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EVALUATION OF THE SUSTAINABILITY SHEEP DEVELOPMENT IN GALANG, DELI SERDANG DISTRICT

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ABSTRACT

This study aims to evaluate the sustainability of sheep farming in Galang, Deli Serdang from March-May 2023. This study used the Multi-Dimensional Scaling (MDS) method with the Rap-Sheep approach for sustainability assessment. The sensitive attributes influencing the sustainability index and sustainability status were analyzed using Leverage analysis, whereas the effects of uncertainty and potential errors were examined using Monte Carlo analysis. The data used in the study included primary data and secondary data. Respondents used amounted to 90 sheep farmers. This study uses 4 dimensions, namely the ecological dimension with 12 attributes, the economic dimension with 10 attributes, the social dimension with 9 attributes, and the technology dimension with 10 attributes. The results showed that the sheep farming in Galang, Deli Serdang currently has a sustainability index value in the ecological dimension of 56,71 (quite sustainable), economic dimension of 51,50 (quite sustainable), social dimension of 63,47 (quite sustainable) and technological dimension of 38,85 (less sustainable). Multi dimensionally, the index value of 52,63 is obtained, which means that the sheep farming in Galang, Deli Serdang is in a fairly sustainable status.

Keywords: Galang Sub District, multidimensional, sheep farming, sustainability indeks and status

INTRODUCTION

Galang has experienced an

increase in sheep population every year with a total sheep population in 2018 of 10,638 heads and a rapid increase of 6,08% in 2021 of 12,579 tails . Lamb meat production in Galang Sub-district amounted to 16,441 Kg in 2018 and in 2021 it amounted to 16,607 Kg so that Galang Sub-district has potential in developing sheep livestock (BPS, 2021). The increase in population and meat production in the development of sheep is still in doubt because it has an impact on environmental sustainability so that special attention is needed in supporting sustainable animal husbandry.

Sustainable animal husbandry aims to fulfill human needs by preserving the natural environment so that these needs can be met both now and in the future. The Global Agenda for Sustainable Livestock (Global Agenda for Sustainable Livestock, 2021) defines that sustainable animal husbandry is expected to overcome the challenges of each dimension, namely the ecological, social, economic and technological dimensions so that it is necessary to evaluate each dimension of the most influential attributes in overcoming these challenges. One way to evaluate each dimension of the most influential attributes in sustainable animal husbandry is to conduct a sustainability analysis. Based on the existing problems and potential, the author is interested in evaluating the sustainability of a sheep farm using the sustainability analysis method in the form of Multi-Dimensional Scaling (MDS) with the Rap-Sheep (Rapid Appraisal for Sheep) approach technique in the development of sheep in Galang Sub-district, Deli Serdang District, North Sumatra Province.

RESEARCH METHODS

The selection of the research location was carried out purposively, with the consideration that Galang Sub-district is a relevant and representative location. Primary data collection in evaluating sustainable animal husbandry uses survey methods and direct observation of respondents (farmers) in Galang Sub-district in developing sheep livestock. Determination of respondents was carried out by Purposive Random Sampling with the requirements of respondents, namely having a minimum livestock population of 10 heads and having a minimum farming experience of 1 year. This study uses 4 dimensions with a different number of attributes. The ecological dimension has 12 attributes, the economic dimension with 10 attributes, the social dimension with 9 attributes, and the technological dimension with 10 attributes.

Evaluating the sustainability of sheep development in Galang sub-district using the sustainability analysis method of Multi-Dimensional Scaling (MDS) with the Rap-Sheep (Rapid Appraisal for Sheep) approach technique. This technique is a development of the Rapfish approach which was originally used to measure the level of sustainability of capture fisheries. This method aims to be able to measure the level of sustainability in terms of ecological dimensions, economic dimensions, social dimensions, technological dimensions and institutional dimensions (Pitcher and Preikshot, 2001; Kavanagh and Pitcher, 2004).

