



Evaluation of Land Suitability for Vegetable and Fruit Crops to Support the Free Nutritious Meal Program on the Bina Umat Islamic Boarding School Grounds

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Abstract

The land owned by the Bina Umat Islamic Boarding School in Tempel Hamlet, Pendoworejo, Girimulyo, Kulon Progo, Special Region of Yogyakarta, located in the Menoreh Mountains, is classified as Alfisol soil. This soil exhibits low quality and fertility due to the leaching of basic cations (Ca, Mg, K, Na), low organic matter content, low pH, high levels of Al and Fe, and low phosphorus (P) availability. These conditions severely limit the land's agricultural potential. The Bina Umat Islamic Boarding School operates a kitchen that provides free, nutritious meals to its students and the general public. The government's Free Nutritious Meal (FNM) program requires a supply of high-quality raw ingredients. This study aims to assess land suitability for fruit and vegetable crops and determine how this information can support the school's FNM program. A descriptive survey method was employed. Purposive sampling based on slope gradient resulted in the selection of 16 sampling points. Data analysis involved matching land characteristics against crop suitability criteria as outlined in the Technical Guidelines for Land Suitability Evaluation for Agricultural Commodities (2011). The results indicate that the actual land suitability class for fruit and vegetable crops is S3 (Marginally Suitable). With improvements to address limiting factors, the land has the potential to reach class S2 (Moderately Suitable). The limiting factors identified at the site include excessively rapid soil drainage, low base saturation, and shallow soil depth.

Keywords: *Evaluation, Land Suitability, Fruit, Vegetable, Free Nutritious Meals, Islamic Boarding School.*

INTRODUCTION

The land in the Pendoworejo area of Girimulyo, Kulon Progo, Special Region of Yogyakarta, is part of the Menoreh mountain range. Characterized by hilly terrain and Alfisol soils, which generally possess low fertility and quality, the area is frequently cultivated with secondary food crops. Soil profiles in this region vary in thickness; as a hilly area dominated by Alfisols, the land features a shallow soil solum with an average depth of less than 50 cm. These karst conditions limit agricultural potential and render the land highly susceptible to erosion. The region is also characterized by water scarcity resulting from its geomorphology, specifically the prevalence of hills. These land-related challenges hinder the achievement of optimal commodity production (Widyawati & Paryotyo, 2025).

Given the existing potential, it is necessary to study the land in Pendoworejo to determine its characteristics. Subsequently, these data are used to assess land suitability by matching it against specific criteria for fruit and vegetable crops (Djaenudin et al., 2011). Land suitability evaluation is crucial, as it assists in determining appropriate land-use types based on the land's specific characteristics. Fundamentally, agricultural land suitability reflects the degree to which the land's physical conditions align with its intended use. Utilizing land in accordance with its potential

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enables maximum productivity while minimizing environmental degradation. The research findings are applicable to marginal soil types, particularly those affected by leaching processes, with the study offering a novel focus on land characterized by high clay content.

LITERATURE REVIEW

Land is defined as an area on the Earth's surface encompassing all biosphere components, whether permanent or temporary, and is subject to various types of land use ([Arotaa et al., 2016](#)). A decline in land productivity, whether temporary or permanent, often results in land being classified as unproductive, critical, or idle; such land is left abandoned and uncultivated, typically becoming overgrown with scrub and brush ([Rajagukguk, 2025](#)).

Land characteristics assessed for agricultural purposes include soil, climate, topography, geological formations, vegetation, and socio-economic factors ([Harahap et al., 2019](#)). Common constraints include difficulties in securing adequate water for crop needs, soil nutrient deficiencies, and rocky soil conditions that severely hinder mechanical land cultivation ([Witman, 2021](#)). Dryland areas constitute an agroecosystem with significant potential for various agricultural activities, including food crops, horticulture (vegetables and fruits), and perennial crops ([Helviani et al., 2021](#)).

Land evaluation involves comparing the requirements of a proposed land-use type against the land's natural qualities. This process reveals the land's potential or suitability class for specific crop uses ([Widiatmaka, 2011](#)).

Actual land suitability refers to the biophysical data of the soil or land resources prior to the application of inputs needed to address existing constraints. Potential land suitability reflects the level of suitability achievable if land improvement measures are implemented ([Khoriiyah et al., 2023](#)).

Several methods exist for assessing land suitability; one such method involves comparing land qualities and characteristics acting as parameters against suitability class criteria established based on land-use requirements ([Hardjowigeno & Widiatmaka, 2011](#)).

