Analysis of Sustainable Agricultural-Based Land Management on the Slope of Lawu Mountain in Indonesia

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Abstract: **Sustainable agricultural land is a field of agricultural land designated to be protected and developed consistently in order to produce staple food for national food self-sufficiency, security and sovereignty. The purpose of this study was to determine the differences in sustainable agriculture based on the slope in the western slopes of Mount Lawu. This research uses quantitative research methods and is described descriptively with the data sources in this study, namely farmers, environmental coordinators, heads of farmer groups and related agencies (BPS, DLH, DISPERTAN). The data collection methods used were questionnaires, interviews, observation and documentation. The sampling technique used was stratified random sampling, which was to classify the population according to certain geographic features in this study, namely the slope on the West Slope of Lawu Mountain. This research is a quantitative study with data analysis using the Sustainable Agriculture Index. The results showed sustainable agriculture index was on slopes 0-2% (110), slopes 2-6% (80.5), slopes 6-13% (96.7), slopes 13-25% (85.1), slopes 25-55% (71.8) , and slopes > 55% (104.3). The conclusion of this research is that the implementation of sustainable land management based on the results is in the high to very high category. This research can be used as a reference to consider in making policies related to sustainable agriculture.**

Keywords: **Sustainable Agriculture, Slopes, Lawu Mountain**

I. INTRODUCTION

The average contribution of the agricultural sector to the Indonesian economy during the 2014 - 2018 period was 13.25%, this is much lower than the average contribution of the manufacturing sector which reached 20.52%. Meanwhile, in terms of production, the tendency of the agricultural sector production index to increase during the 2014 - 2018 period. However, the standard of the contribution and the production index only reflects the economic dimension of agriculture and does not reflect "sustainable" agriculture (Muhammad Fajar, 2019).

Agricultural development in Indonesia is directed towards sustainable agriculture development, as part of the implementation of sustainable development. Sustainable agricultural development (including rural development) is an issue of strategic importance that is of concern and discussion in all countries today. Apart from being a goal, sustainable agricultural development has also become a paradigm for agricultural development patterns (Rudi S.R., 2011).

Topographically, parts of Karanganyar Regency have steep slopes because of their location in a volcanic area (Slopes of Mount Lawu). Diverse topography and high rainfall in this study area cause a very high frequency of weathering, erosion, and mass movement including landslides (Kuswaji et al., 2020). Slope stability can be influenced by various factors such as the influence of geological structures, the influence of rock / soil properties, water factors, human activities, changes in geometry and others (Ika Juliantina et al, 2018: 671).

Abuse in managing land does not only come from outside parties (not local residents) but can also come from local residents. Like the management of agricultural land carried out by residents of Karanganyar Regency. One example is the area of Cetho Hamlet, Gumeng Village, Jenawi District. Farmers in the area have not implemented sustainable land management.

The area of Cetho Hamlet has a steep slope (25-55%). With a hilly morphology and a steep slope of more than 20%, a terracing cropping system should be applied to reduce the rate of erosion and landslides. But this is not applied by local farmers. Because the terraced planting system will reduce the area of land, which ultimately reduces the production and income of farmers. But it resulted in landslides and floods that occurred in Cetho Hamlet in 2019. Local farmers chose to increase their income regardless of land conditions. The increase in the economic aspect is not always high and increases every harvest season. When compared to jobs other than in the agricultural sector, income from the agricultural sector is less promising. The residents considered that their income from farming was relatively small. The time span for farmers to get income from farming is relatively long, two to three months. It is different from when people work as factory workers (Solopos,2015).

The sustainability of the agricultural system is a major concern to ensure the survival and well-being of people in Indonesia. Sustainability is a complex issue involving many broad factors, namely economic, social and environmental aspects. Several regions in Indonesia have established regulations related to sustainable agriculture, one of which is Karanganyar Regency, which is located on the western slope of Mount Lawu.

However, there is little information regarding sustainable agriculture in Karanganyar Regency. So that the researchers want to fill this gap by conducting research on the analysis of sustainable agriculture-based land management based on the slope in the west slope of Mount Lawu.

