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Assessment of Land Suitability for Enhancing Key Crop Commodities: Pineapple, Coffee, and Mango

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ABSTRACT

This study aims to evaluate land suitability for enhancing the production of key crop commodities in Ngancar District, Kediri Regency, particularly pineapple, coffee, and mango. The district has high soil fertility potential due to its location at the foot of Mount Kelud. The research methods include land surveys, soil sampling at depths of 0-30 cm and 30-60 cm, and laboratory analysis to measure soil physical and chemical properties. Results indicate that the land in the study area generally falls into the marginal suitability class (S3), with the main limiting factors being soil texture dominated by sandy loam, low K_2O levels, and high rainfall that affects pineapple growth. Slope gradient is also a limiting factor for coffee and mango cultivation. Adjustments in soil management, such as timely fertilization and planting crops with strong root systems, can improve the land's suitability potential. In conclusion, although the land in Ngancar District has certain limitations, optimizing land use can enhance the productivity of key commodities, particularly through improved soil management and appropriate fertilizer use.

1. INTRODUCTION

Land resources are components derived from natural resources and play a crucial role in the production process within the agricultural sector. However, the emergence of intensive agriculture paradigms has led most farmers to abandon learning within natural environments, instead relying more on external inputs as solutions to agricultural issues. In fact, soil is an essential component of an ecosystem (Pereira *et al*., 2018), and plays a critical role in plant growth, carbon sequestration (Briones, 2014), water filtration (Bünemann *et al*., 2018), biodiversity conservation (Jónsson & Davídsdóttir, 2016), and nutrient cycling (Rabot *et al*., 2018).

Increased pressure on land resources can accelerate land degradation, leading to negative impacts on various ecosystems, one of which is a decline in local food production (Hossain *et al*., 2020). The concept of agricultural development on an intensive scale concerning natural resource use has significant impacts on cropping systems, often with minimal consideration of ecological or environmental aspects (Yang *et al*., 2020), Poor land-use management (Waqas *et al*., 2020), and imbalanced nutrient management are recurrent factors that exacerbate soil health degradation in various regions globally (Tan *et al*., 2005).

Land can be optimally utilized and sustainably developed if managed with improvements that align activities with certain limiting factors present in each land suitability evaluation class for each crop. The land suitability evaluation results provide data on the classification of land suitability for specific crops in a given area (Feronica & Setiawan, 2023). The principle and objective of agricultural land suitability assessment are to identify both the potential and the limiting factors in crop production. Criteria for evaluating agricultural land suitability involve assessing land performance when used for specific agricultural types (Hartati *et al*., 2018).

Land suitability assessments are conducted by comparing land characteristics with the requirements of land use. The results of these assessments can serve as the basis for designing programs and planning agricultural commodity development (Hardwick, 2019). The development of pineapple as a commodity has been ongoing since 1999. Based on observations and interviews with local farmers, pineapple is the most renowned fruit commodity in Ngancar Subdistrict. This is due to the economic potential of pineapple for the community in Ngancar, where 50% of the population cultivates pineapple. Pineapple has become an icon of the area, with a pineapple monument located close to the subdistrict office. This has made pineapple one of the main flagship commodities, central to the economic and tourism sectors in Ngancar. Consequently, the community chooses pineapple as the most widely cultivated crop because it has become a leading commodity in terms of yield, economy, and post-harvest utilization. Kediri Regency is the largest pineapple producer in East Java. The fruit farming sector in Kediri Regency has considerable economic potential. One step to increase pineapple production is through expanded harvest areas and intensive land management by farmers to boost pineapple yield. According to Shabrina *et al*. (2021), pineapple production in Ngancar is the highest in East Java Province.

In addition to pineapple, coffee is the second leading commodity, providing a source of livelihood for the local community. The mountainous terrain of the area allows coffee to thrive (Sopandi & Herwanto, 2020). Moreover, active mountainous regions are often rich in essential minerals and nutrients, offering abundant resources to support coffee plant growth. Minerals such as nitrogen, phosphorus, potassium, and magnesium in mountain soils are essential nutrients for healthy plant growth. Additionally, active mountains typically experience high rainfall, influenced by factors such as altitude, proximity to water sources, mountain ranges, and the surrounding land and water area (Wihatma Andianti *et al*., 2023). Thus, from a land-use perspective, the utilization and production of coffee are well-suited to the existing geographical conditions. Coffee is also a major economic source for farmers throughout the region. High daily coffee consumption levels enable coffee production to get a high market value that improve profit for farmers.

Aside from pineapple and coffee, Ngancar Subdistrict also produces other fruit commodities, such as mango. The mango plant itself originates from India and has numerous varieties; there are currently 2,000 types of mangoes worldwide (Asfiani *et al*., 2019). However, its production volume does not match that of coffee and pineapple. Only pineapple has become an icon of the area. Nonetheless, mango in this region also has significant production potential, similar to pineapple. Mango is another commodity with high economic value due to its popularity and high market price. It also has a high export potential, allowing farmers to gain profits beyond just local sales. From a maintenance perspective, mango is relatively easy to care for, as it is rarely affected by pests and diseases, and even when attacked, the impact on the fruit is minimal. Therefore, mango is easy to cultivate due to low maintenance requirements, yet it yields high returns (Tambunan *et al*., 2024).

