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Sustainability Analysis of Potato Farming System at Sloping Land in Gowa Regency, South Sulawesi

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Abstract

The purpose of this study is to analyse the sustainability of potato farming systems on sloping land in Gowa Regency based on the assessment of sustainability index and their status. The assessment was done using Multidimensional Scaling (MDS) method with RAP-farm software. There are five dimension of potato farming system being analysed; ecological, economic, institutional, technological and social. Results of ordination technique of MDS methods showed that the potato farming sustainability index ranged from 39.6 to 62.8 in 100 scales. The value of ecological, economic, institutional and technological dimensions are including quite sustainable category, while social dimensions is including less sustainable category in potato farming systems. Leverage analysis of RAP-farm found that 19 attributes of 43 attributes being analysed gives sensitive effect on the sustainability index of potato farming systems on sloping land in Gowa Regency, South Sulawesi.

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Keywords: Potato Farming, Sustainability index, Multidimensional Scaling.

1. Introduction

Cultivation of the potato in Gowa Regency with limiting factors such biophysical relatively steep slope, soil sensitivity to landslides and erosion, rainfall is relatively high, and others. Mistakes in the management and utilization of land resources in this area can lead to damage or stress biophysical form of degradation of soil fertility and water availability that impact is not only felt by the people in the highlands, but also in the lowlands below.

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Four things which reflects a decrease in the quality of dryland farming highlands namely (i) farming increasingly unprofitable for farmers that can not meet the economic needs of their families, (ii) decrease in the carrying capacity of the environment is demonstrated by the increasing environmental degradation and low productivity of land, (iii) increasing the volume of rainfall due to climate anomalies that trigger an explosion of pests and diseases of plants, resulting in crop failure and loss of material which is not small, and (iv) the loss of the ability of society to build social capital so that they are not capable of controlling the damage environment and is very dependent on venture capital coming from outside (Irianto et al., 1999; Anyamba et al., 2006; Pranadji, 2006).

The land area planted with potato plants about 69 930 ha (18.19% of the total area of the upstream watershed Jeneberang) in the form of fields and gardens (Makaheming, 2003). Cultivated potato farming on flat land to hilly (0-40%) that a potential land erosion. The rate of erosion in the upstream watershed Jeneberang shows that the total soil erosion on the plot planting scallion without conservation of 80 tonnes ha^{-1} $year^{-1}$ and terraced planting scallion terraced channel by 9 tonnes ha^{-1} $year^{-1}$ (Tangkaisari, 1987); both exceed the erosion that can be allowed is 8 tons / ha. In the years 1993 - 1994 erosion in the upper watersheds Jeneberang is 21.53 tonnes ha^{-1} $year^{-1}$, and in 1999 the erosion increased to 25 tonnes ha^{-1} $year^{-1}$ (Makaheming, 2003).

Alleged pattern of land use in the upstream watershed area Jeneberang Gowa not in line with the ability of the land. Potato crop farming is done in areas with a large slope without regard to conservation efforts. Land use do not take into consideration or not adapted to the ability of land would cause damage to the soil and the environment worse. Because of the magnitude of the danger of erosion and sedimentation, in the absence of management plans and land-use setting to the optimal direction, the possibility of damage to soil and watershed environment as a whole will become more severe in the future and more extensive land unproductive. It is necessary for structuring and setting the optimum land use, so that the expected damage to the soil and the environment can be minimized and economic benefits can be gained to the fullest.

In connection with this, the question arises whether a potato farm in the upstream watershed Jeneberang Gowa can be sustained. Sustainable farming is the implementation of sustainable development. Sustainable development is an effort to synchronize, integrate, and give equal weight to the three aspects, namely economic, social, cultural and environmental aspects (Keraf, 2002). The sustainability of farming measures the stability of production. In maintaining the sustainability of farming required the introduction of technology (Debermann, 2005). The introduction of technology will be adopted by 53% of farmers if the technology is already known in the region, while 47% of farmers would adopt if the technology minimal added value relatively similar to existing technologies in farmers (Backes, 2001). Some criteria that can be a reference for sustainable development, which involves ecological, economic, social, cultural as well as legal and institutional (OECD, 1993; Kay & Alder, 1999). Criteria or attributes of each of these aspects are important in assessing the sustainability status quickly (rapid appraisal), using multivariate non-parametric method called multi dimensional scaling (Susilo, 2003). This study aims to determine the index and the sustainability status of potato farming in Gowa.

