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Sustainability of Community Food Barns (LPM) in Aceh Besar Regency in Supporting Food Security

Mira Handayani*
Students of the Agribusiness Master's Study Program,
Faculty of Agriculture, Universitas Syiah Kuala,
Aceh, Indonesia

Azhar
Agribusiness Study Program, Faculty of Agriculture,
Universitas Syiah Kuala, Aceh, Indonesia

Irfan Zikri
Agribusiness Study Program, Faculty of Agriculture,
Universitas Syiah Kuala, Aceh, Indonesia

Abstract:- The community food barn aims to bring closer access to food for its members and maintain supply stability and grain prices through storage that allows sales to be postponed until farmers receive better prices. This research aims to analyze the level of sustainability of community food storage management in Aceh Besar Regency and identify the factors that influence it. The focus of this research is on four community food barn in three sub-districts, namely (1) Suka Makmur community food barn Harapan Maju, (2) Lhoong community food barn Bersama Sadar, and (3) Kutabaro community food barn Lagang Jaya and community food barn Makmu Beusaree. The purposive sampling method was used to select research locations, while samples were taken using simple random sampling from members of the community food barn group, totaling 144 farmers. The research results showed that Harapan Maju was declared unsustainable in the ecological dimension (value 35.89) due to minimal use of straw waste and high use of chemical pesticide fertilizers. In the economic dimension, Harapan Maju (score 46.31) and Bersama Sadar (score 47.85) are also unsustainable due to suboptimal facilities and limited markets. In contrast, Makmu Beusare (score 57.2) and Lagang Jaya (54.03) are quite sustainable with good financial viability and facilities. In the social dimension, Makmu Beusaree (score of 66.50) and Lagang Jaya (60.92) have high member participation and good community development, while Harapan Maju (score 28.65) and Bersama Sadar (49.60) unsustainable due to lack of community participation and commitment. Factors that influence the sustainability of community food barn management include Environmental Impact Analysis, Environmental Management Efforts, Environmental Monitoring Efforts, soil and water quality, farmer income, government subsidies, as well as social sustainability that depends on food access, community participation, and local economic empowerment. Community food barn plays an important role in strengthening community capacity and participation, as well as improving the quality of life through education, health and decent work.

Keywords:- *Community Food Barn, Sustainability, Local Economic Empowerment.*

I. INTRODUCTION

Community food reserves can be increased by developing community food barns, which aim to bring closer access to food for its members. This granary is considered an effective model for food security in the village, functioning as a storage area to maintain supply stability. With good storage, grain sales can be postponed until a more profitable price for farmers is achieved. The central and regional governments strive to develop community food storage through community empowerment, increasing human resource capacity, optimizing resources, and strengthening institutions. The hope is that the community food barn can develop independently and sustainably, and play an optimal role in providing food. The development of the community food barn consists of three stages: growth, developmentnomen and independence. The growth stage includes identifying locations and physical construction of barns through Special Allocation Funds in the agricultural sector. The development stage includes identifying food storage groups and replenishing food reserves. The independence stage includes strengthening group institutions to develop businesses and maintain the sustainability of food storage.

Aceh Besar Regency is one of the regions that has implemented a community food barn development program. In 2022, the Aceh Besar District Food Service will assist in developing community food barns in four villages spread across three sub-districts, with a total of four farmer groups with 225 members. This program facilitates the physical construction of food barns such as providing warehouse facilities, drying floors, rice milling unit houses, bed dryer houses, grain filling, and strengthening group institutions.

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However, the development and management of group food barns still face many challenges, such as farmer group management systems that are not yet optimal. The Lumbung Harapan Maju group in Luthu Dayah Krueng Village is a clear example of this problem, where they are unable to use important tools such as the Grain Processing Unit and Bad Drayer properly. Errors in recording inventory, market price fluctuations that are not managed properly, and storage procedures that are not ideal are some of the factors that cause instability in food reserves. Another problem that often occurs is administration that has not been completely carried out properly, which is caused by the low competence of farmers in managing food barns. Barn arrangements are often based on conditional agreements, which are sometimes implemented strictly and sometimes loosely.

