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Sustainability Of Community Food Barns: A Case Study Of Traditional Groups In Yogyakarta

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ABSTRACT

Community food barns (lumbung) are one of the local institutions established to maintain food security in rural areas. In line with this objective, several studies have been conducted to address concerns about the declining sustainability of traditional community food barns, which are vital for ensuring food security and preserving cultural heritage in rural areas. This indicates that there is an urgent need to strengthen local food systems and support rural development initiatives by assessing institutional factors influencing their sustainability. Therefore, this study aims to evaluate the sustainability of community food barns and identify the dominant factors. Multidimensional Scaling analysis was used to measure sustainability and determine the dominant influential factors. The study population comprised 32 respondents from 32 groups of barns spread across the Special Region of Yogyakarta. A total of 3 dimensions were involved in the analysis, namely institutional, socio-cultural, and economic. The analysis results showed that the sustainability of community food barns was classified as the 'quo' criterion. This indicated that the current status of the sustainability of traditional barns could not develop naturally to a higher level without intervention. In addition, the dominant factors determining the level of sustainability were identified from the 3 dimensions. Strategies to improve sustainability could be pursued from various aspects. The study showed that fostering farmer group activities and enhancing collaboration with various stakeholders were essential for sustaining traditional community food barns. These efforts strengthened institutional support, promoted knowledge sharing, and ensured collective resource management, ultimately contributing to rural development.

INTRODUCTION

Food security is a crucial concern for the development of a nation, particularly in developing countries with large populations, such as Indonesia. Given its significant implications for social, economic, political, and national security, food security demands immediate attention. The importance of addressing food security issues is

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increasing both presently and in the future. The world is currently experiencing global climate change events that are impacting global food production levels (Gitz et al., 2016; Zarate Malpica & Miranda Zambrano, 2016). The production of grains worldwide is predicted to decrease by 10% to 25% by the late 2100 (IPCC, 2014), while the global population is projected to reach 9.6 billion people (Tripathi et al., 2019) or 17% higher than today. Consequently, the possibility of food insecurity in the coming decades is high.

According to previous studies, Indonesia is still grappling with food insecurity, which is closely associated with poverty. Addressing this issue necessitates combating poverty and vice versa. Enhancing food security is the most effective means of addressing poverty, which has wide-ranging implications beyond an individual's ability to meet their expenses (Bozsik et al., 2022; Lartey, 2015; Pawlak & Kołodziejczak, 2020).

To achieve food security, investment strategies in non-food and non-agricultural sectors are more essential than simply focusing on production (Guyomard & Bureau, 2020; Reardon, 1998). The availability of food in adequate quantities and varieties, along with the establishment of a community-wide institutional system for food management, are crucial components in achieving this objective. Increasing domestic production capacity, proper management of food stocks, and distributing food to reduce regional disparities in supply and demand have also been reported to be effective methods. The community and the government can establish food stocks, including the private sector. To ensure food security at the household level, it is essential to have food stocks managed by the community or household.

The existence of community food barns, locally known as *lumbung*, as food stock institutions has played an essential role in mitigating community food insecurity in rural areas of Indonesia, particularly in the Java region. However, with the changing dynamics of development, including the strengthening of national food stabilization roles, these barns are being marginalized. This marginalization is caused by several factors, such as inadequate management that led to non-optimal function (Riptanti et al., 2018), institutional weakness (Bahua, 2018), as well as policy conflicts and conflicting policy narratives (Mc Carthy & Obidzinki, 2017; Macrae & Reuter, 2020). Despite the challenges, the presence of community food barns remains crucial in addressing community food insecurity in rural areas. Therefore, this study aims to investigate the sustainability of community food barns as communal food stock institutions to combat food insecurity.

The sustainability of community food barns is a critical issue, particularly in traditional groups in Yogyakarta, Indonesia. The decline in the existence of these barns has been identified as a significant problem, leading to food instability in Indonesia (Wulansari et al., 2021).