2. Material and Methods

This research was conducted in the District Tinggi Moncong, in Gowa Regency and lasts from April to November, 2014. The type of data required in the analysis of the sustainability of potato farming in Gowa is the primary data in the form of attributes that are associated with five dimensions of sustainability, namely potato farming dimensional ecological, economic, social, institutional, and technology. Primary data is sourced from the respondents and experts were selected, as well as observations at the sites. Methods of data collection are done through interviews, discussions, questionnaires, and field surveys.

To assess the sustainability of potato-based farming-specific resource quickly (rapid appraisal) use multiple methods of non-parametric attributes (multi dimensional scaling = MDS), which is a modification of the RAP-farm (The Rapid Appraisal of the Status of Farming). Data analysis was performed through several stages, namely: (1) step of determining attributes or criteria of sustainable horticultural farm management, covering five dimensions (ecological, economic, social, institutional, and technological), (2) the stage of assessment of each attribute in an ordinal scale based on sustainability criteria for each dimension, (3) phase ordinated analysis of the sustainability index value by using MDS. The value of sustainability index in this analysis were grouped into four categories of sustainability status, namely: 0-25 (bad), 26-50 (less), 51-75 (quite) and 76-100 (good). Attributes and scores used in

assessing the sustainability of horticultural crops vegetable farming on sloping land in the upstream watershed Jeneberang, covering the dimensions of ecological, economic, social, institutional, and technology.

3. Result and Discussion

Results of RAP-Farm multidimensional analysis using techniques ordinated through MDS method generates an index value of the potato crop farming sustainability of 55.05. Sustainability index value is categorized quite sustainable because the value is between 51-75. This sustainability index values obtained based on an assessment of 43 attributes are covered in the five dimensions of ecology (8 attributes), the economic dimension (9 attributes), the social dimension (9 attributes), the institutional dimension (8 attributes), and the dimensions of technology (9 attributes). Thus all the attributes of the five dimensions used are quite good in explaining the condition of potato farming systems that exist today. To determine the sustainability index of each dimension and sensitive attributes affecting the sustainability of potato farming, has conducted analysis of RAP-Farm and leverage analysis in each dimension (ecological, economic, social, institutional, and technological).

3.1. Ecology Dimension

Results of the analysis of the ecological dimensions of sustainability leverage in Figure 1 is known that of the eight attributes were analyzed, there are four attributes that are sensitive affects potato crop farming system, namely the level of erosion, organic material availability, quality potato crop yields and productivity of potato crops. These four attributes are closely related, because the attribute level of erosion greatly affect the productivity and quality of potato crops. If the attrition rate is high then the productivity and quality of potato crops declined, this was due to the loss of the surface layer of soil. Where in this layer is a layer of fertile soil, organic matter and nutrients needed by plants as nutrients. If the plant nutrient needs are not being met in accordance with the quantity and quality of crop yields will decline (Mardani & Salarpour, 2015). Therefore, it is most important for the ecological dimension is managed at the level of erosion, because it will affect other attributes in potato farming system (Nurkin, 2005). Similarly, the availability of organic material, this attribute will affect the rate of erosion. If the availability of sufficient organic material, then the arte of erosion can be minimized by improving soil physical properties.