The sustainability of community food barn management is largely determined by social factors such as the existence of institutions that convey information and the openness of farmers in receiving this information, whether in the form of technology or other innovations. Economic and social sustainability must be supported by environmental sustainability which emphasizes environmental comfort when food barns operate grain processing machines, to minimize the risk of natural damage and air pollution.

Sustainability indicators are considered important in assessing and implementing sustainable systems. The concept of sustainability is dynamic, what is considered sustainable in one region may not be sustainable in another, and what is considered sustainable at one time may not be sustainable in the future due to changing conditions. Sustainable development is aimed at achieving equality for each generation, now and in the future. Research objectives 1) Analyze the level of sustainability of community food barn management in Aceh Besar Regency. 2) Analyze the factors that influence the sustainability of community food barn management in Aceh Besar Regency.

II. LITERATURE REVIEW

The availability of sufficient food nationally does not guarantee food security at the regional, rural and individual household levels. The study of Saliem *et al*. (2004) shows the importance of managing food availability so that it can be accessed by households in each village area. This management includes the management of food reserves which has not yet been widely researched (Mardalis and Rosyadi, 2015). In the context of "Indonesia Towards a World Food Granary 2045" (LPD-45 Ministry of Agriculture, 2017), a food barn means not only meeting domestic needs but also being a food supplier for other countries, with the main priority remaining national needs.

Article 32 paragraph 2 of the Food Law Number 18 of 2012 mandates that the Government and Regional Governments facilitate the development of community food reserves by local wisdom. This development aims to empower and protect the community from food insecurity through building physical barns, replenishing food reserves, and strengthening group institutions. It is hoped that the community can manage food reserves independently and increase the economic role of groups to maintain and develop food reserves.

Sustainable development includes three main dimensions: economic, social, and environmental. The economic dimension aims to increase economic growth, fight poverty, and change production and consumption patterns in a more balanced direction. The social dimension focuses on solving population problems, improving community services, and improving the quality of education. The environmental dimension aims to reduce and prevent pollution, manage waste, and conserve natural resources.

Sustainable agriculture, according to FAO, is a practice that manages natural resources to meet human needs, conserve resources and improve environmental quality. It involves the use of renewable and non-renewable resources while minimizing negative impacts on the environment. Dyllick and Hockerts (2002) added that sustainable development is based on the idea that humans must have three main types of capital: economic, social, and environmental.

Economic sustainability in the context of development means that economic aspects are mutually sustainable with other aspects. According to Endah Murniningtyas (2014), the economic pillars of sustainable development include economic structure, consumption patterns and production. Governance support from the government, private sector, communities, individuals and other parties is very necessary for sustainable development. Production and consumption patterns must be able to support development and maintain the quality of natural resources through management, technology, efficiency and lifestyle changes. The U.S. Environmental Protection Agency (USEPA) (2013) added that economic sustainability can be measured through employment, incentives, supply and demand, costs, and prices. Jobs maintain employment, incentives encourage work productivity, supply and demand adjust prices to economic developments, costs measure the positive impact of the production process, and prices promote a cost structure that addresses production externalities.

Social sustainability includes social justice, human dignity, and improving the quality of life. Susiana (2015) states that human development is the process of increasing the options given to society, with a focus on productivity, equity, sustainability and empowerment. The goal of human resource development is to increase society's ability to participate in sustainable development. According to Akib (2014), social sustainability can be measured through empowerment, participation, social mobility, population growth and demographics. USEPA (2013) states that the pillars of social sustainability include human health, participation, education, and community dependency.

