Identification of Threats To The Sustainability of Smallholder Dairy Farming Using A Multidimensional Risk Perspective

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Abstract.

The sustainability of dairy cattle businesses in smallholder farms faces various complex and interconnected threats, especially after the outbreak of Foot-and-Mouth Disease, which worsened the national cattle population and milk production. This research aims to identify threats to the sustainability of dairy cattle businesses in Suci Village, Panti District, Jember, using a multidimensional risk approach that includes ecological, economic, social, technological, and institutional dimensions. A quantitative approach was used with a census method on 25 dairy farmers as respondents, using a structured questionnaire. The research results indicate that the majority of dairy farms fall into the "less sustainable" category, characterized by low availability of green fodder, barn capacity, number of livestock, income, education level, farming experience, group role, and low technology utilization. Leverage analysis identifies several sensitive attributes that most influence sustainability levels, namely agricultural waste utilization (ecological), number of livestock (economic), education and farming experience (social), group role (institutional), and mobile phone usage (technological). These findings highlight the need for comprehensive interventions in farmer capacity building, institutional strengthening, technology modernization, and improved feed and waste management to promote the sustainability of smallholder dairy farming at the village level.

Keywords: *Sustainability; dairy cows; multidimensional risk and smallholder farming.*

I. INTRODUCTION

The sustainability of village dairy farming has become an increasingly important issue in recent years, especially after the outbreak of Foot and Mouth Disease (FMD), which caused a decline in dairy cow populations and disrupted the milk production chain. In many rural areas, including the Holy Village in Jember Regency, dairy farming is still managed by smallholder farmers with limited resources. This family-based business system is highly vulnerable to production uncertainty, climate change, market volatility, and limited access to technology and supporting institutions (Ramadhan et al., n.d.). Small-scale dairy farming is one of the main sources of livelihood for rural communities in various regions of Indonesia, including Jember Regency. Beside providing daily income thru milk sales, this subsector plays a role in supporting animal food security and local economic circulation. However, the sustainability of village dairy farming is increasingly threatened by various complex and interconnected factors. Farmers face ecological issues such as a shortage of green fodder, suboptimal waste management, and the risk of greenhouse gas emissions. On the other hand, the economic dimension is also vulnerable due to high feed costs, suboptimal milk productivity, and price fluctuations that squeeze profit margins (Ramadhan et al., n.d.). Social and institutional threats, including environmental conflict with surrounding communities, low capacity of farmer groups, and limited participation in cooperatives, add to the challenges that must be faced.

Technological aspects also worsen the situation—the lack of cooling facilities, low adoption of innovation, and limited access to livestock health services increase production risks. Field findings in Suci Village, Jember, show that most of these risks fall into the high to extreme category, directly impacting the sustainability of the village's dairy farming business.This condition underscores the importance of an approach capable of comprehensively identifying threats. A multidimensional risk perspective is a strategic step toward understanding how ecological, economic, social, and technological threats interact and influence the sustainability of livestock businesses at the village level. Various studies show that the risks in dairy farming are not only single but multidimensional. Ecological risks such as limited green space and waste

accumulation can trigger a decline in productivity. Economic risks related to high feed costs, low milk quality, and dependence on cooperative prices worsen farmers' financial conditions. Social risks arise from low income, environmental conflict, and weak solidarity among farmer groups. Meanwhile, technological risks include a lack of production equipment, low adoption of innovation, and limited livestock healthcare services.Some previous studies have discussed the risks of dairy farming and the integration of these four dimensions into a single analytical framework, but they are still relatively limited, especially in the context of small-scale farming in rural East Java. Therefore, this study aims to identify sustainability threats in village dairy farming using a multidimensional risk perspective. This approach is expected to provide a comprehensive overview of the vulnerability of dairy cattle farming systems and serve as a basis for developing mitigation strategies and strengthening business sustainability at the farmer level.

II. METHODS

This study uses a quantitative research approach, with descriptive statistical analysis methods, which is to describe the relationship between two variables obtained from respondent data to illustrate the phenomenon that is occurring. The measurement scale used for the variable indicators is an ordinal scale. The variables used in this study are categorized into independent variables (X), which are farmers in the Suci Village area, Panti District, Jember, and dependent variables (Y), which is the sustainability of dairy cattle farming businesses. The object of this research is the sustainability of dairy cattle farming businesses among smallholder farmers. Meanwhile, the subjects of this research are the farmers and those who have previously raised dairy cattle in Suci Village, Panti District. The research method used is a census, where the entire population is taken as a sample using a structured questionnaire as the main data collection tool to obtain specific information (Usman & Akbar, 2006). The data obtained is primary data collected directly in the field thru interviews, and secondary data obtained from the dataset owned by the Suci village authorities and relevant literature studies. The sample in this study was determined using the Non-Probability Sampling technique, meaning it was not randomly selected, and the technique used was saturated sampling (census).