II. LITERATURE REVIEW

The concept of sustainability is a multidimensional concept that cannot be measured indirectly. This concept must cover not only economic but also environmental and social intertwining and balance between the three. This concept is applied in agriculture to sustainable agriculture. The concept of "sustainable agriculture" is both ambitious and ambiguous, as various factors influence achievement and assessment. This concept has different components, attributes, and indicators at different scales as well as the complex interactions among the environment, economy and society (Roy and Chan, 2012).

To measure sustainable agriculture, a set of indicators is needed which is divided into three parts, namely indicators on economic, social, and ecological aspects. Each indicator consists of variables that reflect and relate to its objectives (Muhammad Fajar, 2019). Assessment indicators in the sustainability of a land according to Muhammad Fajar (2019: 05):

1. *Economic Aspects*

a. *Agricultural production index*

This index measures the quantity of selected products produced from the agricultural sector.

b. *Agricultural GDP contribution*

This is the percentage contribution of agricultural GDP to GDP.

c. *Agricultural GDP farmer*

It is the gross added value of the agricultural sector divided by the number of people who work in the agricultural sector.

2. *Ecological Aspects*

a. Average pesticide per hectare used by farmers
b. Average chemical fertilizers per hectare used by farmers
c. Environmental quality index, air quality index, water quality index, and land cover quality index.

3. *Social Aspects*

a. The proportion of the population working in the agricultural sector
b. Farmer education level
c. The average number of members of the agricultural household

Agricultural activities carried out by humans try to exploit resources excessively so as to damage environmental and biological conditions, as a result, accelerated damage to natural resources, land and water. The sustainability of land resources is significantly affected, which is shown by increasing the amount of input from outside the farm that must be provided from year to year to obtain the same target yield. Thus, it is not appropriate to combine these two terms, one does not indicate human intervention and depends more on natural conditions, while the other focuses on human intervention in exploiting natural resources without causing negative effects in the long run. exploiting resources excessively so as to damage environmental and biological conditions, as a result accelerated damage to natural resources, land and water. The sustainability of land resources is significantly affected, which is shown by increasing the amount of input from outside the farm that must be provided from year to year to obtain the same target yield. Thus, it is not quite appropriate if these two terms are combined, one does not indicate human intervention and depends more on natural conditions, while the other focuses on human intervention in exploiting natural resources without causing negative effects in the long term (Rudi S. R., 2011).

The economic level of farmers can be a consideration for implementing sustainable agriculture. Because the implementation of sustainable agriculture requires more capital. Although its application can increase the profitability of agriculture in the long run (Lucy Emerton, et al, 2018). Implementing Sustainable Agriculture practices through better training, increasing cultivated agricultural land, grouping agriculture, encouraging farmers to join farmer organizations, introducing and subsidizing labor-saving technologies, making credit accessible, increasing the insurance market, and for PLB practice (Nguyen V Song., Et al. 2020). Sustainable agriculture is a challenge in the world of agriculture that requires farmers to have different and better farming behavior, especially for environmental aspects (Anne Charina, 2018).

Sustainable agricultural management must be adapted to the physical conditions of an area to get maximum results. The physical condition of a space (area) has various characteristics. The characteristics of the highland areas are the morphology, topography, climate and various soil types. One of the physical characteristics in the highlands that is considered for sustainable agriculture is the slope of the slope. Because the slope is tilted, the number of soil grains that are splashed down the slope by the impact of the raindrops increases. If the slope of the soil surface becomes twice as steep, the amount of erosion per unit area will be 2.0 to 2.5 times greater (Arsyad, 2010: 112).

Table 1 Van Zuidam Slope Classification (1985)

Slope	Information	USSSM classification (%)
0-2	Flat-Almost Flat	0-2
3-7	Very gentle slopes	2-6
8-13	Sloping slopes	6-13
14-20	Slopes are a bit steep	13-25
21-55	Steep slopes	25-55
56-140	The slopes are very steep	>55

Source: Van Zuidam, 1985.

Table 3 shows the various classifications of slopes, processes that characterize the land and land conditions. Slope class showing the similarity of critical land accompanied by processes on certain prominent slopes. Certain conservation activities can also be carried out on certain landforms that have a prominent process or conservation class value. The steep slope causes the effect of gravity to move the loose materials even greater. If the process occurs at a slope of more than 8%, the surface runoff will increase in quantity and speed as the slope becomes steeper (Van Zuidam, 1985).