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According to Rowland (2012), environmental sustainability includes carrying capacity, assimilative capacity, and sustainability of recoverable resources. Akib (2014) added that environmental sustainability indicators include ecosystem integrity, carrying capacity, biodiversity, and the global environment. Biodiversity, which includes genetics, species and ecosystems, is important for environmental sustainability. Efforts to manage natural resources, protect ecosystems, and conserve agricultural land are very important to maintain sustainable biodiversity.

III. RESEARCH METHODOLOGY

This research was conducted in Aceh Besar Regency from January to April 2024. Research samples were taken from three sub-districts (Suka Makmur, Lhoong, and Kutabaro) and four food barn groups, namely Gampong Luthu Dayah Krueng, Gampong Teungoh Blang Mee, Gampong Cot Cut, and Rabeu Village. The sample was taken by purposive sampling because this location has an active food barn and received assistance from the physical Special Allocation Fund in 2022. The research population was 225 rice farmers and members of farmer groups in the sub-district. Using the Slovin formula with an error rate of five percent, a sample of 144 farmers was obtained. Sampling was carried out using a simple random method (simple random sampling) to ensure homogeneous representation.

To evaluate the status of community food storage management efforts, the Multi-Dimensional Scaling (MDS) method is used, a non-parametric multi-variable technique. This method uses the rapfish analysis tool, which is a multidisciplinary rapid analysis technique for evaluating sustainability status based on several attributes that are easy to score (Fauzi and Anna, 2005). Rapfish is based on ordination techniques, placing data in the order of the measured attributes, and handling metric data such as ordinal or nominal scales.

Sustainability is measured in three dimensions: ecological, economic, and social, each with sustainability-related indicators. The sustainability scale is 0–25 (poor), 26–50 (less), 51–75 (fair), and 76–100 (good) (Syafruddin *et al*., 2007; Nababan *et al*., 2008). Visualization of the sustainability index is carried out using the Multi-Dimensional Ordination Rapfish diagram, using a kite diagram to show the sustainability status between dimensions (Pitcher and Preikshot, 2001). For sustainability analysis through review, identification and definition of rapfish characteristics. After scoring based on the rapfish method, the data is processed with rapfish software connected to MS-Excel. Multi-Dimensional Scaling (MDS) operations and leverage analysis (JackKnife) were performed to identify the most sensitive attributes to sustainability.

The S-Stress and R^2 values of MDS show good suitability, whereas low S-Stress values indicate good suitability (Malhotra, 2006). Sensitivity analysis determines important attributes that can be improved for better sustainability (Pitcher and Preikshot, 2001). The impact of errors was assessed using Monte Carlo simulations, which helps validate the rapfish model and identify errors in scoring and data analysis (Ramadhan *et al*., 2015). Monte Carlo simulation is used for models that contain risk and uncertainty with known probability distributions (Kakiay, 2004). This analysis was carried out in 25 iterations, which can be changed according to the desired level of confidence. The output graph shows validity with a maximum difference of 5% between Monte Carlo values and sustainability ordination, based on a 95% confidence level.

IV. RESULTS AND DISCUSSION

A. Respondent Characteristics

The characteristics of respondents in this study include age, education, experience, and the number of dependents of farmers who are members of the Community Food Barn. These factors influence their thinking and decision-making abilities in agricultural businesses to achieve satisfactory results. Farmers' age is related to their workability, younger farmers typically have greater physical strength and are more receptive to innovation, which has a positive impact on income. The average age of farmers in the research area is 45 years, included in the productive age category which is correlated with greater levels of activity and physical strength (Abdullah, 2006).

