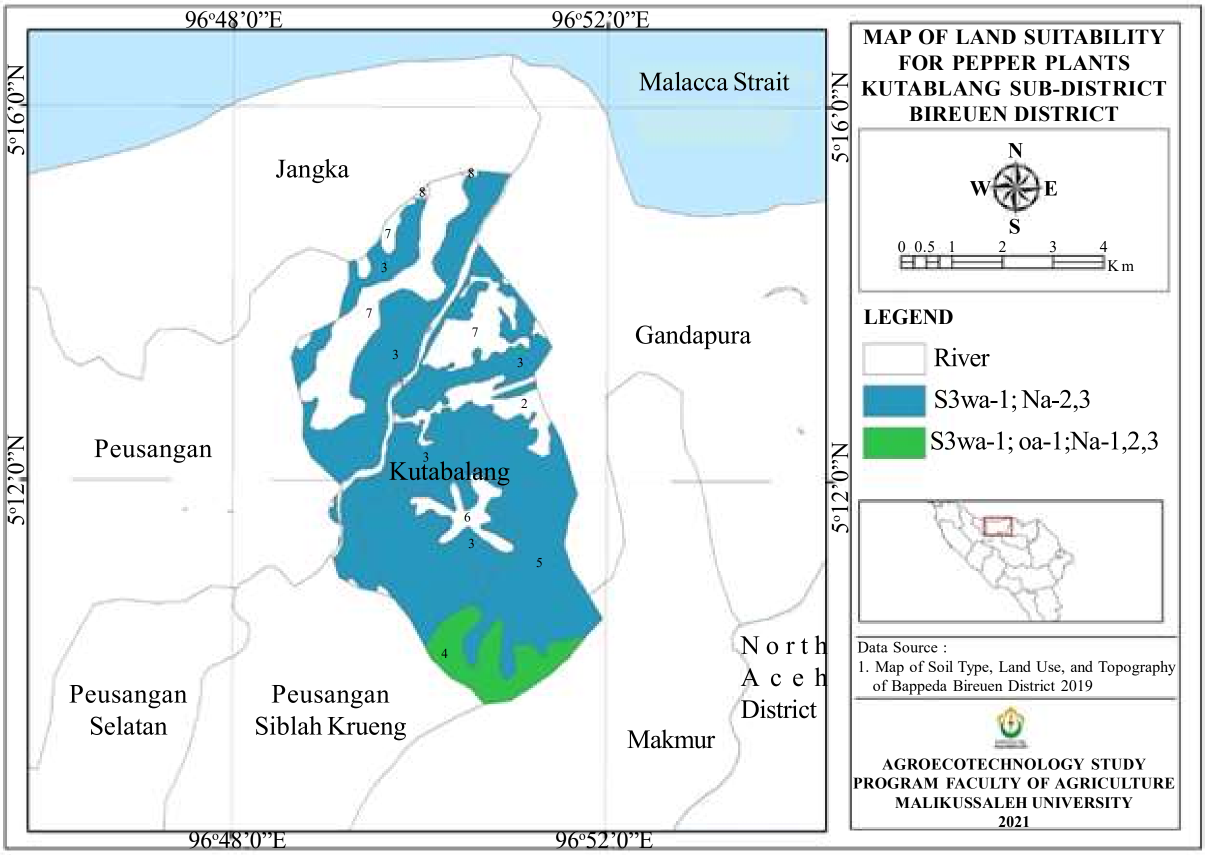

Figure 1. Land suitability map for pepper plants in Kuta Blang District.