III. RESULT AND DISCUSSION

Dairy cows raised by the community in Suci village are generally of the Frisian Holland (FH) breed. The dairy cow management system used is quite intensive, including activities such as gathering grass/green feed, feeding, milking, bathing the animals, and cleaning the barn. The main feed given is green fodder, straw, and concentrate. The green fodder often provided by farmers is elephant grass, and the livestock are also given additional feed in the form of concentrate and bran.The respondents sampled in this study were 25 beef cattle farmers. The characteristics of the respondents were divided into five categories: age, gender, education level, farming experience, and number of livestock owned. Age is one of the determining factors in a person's thinking for decision-making and will make it easier for them to accept new innovations to improve and develop their dairy cattle business.Gender is a concept that analyzes the differences between men and women from a non-biological perspective, such as social, cultural, and psychological (Muthmainah, 2006). As for the dairy farmers in Suci village, there are 15 respondents (60%) who are male and 10 respondents (40%) who are female. The higher number of male respondents indicates that most of the dairy farming is done by men, although it is not impossible for women to also be able to do or assist in dairy farming.Education is an important factor in daily life as well as in relation to the ability of farmers to accept new innovations, information, and technologies to support their dairy cattle farming business. In addition, formal educational background will serve as a basis for thinking in expressing opinions and making decisions, as well as in implementing innovations and renewable technologies.

The research results show that the education levels of the respondents varied from elementary school to high school equivalent, but none reached the university level. From the data, it can be seen that the majority of respondents had an elementary school education background, with 14 people or 46.67%. This indicates that the education of the respondents is still very low and is one of the factors hindering the adoption of technology, so it needs to be improved by providing non-formal education so that farmers do not fall behind the times and technological developments, especially in the field of livestock business

development.Experience is very important for the success of a business. If farmers have sufficient experience in dairy farming over the course of their business, they will be more careful in their efforts and can correct mistakes they have made previously (Murwanto, 2008). The more experience a farmer has, the wiser they will be in making decisions about implementing an innovative enterprise in their business. The research results show that 11 out of 25 respondents have less than 10 years of farming experience, and another 10-20 years. Meanwhile, there are 8 experienced farmers with over 20 years of experience. From this data, it can be seen that the majority of farmers have over 10 years of farming experience, indicating a good level of knowledge and skills in livestock management.

This is because the length of farming experience influences respondents' skills in farming. The longer you raise livestock, the more knowledge you gain, which leads to increased skills. The number of livestock owned is the number of dairy cows owned by the respondents. The indicator for calculating the number of livestock owned in this study is measured by the number of productive animals, namely lactating dairy cows.The number of livestock owned by each respondent varies depending on the individual farmers' business conditions. The number of livestock is grouped into 3 scales: small scale (<3 productive females), medium scale (3-7 animals), and large scale (>7 animals) (Rahayu et al., 2002). The research results show that the majority of respondents own 3-7 dairy cows, with a percentage of 60%. This is a fairly good equivalent because 16 out of 25 farmers are already in the medium scale of livestock ownership. The sustainability level values generated in the study are based on an assessment of attributes covering 5 sustainability dimensions, including: ecological dimension (4 attributes), economic dimension (5 attributes), social dimension (5 attributes), technological dimension (3 attributes), and institutional dimension (3 attributes). The sustainability level values are then categorized into 4 statuses: good, sufficient, insufficient, and poor. The following table presents the categories of dairy farm business sustainability status from the respondents. Table 1. Categories of Sustainability Status for Smallholder Livestock Businesses

Table 1. Categories of Sustainability Status for Smallholder Livestock Businesses

No	**Sustainability Category**	**Total**	
		People	%
1	Good	1	4
2	Sufficient	4	16
3	Insufficient	15	60
4	Poor	5	20
Total		25	100