The purpose of assessing land suitability status is to predict the land's potential concerning its limitations in land use, aiming to preserve the ecological value in areas or regions susceptible to natural degradation (Budianto *et al*., 2021). The principle of this research is to determine whether the three crops—pineapple, coffee, and mango—are suitable for the area and can provide sustainable benefits both financially and in terms of agricultural sustainability. Given that the soil in the region is rich in nutrients beneficial for plant growth (Maroeto *et al*., 2024), it is possible to maximize the potential of the surrounding land and increase the diversity of flagship products produced. This way, farmers can achieve greater financial stability and independence, as they produce more diverse products, thus not relying solely on a single commodity in the event of crop failure.

2. MATERIALS AND METHODS

2.1. Research Area

Ngancar Subdistrict in Kediri Regency is the area closest to Mount Kelud Tourism. This subdistrict consists of ten villages, namely Bedali, Kunjang, Pandantoyo, Jagul, Babadan, Ngancar, Manggis, Margourip, Sempu, and Sugihwaras. With an area of 94.06 km², Ngancar Subdistrict is one of the subdistricts in Kediri Regency, where most of the land is used for plantations, fields, and mixed forests. Besides being known for Mount Kelud tourism, Ngancar Subdistrict is also recognized for its fruit ecotourism.

2.2. Tools and Materials

The tools required for this research include those used for sample collection, such as hoe, crowbars, hammer, rings, GPS, clinometer, plots, cutters, trowels, camera, and buckets. Laboratory analysis tools included digital scale, spectrophotometer, burette, back-and-forth shaker, film bottles, volumetric pipettes, measuring pipettes, centrifuge, digestion tubes, fume cupboards, Erlenmeyer flasks, beakers, test tubes, measuring glass, oven, and crucibles.

The materials used for field sample collection include rubber, gauze, and plastic. For laboratory analysis, the materials used include filter paper, distilled water, 1 N KCl, H_2SO_4, $K_2Cr_2O_7$, tartrate buffer, Na-Phenol, 5% NaOCl, liquid paraffin, alcohol, NaCl, quartz sand, K-jeldahl powder, $NaHCO_3$, phosphate dye, Bray/Olsen extractant, 2 N HCl, 10% H_2O_2, 30% H_2O_2, and 4% $Na_4P_2O_7$.

2.3. Research Stages

2.3.1. Determination of Sampling Points

Sampling points were determined using a purposive sampling method, which emphasizes selecting locations based on data needs and land suitability for sampling purposes (Jiwa Jeni *et al*., 2023). This was based on a map created using the Ngancar Subdistrict Shapefile. The map analysis indicated two dominant land uses: fields and gardens. Samples were collected from these two land uses, which are the most prevalent in the area. Sampling codes were assigned for each type, with gardens labeled as KB and fields as LD. The garden samples were categorized as follows: KB-A for critical land, KB-B for potentially critical land, KB-C for non-critical land, KB-D for moderately critical land, and KB-E for highly critical land. Similarly, field samples were categorized with LD-A for critical land, LD-B for potentially critical land, LD-C for non-critical land, LD-D for moderately critical land, and LD-E for highly critical land.

2.3.2. Land Survey

The land survey stage aimed to determine the sites for sampling and to verify that the sampling points match the map-based information. If the area aligns with the map's classification, markers or coordinates can be recorded to facilitate easy location of sampling sites during sample collection (Maroeto *et al*., 2021).

2.3.3. Soil Sample Collection

Soil samples were collected at two depths: 0 – 30 cm and 30 – 60 cm. Five replicates were collected for each type of land use. This resulted in a total of 30 composite soil samples analyzed in the laboratory. The sample points were taken from the two most commonly used land units by the community, which included plantations and dryland farms.

2.4. Analysis Method

The analysis method used for evaluating land suitability involves physical, chemical, and field observation analyses. The chemical analysis includes parameters such as pH measured using the Conductometry method, Total-N using the Kjeldahl method, Available-P using the Bray II method, Cation Exchange Capacity (CEC) using the Ammonium Acetate method, Organic Carbon using the Walkey and Black method, Base Saturation (BS) using the Ammonium Acetate method, and Available-K using the Flame Photometry method. For soil physical analysis, parameters include Bulk Density (BD) measured using the Volumetric calculation method, Texture using the Pipette method, Specific Gravity (SG) using the Pycnometer calculation method, Porosity using Bulk Density & Specific Gravity calculations, and Permeability using the Permeability calculation method. Slope and elevation data were collected during soil sampling. Temperature and rainfall data were obtained from BMKG. This analysis follows the guidelines of Djaenudin *et al*. (2011), to determine the appropriate land suitability class for each commodity.

The soil testing analysis was conducted in the Land Resource Laboratory of the Faculty of Agriculture at UPN "Veteran" East Java. Parameters evaluated in the land suitability analysis included soil texture, cation exchange capacity (CEC), pH (H_2O), organic carbon, total nitrogen, P_2O_5, and available potassium (Kdd). Field observation data, including slope gradient, elevation, and slope length, were collected during sampling. Rainfall data was obtained from the BMKG website and later averaged for analysis (Luntungan *et al*., 2019).