3.2. Economic Dimension

Results of the analysis of the sustainability of economic leverage seen in Figure 1 that of the nine attributes were analyzed, there are four attributes that are sensitive affects potato crop farming system, which is leading commodity potato crops, potato commodity product prices, the management of potato crops, and farmers' income. Attribute leading commodities potato plants are very big influence on potato farming systems, especially in the economic dimension, because these attributes include growing areas and production of potato plants. Types of potato crops that many farmers cultivated plant species whose production is high and the value of sales in the market is also high. So that seed potato commodity attribute is related to the income of farmers. When the leading commodity with high productivity and high prices and the availability of good marketing will increase farmers' income. Where in the high production and high prices, the farmers' income will increase. Conversely when unseeded crops with low productivity, the contribution of its sales revenue to be small farmers (Said, 2001). Similarly, the management of potato crops will affect the quality of the results. If the management is good, the quality of the results of the potatoes will be good also so the resale value will increase.

3.3. Social Dimension

Results of the analysis of the social dimension of sustainability leverage in Figure 2 is known that of the nine attributes were analyzed, there are three attributes that affect sensitive potato farming systems, ie the intensity of counseling and training in environmentally friendly technology, the existence of government services, and public knowledge about the environment. Attribute intensity of counseling and training of environmentally friendly technologies is very large influence on potato farming systems, especially in the social dimension, because this

attribute can change the behavior of farmers to farm potatoes (Anonim, 2003). If the intensity of counseling and training attributes of environmentally friendly technologies is done properly then it will change the potato farming systems, as subjects or actors of the system changes.

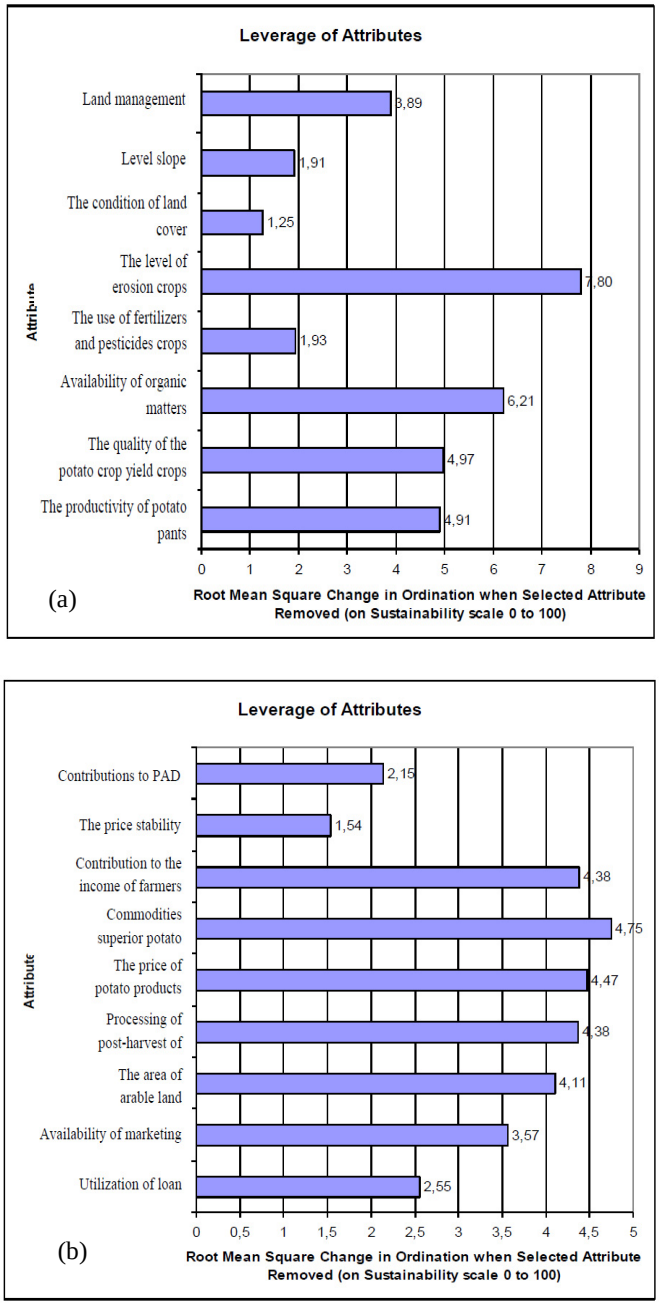
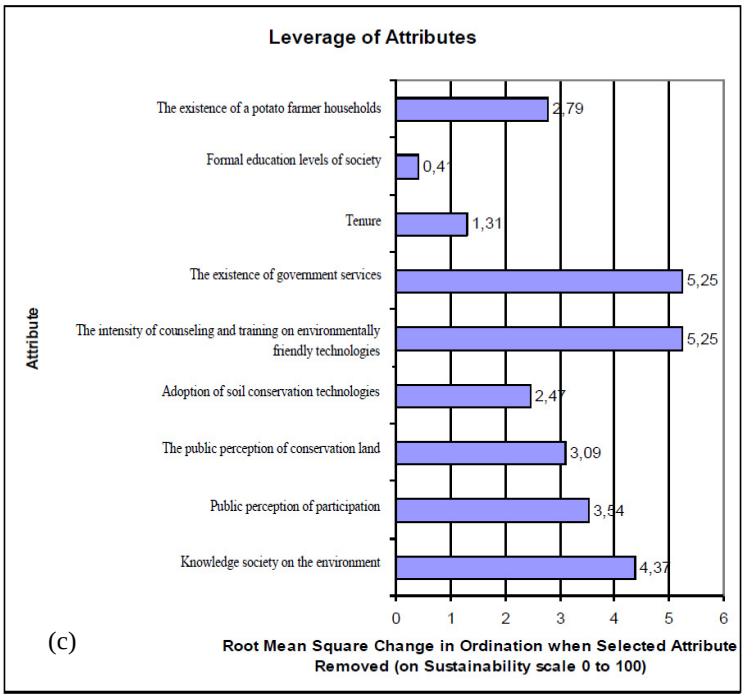


