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Soil Quality in Cultivation Land of Snakefruit (Salacca edulis) in Ledoknongko, Bangunkerto Village, Turi, Sleman Yogyakarta Indonesia

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Abstract— *This study aims to calculate the soil quality index on snakefruit cultivation, so the characteristics and soil quality of the land in the research location are known. The research was conducted in Bangunkerto Village, Turi District, Sleman Regency, Yogyakarta Indonesia using a survey method, sample points was determined by specific objectives (purposive sampling). There are three observation blocks were obtained, which is: block I (certified organic snakefruit cultivation land); block II (snakefruit land with conventional farming systems) and block III (a land that was not used as cultivation) as control. Block I and II are each divided into 4 plots so there are 8 observation plots were obtained, also 1 plot as control with 3 sample point. The parameters were root depth, bulk density, earthworms, soil microbes, porosity, C- organic, the percentage of silt+clay, pH, available N, available P, available K. Soil quality index determined using Mausbach & Seybold method. The results showed that the soil quality index in block I was 0.642 with good criteria, block II was 0.532 with moderate criteria and block III was 0.452 with moderate criteria. Snakefruit land with organic farming systems shows better soil characteristics compared to conventional land in terms of root depth, microbial count and soil porosity, while conventional land shows higher levels of macro nutrient availability (nitrogen and phosphorus) and the control block shows the number of earthworms/ m^2 which is better than other blocks.*

Keywords— *Soil quality index, snakefruit land cultivation, organic farming, anorganic farming.*

I. INTRODUCTION

Soil is a medium for plant growth, changes in soil quality will affect plant productivity which will ultimately determine the level of food security in a region. Soil quality is the ability of the soil to perform various intrinsic and extrinsic functions. Soil quality describes the suitability of the physical, chemical and biological properties of the soil which together function as a medium for plant growth, regulate and share water flow and support the environment [1]. Good soil quality can support cultivated plants to grow and develop optimally, while also supporting the sustainability of the ecosystem.

Salak is one of the most widely grown fruit crops in Indonesia and has good prospects to be cultivated as one of your commodities in the development of fruit agribusiness. In 2018 Indonesian salak production reached 896504 tons with total exports reaching 1234.28 tons and FOB (Free On Board) value reaching 1,430,856 USD [2]. The Province of the Special Region of Yogyakarta is one of the provinces that produces salak. Total production in 2018 reached 10228 tons and the types of salak produced include, salak pondoh, salak sugar, salak ivory, salak mandala and other types of salak.

[3] Stated that salak pondoh farmers in Sleman Regency have a tendency to not only make salak pondoh as a production plant on cultivated land, but local farmers also make salak plants an alternative part of their livelihoods to improve their economic capacity, this is found in some farmers of salak pondoh in the sub-district of turi, grip and paste who use their yards and residual or non-productive land for cultivation and production of salak pondoh plants

Based on the previous explanation, a study is needed to provide an accurate picture to determine the soil quality index on the salak pondoh cultivation area through direct observation in the field and laboratory tests so that the ability of the soil to carry out its functions, especially to support the growth and productivity of salak plants in a sustainable manner, is needed. from the economic, social and environmental aspects.

II. RESEARCH METHODOLOGY

This research was carried out using a field survey method, namely the method of collecting data to obtain information by conducting a review and direct observation in the field. Field survey activities were carried out to obtain primary data in the form of general biophysical conditions of the area and physical, chemical and biological characteristics of the soil. The research was conducted in Bangunkerto Village, Turi District, Sleman Regency, Yogyakarta Indonesia. Soil analysis was carried out at the Land Resources Laboratory and Soil Biology Laboratory, Soil Science Study Program, Faculty of Agriculture, National Development University "Veteran" Yogyakarta.

Determination of sample points was carried out by purposive sampling method with the aim of knowing the characteristics and soil quality index on salak cultivation land with the application of different agricultural systems. The sample points were divided into 3 observation blocks, namely block I which is salak land with a certified organic farming system, block II, namely salak garden with inorganic farming system and block III which is vacant land that is not managed for agricultural activities. Observation blocks that have been determined are then selected 4 representative plots from block 1 and block 2 so that 8 plots of cultivated land are used as sampling locations plus 3 sample points as controls which are original land and not used for agricultural cultivation.

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Soil samples were taken in the center of each representative plot which were then air-dried and brought to the laboratory for analysis of their physical, chemical and biological properties. The results of soil analysis on the observed parameters are then calculated the soil quality index with soil quality rules [4].

