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Evaluation of Land Suitability in Other Use Areas for Local Avocado Production In Muntok Sub-District, West Bangka Regency

Riski Meliya Ningsih*[1], Adhitya Vishnu Pradana[2], Abi Barokah[1] and M. Fiu Muthi[1]
[1]Politeknik Manufaktur Negeri Bangka Belitung, Bangka, Indonesia
[2]Politeknik Negeri Lampung, Lampung, Indonesia

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*Corresponding author:
E-mail:
riski@polman-babel.ac.id

ABSTRACT

The limited availability of fertile land in Bangka Island, driven by the high rate of land conversion and the persistent impacts of mining activities, has become increasingly critical. This condition has intensified the urgency to utilize Other Use Areas (APL) for the development of high-economic-value commodities. This study aims to evaluate the potential and suitability level of APL in Muntok Sub-district, West Bangka Regency, as a cultivation site for local avocado (*Persea americana*). The method used was a descriptive survey with a spatial approach employing Geographic Information Systems and Land Suitability Evaluation (FAO Matching Method). Analysis was conducted on a total of 3,029 hectares of APL by measuring bio-physical soil parameters (pH, organic carbon, drainage) and climate data, which were then matched with optimal growth criteria for avocado. The land suitability evaluation results showed that the study area has no Very Suitable (S1) class. The land was dominated by Moderately Suitable (S2) class covering 66.55% and Marginally Suitable (S3) class covering 20.30%, while 13.15% was classified as Not Suitable (N). Although agroclimatic factors were within optimal limits (S1), edaphic factors were the most critical limiting factors. The main constraint was very low organic carbon content (average 1.18–1.71 g.kg^{-1}) and acidic soil reaction (pH 4.5–5.4), which collectively inhibit nutrient uptake by plants. It is concluded that the potential of APL in Muntok can be significantly improved from S2/S3 to an actual suitability class of S1. The implication of this study is a strategic recommendation for policymakers and farmers to prioritize specific interventions, namely liming to remediate acidity and intensive application of organic materials to enhance soil fertility, thereby supporting sustainable horticulture diversification programs, especially with avocado, in West Bangka.

INTRODUCTION

Optimal land resource utilization is a key factor in supporting food security, diversification of horticultural commodities, and the sustainability of agricultural systems in Indonesia. Productive agricultural land is increasingly limited due to the pressure of land conversion and the exploitation of mineral resources, particularly in Bangka Island, known for tin mining activities. This situation encourages the utilization of Other Use Areas (APL) as an alternative potential agricultural land that has not been maximally utilized. Land potential

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evaluation is a strategic step to assess the biophysical suitability of an area for certain crop types, enabling efficient and sustainable utilization (Susilawati et al., 2019; Mulyani et al., 2020).

Global population growth and rising food demand drive the need to optimize land for high economic value agricultural production (Susilawati et al., 2019). In this context, tropical fruit commodities play an important role not only as nutritional sources but also as economic drivers for rural communities. Indonesia, with its tropical agroclimatic conditions and high biodiversity, has great opportunities in developing tropical fruits, including avocado. Fruits of this plant contains high nutritional value, promising economic potential, and stable market demand, both domestically and globally (Supriyanto et al., 2021). Therefore, avocado is a strategic choice in agricultural diversification programs across various Indonesian regions.

Land potential evaluation is a fundamental aspect of sustainable agricultural development planning, particularly in addressing the limitation of fertile land (Widiatmaka et al., 2016). Spatial and biophysical analysis of land potential can help identify areas with optimal suitability for particular commodities (Susianti et al., 2024). Thus, land management planning can be scientifically directed to increase productivity while preserving natural resources (Pramono et al., 2019). In Indonesia, tropical fruit development, including local avocado, has received government attention due to its potential to increase farmers' income and support horticultural exports (Kementerian Pertanian Republik Indonesia, 2022).

Local avocado is an important genetic resource with potential for regional development due to its adaptation to diverse tropical agroclimatic conditions (Sutopo et al., 2020). In West Bangka Regency, some local avocado varieties possess superior fruit characteristics and resistance to marginal environments. However, scientific information about the suitability and land potential for local avocado development in APL areas remains limited. Such studies are necessary to spatially assess land feasibility and determine appropriate management strategies (Ahmad et al., 2025). Previous research has shown that a Geographic Information System (GIS)-based and biophysical analysis approach is effective in identifying potential locations for horticultural commodity development (Widiatmaka et al., 2016; Sulistyo et al., 2022). However, similar studies for local avocado in West Bangka's APL are still scarce.