Table 1. Land suitability class assessment parameters for pineapple, coffee, and manggo

Parameter	Commodity	Land Suitability Class			
		S1	S2	S3	N
Temperature (tc)	Pineapple	17–20	15 – 17 20 - 30	10 – 15 30 - 35	< 10 > 35
	Coffee	25 - 28	20 – 25 28 - 32	32 - 35	< 20 > 35
	Manggo	18 - 26	15 – 18 26 - 30	10 – 15 > 30	< 10
Water Availability (wa)					
Rainfall (mm)	Pineapple	1,000 - 2,000	500 - 1,000 2,000 - 3,000	250 - 500 3,000 - 4,000	< 250 > 4,000
	Coffee	1,500 - 2,500	2,500 - 3,000	1,250 - 1,500 3,000 - 4,000	1,250 - 1,500 3,000 - 4,000
	Manggo	1,200 - 2,000	1,000 - 1,200 > 2,000	750 - 1,000	< 750
Root Medium (rc)	Pineapple	Fine, Slightly Coarse, Moderate	--	Moderately Coarse	Coarse
	Coffee	Fine, Slightly Coarse, Moderate	--	Inhibited, Slightly Fast	Coarse, Highly Inhibited, Fast
	Manggo	Fine, Slightly Coarse, Moderate	--	Very Fine, Moderately Coarse	Coarse
Soil Depth	Pineapple	< 60	60 - 140	140-200	> 200
	Coffee	> 100	75-100	50-75	< 50
	Manggo	< 60	60 – 140	140 - 200	> 200
Nutrient Retention (nr)					
CEC	Pineapple	> 16	≤ 16	--	--
	Coffee	> 16	≤ 16	--	--
	Manggo	> 16	≤ 16	--	--
pH	Pineapple	5.5 - 7.3	5.0 - 5.5 7.3 - 8.0	< 5.0 > 8.0	--
	Coffee	6.0 - 7.0	5.5 - 6.0 7.0 - 7.6	< 5.5 > 7.6	--
	Manggo	5.0 - 6.5	4.6 - 5.0 6.5 - 7.5	< 4.6 > 7.5	--
C-Organic	Pineapple	> 1.2	0.8 - 1.2	< 0.8	--
	Coffee	> 1.2	0.8 - 1.2	< 0.8	--
	Manggo	> 1.2	0.8 - 1.2	< 0.8	--
Available Nutrients (na)					
N-Total (%)	Pineapple	> 0.21	0.15–0.21	0.1–0.15	< 0.10
	Coffee	> 0.21	0.16–0.21	0.10–0.15	< 0.10
	Manggo	> 0.21	0.11 – 0.2	0.05 – 0.1	< 0.05
P_2O_5 (mg/kg)	Pineapple	>20	10–20	5–10	< 5
	Coffee	> 20	15–20	10–15	<10
	Manggo	> 20	10–20	5–10	> 5
K_2O (cmol/kg)	Pineapple	> 0.4	0.3–0.4	0.2–0.3	< 0.2
	Coffee	> 0.6	0.3 – 0.6	0.1 – 0.3	< 0.1
	Manggo	> 0.5	0.3–0.5	0.1–0.3	< 0.1
Slope (%)	Pineapple	< 8	8 - 15	15-30	> 30
	Coffee	< 8	8 - 15	15-30	> 30
	Manggo	< 8	8 - 15	15-30	> 30

Source: (Djaenudin *et al*., 2011)

2.5. Land Suitability Determination

The land suitability assessment was conducted for three main crops in Ngancar Subdistrict, Kediri Regency: pineapple, coffee, and mango. These crops were selected based on their economic importance in the region, with pineapple being the primary commodity. The suitability class for each crop was determined using FAO (Food and Agriculture Organization) standards (Romadhoni *et al*., 2022). The assessment employed a data-matching method, aligning the land suitability class with soil analysis data obtained from sampling in the study area. The final data implies limiting factors for each suitability class, which were then evaluated to determine the appropriateness for crop cultivation. Table 1 summarized land suitability parameters for the three selected fruits (pineapple, coffee, and mango).

3. RESULTS AND DISCUSSION

3.1. Climatological Data

The total rainfall over the past 5 years, from 2020 to 2024, shows an average annual rainfall of 2824.82 mm. Based on the Schmidt and Ferguson classification (Romadhoni *et al*., 2022) the Ngancar District, Kediri Regency, falls under climate type C, with land use classification that tends towards moderate vegetation cover, resulting in a slightly wet environment with relatively high humidity due to significant rainfall (Hidayat *et al*., 2023). Additionally, the high rainfall impacts the availability of water resources in the area, supporting agricultural activities and maintaining ecosystem balance. However, extreme rainfall patterns also pose risks of natural disasters, such as floods, which local communities must be vigilant about. Therefore, effective water resource management is needed to maximize the benefits of rainfall and minimize potential negative impacts (Hayu *et al*., 2024).

The temperature in Ngancar District, Kediri Regency, tends to be warm, as supported by Soraya *et al*., (2020), which explains that the Heat Index at temperatures of 23 - 26°C tends to be warm. Another factor influencing this is wind speed. Wind speed is a factor that affects the HI value; ideally, the higher the wind speed, the lower the HI value, and vice versa. Based on field observations, wind speeds in Ngancar District, Kediri Regency, tend to be moderately high due to its highland location and proximity to Mount Kelud, which contributes to the increased wind speed.