Table 1 Average Characteristics of Community Food Barn Respondents in Aceh Besar Regency

No	Characteristic Type	Unit	Community Food Barn (LPM)				
			Lagang Jaya	Makmu Beusaree	Harapan Maju	Bersama Sadar	Average
1	Age	Year	42	48	44	44	45
2	Educa tion	-	Junior High Scool	Junior High Scool	Junior High Scool	Junior High Scool	Junior High Scool
3	Experience	Year	18	20	13	15	17
4	The Number of Dependents	People	4	3	4	4	4

Source: Primary Data (processed), 2024

The level of education influences the success of farmers' work. Education helps farmers accept innovations and technologies, as well as market information. The average education level of farmers in the research area is junior high school, which makes it easier for them to accept new ideas in rice farming and managing community food storage (Soekartawi, 1994; Simanjuntak, 2002). Experience is also important; Experienced farmers are more skilled and

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proficient in agriculture, make the right decisions, and use intensive techniques (Soehardjo and Patong, 1999). The average number of family dependents is 4 people. More dependents mean higher expenses, but can also be a source of additional labor and help increase family income through alternative employment (Ellis, 2000; Todaro & Smith, 2015).

B. Sustainability of Community Food Barn in Aceh Besar Regency

➢ *Lagang Jaya Community Food Barn*

Table 2 MDS Analysis Results for the Sustainability of the Lagang Jaya Community Food Barn.

Dimen sions	Index	Status	Monte Carlo	Difference	Stress	R^2
Ecology	61,78	Quite Sustainable	60,413	1,37	0,153	0,937
Economy	54,03	Quite Sustainable	53,879	0,15	0,163	0,937
Social	60,92	Quite Sustainable	60,418	0,50	0,156	0,940

Source: Primary Data (processed), 2024

The results of MDS analysis with RAP-LPM Lagang Jaya in Gampong Cot Cut, Kuta Baro District, show the sustainability index value with sustainability status classification, this value shows that Sustainability of Community Food Barn the business condition is quite sustainable.

Based on Table 2, the highest sustainability index is in the ecological dimension, followed by the social dimension, and the lowest is in the economic dimension. There are no dimensions that are categorized as good or bad, but all are in the fairly sustainable category. This shows that the community food barn business is worthy of implementation and development in the future. These three dimensions interact to form a single sustainability index. Increasing the index value of each dimension can be done by improving the related attributes, which will affect other dimensions. The concept of sustainable development does not require all dimensions to have the same index value, but focuses on the dominant dimensions as a priority. The kite diagram in Figure 1 depicts the sustainability index of these three dimensions.