According to the [FAO \(1976\)](#), as cited in [Widiatmaka \(2011\)](#), land suitability orders are divided into two categories: Suitable (S) and Not Suitable (N) for the intended use. The Suitable (S) category encompasses land that can be used sustainably for the specific purpose under consideration.

The results of a study by [Partoyo et al. \(2015\)](#) indicate that land suitability classes in the Special Region of Yogyakarta are dominated by classes S2 (Moderately Suitable) and S3 (Marginally Suitable). Limiting factors for these land suitability classes include soil fertility, water availability, slope gradient, and erosion. Study by [Nimpuna et al. \(2022\)](#) reports four land units classified as Highly Suitable (S1) and three units as Moderately Suitable (S2). Limiting factors include oxygen availability and nutrient retention. Improvement measures to increase oxygen availability include the construction and repair of drainage channels, while nutrient retention issues can be addressed through fertilization.

A study by [Nugroho et al. \(2020\)](#) indicates that land suitability classes at all observation points fall into class S3 (Marginally Suitable). Limiting factors include slope gradient, rainfall, base saturation, and pH. A study by [Juniarti et al. \(2026\)](#) presents findings for sweet potato cultivation, which identified two classes: S2 (Moderately Suitable) at 23% and S3 (Marginally Suitable) at 31.6%, with limiting factors including water availability (wa), root zone conditions (rc), nutrient retention (nr), and nutrient availability (na).

RESEARCH METHOD

The research was conducted from March to July 2026 in Tempel Hamlet, Pendoworejo, Girimulyo, Kulon Progo, Special Region of Yogyakarta. Soil analysis was performed at the Land Resources Laboratory, Faculty of Agriculture, Universitas Pembangunan “Veteran” Yogyakarta. This study employed a survey method and purposive sampling for soil collection based on slope gradient. There were 16 sampling points on Alfisol soil, namely: TS 1 (flat, 3%), TS 2 (flat, 3%), TS 3 (gentle slope, 8%), TS 4 (gentle slope, 8%), TS 5 (flat, 3%), TS 6 (gentle slope, 8%), TS 7 (gentle slope, 8%), TS 8 (gentle slope, 8%), TS 9 (flat, 3%), TS 10 (flat, 3%), TS 11 (flat, 3%), TS 12 (flat, 3%), TS 13 (flat, 3%), TS 14 (flat, 3%), TS 15 (gentle slope, 8%), and TS 16 (flat, 3%). Equipment used in the study included a soil auger, measuring tape, GPS, and clinometer for field sampling and measurements, as well as distillation apparatus, titration equipment, a pH meter, and an EC meter for laboratory analysis. Materials used included soil samples and chemicals such as distilled water, 1 N NH₄OAc, 1 N K₂Cr₂O₇, concentrated H₂SO₄, 85% H₃PO₄, and 0.5 N FeSO₄.

Parameters analyzed in the laboratory included cation exchange capacity, texture, pH (H₂O), base saturation, organic carbon, salinity, and alkalinity. The analytical methods employed were: 1 N NH₄OAc saturation for cation exchange capacity and base saturation; the pipette method for texture; potentiometry for pH (H₂O); the Walkley-Black method for soil organic carbon; an EC meter for salinity; and the exchangeable sodium percentage (ESP) value for alkalinity. Land suitability classes were determined by matching land characteristics against crop suitability criteria, in accordance with the Technical Guidelines for Land Suitability Evaluation for Agricultural Commodities (Romadhona et al., 2024). The classification system comprises S1 (Highly Suitable), S2 (Moderately Suitable), S3 (Marginally Suitable), and N (Not Suitable). The final suitability class was determined based on the parameter with the lowest rating, which acts as the limiting factor. Suitability classes were established for both actual conditions (actual land suitability class) and potential conditions (potential land suitability class); the potential suitability class is derived by addressing or ameliorating the relevant limiting factors.

FINDINGS AND DISCUSSION

Land Conditions at the Research Site

The agricultural land owned by the Bina Umat Islamic Boarding School is located in Pendoworejo, Girimulyo, Kulon Progo, Special Region of Yogyakarta. Geographically, the site is situated at coordinates 7°44'49.45" South Latitude and 110°11'37.12" East Longitude. The land covers an area of approximately 3 hectares. The terrain is flat, with a slope ranging from 0% to 3%, and is situated at an elevation of 130 meters above sea level.