This issue is exacerbated by land cover changes and spatial planning misalignment, which threatens the role of Yogyakarta as a national food barn (Nurfaizah et al., 2023). The COVID-19 pandemic has also necessitated the analysis of human resource management in the administration of food barns, showing the need for optimized human resources and community and government participation (Gunawan et al., 2022).

Several studies have examined the role of community food barns in Indonesia (Rosmiati et al., 2020; Sawitri Dj & Sudarma, 2018), but did not provide a comprehensive understanding of their sustainability in rural areas.

METHODS

The primary data was obtained from structured interviews and focus group discussions (FGD) in the Special Region of Yogyakarta. This location was selected because the granary was part of the community's way of life, which had become a social institution in rural areas (Anisya & Waluyati, 2019). Stratified random sampling was used in this study, in which the community food barns (based on data recorded at the Special Region of Yogyakarta's Agriculture Agency, a total of 92 groups) were selected according to their active status. Furthermore, 32 community food barns were selected to be involved in this study, which were represented by 32 respondents in total.

This study used quantitative data analysis methods to assess the level of community food barns sustainability. The assessment method applied was a multidisciplinary rapid appraisal method using Rapid Appraisal on Food Stock (RAPFood) based on Multidimensional Scaling (MDS) analysis. RAPFood was a modification of the Rapid Appraisal of Fisheries (RAPFISH) method, a rapid assessment technique including multidimensional aspects developed by the University of British Columbia, Canada. RAPFood used all the principles contained in the RAPFISH method, namely (1) a method of rapid assessment of the sustainability level of an object based on several attributes, (2) attributes could be redefined or replaced according to available information, (3) its effectiveness in decision-making method by considering multi-criteria based on the MDS scale (Pitcher and David, 2001).

The dimensions used in this study in measuring the sustainability level were identified by FGD with representatives of community food barn members. In this study, 3 dimensions were identified, namely economic, socio-cultural, and institutional. These dimensions were formed by several indicators that were used to identify leverage factors of sustainability. The indicators of each dimension defined by using FGD involving academia, farmer group members, local representatives, and community food barns group members were displayed in Table 1. Moreover, since the indicators were defined, structural questionnaires were used to measure the indicators' scores based on 32 respondents' information.

The analysis stages in the RAPFood technique, as proposed by Kavanagh & Pitcher (2004, were as follows:

1. Ordination of RAPFood included: (i) Rating the primary horizontal reference points for the "bad" category (score 1) and the "good" category (score 4); (ii) identifying other primary reference points, specifically the "midpoint" and a vertical reference point or referred to as an "anchor" useful for stabilizers; (iii) standardizing scores on each factor to have uniform weights to eliminate disparities in measurement scale; and (iv) calculating the distance between reference points using the Euclidean distance.
2. Estimation of the sustainability index of community food barns in the range of 0% to 100%, and dividing it into 5 categories of sustainability status. The categories of sustainability status were very poor or very unsustainable (0-20.0%); poor (20.01-45.00%); moderate or 'quo' (45.01-75.0%); good or sustainable categories (75.01-87.0%); and very good or very sustainable (87.01-100%).
3. Analyzing indicators' sensitivity to determine which factors were dominant in influencing changes in the sustainability index of community food barns. The sensitivity strength of each factor could be seen from the "Root Mean Square" (RMS) value on the X-axis. In simple terms, RMS was formulated as follows:

Table 1. Indicators of each dimension and their scoring*

Economic	Socio-cultural	Institutional
Farming capital access	Conducive security	Youth participation in community
Farm scale	Women's role in community food barns	Community initiative on community food barns
Tourism value	Community food barns as local identity	Integration with local organizations
Agricultural wage	Community food barns as a custom and way of life	Collaboration with other community food barns
Post-harvest cost	Farming experience	Partnership with local business units or cooperatives
Farm productivity	Tourism community	Partnership with financial institution
Agricultural employment	Participation of local leaders	Participation of farmer group in community food barns activities
Potential consumer of agricultural product	Agrarian lifestyle	Active administrators
Marketing channel		Partnership with university or NGO
Agricultural inputs availability		Collaboration with government

Note: * Score range 1- 4; best=4, worse=1

$$RMS=\sqrt{\sum_{i=1}^{n}\frac{(Vf_i-Va_i)^2}{n}} \quad .....(1)$$

V_{ai} was the indicator value, V_{fi} was the forecast value, and n showed the number of indicators.