The use of the Multi-Dimensional Scaling (MDS) analysis method is expected to visualize the position of each dimension of sustainability measured in sheep livestock development. According to Nurmalina (2014) that the MDS approach maps two points or the same object in one adjacent point and can map two different points or objects with points that are far apart. The score value of each attribute will describe a matrix X (n x p), where n is the number of regions and their reference points and p is the number of attributes used in evaluating sustainable farming. The score values are then standardized for each attribute score value, so that each attribute has a uniform weight and differences between measurement scales can be eliminated. The standardization method is as follows:

$$Xiksd = (Xik-Xk)/Sk$$

Description:

Xiksd	=	Standard score value of the region (including its reference point) i = 1,2,...n, for each attribute k = 1,2,...p.
Xik	=	Initial score value of the region (including its reference points) to i = 1,2,...n, on each attribute to k = 1,2,...p.
Xk	=	The mean score on each attribute to k = 1,2,...p.
Sk	=	Standard deviation of the score on each attribute to k = 1,2,...p.

Based on Pitcher and Preikshot (2001); Kavanagh and Pitcher (2004); Randu and Hartono (2020), the stages of data analysis are as follows: (1) determine and identify the sustainability attributes of each ecological, social, economic and technological dimension; (2) evaluate each attribute of the dimension using an ordinal scale based on sustainability criteria; (3) use the Rap-Sheep (Rapid Appraisal for Sheep) technique through Rapfish software to calculate the index and sustainability status of each dimension; (4) leverage analysis based on Root Mean Square (RMS) variation on the x-axis to test the influence of sensitive dimensions on sustainability. The percentage (%) with the highest RMS is the most influential sustainability status attribute; (5) using the Monte Carlo analysis method to analyze the influence of errors generated by evaluation, calculation and analysis at the 95% confidence level. A value of less than 1 in the difference in the sustainability index between MDS and Monte Carlo indicates a low level of analysis error so that the small difference between the resulting sustainability indices indicates the consistency and validity of the results of good analysis; (6) calculate the level of accuracy (Goodness-of-fit) of the MDS analysis method through the stress value and the coefficient of determination (R2). According to Sugito and Marliyana (2021), the stress value and the coefficient of determination (R2) are acceptable if the stress value is below 0.25 (25%) and the R2 value is close to 1.

Table 1. Ranch Sustainability Status Categories Index Value Result

Index value	Category
0-25	Bad
26-50	Less
51-74	Fairly
75-00	Good

Source: Kavanagh (2001)

All values of each sustainability dimension attribute are then analyzed multidimensionally to determine the sustainability ordination point. There are 4 reference points in the development of sheep livestock, namely "good", "fairly", "less" and "bad". The sustainability index value of each dimension is in Table 1.

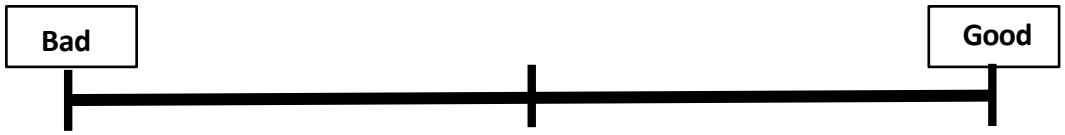

Figure 1. Illustration of sheep development sustainability index.

Figure 1 shows an illustration of the position of the four reference points "good", "fairly", "less" and "bad" using the horizontal axis using the MDS method. If the sustainability index value is in the range of 75-100, the dimension under study has a sustainable status; if the sustainability index value is in the range of 51-74, the dimension under study has a fairly sustainable status; if the sustainability index value is in the range of 26-50, the dimension under study has a less sustainable status and if the sustainability index value is in the range of 0-25, the dimension under study has an unsustainable status.