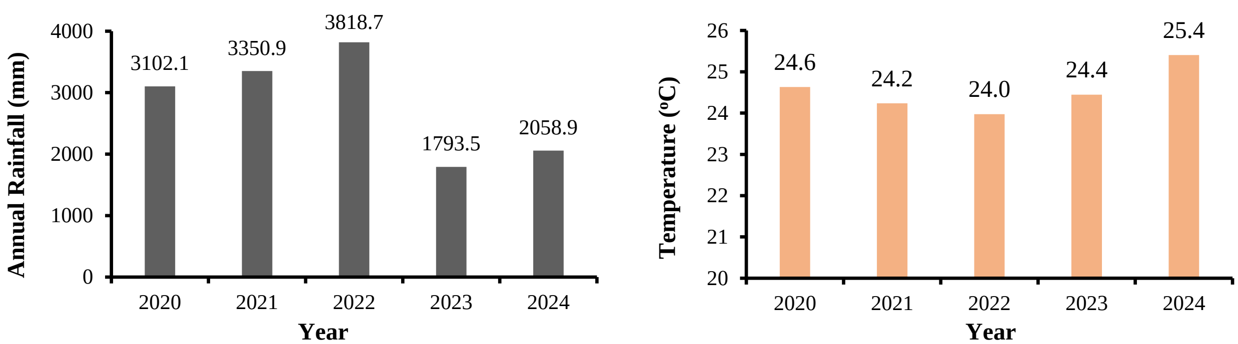

Figure 1. Average climatological data in Ngancar District over the past 5 years: annual rainfall (left), and air temperature (right)

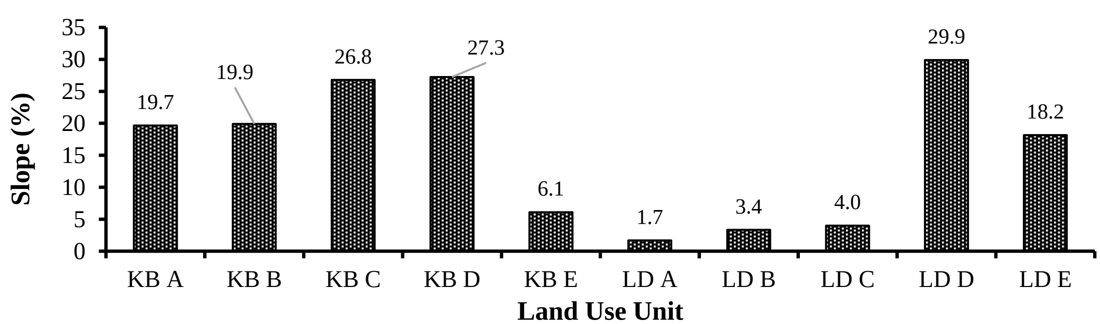

Figure 2. Slope gradient of Ngancar District, Kediri Regency, based on land use unit (LUU)

3.2. Agrological Data

3.2.1. Slope

The slope gradient in the study area is presented in Figure 2. The slope gradient in Ngancar District is generally high, as the study area is located on highlands at the foothills of Mount Kelud. High slope gradients increase the potential for erosion due to its position near an active volcano and the lack of vegetation cover on areas with steep slopes. Delfianto *et al*., (2021) state that slope is often related to soil erosion, as erosion can occur when water flows from the top of the slope to the bottom, causing shallower soil layers on the upper slope. Erosion deposits can contribute to increased soil depth and affect the soil horizon and moisture regime. This factor occurs due to varying slope gradients. In this region, the steep slope gradient and limited vegetation cover lead to soil loss of clay particles, making the soil more susceptible to erosion, which results in potentially high erosion values.

3.2.2. Soil Texture

Based on data analysis from sampling in Ngancar District, Kediri Regency, the soil texture is predominantly sandy loam (Table 2). This is attributed to the geographical conditions near the still-active Mount Kelud, where volcanic eruptions have left deposits in the area. As a result, the soil at the mountain's foothills tends to be sandy with limited clay and silt content. According to Sukarman *et al*. (2020), mountain slope soils typically vary in texture, as volcanic soil has high organic matter, low bulk density, high water absorption, and total porosity. Additionally, this soil is loose, with low plasticity and non-sticky consistency. In active mountainous areas, soil tends to be sandy, with high sand content, single-grain or unstructured, and becomes loose or friable after long periods post-eruption. These volcanic materials significantly impact soil fertility on mountain slopes, which in turn influences crop productivity on dryland and plantation areas (Baihaqi *et al*., 2022).

Table 2. Soil texture in Ngancar District, Kediri Regency

Land use Kebun	Texture	Land use Ladang	Texture
KB A	Sandy loam	LD A	Sandy loam
KB B	Sandy loam	LD B	Sandy loam
KB C	Loamy sand	LD C	Loamy sand
KB D	Sandy loam	LD D	Sandy loam
KB E	Sandy loam	LD E	Loamy sand

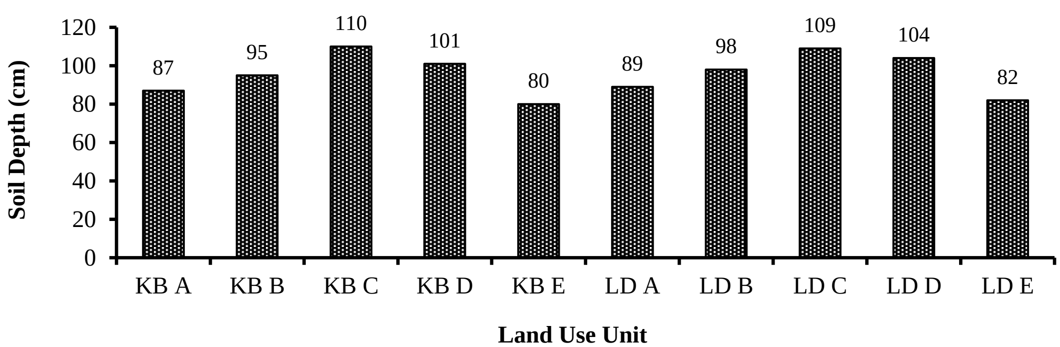

Figure 3. Soil depth in Ngancar District, Kediri Regency, based on land use unit (LUU)