Table 2 Relationship of Slope Classification with Process Properties and Land Conditions

USSSM Slope Classification (%)	Processes, Characteristics, and Land Conditions
0-2	Flat or nearly flat, no major erosion, can be treated easily in dry conditions.
3-7	Slopes are very gentle, landslides move at low speed, erosion and erosion will leave very deep marks.
8-13	Sloping slopes, low landslide movement speed, very prone to erosion.
14-20	Slopes are rather steep, prone to landslides, there are grooves and surface erosion.
21-55	Slopes are steep to steep, erosion often occurs and the soil moves at a slow pace. Areas prone to erosion and landslides.
56-140	Slopes are very steep, often found rock outcrops, prone to erosion.

Source: Van Zuidam, 1985.

States that human activity factors, human activities that are not friendly to nature cause landslides, such as the construction of heavy traffic and an inadequate drainage system (Ika Juliantina, 2018).

III. RESEARCH METHODS

3.1 Study Area

The region in the West Slope of Mount Lawu is Karanganyar Regency. Karanganyar Regency is astronomically located between 110 ° 40 "- 110 ° 70" East Longitude and 7° 28"- 7° 46" South Latitude. Karanganyar Regency administratively consists of 17 districts.

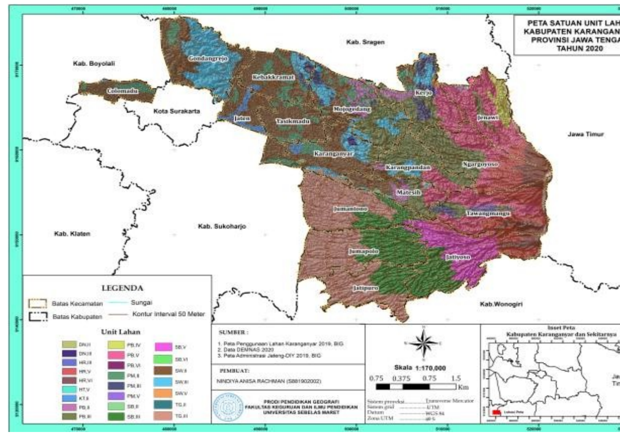

Figure 1 Map of Land Units of Karanganyar Regency.

The research location was determined based on the slope classification of Van Zuidam represented by six (6) sub-districts in Karanganyar Regency. The data is obtained from the 2020 Karanganyar Regency Land Unit map and is supported by the Google Earth Pro application to determine the location point according to the slope.

Karanganyar Regency has an area of 77,378.64 Ha or 2.38% of the total area of Central Java Province, which consists of a rice field area of 22,340.45 Ha and a dry land area of 55,038.19 Ha. Paddy land consists of 19,212.51 ha of technical irrigation, 1,895.60 ha of non-technical, and 1,232.34 ha of non-irrigation. State forest that is still maintained covering an area of 1,836.34 hectares. Meanwhile, the land area used for plantation land is 3,622.16 hectares, and other uses are 11,210.80 hectares.

Tabel 3 Research Location Based on Van Zuidam Slope Classification

Slope (USSM) (%)	Location	Koordinat (UTM)
0-2	Karanganyar District	498227,37 m E dan 9158520,70 m S – 498291,23 m E dan 9158686,93 m S
2-6	Mojogedang Distric	502828,59 m E dan 9165382,89 m S – 502867,38 m E dan 9165336,75 m S
6-13	Kerjo District	507509,85 m E dan 9165635,05 m S – 507425,09 m E dan 9165580,69 m S
13-25	Ngargoyoso District	513605,32 m E dan 9158798,07 m S – 513789,96 m E dan 9158796,00 m S
25-55	Jenawi District	516935,28 m E dan 9160823,73 m S – 517185,00 m E dan 9160750,56 m S
>55	Tawangmangu District	514283,03 m E dan 9151895,24 m S – 514380,87 m E dan 9152261,74 m S

Source: Google Earth Pro Karanganyar Regency, 2020.

Determining the research location into 6 sub-districts in Karanganyar Regency based on the slope classification of Van Zuidam.