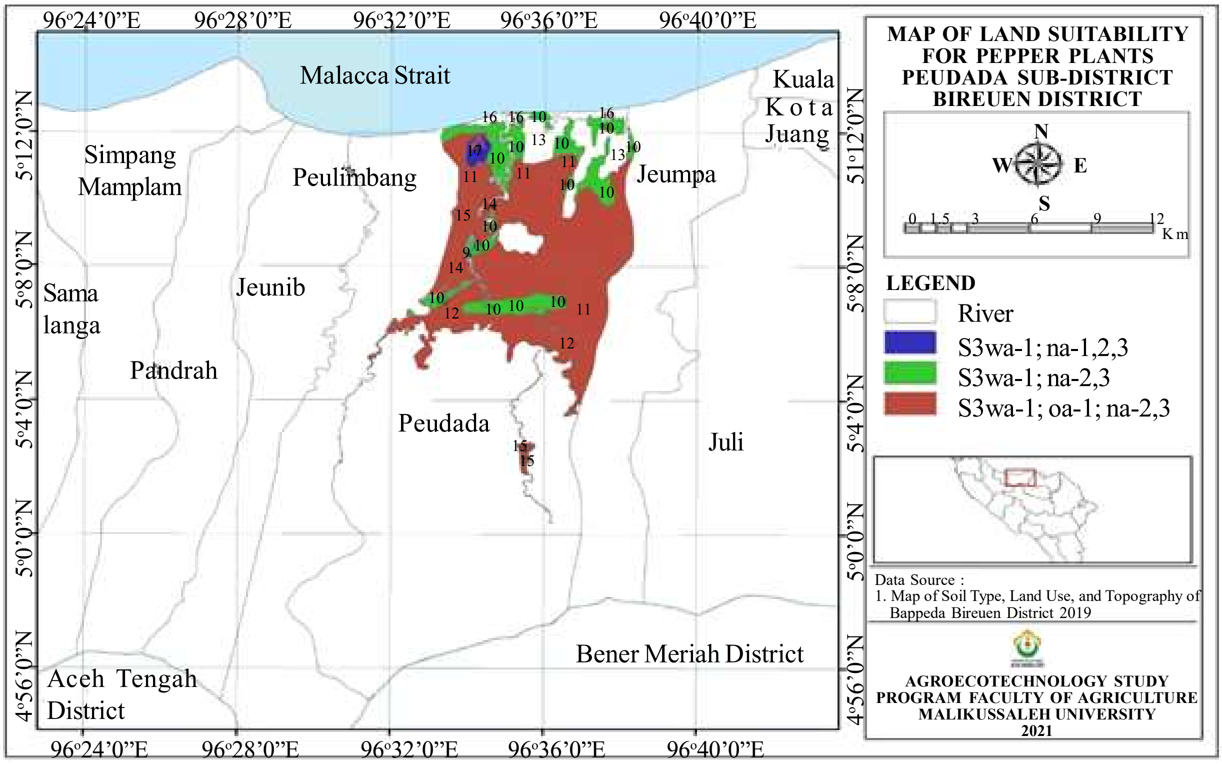

Figure 2. Land Suitability Map for Pepper Plants in Kuta Peudada District.