3.2.3. Soil Depth

Field observations in Ngancar District, Kediri Regency, indicate that most samples show a medium to thick soil depth classification (Figure 3). According to Jiwa Jeni *et al*. (2023) and Maroeto *et al*. (2024), mentioned that the depth of solum has several class categories. One of them is the very thin solum thickness class has a depth range of 0 – 30 cm, then for the solum depth class of 31 – 70 cm has a thin solum depth class, the solum thickness range of 71 – 90 cm is included in the medium class, while for the depth of thick solum, the range is <90 cm. Firmansyah & Sukwika (2020), state that the thickness of the soil solum describes the effective depth of the soil at which the roots of the plant can grow and develop optimally. The root system is limited in development by a barrier layer on the soil, such as a padas layer or stone layer, toxic layer, groundwater table, and contrast layer. The existence of plantation plants, especially coffee which is in the category of annual crops, has a special match for the influence of the thickness of the solum, because the roots tend to extend to find nutrients and water, so that solum in the plantation area has a medium to thick value. In the moor area, because of its diverse vegetation, and combined with plants such as mahogany, or other woody plants, it has proven why solum in the moor area also tends to have a thick class.

3.2.4. Cation Exchange Capacity (CEC)

Cation Exchange Capacity (CEC) plays a crucial role in determining soil fertility, especially during the process of pedogenesis. The CEC values in deeper soil horizons are often higher compared to surface horizons, indicating the influence of organic matter and clay mineral content in the soil (Sahfitra, 2023). Based on the results of CEC analysis, the CEC values in the Ngancar subdistrict, Kediri Regency, tend to be very low to moderate, ranging from 2.30 to 15.37 cmol/kg (Figure 4). According to research published by Delfianto *et al*., (2021), one of the causes of low CEC in soil is its sandy texture. Soils with higher sand content are less able to retain nutrients that can be absorbed by plants. This is because there are no binding fractions, such as clay or silt, which help retain organic matter and essential nutrients for plants and soil, leading to lower soil fertility and reduced agricultural productivity.

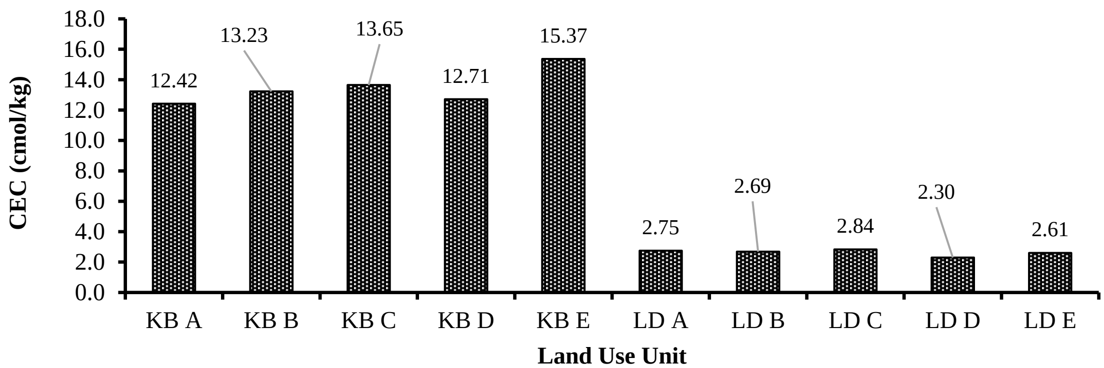

Figure 4. CEC in Ngancar District, Kediri Regency, based on land use unit (LUU)

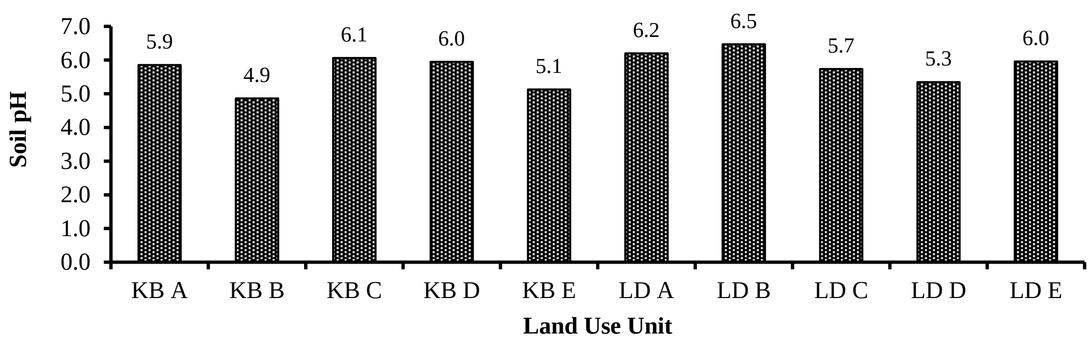

Figure 5. Soil pH in Ngancar District, Kediri Regency, based on land use unit (LUU)

3.2.5. pH (H_2O)

The results of soil pH analysis indicate that the soil tends to be acidic (Figure 5). One of the factors contributing to the low pH value is high rainfall. Heavy rainfall can cause the soil to become more acidic, as basic minerals in the soil are leached away due to the high precipitation (Baihaqi *et al*., 2022). Based on the rainfall data collected, the region falls under a Type C climate, which is categorized as moderate. Supporting studies, such as those by Agustin & Suntari (2018), Shabrina *et al*. (2021) and Baihaqi *et al*. (2022), confirm that the Mount Kelud area typically has soil pH values ranging from slightly acidic to neutral.