3.2 Population and Samples

The population in this study is the area of agricultural land in six districts consisting of Karanganyar District, Kerjo District, Mojogedang District, Jenawi District, Ngargoyoso District and Tawangmangu District.

The sampling method used was the Porposive Sampling technique, namely to classify the population according to the slope in the West Slope of Mount Lawu. Land area samples were obtained from the 2020 Land Unit Map of Karanganyar Regency, 2013 Karanganyar Regency Agricultural Survey Data and the Google Earth Pro Application. Karanganyar Regency Slope Map 2020 to get location points with certain slope classifications according to Van Zuidam and determine coordinate points. Karanganyar Regency Agricultural Survey Data for 2020 to obtain data on the area of agricultural land at the sub-district level in Karanganyar Regency. The Google Earth Pro application in this study is to ensure the condition of the research location that has been obtained from the slope map.

3.3 Research Design

This study uses a spatial comparative analysis approach. The spatial comparative analysis referred to in this study is to analyze the differences in sustainable agriculture at each research location.

The research variables used in this study are one independent variable and the dependent variable. The independent variable in this study is the slope which gives a difference effect on the dependent variable, namely sustainable agriculture on the West Slope of Mount Lawu.

3.4 Data and Data Sources

The data needed in this study are secondary data. Secondary data can be in the form of data related to government agencies, such as the Central Statistics Agency, related agencies (sub-district offices and sub-district offices), DLH, and the Agriculture Office.

3.5 Data collection technique

Data collection techniques used in this study are in the form of observation, interviews, and data interpretation. The observation technique in this study was used to observe the object of research, namely the ecological aspects of the land environmental quality indicators (including water quality, air quality and land cover quality). Structured interviews in this study were used to obtain data on how to manage agriculture sustainably. Interpretation is carried out in a limited manner, namely interpreting the data in accordance with this study.

3.6 Data Analysis

Analysis of the data used to describe the differences in sustainable land management based on the slope of the slope on the West Slope of Mount Lawu in 2020 uses a sustainable agriculture index assessment according to Muhammad Fajar (2019). The data used for analysis is secondary data obtained from several related agencies such as BPS, DLH, Dispertan, and sub-district or sub- district offices. All data is then calculated using the following formula:

a. *Economical Aspect*

$$I_{economic} = \frac{\widetilde{IPP} + \widetilde{KP} + \widetilde{PDBP}}{3}$$

b. *Ecological Aspect*

$$I_{ecologic} = \frac{\widetilde{RPest} + \widetilde{RPuk} + \widetilde{IKLH}}{3}$$

c. *Social Aspect*

$$I_{social} = \frac{\widetilde{PP} + \widetilde{TPP} + \widetilde{RAP}}{3}$$

d. *Sustainable Agricultural Index*

$$SAI = \left(\sqrt[3]{I_{ekonomi} \times I_{ekologi} \times I_{sosial}}\right) \times 100$$

To see the achievements of SAI between research locations, it can be seen through the classification of SAI into several categories, namely:

SAI Low : $SAI < 60$

SAI Medium : $60 \leq SAI \leq 70$

SAI High : $70 \leq SAI < 80$

SAI Very High : $SAI \geq 80$

The classification of the Sustainable Agriculture Index (SAI) in this study will be used to analyze the differences in sustainable land management based on the slope of the West Slope of Mount Lawu in 2020.

IV. RESULTS AND DISCUSSION

4.1 General Description

Based on its geographical position, Karanganyar Regency has regional boundaries:

West side : Surakarta City and Boyolali Regency

East side : East Java Province, Magetan Regency

North side : Sragen Regency

South side : Wonogiri Regency and Sukoharjo Regency

Karanganyar Regency has an area of 77,379 Ha or 2.38% of the total area of Central Java Province, which consists of:

Table 4 Area, Agricultural Land Area, Height and Slope of Research Location

Location	Area (Ha)	Agricultural Land Are (Ha)	Elevation (mdpal)	Slopes (%)
Karanganyar	430.264	1.707	320	0-2
Mojogedang	533.099	2.025	500	2-6

Kerjo	468.227	1.130	520	6-13
Ngargoyoso	653.394	690	880	13-25
Jenawi	560.828	539	750	25-55
Tawangmangu	700.316	712	1200	>55

Source: Bappeda Karanganyar Regency, 2019.