Climatic conditions in Girimulyo District, Kulon Progo Regency, feature an annual rainfall of approximately 2,250 mm. The region experiences six wet months (rainfall >200 mm) and four dry months (rainfall <100 mm). The average air temperature is 26.5°C, with an average humidity of around 83% (data from the BMKG Climatology Station, Special Region of Yogyakarta). Based on the Oldeman climate classification, the region's climate falls into category C2, indicating moderately wet climatic conditions.

Field observations indicate that the land features flat (0–8%) and gentle (8–15%) slopes, with a terraced landform. Irrigation water is sourced from a well-supplied by an irrigation canal located at the lower end of the site. At the time of the survey, the land was planted with bananas. Interviews with the landowner revealed that the site was previously used for paddy rice cultivation. Land boundaries were determined using GPS by tracking and marking perimeter points indicated by a representative of the Islamic boarding school. The coordinate points were subsequently processed using ArcGIS software to generate a land boundary map.

The land suitability class for upland red rice was classified as S3 (marginally suitable), with limiting factors including oxygen availability (oa), root zone conditions (rc), and nutrient retention (nr). However, the suitability class could be upgraded to S2 (moderately suitable) through improvements in drainage and base saturation (13). Three types of peatland were classified as S2 (moderately suitable), with nutrient retention identified as the main limiting factor (S2nr) (4). Most areas of Sleman were classified as S2 (moderately suitable) for snake fruit cultivation (16). For fruit crops, land suitability classes were S2 (moderately suitable) for durian, S3 (marginally suitable) for rambutan, and S2 (moderately suitable) for mango. The main limiting factors included rainfall, slope gradient, drainage, base saturation (BS), cation exchange capacity (CEC), soil pH, and organic carbon. Potential measures to improve productivity included the application of organic matter and lime..

Table 1. Results of laboratory soil analysis

Titik Sampel	SMC 0,5 mm (%)	SMC 2,0 mm (%)	Organic-C (%)	Organic Matter (%)	CEC (me%)	pH H ₂ O	N- Total	Soil Texture	EC (mS/cm)	K (me%)	Na (me%)	Ca (me%)	Mg (me%)	P- available (ppm)	BS (%)	Alkalinity/ ESP (%)
1	7,61	7,06	0,78	1,34	5,85	7,2	0,04	clay loam	870	0	0,61	27,17	7,94	13,89	6,1	0,1
2	3,19	3,94	1,51	2,6	3,54	6,7	0,06	clay loam	820	0	0,98	25,02	5,42	19,57	8,88	0,28
3	6,14	5,47	1,03	1,78	4,48	6,9	0,05	clay loam	520	0	0	17,25	9,02	12,37	5,86	0
4	3,49	3,61	0,81	1,4	3,45	5,7	0,04	clay loam	640	0	0,65	17,85	5,3	10,12	6,9	0,19
5	3,38	3,51	0,81	1,4	4,17	6	0,05	clay loam	440	0	0,48	13,96	6,46	11,4	5,01	0,12
6	4,16	3,93	1,52	2,62	4,26	6	0,06	clay loam	390	0	0,37	17,07	6,25	11,08	5,56	0,09
7	6,41	5,82	0,93	1,6	5,03	6,1	0,04	clay loam	970	0	0,66	29,53	5,45	18,24	7,09	0,13
8	6,36	6,71	1,86	3,2	7,8	5,8	0,07	clay loam	139	0	3,12	32,84	6,38	14,22	5,43	0,4
9	5,7	5,5	0,1	0,17	5,69	6,1	0,01	clay loam	490	0,05	0,94	24,18	6,87	13,12	5,63	0,17
10	6,6	7,05	1,04	1,8	7,45	6,3	0,01	clay loam	890	0,14	1,58	24,52	8,8	10,46	4,7	0,21
11	6,36	6,47	1,87	3,22	8,13	7	0,07	clay loam	490	0	0,55	30,84	4,92	13,98	4,47	0,07
12	6,06	6,4	1,45	2,5	8,9	6,3	0,06	clay loam	620	0,16	0,27	30,76	2,52	37,81	3,79	0,03
13	6,82	7,27	1,04	1,8	8,47	6,5	0,04	clay loam	720	0,13	0,67	31,11	8,95	14,87	4,82	0,08
14	5,92	5,8	0,62	1,07	7,02	7,24	0,03	clay loam	134	0	1,68	32,31	5,7	13,53	5,65	0,24
15	5,37	5,04	0,92	1,59	6,72	6,7	0,04	clay loam	168	0,27	1	31,08	3,95	10,26	5,4	0,15
16	6,05	5,7	0,1	0,17	4,67	6,6	0,01	clay loam	690	0,02	0,83	31,55	7,42	19,34	8,53	0,18