The sustainability index values obtained from each ecological, social, technological and institutional dimension can be visualized in the form of a polygonal kite diagram. Figure 5 illustrates the sustainability index values for each parameter/dimension. By using this diagram, information about the level of sustainability in each dimension can be clearly seen and facilitates data interpretation.

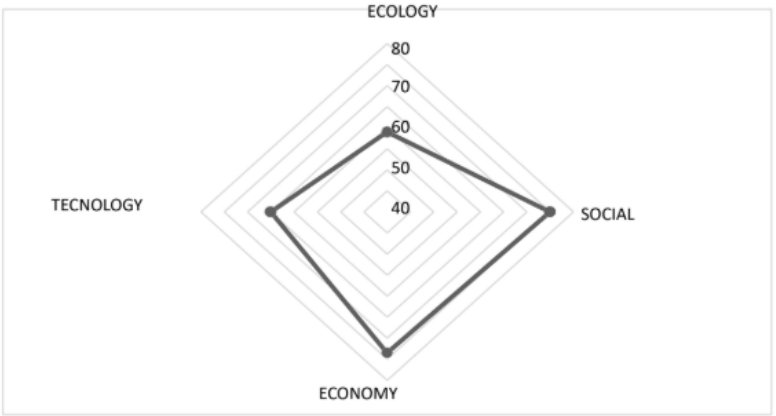

Figure 2. Illustration of a polygonal flight diagram using the Rap-Sheep technique.

RESULTS AND DISCUSSION

Sustainability Index and Status

Based on Table 2, it is known that the multidimensional sustainability index shows a value of 52.63, which represents that the development of sheep livestock in Galang Sub-district is quite sustainable. Randu and Hartono (2020); Abdullah *et al*. (2015); Suyitman *et al*., (2012); stated that the index value in the range of 51-74 is a fairly sustainable status category. The results of the Monte Carlo analysis in Table 2 show that the sustainability index value of sheep development in Galang Subdistrict at the 95% confidence level does not differ from the results of Rap-Sheep (MDS). This can be seen through the difference between the MDS and Monte Carlo values of less than 1, which ranges from 0.18 to 0.94. These results prove that the difference is less than 1, and there is little error in scoring each attribute. This statement is supported by Randu and Hartono (2020) that the stability of data analysis results if done repeatedly; the small error in making attribute scores and the low error in entering data have a difference value of less than one. The results of the evaluation of the index assessment and the status of multi-dimensional sustainability of sheep livestock development in Galang District, Deli Serdang Regency are shown in Figure 3 based on MDS analysis with the Rap-Sheep approach applied to four dimensions of ecology, economy, social and technology and are presented in Table 2.

Table 2. Results of Multi-Dimensional Analysis of Sheep Development in Galang Subdistrict

Dimensions	Sustainability Index		Difference	Statistic		Sustainability Status
	MDS	Monte Carlo		Stress	R^2	
Ecology	56,71	56,33	0,38	0,13	0,95	Sufficiently Sustainable
Economy	51,50	50,82	0,68	0,14	0,95	Sufficiently Sustainable
Social	63,47	62,87	0,60	0,14	0,95	Sufficiently Sustainable
Technology	38,85	39,79	0,94	0,13	0,95	Less Sustainable
Multi-Dimensional	52,63	52,45	0,18	0,14	0,95	Sufficiently Sustainable

Source: Primary Data 2023

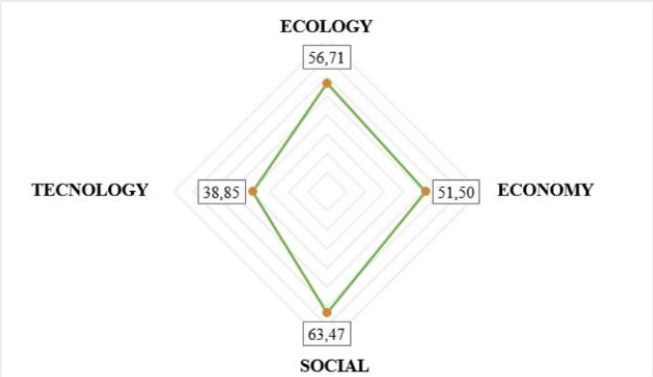

Figure 3. Kite Diagram of Sustainability Index Value of Sheep Development in Galang Sub-district