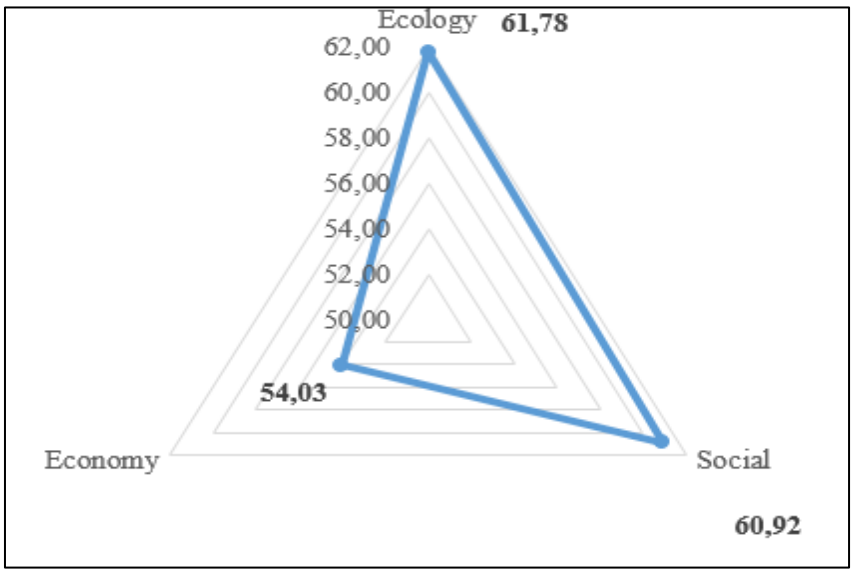

Fig 1 Sustainability Index Kite Diagram for the Lagang Jaya Community Food Barn

The stress and R^2 values are used to determine the need for additional attributes in the MDS. Stress measures data mismatch with the MDS model. The R^2 value is close to 1 for the ecological (0.937), economic (0.937), and social (0.940) dimensions, indicating a good model and does not require additional attributes. The stress value for the ecological (0.153), economic (0.163), and social (0.156) dimensions is below 0.25, indicating a valid and accurate model (Kavanagh and Pitcher, 2004). Monte Carlo analysis examines errors in the analysis, such as differences in respondents' assessments, data errors, and missing data. The Monte Carlo scatter plot results show a valid and reliable model, with converging iterations. The difference in sustainability index values at the 95% confidence interval for the ecological (1.37), economic (0.15), and social (0.50) dimensions is below 5%, indicating a high level of confidence and the influence of small errors (Thamrin *et al*., 2007).

➢ *Community Food Barn Bersama Sadar*

Based on Table 3, only the ecological dimension has a sufficiently sustainable index, while the economic and social dimensions are less sustainable, indicating that community food barn businesses are less feasible to implement and develop. The sustainability index of these three dimensions is depicted in a kite diagram (Figure 2).

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Table 3 Results of MDS Analysis of Sustainability of Lhoong Community Food Barn.

Dimensions	Index	Status	Monte Carlo	Stress	R^2
Ecology	52,46	Quite Sustainable	52,356	0,167	0,933
Economy	47,85	Less Sustainable	47,599	0,161	0,938
Social	49,60	Less Sustainable	49,339	0,159	0,939

Source: Primary Data (processed), 2024

The Bersama Sadar community food barn has an unsustainable status with an index value of 47.85. The results of discussions and interviews show that the economic dimension only reaches break-even status. The growth of the economic sector from the granary only had a minimal impact on the community, with marketing of grain and rice limited to the sub-district market and household needs only being met. Grain and rice management has not been able to meet reserve stocks because the group has not been able to rotate stocks. Many farmers who are members of the barn are reluctant to sell and store their grain in community food barns. The group very rarely holds regularly scheduled meetings. The unsustainable status of the Bersama Sadar community food barn in the social dimension is influenced by the low level of community commitment in developing the community food barn and the lack of socialization of work in cooperative management of the barn which is still carried out by group administrators.

Stress and R^2 values are used to determine model accuracy. The R^2 value for the ecological (0.933), economic (0.938), and social (0.939) dimensions is close to 1, indicating a good model without the need for additional attributes. The stress values for the ecological (0.167), economic (0.161), and social (0.159) dimensions are below 0.25, indicating good and accurate model suitability (Kavanagh and Pitcher, 2004; Fauzi and Anna, 2005).

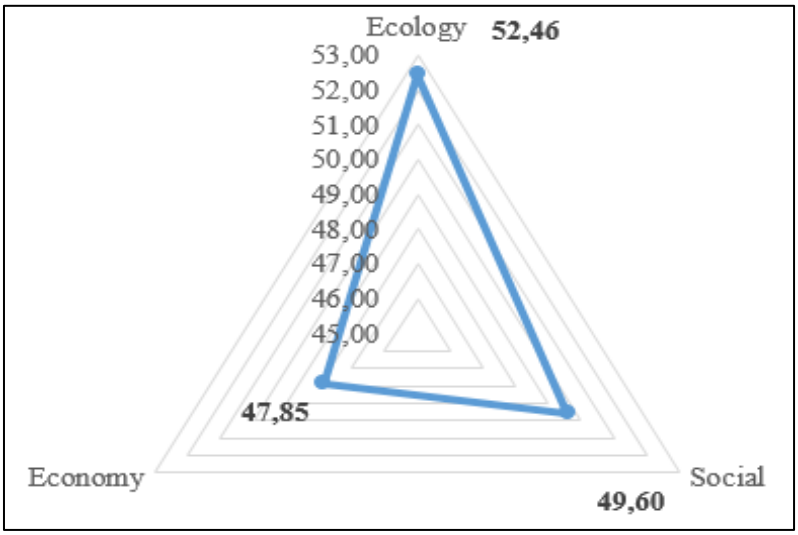

Fig 2 Sustainability Index Kite Diagram for the Community Food Barn Bersama Sadar