In terms of morphology, Karanganyar Regency consists of flat, wavy, steep and very steep areas, showing a wavy uphill shape. Altitude ranges from 80 to 2,000 meters above sea level (masl), with most of them being at an average of ± 511 masl. Karanganyar Regency has various slopes, from flat to very steep. The above conditions are controlled by geological structures based on regional geological maps showing the fault structure, it is estimated that there are several fault structures and several alignment structures.

Table 5 Type of Soil Research Location in 2020

District	Type of Soil
Karanganyar	Brown Mediterranean
Mojogedang	Brown lithosol, Brown Mediterranean
Kerjo	Brown lithosol
Ngargoyoso	Brown Andosol, yellowish brown andosol, dan lithosol
Jenawi	Lithosol, brown lithosol, reddish brown mediterran, andosol coklat, and , yellowish brown andosol.
Tawangmangu	Brown Andosol, , yellowish brown andosol, dan lithosol.

Source: Departement of Agriculture, 2019.

Climatic general weather conditions prevailing in a region, such as temperature, air pressure, humidity, rainfall, sunshine, cloudiness, and wind, with a calculation of the average throughout the year. The climatological condition in Karanganyar Regency has a tropical climate.

Table 6 Average Temperature, Rainy Day and Rainfall by Month in Karanganyar Regency in 2019

Month	Temperatur e (°C)	Rainy Day (day)	Rainfall (mm)	Average (mm/day)
January	26	23	412	18,3
February	26	16	365	22,8
March	26,3	22	480	21,9
April	26,6	12	228	19
May	26,2	5	65	13,7
June	25,6	0	0	0
July	24,9	0	0	0
August	25,2	0	0	0
September	25,9	0	0	0
October	26,5	2	37	21,3
November	26,4	5	84	16
December	26,1	18	362	20,4
Amount thn. 2019	113	102	2034	153
Average	26	9	169	13

Source: Bappeda Karanganyar Regency, 2019

4.2 Results

The difference in sustainable agriculture based on the slope in this study was analyzed using the calculation of SAI (Sustainable Agriculture Index) according to Muhammad Fajar (2019). IPB calculations are obtained from secondary data and primary data consisting of economic aspects, ecological aspects and social aspects.