Figure 3 shows a scatter diagram of the sustainability index value of each dimension where the value of the ecological dimension is 56.71; the economic dimension is 51.50; the social dimension is 63.47; the technological dimension is 38.85. In these four dimensions, there are three dimensions with a fairly sustainable status, namely the ecological, economic and social dimensions, while the technology dimension has a less sustainable

status. The correlation of each dimension in increasing the index value and sustainability status needs to be considered, in addition to the attributes in the dimension itself. The linkages between different dimensions and their attributes are important in improving the index value and sustainability status of each dimension, especially the technological dimension. Comprehensive understanding and effective management and synergy between different dimensions, such as the attributes of ecological, economic, social and technological dimensions in the development of sheep farming in Galang Sub-district can be improved towards better sustainability.

Ecological Dimension

In the ecological dimension, the sustainability of sheep development in Galang Sub-district was analyzed by considering 12 relevant attributes. The results of the analysis showed that the sustainability index value in the ecological dimension reached 56.71. This places it in the range of sustainability status categories between 51-74, based on data processing using the Rap-Sheep approach. The results of the analysis are depicted in Figure 4, which shows the results of the analysis using Rap-Sheep.

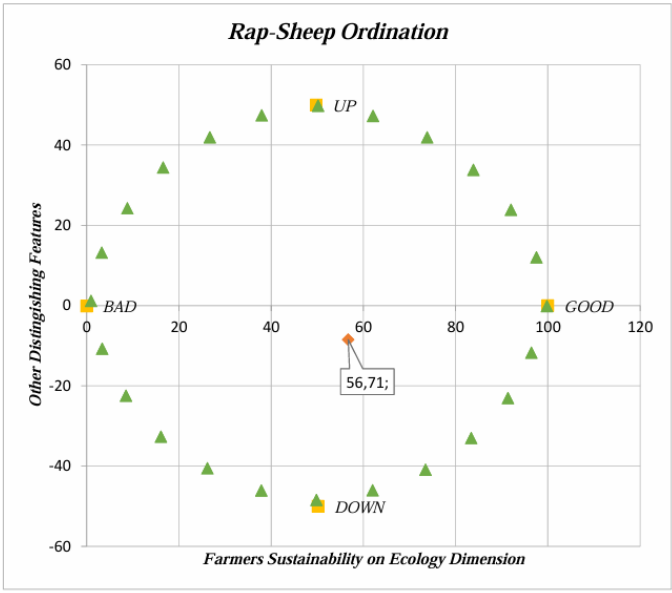

Figure 4. Ecology Dimension Sustainability Index Value

Based on the data contained in Figure 4, it can be concluded that the development of sheep in Galang Sub-district has a fairly sustainable ecological sustainability status so that in analyzing the attributes that have a significant influence on the sustainability index value, a leverage analysis is carried out. The results of the leverage analysis can be seen in Figure 5, providing information on sensitive attributes that affect the value of the sustainability index in the ecological dimension.