4. A total of 3 test tools were used to evaluate the scoring validity and accuracy assessment of the RAP-Food analysis results: (1) according to the value of the standardized residual sum of the square (stress) determined by applying the formula below (Pitcher & Preikshot, 2001):

$$Stress=\sqrt{\frac{1}{m}\sum_{k=1}^{m}\left[\frac{\sum_i\sum_j\left(d_{ijk}^2-o_{ijk}^2\right)^2}{\sum_i\sum_j o_{ijk}^4}\right]} \quad .....(2)$$

O_{ijk} was the origin point in the dimensions (i, j, k), d_{ijk} was the squared distance, and *m* represented the number of dimensions. When the *stress* number was under 0.20, the statement was true and accurate; (2) the coefficient determination (R^2) was greater than 50%.

RESULTS AND DISCUSSION

Socio-culture dimensions

The results of the existing MDS on the socio-cultural dimension showed a value of 61.01 from the s scale of 0- to 100 as displayed in Figure 1. These results indicated that the sustainability of community food barns was classified as the 'quo' criterion. This suggested that the current status of the sustainability of traditional barns could not develop naturally to another state without intervention.

When the community food barns conservation program was implemented there, it had a sustainable value in the socio-cultural aspect. The feasibility analysis of the model on this dimension showed a stress value of 0.149 and a R^2 of 0.944.