Notes:

SMC = Soil moisture content

EC = Electrical Conductivity

ESP = Exchangeable Sodium Percentage/ Alkalinity

CEC = Cation exchange capacity

BS = Base Saturation

Laboratory Analysis Results

The soil analysis results in Table 1 indicate that the soil texture is predominantly silty clay, with low moisture content, low organic matter content (0.17–3.22%), low Cation Exchange Capacity (3.45–8.9 me%), soil pH ranging from slightly acidic to neutral (5.7–7.24), low total

Nitrogen content (0.01–0.07%), available P content ranging from low to moderate (10.26–37.81 ppm), low Potassium content (0–0.27 me%), low electrical conductivity (0.13–0.97 mS/cm), low base saturation (3.79–8.88%), and low ESP/alkalinity (0–0.4%).

Land Suitability Classes for Vegetable and Fruit Crops

Land use requirements for vegetable crops (cucumbers, lettuce, and legumes), melons, bananas, and citrus crops are based on the Technical Guidelines for Land Evaluation for Agricultural Commodities. The results of the land suitability classification for vegetable and fruit crops are presented in Table 2.

Table 2. Land suitability class results for vegetable and fruit crops.

Sample Point	Limiting Factor	Cucumber	Lettuce	Beans	Melon	Banana	Orange
1	Rainfall (wa), Soil depth (rc), Base saturation (nr), Organic carbon (nr)	S3 (wa, rc, nr)	S3 (tc, wa, rc, nr)	S3 (wa, rc, nr)	S3 (wa, rc, nr)	S3 (wa, rc, nr)	S3 (rc, nr)
2	Rainfall (wa), Base saturation (nr),	S3 (wa, nr)	S3 (tc, wa, nr)	S3 (wa, nr)	S3 (wa, nr)	S3 (wa, nr)	S3 (nr)
3	Rainfall (wa), Soil depth (rc), Base saturation (nr)	S3 (wa, rc, nr)	S3 (tc, wa, rc, nr)	S3 (wa, rc, nr)	S3 (wa, rc, nr)	S3 (wa, rc, nr)	S3 (rc, nr)
4	Rainfall (wa), Soil depth (rc), Base saturation (nr)	S3 (wa, rc, nr)	S3 (tc, wa, rc, nr)	S3 (wa, rc, nr)	S3 (wa, rc, nr)	S3 (wa, rc, nr)	S3 (rc, nr)
5	Rainfall (wa), Base saturation (nr)	S3 (wa, nr)	S3 (tc, wa, nr)	S3 (wa, nr)	S3 (wa, nr)	S3 (wa, nr)	S3 (nr)
6	Rainfall (wa), Soil depth (rc), Base saturation (nr)	S3 (wa, rc, nr)	S3 (tc, wa, rc, nr)	S3 (wa, rc, nr)	S3 (wa, rc, nr)	S3 (wa, rc, nr)	S3 (rc, nr)
7	Rainfall (wa), Soil depth (rc), Base saturation (nr)	S3 (wa, rc, nr)	S3 (tc, wa, rc, nr)	S3 (wa, rc, nr)	S3 (wa, rc, nr)	S3 (wa, rc, nr)	S3 (rc, nr)
8	Rainfall (wa), Soil depth (rc), Base saturation (nr)	S3 (wa, rc, nr)	S3 (tc, wa, rc, nr)	S3 (wa, rc, nr)	S3 (wa, rc, nr)	S3 (wa, rc, nr)	S3 (rc, nr)
9	Rainfall (wa), Soil depth (rc), Base saturation (nr)	S3 (wa, rc, nr)	S3 (tc, wa, rc, nr)	S3 (wa, rc, nr)	S3 (wa, rc, nr)	S3 (wa, rc, nr)	S3 (rc, nr)
10	Rainfall (wa), Base saturation (nr)	S3 (wa, nr)	S3 (tc, wa, nr)	S3 (wa, nr)	S3 (wa, nr)	S3 (wa, nr)	S3 (nr)
11	Rainfall (wa), Soil depth (rc), Base saturation (nr)	S3 (wa, rc, nr)	S3 (tc, wa, rc, nr)	S3 (wa, rc, nr)	S3 (wa, rc, nr)	S3 (wa, rc, nr)	S3 (rc, nr)
12	Rainfall (wa), Soil depth (rc), Base saturation (nr)	S3 (wa, rc, nr)	S3 (tc, wa, rc, nr)	S3 (wa, rc, nr)	S3 (wa, rc, nr)	S3 (wa, rc, nr)	S3 (rc, nr)
13	Rainfall (wa), Soil depth (rc), Base saturation (nr)	S3 (wa, rc, nr)	S3 (tc, wa, rc, nr)	S3 (wa, rc, nr)	S3 (wa, rc, nr)	S3 (wa, rc, nr)	S3 (rc, nr)
14	Rainfall (wa), Soil depth (rc), Base saturation (nr))	S3 (wa, rc, nr)	S3 (tc, wa, rc, nr)	S3 (wa, rc, nr)	S3 (wa, rc, nr)	S3 (wa, rc, nr)	S3 (rc, nr)
15	Rainfall (wa), Soil depth (rc), Base saturation (nr)	S3 (wa, rc, nr)	S3 (tc, wa, rc, nr)	S3 (wa, rc, nr)	S3 (wa, rc, nr)	S3 (wa, rc, nr)	S3 (rc, nr)
16	Rainfall (wa), Soil depth (rc), Base saturation (nr)	S3 (wa, rc, nr)	S3 (tc, wa, rc, nr)	S3 (wa, rc, nr)	S3 (wa, rc, nr)	S3 (wa, rc, nr)	S3 (rc, nr)