The final stage of sustainability analysis is Monte Carlo analysis to examine errors in the analysis, such as differences in respondents' assessments, data errors, and missing data (Kavanagh, 2001). This analysis evaluates the impact of random errors in statistics (Kavanagh and Pitcher, 2004). Monte Carlo scatter plot visualization shows a valid and reliable model with converging iterations. The results of the difference in sustainability index values at the 95% confidence interval for the ecological (0.104), economic (0.251), and social (0.261) dimensions show a small error, which indicates a high level of confidence. Small differences in values indicate attribute score errors, opinion variations, stability of MDS analysis, and minimal data errors (Thamrin *et al*., 2007).

➢ *Community Food Barn Harapan Maju*

A multi-dimensional analysis of the sustainability status of the Community Food Barn, which consists of the ecological dimension, economic dimension and social dimension, shows a sustainability index value of between 25.01 – 50.00. This means that the Community Food Barn business status is less/ unsustainable.

Table 4 Results of MDS Analysis of Sustainability of Community Food Barn Harapan Maju

Dimensions	Index	Status	Monte Carlo	Stress	R^2
Ecology	35,89	Less Sustainable	36,125	0,153	0,940
Economy	46,31	Less Sustainable	45,696	0,161	0,938
Social	28,65	Less Sustainable	30,361	0,141	0,945

Source: Primary Data (processed), 2024

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Based on Table 4, one dimension, namely the ecological dimension, has a sustainability index, while the economic dimension and social dimension, it can be concluded that these dimensions are less/not sustainable. In other words, the community food barn business indicates that it is not feasible to be implemented and developed in the future. Based on the analysis results, only community food barn Harapan Maju has "unsustainable" status with a value of 35.89. Interview results show that the use of rice straw waste as organic fertilizer or animal feed is still very minimal, with the straw often burned or piled on the edge of rice fields. The economic sustainability index for the Harapan Maju community's food barn is 46.31, because facilities such as the Rice Milling Unit (RMU) and grain drying equipment have not been operated. Lumbung only manages grain in the warehouse without meeting the success indicators for grain and rice stocks. Harapan Maju community food barns have an "unsustainable" status in the social dimension with values of 28.65 and 49.60 respectively. Influencing factors include lack of group member participation, lack of sustainable rice stocks, and lack of regular meetings. Community commitment in developing community food barns is still lacking, and socialization of work in cooperative management of barns is still carried out by group administrators. The sustainability index for these three dimensions is depicted in the form of a kite diagram as in Figure 3.