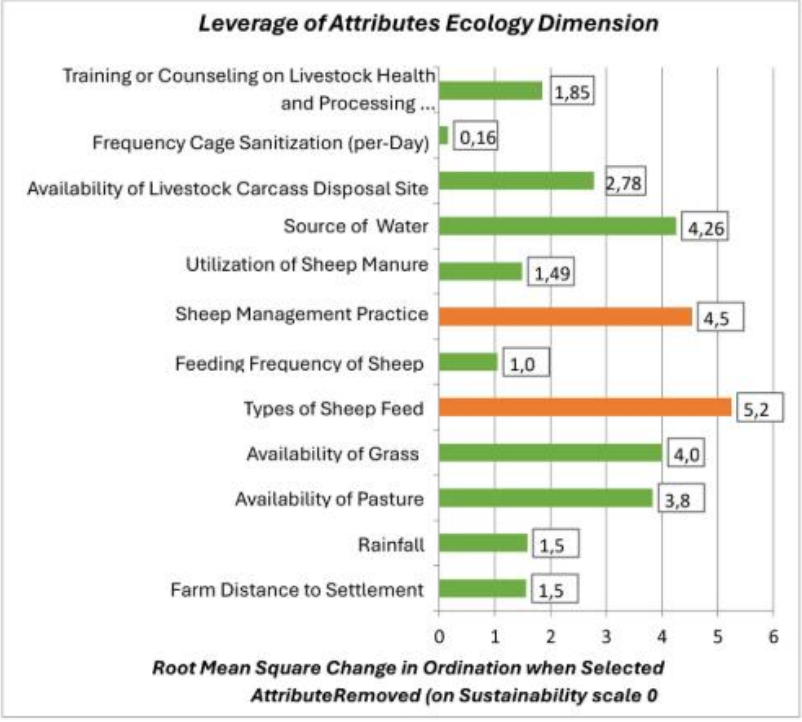

Figure 5. Leverage of Attributes Ecological Dimensions

Two sensitive attributes that affect the sustainability index of the ecological dimension were obtained based on Figure 5, including: (1) Type of sheep feed; (2) Sheep husbandry system. Feed is one of the most important factors in supporting sustainable livestock development (Sugito and Marliyana, 2021). Looking at the conditions encountered in Galang District, it shows that the type of sheep feed used is only one type of feed ingredient in the form of weeds. The sheep farming system that is widely used by farmers in Galang District is an intensive maintenance system where livestock are always caged so that in feeding and managing sheep livestock is more efficient. This statement is supported by Pranoto *et al*. (2016) that an intensive maintenance system makes it easier for farmers to manage feed and livestock health so that livestock raised with this system generally have better performance and body condition.

Economic Dimension

The results of the analysis show that the economic dimension sustainability index value is 51.50, within the range of 51–74, which indicates a fairly sustainable status. We used the Rap-Sheep approach in the MDS data processing to obtain these results. This information can be seen more clearly in Figure 5, which illustrates the results of the analysis using Rap-Sheep.

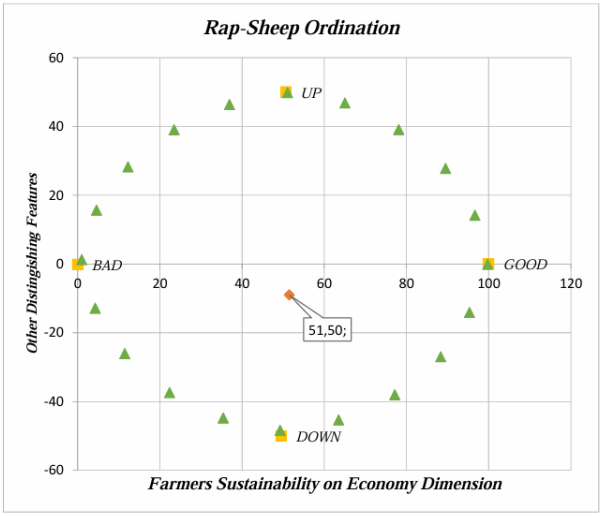

Figure 6. Economic Dimension Sustainability Index Value

The economy of sheep development in Galang sub-district is quite sustainable. Attributes that are sensitive to the sustainability index value were analyzed using leverage analysis. Figure 6 shows the results of the leverage analysis to determine the sensitive attributes that affect the sustainability index value in the economic dimension.