3.2.6. Organic Carbon (C-Organic)

Based on the analysis results for the C-organic parameter, organic carbon content is considered high (Figure 6). Organic matter content around Mount Kelud is notably elevated, as the sampling area comprises routinely managed land. Agricultural activities and soil management to boost crop productivity contribute to the high levels of organic matter, specifically C-organic, in the soil (Delfianto *et al*., 2021). Various publications indicate that high-quality soil contains essential nutrients that contribute to optimal fertility, one of which is C-organic. C-organic, a primary determinant of soil fertility, consists of organic materials within and on the soil surface originating from natural carbon compounds. Various types of organic matter in soil, such as plant litter, light organic matter fractions, microbial biomass, and water-soluble organic substances, all contribute to the soil's carbon content. The activity of soil carbon further influences this carbon level, which in turn enhances crop productivity and promotes agricultural sustainability by improving soil fertility and nutrient use efficiency (Sari *et al*., 2023).

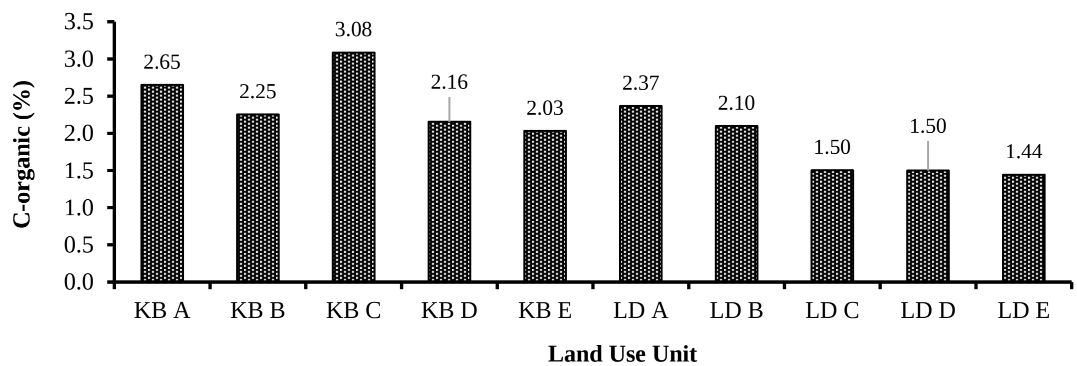

Figure 6. Variations of Organic carbon (C-organic) in Ngancar District, Kediri Regency, based on land use unit (LUU)

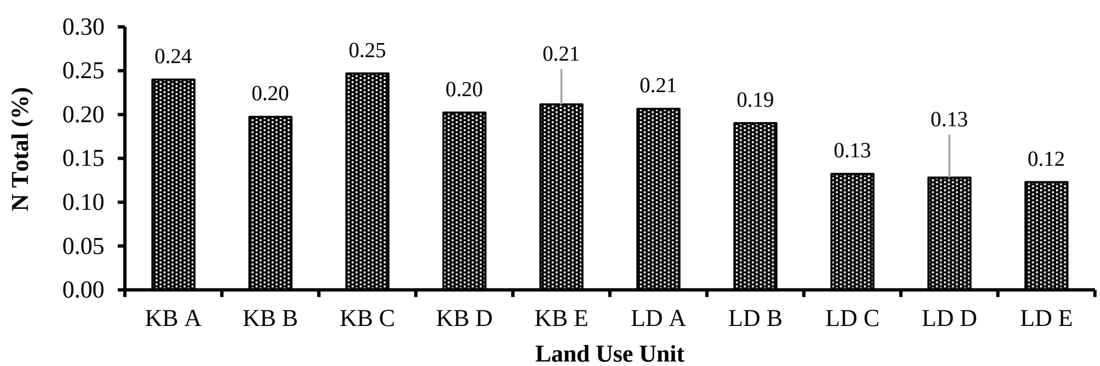

Figure 7. Variations of Nitrogen (N-Total) in Ngancar District, Kediri Regency, based on land use unit (LUU)

3.2.7. Total Nitrogen (N-Total)

Based on observations and analysis of soil samples taken from the Ngancar subdistrict, Kediri Regency, the total nitrogen (N-total) content is categorized as moderate to high (Figure 7). This is in line with the land suitability classification for crops such as coffee, pineapple, and mango. The data indicates that the N-total content in this area is relatively high, which is reflected in the significant amount of organic matter, as shown by the high C-organic levels. The soil's ability to provide nitrogen is influenced by the amount of organic matter it contains (Parjono, 2019). Furthermore, research by Mahamad *et al*. (2022) indicates that high nitrogen content in soil can supply the necessary nutrients for plants, thus supporting their growth. This, in turn, can positively affect crop productivity, such as promoting broader leaf development to enhance photosynthesis, ultimately leading to higher agricultural yields (Kurniawan *et al*., 2023).