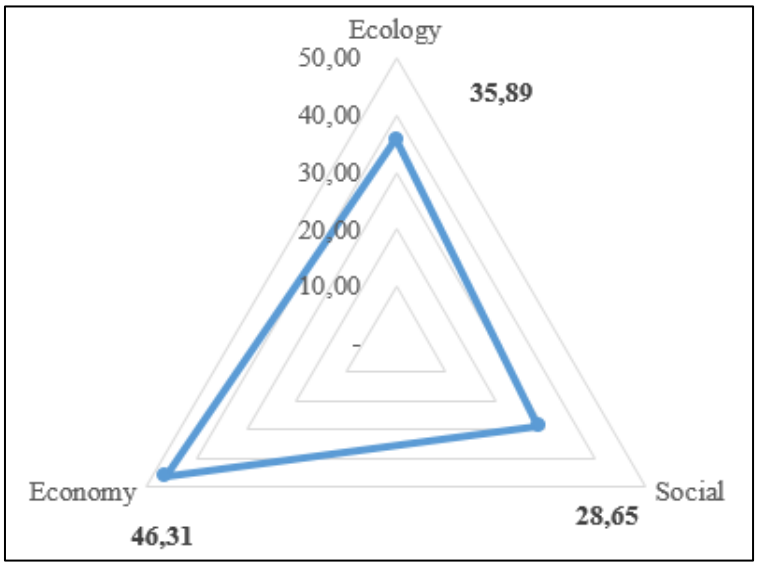

Fig 3 Sustainability Index Kite Diagram for the Harapan Maju Community Food Barn

The stress and R^2 values are used to determine the need for additional attributes in the MDS. Stress measures data mismatch with the model, while R^2 is close to 1 for the ecological (0.940), economic (0.938), and social (0.945) dimensions, indicating a good model without the need for additional attributes. The stress values for the ecological (0.153), economic (0.161), and social (0.141) dimensions are below 0.25, indicating an accurate and reliable model (Kavanagh and Pitcher, 2004; Fauzi and Anna, 2005).

The final stage is Monte Carlo analysis to examine errors in respondents' judgments, data errors, and missing data (Kavanagh, 2001). This analysis evaluates the impact of random errors in statistics (Kavanagh and Pitcher, 2004). Monte Carlo scatter plot results show a valid and reliable model, with iterations that converge to show consistent values (Lampran, 20). MDS analysis results with differences in sustainability index values at the 95% confidence interval for the ecological (-0.235), economic (0.614), and social (-1.711) dimensions are below 5%, indicating minimal error and a high level of confidence. Small differences in values indicate attribute score errors, opinion variations, analysis stability, and minimal data errors (Thamrin *et al.*, 2007).

➢ *Community Food Barn Makmu Beusaree*

Multi-dimensional analysis of the sustainability status of the Community Food Barn, which consists of the ecological dimension, economic dimension and social dimension shows a sustainability index value of between 50.01 – 75.00. This means that community food barn business status is quite sustainable.

Table 5 Results of MDS Analysis of Sustainability of Community Food Barn Makmu Beusaree

Dimensions	Index	Status	Monte Carlo	Stress	R^2
Ecology	59,47	Quite Sustainable	58,225	0,154	0,939
Ekonomi	57,20	Quite Sustainable	57,054	0,163	0,937
Sosial	66,50	Quite Sustainable	65,163	0,152	0,943

Source: Primary Data (processed), 2024

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Based on Table 5, the dimensions have a good sustainability index, while the economic and social dimensions are not sustainable, indicating that community food barn businesses are worthy of development. The kite diagram in Figure 4 depicts the sustainability index of these three dimensions.

Soil and water quality attributes (6.30) are critical for rice growth, ensuring high and quality yields, and supporting human well-being, economic and ecosystem sustainability. Government, industry and society need to prioritize protecting and improving the quality of land and water. The land suitability attribute for rice (5.24) is an important factor in the success of the Community Food Barn. It is important to map and evaluate land suitability, including physical and ecological characteristics, to determine the optimal potential for rice farming. This understanding enables effective and sustainable planning in the development of community food barn (Ozsahin and Ozdes, 2022).

The influential economic dimension attribute is the financial and economic feasibility of developing community food barns, which influences other economic growth. Farmers on average make decent profits from community food barn, because they can store and sell grain when prices rise. Community food barn facilities such as drying floors, bad dryers, and Rice Milling Units (RMU) are very helpful in post-harvest handling of rice. The highest average social dimension attribute is found in the participation of members of the community food barn in the management of the barn, which shows a very good level of participation. The community development attribute around the community food barn also showed very positive results, with the community's commitment to developing the community food barn being quite strong. The availability of access to safe, nutritious and affordable food around the barn has been going well, which can be seen from the consistent availability of rice and grain stocks in the barn.

Stress and R^2 values are used to determine model accuracy. The R^2 value for the ecological (0.939), economic (0.937), and social (0.9435) dimensions is close to 1, indicating a good model without the need for additional attributes. The stress value for the ecological (0.154), economic (0.163), and social (0.152) dimensions is below 0.25, indicating an accurate and accountable model (Kavanagh and Pitcher, 2004; Fauzi and Anna, 2005).