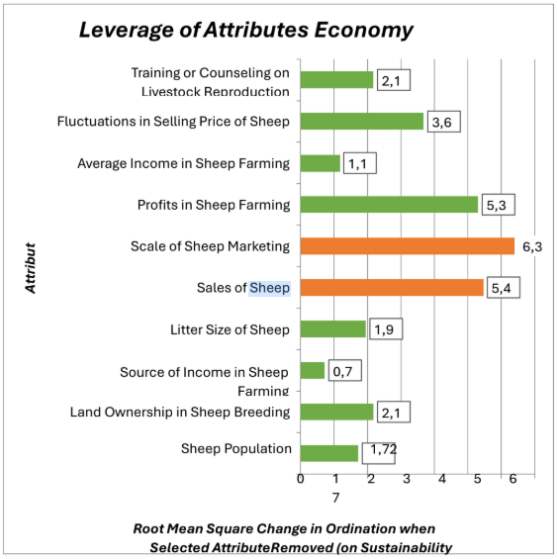

Figure 7. Leverage of Attributes Economic Dimension

Based on Figure 7, there are two sensitive attributes that affect the sustainability index of the economic dimension, including: (1) sheep marketing scale; and (2) sheep sales . The following is an explanation of the meaning and difference between sheep marketing and sales scale. The scale of sheep marketing is a very important attribute for the long-term sustainability of livestock operations. Currently, the majority of farmers in Galang sub-district sell their livestock on a small scale in the local market. On the other hand, expanding the marketing scale to regional or national markets has great advantages. Farmers can increase sales opportunities, reach a wider range of consumers, and increase their income by increasing their marketing reach (Simbolon, 2013). The sheep sales attribute is also related to the scale of livestock sales, which is an important aspect of animal husbandry that has a direct impact on economic aspects. The results of the leverage analysis on the livestock sales attribute have a higher value than Sugito and Marliyana (2021), with a research focus on bean goats on the attributes of the livestock sales system of 1.24.

Based on the condition of farmers in Galang Sub-district, the livestock population owned by each farmer ranges from 10 to 60 livestock, and the litter size ranges from 1-3 litters per birth. Although these two attributes are

not considered sensitive in the analysis, they are important to be considered and improved because they have a significant impact in the economic context of sheep farming. This statement is supported by Simbolon (2013), who found that a high livestock population and litter size can increase the economic value of farmers.

Social Dimension

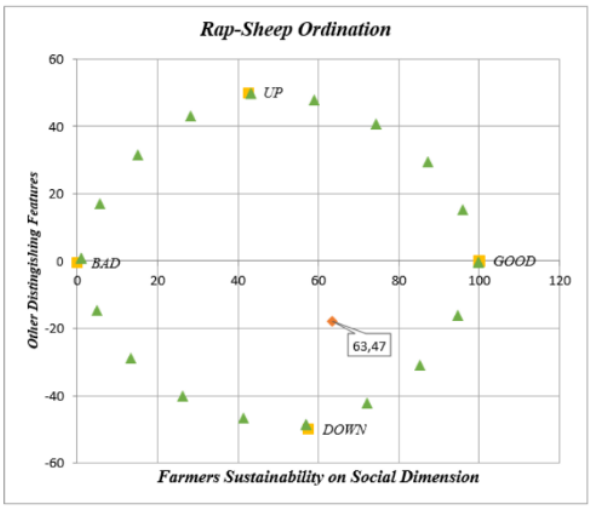

Figure 8. Social Dimension Sustainability Index Value

The results of the analysis show that the sustainability index value of the social dimension reaches 63.47, which places it in the range of 51–74 and in the category of moderately sustainable status. Based on the visualization contained in Figure 8, it can be seen that the social dimension of sheep development in Galang sub-district shows a fairly sustainable level of sustainability.