Figure 1. The sensitive attributes that affect the sustainability of potato farming - ecology dimension (a) and economic dimension (b).



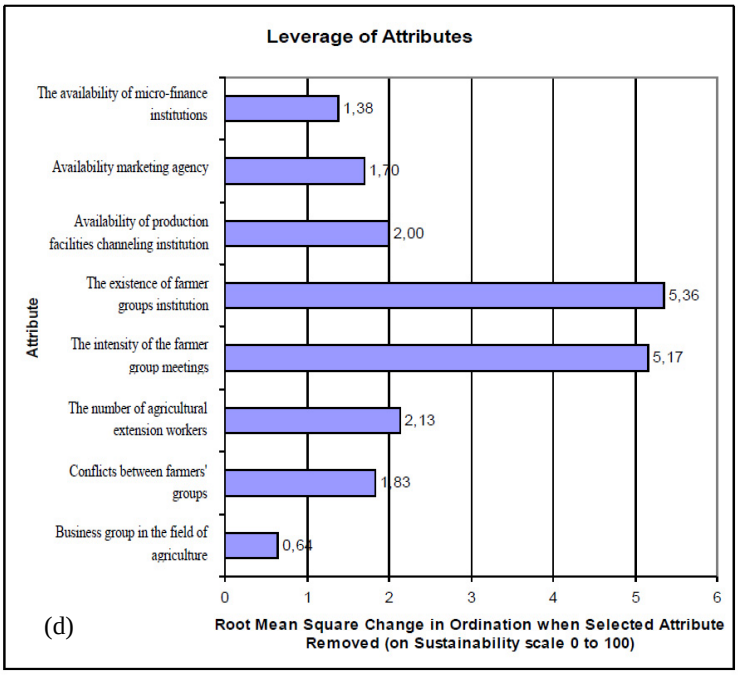


Figure 2. The sensitive attributes that affect the sustainability of potato farming - social dimension (c) and institutional dimension (d).