In the table above, it can be seen that the sustainability status of dairy cattle farming businesses is predominantly in the less sustainable category, with 15 out of the farmers and a percentage reaching 60.00%. In fact, not a single farmer received a "good" rating for their dairy cattle farming business. Generally, the large number of unsustainable dairy farming operations is due to the fact that the farms are still medium-scale, have low average daily milk production, inadequate grazing land, and lack proper waste management. From the leverage analysis conducted on each dimension, the sensitive attributes found in each dimension include: (1) ecological dimension, which is the availability of grassland and the availability of stables; (2) economic dimension, which is the number of livestock and income; (3) social dimension, which is other work beside livestock farming, social activities, and farming experience; (4) institutional dimension, which is the role of the group; and (5) technological dimension, which is the use of mobile phones. This unsustainable condition also illustrates the presence of low-value dimensions in sustainability measurement (ecological, economic, social, technological, and institutional dimensions), which affects sustainability in general. The sustainability status of millennial farmer businesses per dimension is presented in the following table.

Table 2. Sustainability Status of Smallholder Livestock Farming by Dimension

No	Dimention	Category (number of respondents in percent)				Total
		Good	Sufficient	Insufficient	Poor	
1	Ecology	0,00	3,33	20,00	76,67	100
2	Economy	6,67	43,33	36,67	13,33	100
3	Social	0,00	6,67	53,33	40,00	100
4	Technology	0,00	3,33	16,67	80,00	100
5	Kelembagaan	0,00	36,67	33,33	30,00	100

Based on this data, the sustainability level of dairy cattle farming for the ecological and technological dimensions is predominantly in the unsustainable category, while for the economic and institutional dimensions it is in the moderately sustainable category, and for the social dimension it is in the less sustainable category. This situation affects the overall/multidimensional sustainability value, so that overall, the sustainability of millennial farmers falls into the less sustainable category. Therefore, to increase the multidimensional sustainability level, development is needed not only in related dimensions but also in the overall dimension.The sustainability index value is composed of various indicators/attributes covering ecological, economic, social, technological, and institutional dimensions. These indicators/attributes were then analyzed using leverage to determine which attributes had the greatest impact on each dimension of sustainability. This analysis was conducted to identify the most important attributes in determining the level of sustainability by examining the impact of each Root Mean Square (RMS). The value of the RMS change caused by the loss of an attribute is positively correlated with the function of that attribute as a determinant of the sustainability of the dairy farming business.

The results of the leverage analysis for the ecological dimension show that out of the 4 attributes analyzed, the attribute with the highest value is (4) utilization of agricultural waste. This ecological dimension can raise issues regarding land area for other commodity crops, resulting in a decrease in livestock feed carrying capacity for dairy cow development (Sutanto & Hendraningsih, 2011). The results of the leverage analysis on the economic dimension show that out of the 5 attributes used as indicators, there is one attribute that influences the sustainability of dairy cow farming, namely (1) the number of livestock. The results of the analysis on the social dimension show that out of the 5 attributes analyzed, there are 2 sensitive attributes that influence dairy cow farming among millennial farmers, namely (4) education, and (5) farming experience. Three components of society, namely social, economic, and environmental, must be integrated for change to occur, and individuals and organizations must play a role in each other (Zakaria, 2010). From the results of the leverage analysis of the institutional dimension, it can be concluded that attribute (2), group role, is the only attribute that has the greatest influence on the sustainability of dairy cattle farming. Meanwhile, from the technology dimension, there is 1 attribute that is most sensitive to the sustainability of dairy cattle farming. The most influential attribute is (2) mobile phone usage.

IV. CONCLUSION

Based on the research findings and discussion, it can be concluded that the sustainability of dairy cattle farming businesses in Suci Village, Pantin District, when viewed from the sensitive attributes of each ecological, economic, social, institutional, and technological dimension, is in the "less sustainable" category. All of the most sensitive attributes mentioned above are the most influential indicators for measuring the sustainability of dairy cattle farming businesses. By paying attention to and improving each of these attributes, the sustainability of dairy cattle farming businesses can be easily achieved. The results of this study can help increase the knowledge and awareness of farmers and policymakers such as cooperatives and the District Livestock Service, to strive to boost national cow milk production in order to meet the demand for cow milk in Indonesia.

V. ACKNOWLEDGMENTS

This research was funded by DIPA PNBP Politeknik Negeri Jember, Year 2025, under the grant number 8721/PL17/KP/2025.

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