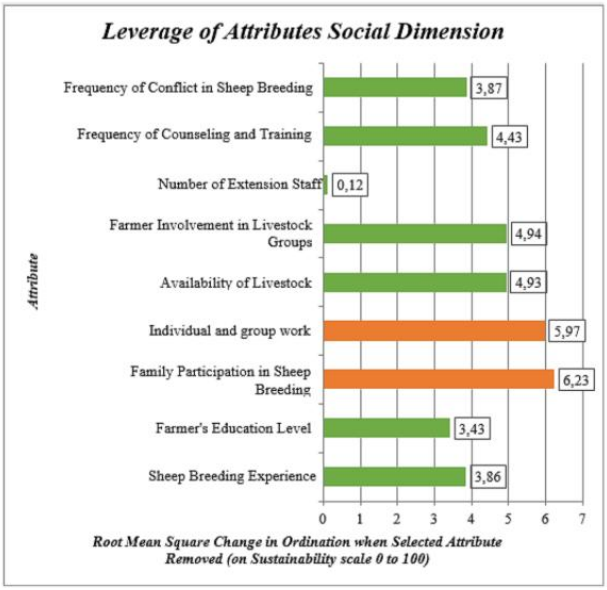

Figure 9. Leverage of Attributes Social Dimension

Based on Figure 9, there are two sensitive attributes that affect the sustainability index of the social dimension, including: (1) family participation in sheep farming; (2) individual and group work. Family participation in raising livestock has significant relevance in the social context. The value of the attribute of family participation in raising livestock has a greater value or influence on the sustainability of the social dimension compared to the results of research by Randu *et al.*, (2022) which focused on bean goats. Farmers can share the workload, knowledge, and skills needed in animal husbandry by involving family members. This statement is supported by Annesa (2016) who states that family cooperation in livestock

farming can increase productivity, optimal division of responsibilities, and strengthen overall family relationships.

Based on a survey of farmers in Galang Sub-district, the majority of farmers tend to work individually despite the formation of livestock groups. However, there are a small number of farmers in Sei Putih Village who breed in groups. The results of the leverage analysis on this attribute have a greater value than the research of Suyitman *et al.* (2012) with a focus on beef cattle research of 0.20 . Efforts to increase the sustainability index of the social dimension of sheep business in Galang Sub-district are to encourage extension workers and farmers to be active in group activities such as counseling and training.

Discussion should be consistent and should interpret the results clearly and concisely, address biological mechanism and their significance, supported with suitable literatures. The discussion should show relevance between the results and the field of investigation and/ or hypotheses.

Technology Dimension

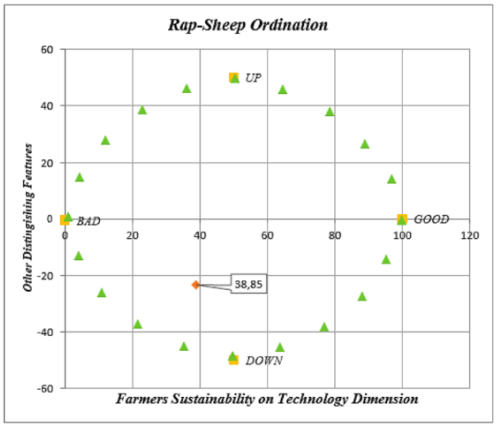

Figure 10. Technology Dimension Sustainability Index Value

Sustainability analysis in the technological dimension of sheep development in Galang sub-district was conducted by considering 10 relevant attributes. The results of the analysis show that the sustainability index value in the technology dimension is 38.85, or within the range of 26–50, which indicates a less sustainable status. The Rap-Sheep approach was used in MDS data processing to generate this information. The results of the analysis can be seen in more detail in Figure 12, which visualizes the results of the analysis using Rap-Sheep.