3.2.8. Available Phosphorus (P)

Based on soil sample data analysis, the available phosphorus (P) content in the land of Ngancar Subdistrict, Kediri Regency, is classified as high (Figure 8). The high availability of phosphorus in the soil is partly due to the acidic nature of the soil, with a pH that tends to be on the lower (acidic) side. Analysis of the pH levels in the region confirms that the soil tends to be acidic. According to Musyadik (2019), the availability of phosphorus (P) in the soil for plants is influenced by soil acidity. The optimal range for phosphorus availability to plants typically lies between a pH of 5.5 and 7.0. In this pH range, phosphorus is more readily available and can be effectively absorbed by plants, supporting their growth and development. Extremely low or high acidity levels can reduce the availability of phosphorus, so it is important to maintain the soil pH within this optimal range to ensure efficient nutrient uptake by plants. Furthermore, research by Fitriyani *et al*. (2023), indicates that high levels of available phosphorus in plants are correlated with the total phosphorus content in the soil. The greater the amount of available phosphorus, the higher the total phosphorus content in the soil. However, high levels of total phosphorus in the soil do not necessarily correlate with higher levels of available phosphorus in plants.

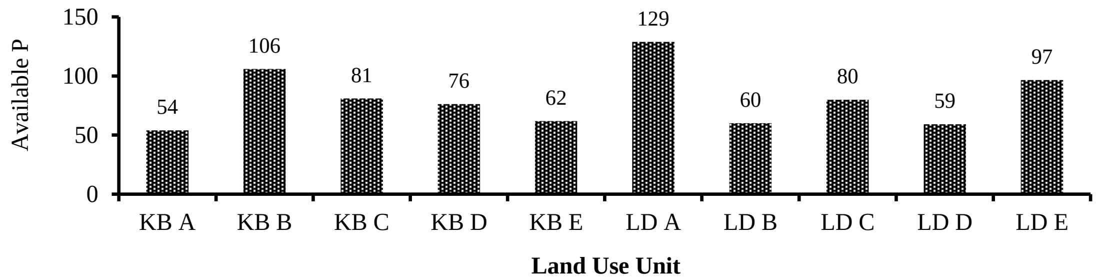

Figure 8. Variations of available Phosphorus (P) in the Ngancar Subdistrict, Kediri Regency, based on land use unit (LUU)

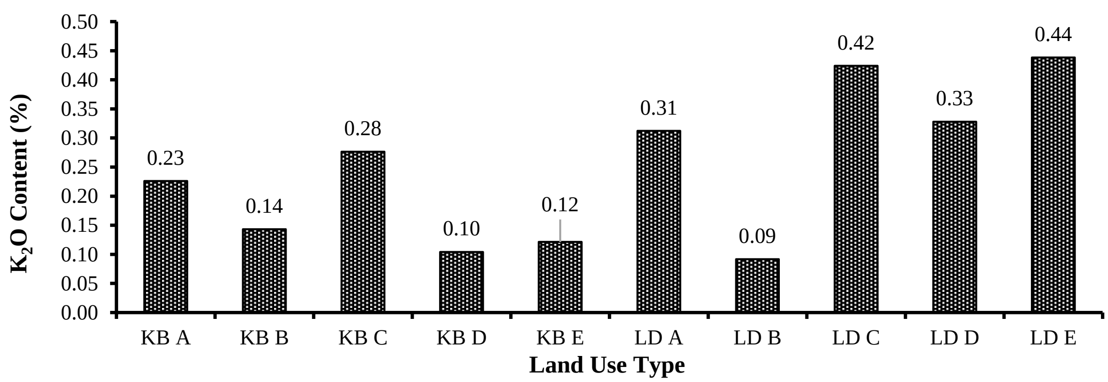

Figure 9. Variations of K_2O content in Ngancar Subdistrict, Kediri Regency, based on land use unit (LUU)

3.2.9. K_2O Content in Soil

The analysis results from soil samples in Ngancar Subdistrict, Kediri Regency, show that the potassium oxide (K_2O) content is very low (Figure 9). One of the contributing factors is the region's geographical location at the foothills of Mount Kelud. Research publications have noted that areas near active mountains tend to have low K_2O values, as volcanic material—newly formed from volcanic eruptions—comprises basaltic minerals, which are low in K_2O content (Ningsih *et al*., 2024). Additionally, the low K_2O values can be attributed to the relatively high rainfall in the study area. This conclusion is supported by rainfall data, which classifies the region under Type C rainfall. According to Putri *et al*. (2019), the low K_2O content is largely due to leaching, as K_2O is easily washed away by rainfall. This leaching process allows K_2O to be carried from the upper soil layers down to deeper layers, further reducing its availability in the upper soil profile.

Table 3. Results of Land Suitability Evaluation in Ngancar District, Kediri Regency

Land Suitability Parameter	Data Result	Pineapple Suitability	Coffee Suitability	Mango Suitability
Temperature (tc)	25.40	S2	S2	S1
Water Availability (wa)				
Rainfall	2058.9	S3	S1	S2
		Root Medium (rc)		
Soil Texture	Coarse	N	N	N
Soil Depth	95.5	S2	S2	S2
		Nutrient Retention (nr)		
CEC	8.05	S1	S1	S1
pH	5.75	S1	S2	S1
C-Organic	2.11	S1	S1	S1
		Available Nutrients (na)		
N-Total	0.18	S2	S2	S2
P_2O_5	80.35	S1	S1	S1
K_2O	0.24	S3	S3	S3
Slope (eh)	15.68	S3	S3	S3
Actual		Nrc	Nrc	Nrc
Potential		S3	S3	S3

Source: Ritung & Kartawisastra (2018); Djaenudin *et al*. (2011).