Muntok Sub-district is one of the areas in West Bangka Regency with significant APL extent and varied topographic conditions, yet most of this land remains underutilized productively. Agricultural development in this area needs to start with land potential evaluation considering important parameters such as soil texture, drainage, effective depth, slope, and local climate (Lidarti et al., 2025). This information can serve as a scientific basis for decision-making in sustainable land use planning and development of priority commodities (Firdaus et al., 2022). Accurate land suitability determination is an imperative need to prevent errors in cultivation site selection and ensure long-term productivity sustainability (Ndofah & Santosa, 2023).

Land suitability determination is a complex process involving comprehensive analysis of physical, chemical, topographic, and climatic factors (Fadli et al., 2024). Although avocado is adaptable to various conditions, local varieties have specific requirements to achieve maximum productivity, which are commonly categorized using the FAO land suitability classes (S1, S2, S3, N) (FAO, 1976). The absence of detailed suitability data and maps in Muntok Sub-district constitutes a practical obstacle for strategic decision-making. So far, land evaluation has mostly focused on staple crops, while specific studies for local avocado in APL are very limited.

Based on this background, this study aims to evaluate land potential in Muntok's APL to enable accurate and sustainable development of local avocado. Specifically, this research will identify physical and chemical land characteristics, analyze land suitability levels for local avocado cultivation, and provide recommendations for priority locations and appropriate land management strategies.

MATERIALS AND METHODS

This study was conducted in Muntok Sub-district, West Bangka Regency, from August to October 2025 (Figures 1 and 2). The study aimed to evaluate the land potential in APL to support the development of local avocado using a land suitability evaluation approach based on biophysical parameters. Data collection was performed through field surveys to obtain primary data, including physical land characteristics such as soil texture, depth, slope, drainage, soil pH, and climatic conditions. Secondary data were obtained from topographic maps, soil maps, and climate information from relevant agencies. Laboratory analysis was conducted to examine soil chemical properties pertinent to avocado growth requirements.

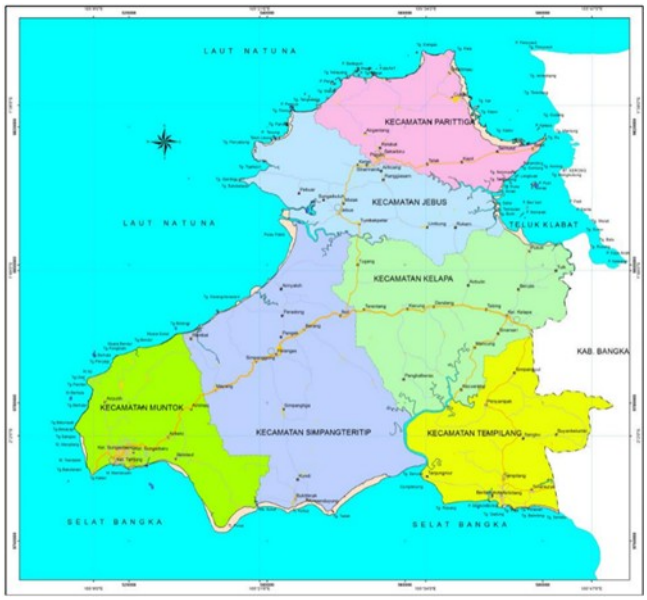

Figure 1. Administrative map of West Bangka Regency
(Source: Spatial Planning Framework of West Bangka Regency, 2014–2034)

Land potential evaluation used a matching method based on the FAO land suitability assessment system and Eviati & Sulaeman (2009), which categorizes land into very suitable (S1), moderately suitable (S2), marginally suitable (S3), and not suitable (N) classes for avocado cultivation (Table 1). This potential method associates land biophysical characteristics with the growth requirements of avocado plants to produce thematic land suitability maps that facilitate land use recommendations. Data processing and statistical analyses were carried out using ArcGIS software for spatial mapping and descriptive statistics software to interpret soil and climate data. This analysis ensures the validity and accuracy of recommendations for the development of local avocado agriculture based on detected land potential.