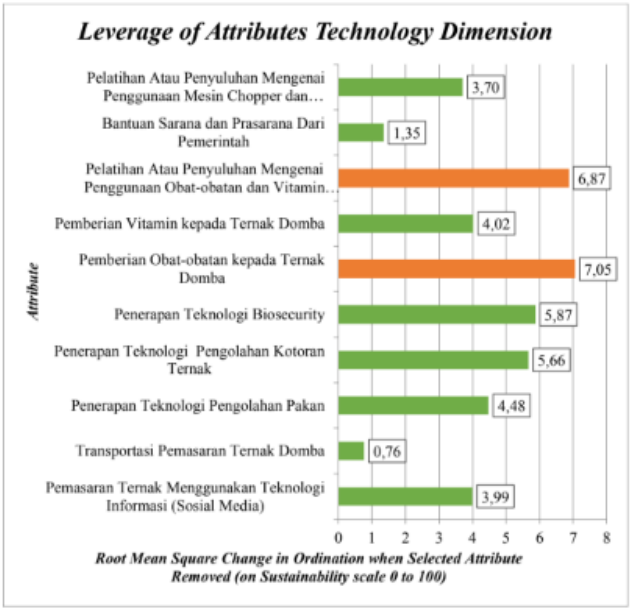

Figure 11. Leverage of Attributes Technology Dimension

Based on the image above, two sensitive attributes are obtained that affect the sustainability index of the technological dimension, including: (1) Provision of medicines to sheep; (2) Training or counseling on the use of drugs and vitamins to livestock. Giving medicines to sheep is a key factor in success in livestock farming because it has an impact on livestock health (Anggita, 2023). The results of leverage analysis on this attribute showed a higher value than the previous study conducted by Suyitman *et al*. (2012) which focused on beef cattle.

Based on a survey conducted on farmers in Galang District, the use of drugs has mostly been routinely carried out by farmers. Farmers routinely provide drugs in the form of deworming and vitamins in the form of B-Complex. This reflects the awareness and efforts of farmers in maintaining and improving the quality of livestock production by applying technology which is used in the development of sheep farming business in Galang District. The role of extension workers who provide training to farmers regarding the use of medicines and vitamins also supports awareness so that these two sensitive attributes are interrelated. Thus, the provision of medicines and vitamins as well as counseling to farmers can make a significant contribution. significant to sustainability in the technological dimension of the sheep farming sector.

Other attributes that are not sensitive but important to note are the application of feed processing technology and livestock marketing using information technology (social media). Based on the results of a survey of farmers in Galang Subdistrict, as many as 90 farmer respondents, only 5 farmers used chopper and silage machines in animal feed management.

The value of this attribute is higher than the results of research by Suyitman *et al.* (2012) which focused on beef cattle with an attribute value of 1.10. The use of feed processing machines in the form of choppers can help efficiency in feed processing. The attribute of livestock marketing using information technology (social media) also has an important role in today's digital era. Social media has become an effective platform for marketing products in the livestock industry. The utilization of social media as a marketing tool can increase a wider marketing reach, thus helping to increase farmers' profits. Social media also helps provide direct interaction between farmers and potential consumers, enabling the exchange of information, questions and responses in real time.

CONCLUSION

Sheep livestock development in Galang Sub-district, Deli Serdang Regency, currently has an index value with a fairly sustainable status, namely in the ecological dimension (56.71), economic dimension (51.50), and social dimension (63.47), while the technology dimension has a less sustainable status with a value of 38.85. In multidimensional terms, the index value of 52.63 isobtained, which means that sheep livestock development in Galang Subdistrict, Deli Serdang Regency, is fairly sustainable. Efforts to improve the sustainability status of sheep livestock development in Galang Sub-district can be done with comprehensive improvements to the attributes that have the greatest sensitivity values, namely: (1) type of animal feed; (2) scale of livestock marketing; (3) family participation in raising livestock; and (4) provision of medicines to livestock, so that it is expected that all dimensions can fall into the category of highly sustainable status.

SUGGESTION

It is suggested that a more in-depth study be done by adding legal and institutional dimensions as one of the supporting aspects in evaluating the sustainability of sheep livestock development in Galang District, Deli Serdang Regency.

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