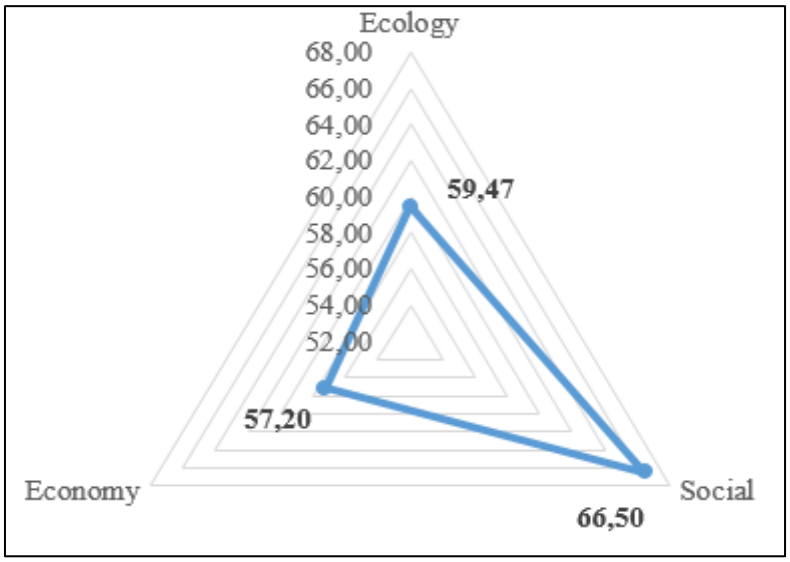

Fig 4 Sustainability Index Kite Diagram for the Makmu Beusaree Community Food Barn

The final stage of sustainability analysis uses Monte Carlo analysis to examine errors in the analysis, such as differences in respondent assessments, data errors, and missing data (Kavanagh, 2001). This analysis evaluates the impact of random errors in statistics (Kavanagh and Pitcher, 2004). Monte Carlo scatter plot visualization shows a valid and reliable model with converging iterations. The results of the difference in sustainability index values at the 95% confidence interval for the ecological (1.245), economic (0.146), and social (1.337) dimensions are below 5%, indicating minimal error and a high level of confidence. Small differences in values indicate attribute score errors, opinion variations, analysis stability, and minimal data errors (Thamrin *et al*., 2007).

V. CONCLUSION

Analysis of the sustainability of community food barn in Aceh Besar Regency shows that:

➢ *Sustainability Index:*

- Ecological Dimension: Harapan Maju Community Food Barn is "not sustainable", while Lagang Jaya Community Food Barn, Makmu Beusaree Community Food Barn, and Bersama Sadar Community Food Barn are "moderately sustainable".
- Economic Dimension: Community Food Barn Harapan Maju and Community Food Barn Bersama Sadar of "unsustainable"; The Makmu Beusare and Lagang Jaya Community Food Barn is "fairly sustainable".

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- Social Dimension: Makmu Beusaree and Lagang Jaya Community Food Barn are "fairly sustainable"; The Harapan Maju Community Food Barn and the Together Aware Community Food Barn are "unsustainable".

➢ *Determining Factors of Sustainability:*

- Ecology: Compliance with Environmental Impact Analysis, Environmental Management Efforts, Environmental Monitoring Efforts, and soil and water quality.
- Economic: The highest factors include household food needs (Lagang Jaya Community Food Barn), average farmer income (Bersama Sadar Community Food Barn), and marketing and markets (Hope Forward and Makmu Beusaree Community Food Barn).
- Social: Availability of food access (Lagang Jaya Community Food Barn), community participation (Makmu Beusaree Community Food Barn), community commitment (Bersama Sadar Community Food Barn), and community social status (Harapan Maju Community Food Barn).

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