Spatial analysis of the evaluation results was performed to produce land potential maps for local avocado development. The area of each suitability class was automatically calculated using the zonal statistics function in GIS. Subsequently, quantitative data from laboratory results and environmental parameters were analyzed descriptively to characterize the

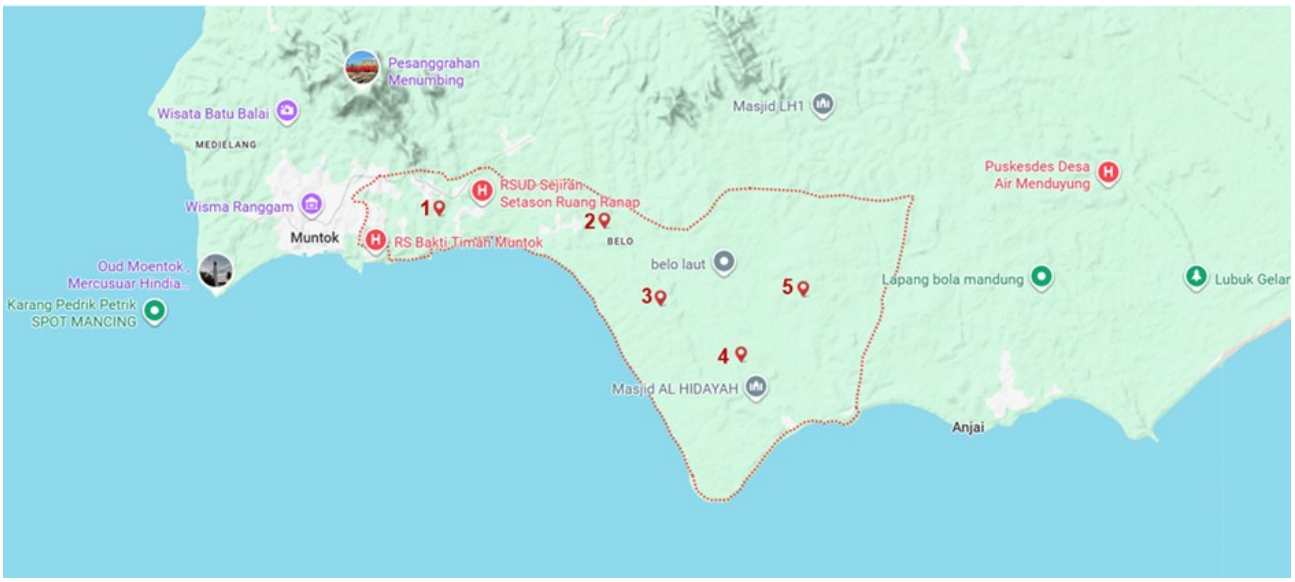

Figure 2. Research location map in Belo Laut Village, Muntok Sub-district, West Bangka Regency
(Source: https://www.google.com/maps/place/Belo+Laut)

Table 1. Land suitability evaluation criteria for avocado

Factor	Unit	S1 (Very Suitable)	S2 (Moderately Suitable)	S3 (Marginally Suitable)	N (Not Suitable)
Average Temp.	°C	18–28	28–30	30–32	>32 / <18
Rainfall	mm/year	1200–3000	3000–3500	3500–4000	>4000 / <800
Slope	%	<8	8–15	15–25	>25
Soil pH	-	5.5–6.5	4.8–5.4 / 6.6–7.2	4.5–4.7 / 7.3–7.5	<4.5 / >7.5
Soil Texture	-	Sandy loam	Clay loam	Clay	Coarse sand
Effective Depth	cm	>75	50–75	30–50	<30
Drainage	-	Good	Moderately	Restricted	Waterlogged

Note: FAO (1976); Ritung et al. (2011); Nugraha et al. (2022)

biophysical land condition and main limiting factors. Validation of results was conducted through additional field observations and consultations with local farmers and technical agencies. All analysis results were interpreted to formulate land use recommendations aligned with sustainable agriculture principles and natural resource conservation (Hardjowigeno & Widiatmaka, 2015).

RESULTS AND DISCUSSION

Bio-physical Characteristics of Other Use Areas

The results of soil bio-physical analysis at five observation points (A1–A5) APL of Muntok Sub-district indicate variations in characteristics that influence land suitability potential for the development of avocado. These variations arise from the overlapping of soil type maps, slope gradients, and land use. The bio-physical characteristics of each point, which serve as the basis for determining land suitability classes, are detailed in Table 2. According to laboratory analysis by Bengkulu University (2025), soil pH values ranged from 4.5 to 5.8, indicating slightly acidic to acidic conditions, slightly below the optimal growth range for avocado (5.5–6.5) (Wijaya et al., 2015; FAO, 1976). In general, the bio-physical soil condition at APL in Muntok shows that most observation points have potential land suitability ranging from moderately suitable to marginally suitable for avocado cultivation, with the main limiting factors being acidic soil reaction and low organic matter content. Mount Muntok District is situated at an elevation of 27 meters above sea level (mdpl), based on data from the 2024 BPS report.