Block I consists of 4 sample points, namely organic 1 , organic 2, organic 3, and organic 4. Block II consists of inorganic 1, inorganic 2, inorganic 3 and inorganic land 4. Block III is vacant land that is not used for plant cultivation activities . Soil quality assessment in this study was based on the calculation of the soil quality index criteria of Mausbach and Seybold (1998) which was then adjusted again to field conditions using Minimum Data Set (MDS) analysis. The selection of indicators is based on the concept of a minimum data set, which is as little as possible but can meet the needs. Soil quality indicators are then selected from the properties that indicate the functional capacity of the soil. Changes were made to several things, namely: The selection of indicators and the weighting were adjusted to the effect of these indicators describing the function of the soil. The total C indicator was replaced with organic C, with the consideration that it was easier to measure organic C. The upper and lower limits of several soil indicators are lowered or increased, according to the results of parameter measurements in the field.

Soil quality assessment is based on the results of the soil index assessment. The index calculation method is as follows:
1) Determine the weighting value of each soil function and key indicators that have been formulated previously. Rating index consists of 3 basic weight indexes, where the second and third weight indexes are derivatives of the first weight index. The weighting is done because each parameter has a different intensity of influence on soil quality.
2) The weight index is calculated by multiplying the weight of the soil function (weight 1) by the weight of the soil indicator (weight 2) and the weight of each parameter (weight 3). For example, the weight index for porosity is obtained by multiplying 0.40 (weight 1) with 0.33 (weight 2) and 0.60 (weight 3), resulting in a weight index of 0.080.
3) The assessment function is based on the upper and lower limits of the observations or can be seen from the example of the function assessment by Karlen (1994). If the result of the observation has a lower value than the lower limit of the assessment function, then the result of the observation is determined to be the lower limit of the assessment. Vice versa.
4) Transform the value of each soil parameter through scoring. The score is calculated by comparing the observed data from the soil indicator and the assessment function. Scores ranged from 0 for poor condition and 1 for good condition. Scoring can be done through interpolation or linear equations in accordance with the set range based on values or based on the data obtained. The Linear Scoring Function (FSL) is:
$(Y) = (X-X2)/(X1-X2)$ (1)
$(Y) = 1 - (X-X2)/(X1-X2)$ (2)
Where:
Y is the result of a linear score, X is the value or data from laboratory tests for each soil characteristic
X1, is the lower limit value, and X2, is the upper limit value
5) Soil quality index is calculated by multiplying the weight index and the score of the indicator
6) Assessment of soil quality using the soil quality index equation by summing up each indicator. Here's the formulation:
IKT = WixSi (3)
Where:
IKT = Soil quality index Wi = Weight index
Si = Score on the selected indicator
7) The total value of the soil quality index is classified into five soil quality classes which are presented in Table 1.

TABLE 1. Land appraisal criteria based on performance indicators

No	Class IKT Value	Soil Quality Criteria
1	0,80 – 1,00	Very Good
2	0,60 – 0,79	Good
3	0,40 – 0.59	Medium
4	0,20 – 0,39	Low
5	0,00 – 0,19	Very low

III. RESULTS AND DISCUSSION

Soil Characteristics

Differences in agricultural systems applied to cultivated land will affect the conditions and characteristics of the soil itself. [5] stated that the condition of nutrients in the soil is highly dependent on the land management system and fertilization.

The results of the analysis of the characteristics of each block of observations in table 2.

TABLE 2. Soil characteristics of the research site based on the results of laboratory Analysis

Parameters	Observation Block		
	I	II	III
Available N (mg/kg)	46,43 vl	61,9 vl	44,9 vl
Available P (mg/kg)	5,465 l	5,8 l	0,164 vl
Available K (%)	0,744 vl	0,798 vl	1,092 vl
pH	5,7 sa	5,3 a	5,6 sa
C- Organik (%)	0,93 vl	0,92 vl	0,74 vl
Total Microbial Population (cfu/g)x 10^5	2,90	1,49	2,73
Number of earthworms (individual/m2)	1,3	1,7	3,6
Root depth (cm)	77 a	56 qa	66 qa
Dust + clay (%)	33,760	26,253	23,733
Porosity (%)	52,85	54,5	58,33
Volume weight (g/cm3)	1,284	1,227	1,132
Density (g/cm3)	2,72	2,70	2,71

Note: Block I: Organic land; Block II: Inorganic land; Block III: control; vl: very low; l: low; sa: slightly acidic pH ; a: acid ; a: appropriate; qa: quite appropriate
Sources of land appreciation: [6] and [7].