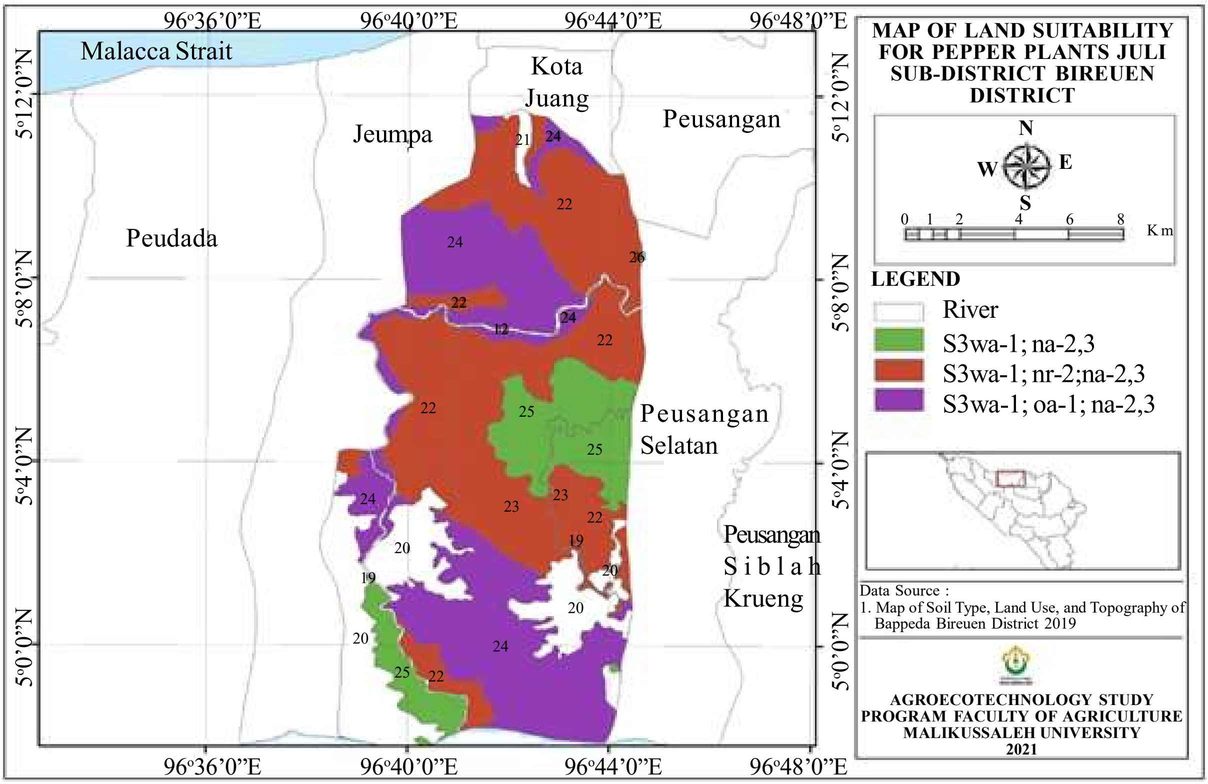

Figure 3. Land Suitability Map for Pepper Plants in Juli District.

Efforts must be made to improve drainage by improving the drainage system or making drainage channels. An easy improvement method is to use a surface drainage system, mounds, and open channels (Suhairin *et al.* 2015). Based on Table 5, the limiting factors for drainage are found in *SPL* 4, 12, 13, 15, and 24.

Slope limiting factors and erosion hazards were found in *SPL* 26 with a slightly steep slope category. Efforts that need to be made to improve slopes and erosion hazards are mechanical conservation which is recommended by making rorak. The rorak system is a conservation technique that functions as a sediment trap and accommodates topsoil washed away by surface runoff. According to Raharjo (2020), the mechanical conservation technique (rorak) is a method of harvesting water that is classified as effective, especially on a rather steep land (10-25%). Making rorak reduces surface runoff and erosion. Making rorak is recommended because this conservation technique is cheap and easy to do, so it is efficient to be recommended (Pratiwi and Andi 2013)

Improvements were made to increase nutrient retention by applying organic matter such as manure application. According to Rina *et al.* (2015), applying organic matter such as manure can increase pH and base saturation because soil pH plays a role in increasing base saturation. The limiting factor for base saturation was *SPL* 15, 22, 23, 25, and 26.

The limiting factor of N total was found in *SPL* 4 and 18. Improvement efforts must be made in the provision of organic matter that can increase soil pH while increasing the availability of nitrogen for the needs of soil microorganisms which will accelerate the decomposition and mineralization of organic matter, so that nutrient requirements in the soil are quickly available.

The limiting factors for P_2O_5 and K_2O were *SPL*s 3, 4, 5, 11, 12, 13, 15, 16, 18, 22, 23, 24, 25 and 26 (all observed *SPL*s). Improvement efforts can be made by providing fertilizers containing P, both organic and inorganic. P fertilization in plants is a common method in agricultural cultivation and can increase soil P availability (Susila 2013). Efforts are being made to improve K_2O in the soil, namely by giving inorganic fertilizers such as N, P, and K because pepper is a plant that requires large enough nutrients to improve soil conditions. According to Kadir and Darmawidah (2005), the combination of inorganic fertilization will cause the pepper plant growth index to be higher than single fertilization or without fertilization.

CONCLUSIONS

Land suitability class for pepper plants in Bireuen Regency includes marginal suitability (S3) in all *SPL*, with limiting factors, are rainfall, drainage, BS, N total, P_2O_5, K_2O, slope, and erosion hazard. While the improvement for BS, N total, P_2O_5, and K_2O, is by adding organic matter and inorganic fertilizer. Efforts must be made to overcome the limiting factors of rainfall, drainage, slopes, and erosion by applying soil and water conservation techniques.

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