Table 2. Average bio-physical soil characteristics of unit mapping lands (IML) in APL, Muntok Sub-district

Observation	Avocado Criteria	Sample Points				
		A1	A2	A3	A4	A5
Coordinates	Latitude	-2.134	-2.138	-2.142	-2.045	-2.042
	Longitude	105.192	105.197	105.203	105.238	105.233
Soil Texture		Clay/ sandy clay	Sandy clay	Clay	Sandy clay	Sand
Sandy clay loam						
Soil pH (H2O)	5.5–6.5	5.4	5.8	4.5	4.8	5.1
Organic C ($g.kg^{-1}$)	>20	1.23	1.45	1.71	1.51	1.18
Total N ($g.kg^{-1}$)	>15	0.13	0.15	0.19	0.17	0.21
Available P ($mg.kg^{-1}$)	>15	12.1	10.4	14.7	12.4	13.7
Available K ($mg.kg^{-1}$)	>0.30	0.21	0.24	0.28	0.15	0.22
Effective Depth (cm)	>75	65	75	90	115	110
Slope (%)	<8	3–8	8–15	2–5	10–15	8–10
Drainage		Good	Good	Good	Moderate	Moderately rapid

Note: Soil laboratory analysis by Bengkulu University (2025); Wijaya et al., (2015); FAO (1976)

Determination of Land Suitability Classes, Limiting Factors, and Interpretation of Suitability Evaluation Results

Based on the matching method between Land Mapping Unit (LMU) bio-physical characteristics and the growth requirements of local avocado, the distribution of potential land suitability classes in APL Muntok is classified as Suitable (S) and Not Suitable (N). Overall, from a total area of 3,029 hectares, most land (66.55%) is categorized as S2, 20.30% as S3, and 13.15% as Not Suitable (N) (Tables 3 and 4). No land was found in the Very Suitable (S1) class. This indicates that most areas of APL in Muntok are moderately suitable for developing local avocado, although some land requires interventions to address limiting factors to improve productivity.

The absence of the Very Suitable (S1) class and the dominance of Moderately Suitable (S2) and Marginally Suitable (S3) classes in APL Muntok reflect that, although the physical conditions of the land such as soil depth are favorable, chemical and fertility constraints exist and must be overcome (Table 3). Low organic carbon contents directly restrict nutrient availability, a common characteristic of lands with minimal or marginal/degraded usage history.

Integration of Findings and Practical Implications

Based on climate factor summaries in West Bangka Regency, the agroclimatic conditions show moderate suitability for local avocado cultivation (Table 5). The monthly rainfall recorded is 105 mm, with annual rainfall reaching 1864.4 mm, within the optimal range of 1200–3000 mm per year. The average annual temperature of 27.35°C aligns with the optimal criteria of 18–28°C. Relative humidity is recorded at 86.79%, slightly above the optimal range of 70–85%, necessitating special attention regarding disease risk. The average sunlight duration of 5.5 hours per day falls within the optimal range of 5–8 hours, supporting photosynthesis and crop growth.

Discussion

The land suitability analysis results indicate that the Other Use Areas (APL) in Muntok Sub -district exhibit variation in characteristics influencing the land suitability potential for local avocado (*Persea americana*) development. However, no Very Suitable (S1) class was found for local avocado cultivation; instead, the land is dominated by Moderately Suitable (S2) covering 66.55% and Marginally Suitable (S3) covering 20.30% (Table 4). Based on land suitability evaluation for local avocado cultivation in Muntok, the majority of the area (66.55%) falls within S2 class, with a major limiting factor being slightly acidic soil pH. Approximately 20.30% of the land belongs to S3 class, with acidic soil pH as the principal limiting factor. Meanwhile, 13.15% falls into the Not Suitable (N) class, mainly limited by acidic soil pH and sandy texture (Table 3).

The bio-physical soil characteristic analysis at APL in Muntok shows that most land suitability parameters do not fully meet optimal criteria for avocado growth. According to FAO classification (1976), avocado requires clay to sandy clay soils with good drainage, neutral to

Table 3. Land suitability classes in Muntok Sub-district for local avocado

Sample Point	Main Limiting Factor	Area (ha)	Suitability Class	Description
A1	Slightly acidic pH	0.394	S2	Moderately suitable, liming needed
A2	Moderate slope	0.826	S2	Moderately suitable, moderate erosion risk
A3	Acidic pH	0.615	S3	Marginally suitable, liming needed
A4	Acidic pH, sandy texture	0.398	N	Not suitable, relatively high erosion potential
A5	Slightly acidic pH	0.796	S2	Moderately suitable, liming needed

Note: GIS analysis and Land Evaluation (2025)

Table 4. Area of land suitability classes in Muntok Sub-district for local avocado

Suitability Class	Area (ha)	Percentage (%)
S1	0	0
S2	2,016	66.55
S3	615	20.30
N	398	13.15
Total	3,029	100

Note: Result of spatial overlay land suitability map (2025)

slightly acidic pH (5.5–6.5), and high organic matter content to support extensive root growth and soil microbial activity. Observations show that although soil texture at most points is within suitable category (sandy clay to sandy clay loam) and drainage is generally good, the main limiting factors are soil reaction and organic matter content.