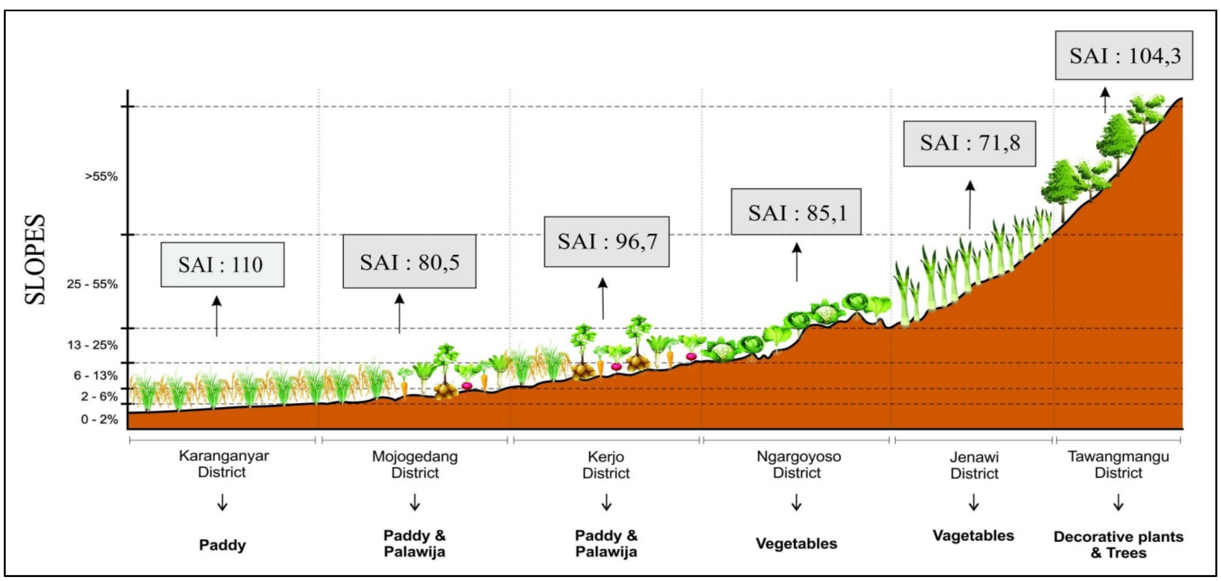

Figure 2 Toposequence of Sustainable Agricultural Index based on Slopes

Based on (Figure 11) shows that the results of the sustainable agriculture sensory value in each study location have differences. The highest sustainable agriculture index value is 110 in Karanganyar District with the very high SAI category. While the lowest sustainable agriculture index value was 71.8 in Jenawi District with the high SAI category. Sustainale agriculture index value of Mojogedang District is 80.5 (Veri high), Kerjo District is 96.7 (very high), Ngargoyoso District is 85.1 (very high), and Tawangmangu District is 104.3 (very high).

The plant commodities in each study location with different slopes have differences. This study refers to the classification of slopes according to Van Zuidam, 1985. There are different plant commodities in each slope and the same. Due to adjusting the slope of the slope, water availability, climate and soil type. The first slope classification is 0-2% in Karanganyar District with the rice crop agricultural commodity. The II slope classification is 2-6% in Mojogedang District, the agricultural commodity is rice and secondary crops. The III slope classification is 6- 13% in Kerjo District, agricultural commodities of rice and secondary crops. The IV slope classification is 13-25% in Ngargoyoso District for vegetable crops. The classification of slope V is 25-55% in Jenawi Subdistrict, the dominant vegetable crop is leeks. The slope classification of VI slope is> 55% in Tawangmangu District, agricultural commodities of ornamental plants and vegetables.

The difference in crop commodities is caused by differences in slopes. Slope stability is different for each gradient. The steeper the slope, the lower the stability. It is also influenced by human activities in managing agricultural land. Therefore, to maintain the sustainability of agricultural land, it is necessary to have differences in crop commodities that are adjusted to the stability of the slopes. For the flat slope (0-2%) can be planted with rice and secondary crops. Whereas with steep - very steep slopes, agricultural land needs to be planted with tree crops to maintain slope stability and reduce erosion rates.

Maintaining land sustainability in ecological aspects will have an impact on social and economic aspects. If the managed agricultural land is of good quality, it can increase agricultural productivity. With the increase in agricultural production, then the impact on the welfare of farmers increases.

Table 7 Sustainable Agriculture Index Value on the West Slope of Mount Lawu in 2020

Aspect	Indikator	Value					
		L1	L2	L3	L4	L5	L6
Economical Aspect	Sustainable Agricultural Index	0,34	0,50	0,50	0,50	0,66	0,49
	Agricultural GDRP contribution	0,49	0,49	0,49	0,49	0,49	0,49
	Agricultural GDRP farmer	0,21	0,21	0,21	0,21	0,17	0,21
Average		0,40	0,40	0,40	0,40	0,44	0,40
Ecological Aspect	Average pesticide used by farmer	0,56	0,27	0,47	0,25	0,25	0,24
	Average chemical fertilizers	0,76	0,29	0,57	0,30	0,27	0,45
	Environmental quality index	0,43	0,51	0,48	0,57	0,40	0,98
Average		0,58	0,36	0,51	0,38	0,31	0,55
Social Aspect	The proportion of farmer	0,72	0,31	0,45	0,72	0,27	0,56
	Farmer education level	0,32	0,63	0,71	0,41	0,48	0,33
	The average number of members of the agricultural hosehold	0,60	0,60	0,50	0,50	0,33	0,60
Average		0,55	0,51	0,55	0,54	0,36	0,50
Sustainable Agricultural Index		110,00	80,49	96,76	85,15	71,80	104,32

Source: Secondary Data, 2020.

