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Multi-dimensional Analysis of Laying Hen Farming System in Agropolitan Area of Lima Puluh Kota Regency West Sumatra Indonesia

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Abstract. The purpose of this study was to assess the agropolitan area's sustainability using the laying hen farming technique. This study sought to determine the index and sustainability status of the laying hens farming system; to determine the index and sustainability status of each dimension (ecology, economy, socio-cultural, technology-infrastructure, and legal-institutional); to identify sensitive attributes affecting the laying hens farming system; and to determine the most influential factors. Data analyzed using Multi-Dimensional Scaling method. The results showed that sustainability index of laying hens farming system in the agropolitan area was 61.04 and categorized as moderately sustainable. Analysis for five dimensions showed an index with moderately sustainable, except for the socio-cultural dimension which was less sustainable. Based on the location of the agropolitan area, Guguk Sub-District had the best sustainability. Identification of influential factors showed that 27 of the 45 attributes observed were sensitive factors that influencing the laying hens farming system. The leverage analysis revealed seven critical aspects affecting the laying hens farming system that must be controlled appropriately and that various states may occur in the future in order to fulfill the objective of developing a sustainable laying hens farming system.

Keywords: laying hens farming business, sustainability, moderate-sustainable

1. Introduction

Lima Puluh Kota Regency has great potential in the laying hens farming sub-sector. This great potential can be developed with an agropolitan concept to balance development with the concept of rural-urban development. Therefore, the effect of depletion (backwash effect), both depletion of natural resources and human resources in rural can be avoided. According to [1], the development of agropolitan will encourage the decentralization of development and authority in the area, in which villages and cities can be mutually reinforcing, and encourage the occurrence of local resource-based economic development through the empowerment of local communities [2].

SD has become a common buzzword in modern development debate [3]. The objective is to ensure that the development process is sustainable. Sustainable development is defined as development that

satisfies current needs without jeopardizing future generations' ability to satisfy their own [4]. Sustainable development is a concept that seeks to strike a balance between economic growth (economic dimension), environmental preservation (ecological component), and equity (socio-cultural dimension). Certain perspectives add technological-infrastructure, legal-institutional, and political-institutional dimension to the execution of sustainable development. The notion of sustainable development must be applied to a genuine system, which demands a strong commitment from the system's primary players (stakeholders) to assure the development's success [5]. According to [6], sustainable development refers to the ecological, economic, sociocultural, and legal-institutional components [7] added a technological dimension, bringing the total to five dimensions: (1) ecology, (2) economics, (3) sociocultural, (4) legal-institutional, and (5) technology. Finally, the technology axis is connected to the infrastructure axis [8].

The purpose of this study was to determine the viability of the agropolitan area in Lima Pulu Kota Regency. The objectives of this study were to: (1) determine the index and sustainability status of the laying hens farming system; (2) determine the sustainability index for each dimension (ecological, economic, sociocultural, technological, and institutional); (3) identify sensitive attributes affecting the laying hens farming system; and (4) determine the most influential factors in the laying hens farming system. The findings of this study will serve as a guide for enhancing productivity and ensuring the sustainability of laying hen husbandry. At the same time, it becomes a guideline for developing agropolitan areas by managing sensitive attributes in each dimension that affects sustainability.

2. Methodology

The scope of this research was to examine the sustainability of the laying hens farming system located in three sub-districts in the agropolitan area of Lima Pulu Kota Regency, namely Mungka Sub-District, Payakumbuh Sub-District, and Guguak Sub-District.

The research method used was a descriptive method using multi-dimensional scaling (MDS). The data used were primary data and secondary data. Secondary data from 2014 – 2020 were collected from various sources such as Central Bureau of Statistics, West Sumatra in figures, Lima Pulu Kota Regency in figures, West Sumatra Provincial Livestock and animal health Service, and other relevant sources. Furthermore, sustainability laying hens farming system was approached by five dimensions of ecology, economy, socio-culture, technology infrastructure, and legal-institutional. The index and sustainability status were assessed using multidimensional scaling (MDS) method. Meanwhile, the attributes of each dimension as well as the criteria for good and bad follow the concept proposed by [9] and [10] as well as the opinions of experts and stakeholders related to laying hens farming systems. S-Stress Values reflect the goodness of fit in MDS.

The ordination analysis of rap-laying hens was conducted in several stages, including the following: (1) determining the attributes of the five dimensions totaling 45 attributes: ecological dimension (10 attributes), economic dimension (9 attributes), socio-cultural dimension (9 attributes), infrastructure dimension (7 attributes), and legal-institutional dimension (10 attributes); (2) assigning an ordinal value to each attribute (score) based on the sustainability criteria for each dimension; (3) analyzing the ordination of Rap-laying hens using SPSS software to determine the ordinance and stress value; (4) assessing the index and sustainability status of the laying hens farming system on a multidimensional and per-dimension basis; and (5) leverage analysis to ascertain sensitive variables affecting the system's sustainability; and (6) evaluating the effect of error on the estimation of the ordinance value of agropolitan area development based on the laying hens system, using Monte Carlo analysis. Monte Carlo analysis was employed aiming to take into account the uncertainty aspect [11].