Based on a land suitability evaluation using the matching method, comparing site characteristics with the growth requirements of vegetable and fruit crops, all sample points fell into the actual land suitability class S3 (Table 2). Suitability classification was determined using the "law of the minimum" (or maximum limitation) principle, where the final class is dictated by the land characteristic with the lowest suitability level.

The primary limiting factors for cucumber cultivation at the study site were water availability (wa), nutrient retention (nr), and at certain points, rooting conditions (rc). Water availability emerged as a limiting factor because annual rainfall at the site reaches approximately 2,250 mm/year, whereas the optimal requirement for cucumbers ranges from 350 to 600 mm/year. Excessive rainfall can increase environmental humidity, heighten the risk of disease outbreaks, and cause nutrient leaching from the soil.

The next limiting factor was nutrient retention (nr), specifically the low base saturation values observed at most sampling points. According to land suitability criteria, base saturation levels below 35% fall into class S3. This condition indicates a limited soil capacity to supply and retain basic cations such as Ca, Mg, K, and Na, which can hinder cucumber growth and productivity. Furthermore, low organic-C content at several points reinforced the status of nutrient retention as a limiting factor.

Rooting conditions (rc) also limited productivity at some sampling points, as the effective soil depth ranged from 35 to 55 cm. This relatively shallow soil depth can restrict cucumber root development, thereby impeding optimal water and nutrient uptake. Nevertheless, other land characteristics indicated conditions favorable for cucumber cultivation; soil drainage was generally classified as good to somewhat impeded, soil texture was somewhat fine, and salinity and ESP values were low. Furthermore, there are no significant issues regarding waterlogging or erosion risk. Soil pH levels fall within the range suitable for cucumber cultivation (approximately 5.6–7.6). Research findings indicate that the land at the study site has potential for cucumber cultivation. Recommended improvements include adjusting the planting schedule, constructing drainage channels, creating raised beds or ridges to manage excess water, adding organic matter to enhance nutrient retention capacity, and applying lime to increase soil base saturation. With such management, cucumber productivity could potentially be increased, even though the land is currently classified as Class S3.

CONCLUSIONS AND FURTHER RESEARCH

The actual land suitability class for vegetable and fruit crops is S3 (Marginally Suitable). Potential land suitability could be upgraded to S2 (Moderately Suitable) by addressing limiting factors through improvement measures. The limiting factors at the study site include low nutrient availability, rapid soil drainage, low base saturation, and shallow soil depth. Rapid drainage can be managed by constructing irrigation channels, while nutrient availability and base saturation can be addressed through fertilization. However, the limiting factor of shallow soil depth is difficult to rectify. To ensure successful cultivation on marginal land and achieve optimal crop productivity, a land suitability evaluation is necessary. Given the marginal suitability (S3) classification, further research involving trials with mineral/inorganic amendments and organic matter is recommended.

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