Based on (table 4) shows the results of primary data processing and secondary data from each indicator. The agricultural production index indicator with the lowest value was in Karanganyar District (L1), namely 0.34, and the highest was in Jenawi District (L5), namely 0.66. Agricultural GRDP contribution with a value of 0.49 in all locations. The lowest value of GRDP per farmer is in Jenawi District, namely 0.17. The average pesticide use per hectare by farmers had the highest value in Karanganyar District (L1), namely 0.56 and the lowest value in Tawangmangu District (L6), namely 0.24. The average use of chemical fertilizers per hectare by farmers had the highest value in Karanganyar District (L1), namely 0.76 and the lowest value in Jenawi District (L5), namely 0.27. The index of environmental quality had the highest score in Tawangmangu District (L6), namely 0.98 and the lowest in Jenawi District, 0.40. The highest proportion of the number of farmers was in Karanganyar (L1) and Ngargoyoso (L4) Districts, namely

0.72 and the lowest in Jenawi District (L5), namely 0.27. The proportion of farmers' education level has the highest score in Kerjo District (L3), namely 0.71 and the lowest score in Karanganyar District, which is 0.32. The lowest score for farmer household members is in Jenawi District (L5), namely 0.36.

Each research location has the highest value from each aspect. Karanganyar District (L1) had the highest score in the ecological aspect, namely 0.58. Mojogedang District (L2) had the highest score on the social aspect, namely 0.51. Kerjo Subdistrict (L3) has the highest score in the social aspect, namely 0.55. Ngargoyoso District (L4) has the highest score in the social aspect, namely 0.54. Jenawi District (L5) has the highest score in the economic aspect, namely 0.44. Tawangmangu District (L6) had the highest score in the ecological aspect, namely 0.55.

4.3 Discussion

Sustainable Agriculture (SA) is a procedure or procedure for managing agricultural land with a sustainability orientation in several aspects. The aspects of sustainability in question are economic, ecological and social aspects. The indicators of these three aspects will be used as a reference for analyzing the difference in the index value of sustainable land management in the research location. PB index assessment uses secondary data and primary data. Economic aspect indicators consist of the agricultural production index, the contribution of agricultural GRDP, and agricultural GRDP per farmer. Ecological aspect indicators consist of the average use of pesticides, the average use of chemical fertilizers, and an index of environmental quality. Indicators for the social aspect consist of the proportion of the number of farmers, the proportion of the education level of the farmers, and the average number of members of the farmer household.

There is a difference in the sustainable agricultural index value in this study, although not significant. SAI slope I (Karanganyar District) is 110, SAI slope II (Mojogedang District) is 80.49, SAI slope III (Kerjo District) is 96.76, SAI slope IV (Ngargoyoso District) is 85.15, SAI slope V (District Jenawi) is 71.8, SAI slope VI (Tawangmangu District) is 104.3. The results of the sustainable agricultural index assessment from six locations were classified as high to very high.

The difference with previous research by Xavier A, et al (2018) entitled A regional composite indicator for analyzing agricultural sustainability: A goal programming approach in Portugal. The sustainable agriculture indicator according to Xavier A, et al (2018) in economic aspects consists of the total standard output of agriculture per hectare, the area of agricultural land and the proportion of agriculture with other sources of income besides agriculture. Social aspects include the proportion of land with permanent workers, the proportion of farmers aged 65 years and over, the proportion of land managers and the index of equality between sexes. Finally, the environmental aspect includes the share of intensive horticultural crops across all land used, livestock per hectare, the proportion of agriculture with rights to water and storage facilities and the proportion of agriculture that burns plant debris without reuse. The extended goal programming (EGP) method is applied to determine sustainability ratings. When there are territorial units with the same value in the ranking, use the entropy approach. Finally, spatial indicators and ranking patterns were analyzed using Geographic Information Systems (GIS).

V. CLOSING

5.1 Conclusion

Sustainable land management based on the slope in the West Slope of Mount Lawu has differences. The SAI difference analysis uses the sustainable agriculture index (SAI) formula with the low to very high category. The results of SAI at the locations in this study indicate the high to very high category. This research can be used as a consideration for formulating policies related to sustainable agriculture.

5.2 Aknowledgement

The author would like to express his sincere appreciation to the farmers who are willing to be respondents in this study and to the heads of sub-districts in Karanganyar, Mojogedang, Kerjo, Ngargoyoso, Jenawi Tawangmangu districts. The author also expresses his deepest gratitude to the offices of the Central Bureau of Statistics, the Department of Environment, and the Department of Agriculture in Karanganyar Regency.

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