Soils with pH <5.0, such as points A3 and A4, potentially reduce macro nutrient availability, such as phosphorus, potassium, and calcium, while increasing aluminum and iron toxicity (Manalu et al., 2024). This results in low nutrient uptake efficiency by avocado roots, which are sensitive to acidic conditions. Moreover, very low organic carbon (<2 $g.kg^{-1}$) reflects minimal soil biological activity, leading to unstable soil structure and limited water and nutrient retention capacity (Pakaya et al., 2024). Therefore, improving organic matter content through manure, compost, or organic mulch application is necessary to enhance soil fertility and strengthen root systems.

Compared to similar studies in other tropical regions, such as Rinady et al. (2023), land conditions in Muntok exhibit similar features with relatively suitable texture but limited by low pH and soil fertility. Thus, based on the FAO (1976) land suitability evaluation approach, the observed area can be categorized from S2 (moderately suitable) to S3 (marginally suitable) with primary limiting factors being pH and soil organic matter.

Agroclimatic evaluation indicates that the average annual temperature (27.35°C) and annual rainfall (1868.4 mm) fall within the optimal S1 range (Tables 5 and 1), confirming that the primary limiting factors derive from edaphic characteristics, not climate. The most prominent bio-physical constraints are organic carbon content and soil pH. Organic carbon values across all sample points ranged from 1.18 to 1.71 $g.kg^{-1}$ (Table 2), well below the S1 threshold (>20 $g.kg^{-1}$), which commonly indicates low fertility in marginal tropical soils due to rapid mineralization and low organic inputs (Rahmawaty et al., 2019). Additionally, the acidic soil pH (4.5–5.4) serves as a significant secondary limiting factor (Table 3), lowering suitability from S1 to S2 and S3. The acidity level, especially in sample A3 (pH 4.5), can increase aluminum toxicity and reduce the absorption of essential nutrients such as phosphorus and potassium, thereby lowering fertilization efficiency and avocado productivity (Persea americana) (Kumari et al., 2022). Therefore, land potential in Muntok can only be optimized to the actual suitability class S1 through targeted management interventions, particularly liming to raise pH and intensive organic matter additions to improve soil chemical and physical fertility (Hardjowigeno & Widiatmaka, 2015).

These findings imply that the development of local avocado in the APL of Muntok Sub-district remains feasible if supported by adaptive soil fertility management. Overall, the bio-physical and climatic conditions in Muntok are sufficient for local avocado cultivation.

Table 5. Summary of climate factors determining agroclimatic conditions in West Bangka Regency

Variable	Unit	Value	Avocado Optimal Criteria
Precipitation	$mm.month^{-1}$	155.7	
	$mm.year^{-1}$	1868.4	1200–3000
Average Annual Temp.	°C	27.35	18–28
Relative Humidity	%	86.79	70–85
Sunlight Duration	$hours.day^{-1}$	5.5	5–8

Note: Data from BPS West Bangka Regency (2024),; Rahmawati et al., (2023)

Most land falls in S2 and S3 classes, indicating potential for development with appropriate agronomic treatments such as liming to reduce soil acidity. Good moisture management is also necessary to prevent disease risk, along with organic amendments to improve soil structure and cation exchange capacity, and selection of acid-tolerant avocado varieties. Such measures are expected to enhance productivity and sustainability of avocado cultivation in the area.

CONCLUSION

The land potential evaluation in Muntok Sub-district indicates that the study area is dominated by Moderately Suitable and Marginally Suitable classes, suggesting that the land is fit for avocado development but requires improvement. The primary goal of this study was achieved by identifying that the agroclimatic factors are optimal, while edaphic factors act as limiting constraints. The critical barriers restricting the suitability of local avocado land are low organic carbon content and acidic soil reaction. The practical implication of these findings is that the development of local avocado in Muntok's APL must be preceded by focused management interventions, including liming applications and sustainable organic matter additions, to enhance soil fertility and achieve optimal yield potential.

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