3.3. Land Suitability Evaluation

Land suitability evaluation is an activity carried out to assess the characteristics and suitability of a piece of land for the growth requirements of a particular commodity (Wijaya *et al*., 2024). In their research, it is explained that land suitability evaluation requires environmental data and soil quality data, which are obtained through sampling in a specific area. The land suitability assessment for agricultural characteristics includes topography, climate, soil conditions, soil quality, and various physical environmental properties of the land being evaluated (Iswan *et al*., 2019). Based on field observations, sample collection, and soil analysis, data have been obtained using average calculations. These data (Table 3) indicate that the land in Ngancar District, Kediri Regency, shows two land suitability classes: S3 (marginally suitable) and N (not suitable). The distribution of land suitability class in Ngancar District is portrayed in Figure 10.

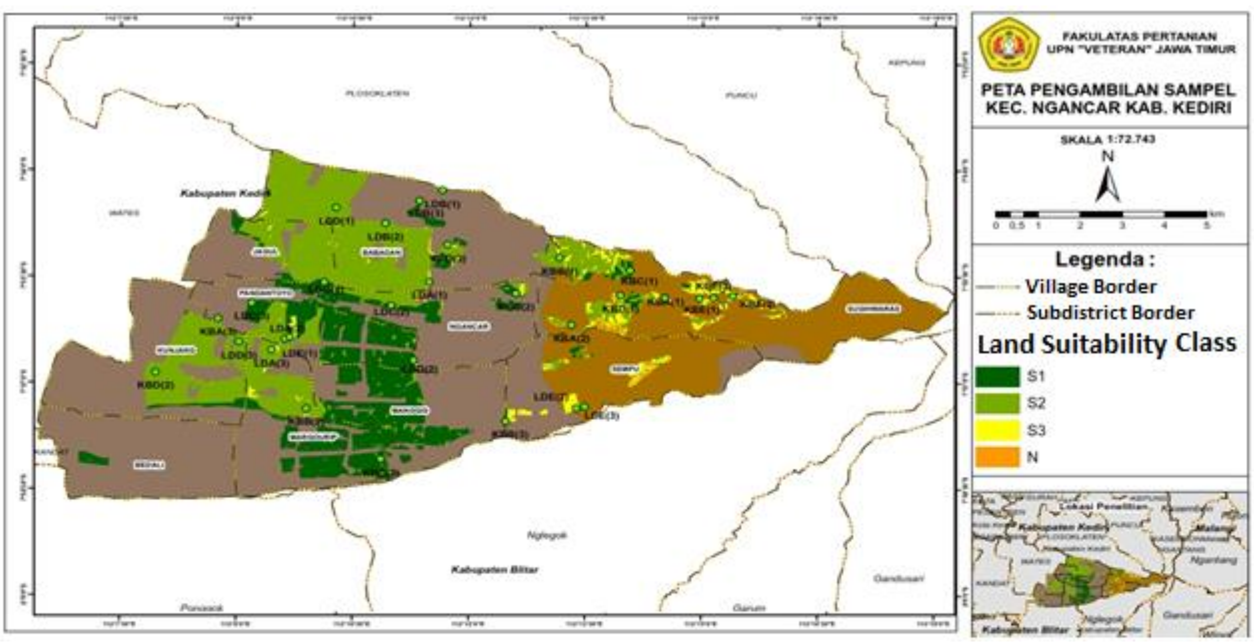

Figure 10. Land suitability map of Ngancar District, Kediri Regency

A common limiting factor for each primary commodity crop, such as soil texture, has been identified. This factor relates to natural conditions that cannot be directly controlled by humans. Thus, to improve soil texture in this area, certain steps are needed that require a considerable amount of time and discipline from the community to avoid farming activities that are not in line with sustainable agricultural practices. In addition to the soil texture, other limiting factors for land suitability for each primary commodity include low K_2O/na levels. A recommended alternative is to apply both organic and inorganic fertilizers in appropriate and balanced doses and at the right time. The slope gradient is another limiting factor that cannot be improved. However, selecting the right crop commodities, such as perennial or woody plants with strong root systems, for planting on steeper slopes should be reconsidered. This approach can prevent soil erosion because plants with larger root systems can effectively hold the soil, ensuring the necessary soil nutrients for plant growth are maintained. For pineapple crops, annual rainfall above 1,500 mm is a limiting factor. Pineapples require a maximum rainfall of 1,500 mm/year. Rainfall above this threshold can cause the pineapples to rot quickly, reducing the productivity of the pineapple crop. The limiting factor related to rainfall does not need improvement as it does not pose a significant risk to pineapple growth.

4. CONCLUSION

The land suitability class for the three primary commodities, namely Pineapple, Coffee, and Mango, in Ngancar District, Kediri Regency, has an actual value of N due to the limiting factor of Root Medium (rc) in the parameter of Soil Texture. Meanwhile, the potential land suitability class has a value of S3 due to the limiting factors of nutrient availability (na) K_2O, rainfall (wa) for pineapple, and slope gradient (eh). The characteristics of the land that affect the productivity of these primary commodities include soil texture.

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