3. Result and discussion

Lima Pulu Kota Regency is one of the regencies in West Sumatra which is popular as a producer of chicken eggs. In general, the topography in the study area is flat and lowland and only a small part has a hilly topography. The climatic conditions in Lima Pulu Kota Regency are almost the same in all sub-districts. The temperature of this area is approximately 24.7°C - 27.9°C with an average rainfall of 313.25 cm per year classified as having high rainfall [12].

3.1. Analysis of the Sustainability Index and Status

The results of the Rap-Laying hens analysis showed that Lima Puluh Kota Regency had an average value of sustainability index of the layer hens farming system of 61.04. This level of sustainability is classified as moderately sustainable. The sustainability index value was calculated using an evaluation of 45 attributes representative of the five dimensions of sustainability, as presented in Table 2.

Table 2. Sustainability status of each sub-district in Limapuluh Kota Regency

Dimensions	Mungka Sub-District (KCM)		Payakumbuh Sub-District (KCP)		Guguak Sub-District (KCG)		Lima Puluh Kota Regency	
	Index	Status	Index	Status	Index	Status	Index	Status
Ecology	61.24	Moderate	61.35	Moderate	65.07	Moderate	62.55	Moderate
Economy	59.59	Moderate	56.13	Moderate	71.66	Moderate	62.46	Moderate
Social-culture	38.84	Less	40.06	Less	45.15	Less	41.35	Less
Legal-institutional	58.90	Moderate	66.16	Moderate	75.33	Fair	66.80	Moderate
Technology-infrastructure	66.79	Moderate	72.45	Moderate	76.90	Fair	72.05	Moderate
Average	57.02	Moderate	59.23	Moderate	66.82	Moderate	61.04	Moderate

Based on Table 2, the sustainability of the laying hens farming system has moderately sustainable status, which is indicated by four sustainability dimensions with index values in the range of 50-75. This index shows that the implementation of agropolitan policies is quite successful, although not optimal. The ecology, economy, technology- infrastructure, and legal-institutional dimensions show index values of 62.55, 62.46, 66.80, 72.05, respectively, indicating good sustainability. These dimensions need to be managed properly to improve performance and sustainability. The socio-cultural dimension shows a less sustainable index, this is due to various conflicts that occurred, ranging from the unpleasant smell of laying hens' farms and public disturbances because of traffic bringing raw materials to the farmer's cages. In addition, fluctuations in feed prices and erratic egg prices have caused many farmers to be unable to maintain their laying hen's business. This is due to a decrease in the number of laying hen's farmer households. Currently, there are more and more alternative jobs in the city so that urbanization increases.

Guguak Sub-District is the best agropolitan area for the sustainability of the laying hens farming system. The four dimensions of sustainability show moderately sustainable status. The socio-cultural dimension shows a less sustainable status. The ecological and economic dimensions have indexes of 65.07, 71.66, respectively, which indicate moderate sustainability, as well as the technology-infrastructure and legal-institutional dimensions with indexes above 75, those are 75.33, 76.90, respectively, indicating a very sustainable status.

3.2. Leverage analysis

To assess the sustainability of each dimension, the Rap-laying hens ordinance technique used the Multi-Dimensional Scaling (MDS) method. Through leverage analysis, this technique may also be utilized to discover sensitive features that affect the sustainability index of the layer farming system in each dimension. Each dimension's viability will be discussed in detail below:

3.3. Sustainability of the ecological dimension

The analysis results of ordination and leverage analysis for the ecological dimensions for the three sub-districts are different. The ordination value was 61.24 for Payakumbuh sub-district, 61.35 for Mungka sub-district and 65.07 for Guguak sub-district. All figures indicate moderate sustainability status. Compared to the multidimensional sustainability index value which was 61.04, Guguak sub-district sustainability rate was higher, while the other two sub-districts were lower.

The ecological dimension of leverage analysis results (Figure 3) indicate that, of the ten variables evaluated, seven were sensitive and had an effect on the laying hens farming system.