3.4. Institutional Dimension

Results of the analysis of the institutional dimension of sustainability leverage at Figure 2 note that of the eight attributes were analyzed, there are two attributes that affect sensitive potato crops farming systems, namely the existence of farmers' groups and the intensity of farmer group meetings. Attribute where farmer groups are very big influence on potato farming systems, especially on the institutional dimension, because this attribute forum for potato growers to deliver their aspirations and through this container can also function as facilitation to establish cooperation with the parties or other institutions. If the agency attributes the existence of farmer groups as a basis strengthened and well done it will change the potato farming system, because there is the core to develop farmer groups. And attribute farmer groups have a very close relationship with the other attributes that exist in the institutional dimension. Likewise with the intensity of farmer group meeting, when its intensity increased and carried out regularly, then the farmer groups will be increasingly developed and developing (Bagheri, 2010). This is due to the farmer group meeting will take place the exchange of experience and good ideas that can be applied in making farming potatoes.

3.5. Technological Dimension

Results of the analysis of the sustainability dimension leverage technology as shown in Figure 3 is known that of the nine attributes were analyzed, there are five attributes that affect sensitive potato crops vegetable farming system, which is a technique of mulching, use of organic fertilizer and biofertilizer, organic fertilizer production technology, the intensity of the use of pesticides, and the technology of making biopesticides. The fifth of these attributes are very big influence on potato farming systems, especially in the technological dimension, because this attribute determines the quantity and quality of potato production (Zubair, 2005). If all five of these attributes properly implemented it will revamp potato-farming system. Five of these attributes have a very close relationship with the other attributes that exist in dimensions and other attributes of technology especially in the other dimension.

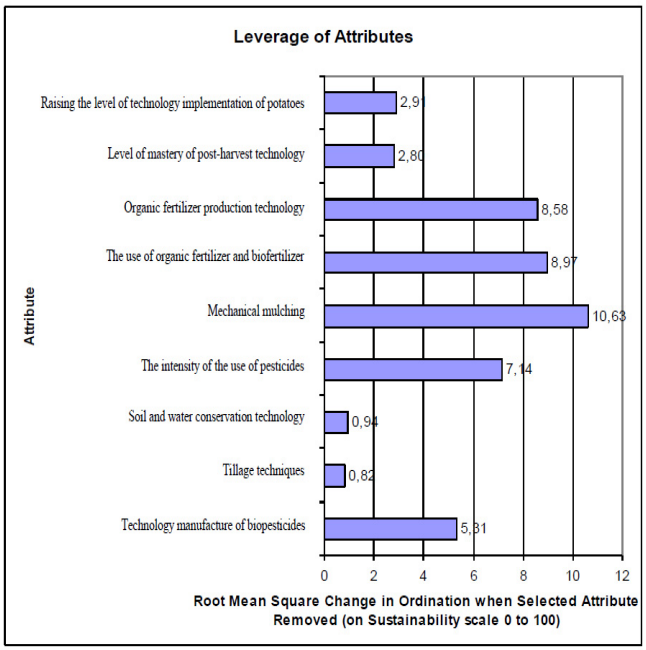


Figure 3. The sensitive attributes that affect the sustainability of potato farming - technological dimension.

Kite diagrams value of the five dimensions of sustainability indices for commodity potatoes presented in Figure 4. From kite diagram is known that each dimension of each commodity has a value of sustainability index different and require different management. Dimension which should be prioritized to be a priority in its management is an ongoing dimension with less status, so it can be good or quite sustainable status. Kite diagram in Figure 4 shows that the social dimension has an index value of between 39.6 are at less sustainable status, while the ecological dimension with an index value of 52.4, the economic dimension with an index value of 64.8, the institutional dimension with an index value of 56, 5 and technological dimension with an index value of 56.7 is the status of sustainable enough.