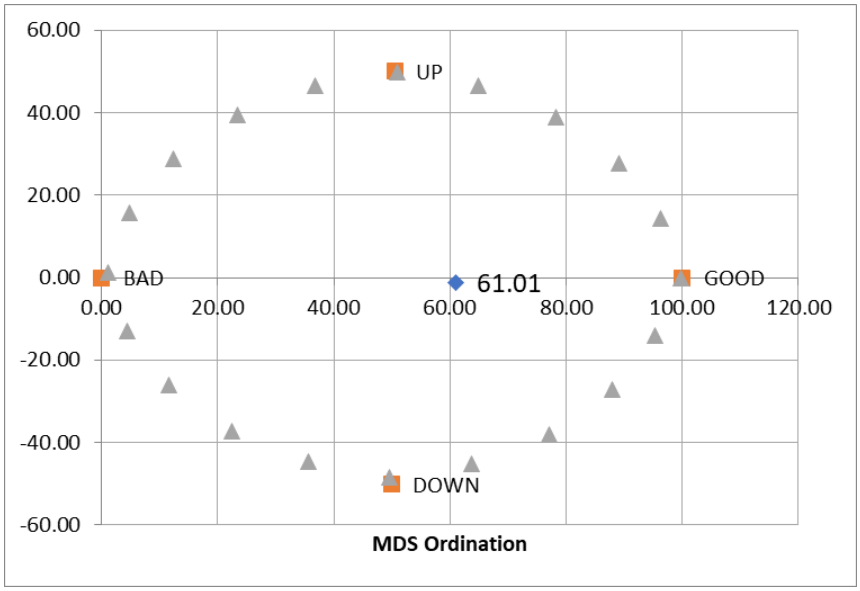

Figure 1. Socio-cultural Dimension Sustainability Ordination

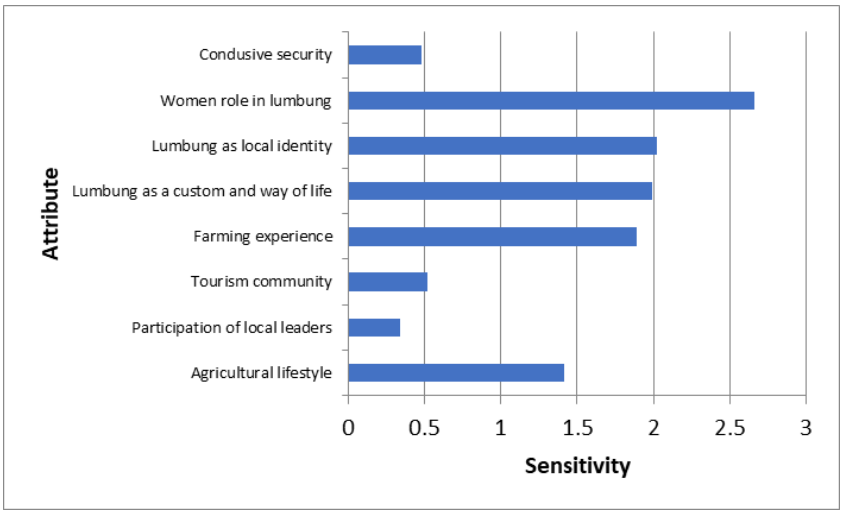

Figure 2. Leverage value (sensitivity) of socio-cultural attributes

Therefore, the MDS analysis on the socio-cultural dimension was feasible to be used as an evaluation of sustainability measurement.

The results of the MDS analysis also measured the sensitivity of each attribute on the socio-cultural dimension shown in Figure 2. Furthermore, the sensitive factor was an attribute that acted as an obstacle or supporter of the sustainability of the barn. A total of 8 attributes in the socio-cultural dimension were analyzed as previously stated. The attribute that had the greatest leverage value for the sustainability of traditional community food barns on the socio-cultural dimension was "women's role in community food barns management", with a sensitivity index value of 2.66. Women played a significant role in initiating the use of community food barns and had the flexibility to actively manage traditional community food barns due to their availability. This was supported by Irawan & Nara, 2020, who found that women were primary contributors to the development of sustainable tourism in their community, managing economic, socio-cultural, and environmental sustainability. Additionally, Daskon (2016) revealed the significance of cultural values in strengthening livelihood assets and the sustainability of rural communities. Wulansari et al. (2021) emphasized the importance of achieving food barns in the modern category through participatory development. These references collectively indicated the major role of women in managing traditional community food barns and promoting socio-cultural sustainability.

Institutional dimension

The results of the MDS on the institutional dimension showed a value of 49.6 from the s scale of 0 to 100 (Figure 3). These results indicated that the sustainability of community food barns was classified as the 'quo' criterion. This suggested that the current status of the sustainability of traditional barns could not develop naturally to another state without intervention. The feasibility analysis of

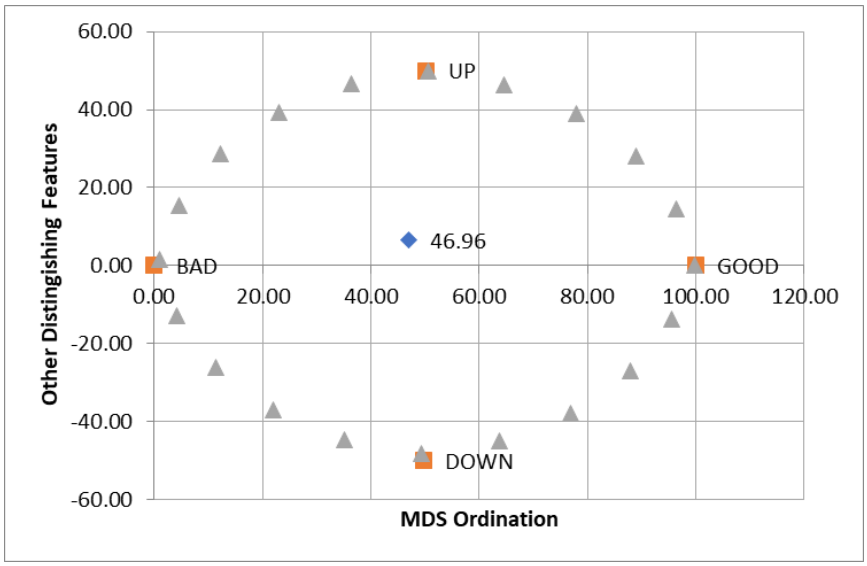

Figure 3. Institutional dimension sustainability ordination

the model on this dimension showed a stress value of 0.147 and a R^2 of 0.946. Therefore, the MDS analysis on the institutional dimension was worthy of being used as an evaluation of sustainability measurement.