Soil character affects plant growth and productivity. Judging from the chemical properties of the soil, it is known that the average organic C content in block III is 0.734%, block I is 0.928% and block II is 0.924%. This shows that there are differences in organic matter levels in the observation area that occur due to the application of organic matter with a frequency of 2-3 times a year and with a dose of 5-6 kg of manure/plant in block I and block II. In addition, the organic C content in block III is lower because the area is not planted with salak pondoh plants or other agricultural commodities, so that humans do not give organic matter, in this case, farmers to the soil in block III.

When viewed from the level of soil acidity, block II has a more acidic soil pH than block III and block I. The soil in block

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I has a pH of 5.7, block II 5.3 and block III 5.5 (table 2). One of the reasons for this is the application of inorganic chemical fertilizers to the soil in block II. [8] stated that one of the factors that affect soil pH is the way farmers cultivate. In this case, farmers who grow salak in their block II land use urea, SP-36 and KCl as nutrient inputs. The results of the study [9] showed that the application of urea fertilizer had a significant effect on soil acidity (soil pH), where H+ ions were produced in the nitrification reaction which then lowered soil pH until the sixth week of observation. [10] stated that in soils with a pH of less than 6.3, urea fertilizer requires 2H+ ions for each urea molecule so that the decomposition process of urea fertilizer occurs. This incident tends to increase the soil pH at first but then the soil pH drops even more so that the soil pH becomes more acidic than before.

The physical properties of the soil in the research area showed differences in results when viewed from the percentage of dust + clay content in each observed block. This difference is caused by one of the factors of altitude and the level of weathering that occurs in the soil in the area. Block II is located at a higher location (380-440 masl) and closer to Mount Merapi than block I and block III (about >370 masl) so that the area gets more additional material due to volcanic activity.

Observations in the field directly in the field, showed that many large rocks were found, this was supported by data on root depth measurements in block II which had the lowest root depth compared to other blocks observed. [11] stated that the area close to the volcano, experienced the addition of volcanic material to the soil directly. The low dust and clay content in block III can also be caused by the lower level of soil weathering compared to other blocks observed. One of the factors that affect the level of soil weathering is the activity of organisms on it, namely plants. The land in this block contains only grass and is not processed for continuous cultivation of agricultural crops.

The biological properties of the soil observed in the research area showed that the low population of soil microbes in block II could be caused by the pH of the soil which tends to be acidic, where pH is very important in determining the activity and dominance of microorganisms in the soil. For example, the growth of phosphate solubilizing bacteria is strongly influenced by soil acidity where the growth and mineralization activity of phosphate by phosphate solubilizing bacteria increases with increasing soil pH. In general, phosphate solubilizing bacteria belong to the group of spore-forming aerobic microbes that live at pH 4-10.6 (Balittanah, 2006). In addition to soil pH, other factors that affect microbial activity are vegetation and soil moisture. This causes the soil in block III to have a higher number of microbes than the number of microbes in the soil of block II. The soil in block II has grass that covers the entire surface of the land and its location is next to the irrigation flow so that the soil in this block is more moist than the soil in block I and

II. According to [12], in addition to mineral and organic matter, the regional climatic conditions, growing vegetation, reactions that take place and moisture content affect the population of microorganisms in the soil.

The parameter of root depth, measurements were carried out to a layer that was impermeable to plant roots. The layer can be a hard solid layer, clay solid, brittle solid or phlintite layer [13]. Based on the data obtained, the observation block has a depth ranging from 56-77cm. The results of field observations showed that in block II, large rocks from the eruption of Mount Merapi were found, besides that at several drilling points, hard layers of rock were found. The deeper the roots can grow, the better the plant production will be, this is stated in research [3] which states that the deeper the depth of the salak plant in the research area, the higher the production of salak fruit

The presence of earthworms can be a parameter of soil fertility because most of the mineral soil material digested by earthworms is returned to the soil in the form of nutrients that are easily utilized by plants. In addition, earthworm droppings are also rich in nutrients because earthworm activity can increase the availability of nutrients N, P, and K in the soil for plants [14]. From the results of observations made, the average number of earthworms found in block III was 3.6 earthworms/m^2, while in block II and block I, respectively, earthworms were found to be 1.7 earthworms/m^2 and 1.3 earthworms. /m^2. Block III is land that is not used for cultivation activities, based on field observations the land in this area is covered by grass that covers the ground, while in blocks I and block II there is no grass covering the ground. This is in accordance with [15] which states that earthworms are one of the soil macrofauna whose existence is strongly influenced by land cover.