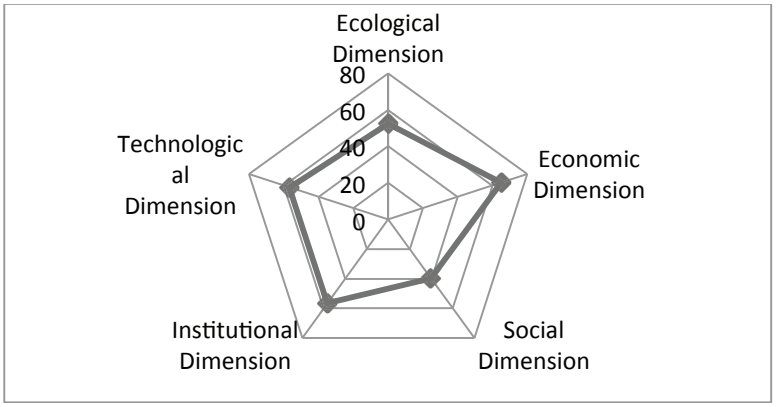


Figure 4. Kite diagram of index analysis and sustainability status of potato farming systems in Gowa.

The social dimension needs to be prioritized so that the management can be upgraded to the status of sustainable enough. To increase the value of the index on the social dimension of the management of sensitive attributes that affect the sustainability of the social dimension, especially managing attribute existence government services, intensity of counseling and training on environmentally friendly technologies, public knowledge about the environment, public perception of the participatory, and public perception of the soil conservation efforts. Existing condition potato farming, government services on farmers, especially farmers potato farmer has not met expectations, counseling and training on environmentally friendly technology has not been intensively conducted by the sub-district agricultural extension Tinggimoncong Gowa, so this needs to be improved because it is very instrumental attributes (attributes sensitive) in influencing potato farming system. Counseling and training provided to the poor, so that the public knowledge about the environment is also low (Barrantes & Yague, 2015). Consequently does not apply to farm community in the principles of conservation farming. Similarly, the public perception of participatory and soil conservation efforts. People do not understand about participatory, so that farmers are always waiting for help from the Government, the new farm community involvement at the implementation stage.

Table 1. Statistical parameters (Goodness of fit) of the analysis of the index and the sustainability status of potato farming in Gowa.

Dimension	Stress Values	Determination (R^2)
Ecology		0,95
Economic	0,15	0,95
Social	0,15	0,95
Institutional	0,15	0,94
Technology	0,13	0,94

MDS analysis results in Table 1, shows the stress values for all dimensions and multidimensional has a value of less than 0.25 ranged between 0.13 to 0.15. The smaller the stress value the better the data used. This means that the effect of errors on the assessment of an attribute is very small, so it can be ignored. While the value of the coefficient of determination (R^2) in each dimension and multidimensional ranged from 0.94 to 0.95, these values are high enough and close to 1. It shows that there is a close correlation between the attributes in a dimension that is tested. Both of these statistical parameters (stress and R^2 value) indicates that all attributes are used in every dimension on potato farming has been good enough to explain the sustainability of potato farming systems in Gowa.

Table 2. Results of Monte Carlo analysis and multidimensional (MDS) for the value of RAP Farm with a 95% confidence interval on potato farming.

Dimension	MDS	Montecarlo	Status
Ecology	52,4	65,3	Q
Economic	62,8	57,9	Q
Social	39,6	40,3	L
Institutional	56,5	55,5	Q
Technology	56,7	49,6	Q/L

Notes: Q is quite and L is less.

Results of Monte Carlo and Multidimensional (MDS) analysis (Table 2) shows that the value of sustainability index status of potato farming in each dimension with a 95% confidence interval, for multidimensional analysis ranged from 39.6 to 62.8 and Monte Carlo analysis ranged between 40.3 - 65.3. And the difference between them is relatively small range between 0.7 to 12.9. The small difference between the two index values of sustainability analysis indicates that the error in making scores of each attribute is relatively small, the variety of scoring due to the relatively small differences in opinion, the analysis carried out repeatedly stable, and data entry errors and lost data can be avoided. This difference also shows that the potato farming systems studied had a high level of confidence. Some parameters of this statistical test results show that the method Rap-farm good enough to be used as one means of evaluating the sustainability of potato farming systems in Gowa quantitatively and rapidly.

4. Conclusion

Sustainability index for potato farming systems ranged from 39.6 to 64.8. Ecological dimension (52.4), the economic dimension (64.8), institutional dimension (56.5), and the technological dimension (56.7) including status is quite sustainable, while social dimension (39,6) including less sustainable status.

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