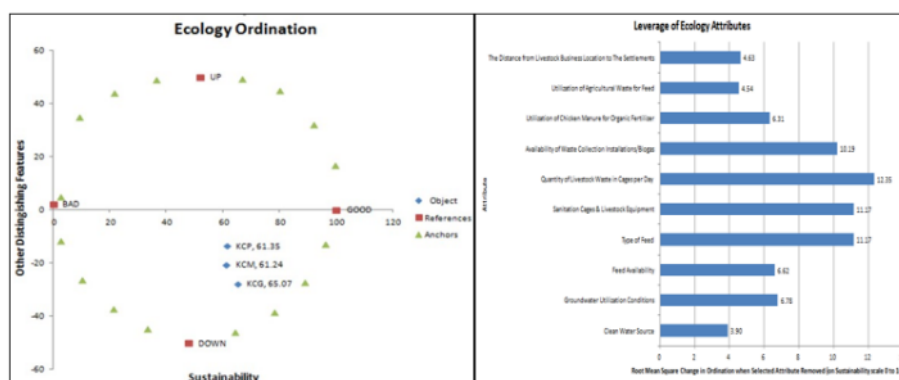


Figure 3. Analysis of the Index and Sensitive Factors of the Ecological Dimension of Sustainability

The seven sensitive qualities were identified by removing those with a change in root mean square (RMS) value greater than half the value scale on the x-axis. The seven sustainability-sensitive characteristics are as follows: (1) Utilization of chicken manure for organic fertilizer; (2) Availability of waste/biogas storage installations; (3) Quantity of livestock waste remaining in the pen per day; (4) Sanitation of animal pens and equipment; (5) Types of feed; (6) Availability of feed; and (7) Conditions of groundwater use. Thus, these attributes need to get attention and be managed properly, in order to increase the sustainability index value of the ecological dimension in the future. The most influencing factor in the ecological dimension is the amount of livestock waste left in cages per day (12.35 percent); the sanitation of animal pens (11.17 percent); and the equipment and availability of waste/biogas storage facilities (11.17 percent). On a daily basis, based on firsthand observation, the amount of waste (feces) remained in the cage was rather substantial. This condition reflects that farmer have not fully paid attention to the cleanliness of the cage. Manure is allowed to pile up around the pens before being sold to buyers who always come once a week. This condition causes an unpleasant smell, so often cause conflicts with neighbors. The availability of waste processing/container installations is still not available. In general, farmers directly sell the manure without processing it first, the waste is put into sacks and then sold when the buyer comes to pick it up.

3.4. Sustainability of the Legal-institutional dimension

A leverage analysis was conducted to determine the sensitive factors that affect the legal-institutional dimension's sustainability index value. In Figure 7, the findings of the ordination analysis and leverage analysis for the Legal-institutional dimension are provided.



Figure 7. Analysis of Sustainability Index and Sensitive Factors of the Technology-infrastructure

It determined seven attributes that are sensitive to the legal-institutional dimension's sustainability index value based on the results of the leverage analysis. These are as follows: (1) Livestock farmer groups; (2) Microfinance institutions (banks/credit); (3) Policy transparency and information delivery; (4) Agricultural extension institutions; (5) Development of livestock cooperatives; (6) The intensity of business activities that violate the law; and (7) The suitability of the land use zoning of, in Indonesia is called RTRW. The most influential sensitive attributes are policy transparency and information delivery. Attributes of laying hens farming system policies are not well planned, so the aspects that are the main requirements for agropolitan areas are not fulfilled. Disclosure of policies and information is very limited, as a result, the goal of establishing this agropolitan area is not achieved. The role of farmer institutions in the form of farmer groups is needed to mediate and facilitate farmers in the context of farmer empowerment. Farmer groups can bridge the interests of farmers with upstream and downstream industries, create business partnerships, improve their bargaining position with other parties. Business institutions, communicating with each other to obtain information on technology, production facilities, as well as financing and marketing. Another influential sensitive attribute is the availability of farmer cooperatives. The existence of cooperatives can be used as capital in fostering partnerships between farmers and government agencies in counseling, technological assistance, obtaining additional capital.

4. Conclusion

On the basis of this study's findings, it can be inferred that: 1) The sustainability index value of the multidimensional laying hen farming system in the agropolitan area of Lima Puluh Kota Regency is 60.41 categorized as moderately sustainable; 2) Meanwhile, the sustainability index value in each dimension is in the range of 38.84 - 76.90. The Social-culture dimension has the lowest sustainability index, followed by Legal-institutional, economic, ecological, and Technology-infrastructure dimensions, respectively; 3) Multidimensionally, the agropolitan area based on the laying hens farming system in Lima Puluh Kota Regency is moderately sustainable. The results of attribute identification found 45 attributes that support the system. Furthermore, the leverage analysis results found 27 sensitive attributes that have an effect on increasing the sustainability index of the system consisting of 7 ecological attributes, 6 economic attributes, 3 socio-cultural attributes, 7 technology-infrastructure attributes, and 4 legal-institutional attributes; and 4) In order for the sustainability of the system to be improved, the 27 sensitive attributes must be managed properly.

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