Soil Quality Index

Soil quality index is an integration of physical, chemical and biological properties of soil that can describe the level of quality of a soil. Determination of soil quality (soil quality) is based on the results of the calculation of the value and weight of each soil quality indicator. The results of the calculation of soil function and soil quality index in each area can be seen in Figure 1 and Table 3.

Figure 1 shows that the organic farming system (Block I) has better soil characteristics and quality than the salak cultivation land which is managed inorganically (inorganic) and the control block has both the function of preserving biological activity, the function of regulating and distributing water and the function of filtering. and buffering. The results obtained are in accordance with research conducted by [16] who is a joint researcher from IOWA State University and USDA-Agricultural Research Service who reported that the application of organic farming systems during one growing season showed a better response than inorganic farming systems on several soil quality indicators. such as total carbon, available nitrogen, water holding capacity, electrical conductivity and soil pH.

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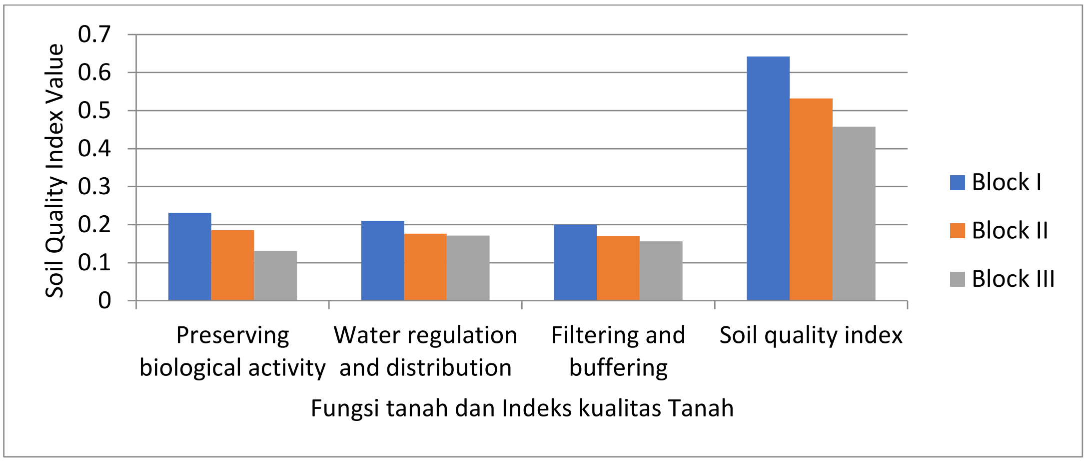

Fig. 1. Soil function and soil quality index at the study site.

TABLE 3. Classification of soil quality at the study site

No	Observation Block	Sample Point	Soil Quality Index	Average	Criteria
1	Blok I	Organic.1	0,712	0,642	Good
		Organic. 2	0,639		
		Organic. 3	0,575		
		Organic. 4	0,641		
2	Blok II	Anorganic. 1	0,455	0,562	Medium
		Anorganic. 2	0,623		
		Anorganic. 3	0,606		
		Anorganic. 4	0,445		
3	Blok III	Control 1	0,456	0,458	Medium
		Control 2	0,465		
		Control 3	0,453		

Based on the soil quality index that has been obtained, block I has an IKT value of 0.642 with a good soil quality classification, block II is 0.562 which is included in the medium quality soil classification, and block III has an IKT value of 0.458 with a moderate soil quality classification. The IKT value obtained shows that the soil on the salak land with organic farming system applied by the farmer group "SICANTIK" has better soil characteristics and quality than the salak cultivation land which is managed inorganically (inorganic) and good control block from the function of preserving activities. biology, water regulation and distribution functions as well as filterring and buffering functions. Related research was also carried out by [17] which stated that the application of organic farming systems was able to improve the physical, chemical and biological characteristics of the soil including blackish soil color, decrease soil bulk density, increase total soil pore space, and increase soil permeability. The application of organic farming systems can increase soil respiration, the number of soil microorganisms, and the population of earthworms.

IV. Conclusion

Based on the results of the research that has been done, it can be concluded that the quality of the soil on the salak pondoh land which is managed organically has good soil quality, while the soil managed with the inorganic system has moderate soil quality. The soil quality index in the research area is described by soil characteristics that have similarities in terms of physical properties and nutrient availability, which are low in all observation blocks. Differences were found in the chemical and biological properties of the soil in each block of observations. Soil pH in block II (inorganic) tends to be more acidic and has lower root depth than blocks I and III, and block I (organic) has a better total microbial population and root depth than blocks II and III.

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