In Figure 4, the sensitivity of each attribute on the institutional dimension was shown. The attribute that had the greatest leverage value for the sustainability of traditional community food barns on the institutional dimension was "the existence of farmer groups in barn activities", with a sensitivity index value of 2.29. Meanwhile, the other attributes that exhibited a sensitivity value of more than 1 were "integration with local organizational activities", "partnerships with business units, cooperatives, or BUMDES", "Collaboration with other regional barns", "participation of barn managers", "collaboration with government agencies, "collaboration with educational institutions or NGOs.

Several findings were consistent with the significance of community engagement and collaboration in promoting sustainable agricultural practices and rural development (Beus and Dunlap 1990; Cobb et al. 1999; Warner 2007; Velten et al. 2015; Purnomo et al., 2023). Moreover, the role of farmer groups and partnerships with local organizations and businesses emphasized community empowerment and economic development in rural areas (Purnomo et al., 2023; Ordonez-Ponce et al., 2021). The existence of farmer groups in barn activities was essential for the sustainability of traditional community food barns, as it signified collective efforts and shared responsibility in managing and preserving these essential cultural assets. Furthermore, the emphasis on collaboration with several stakeholders, including government agencies, educational institutions, and NGOs, indicated the interconnectedness of traditional community food barns with broader

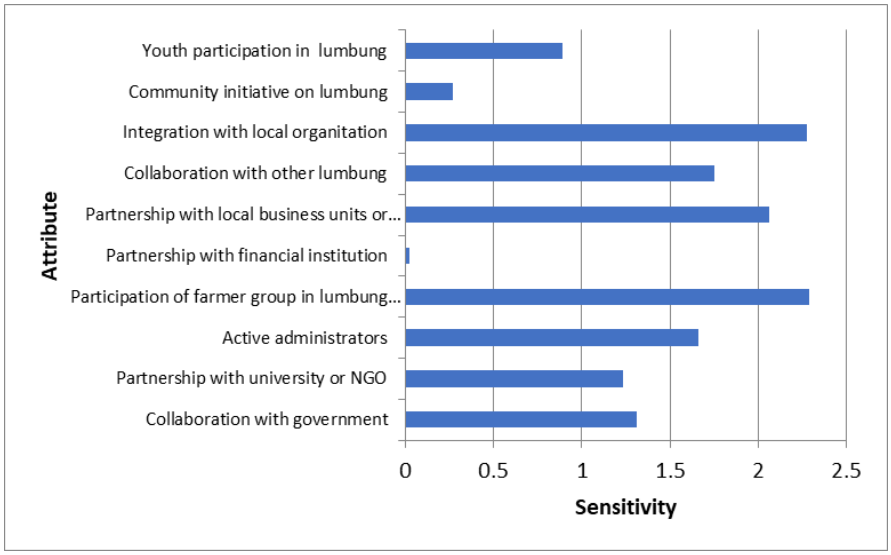

Figure 4. Leverage value (sensitivity) of Socio-cultural attributes

institutional and organizational networks, emphasizing the need for multifaceted partnerships to ensure their sustainability (Irungu et al., 2023; Purnomo et al., 2023). These findings revealed the intricate web of relationships and collaborative efforts required to uphold the institutional dimension of traditional community food barns, reflecting the complex interplay between cultural heritage, community engagement, and institutional support in sustaining these vital structures.

Farmer group activities significantly enhanced the sustainability of community food barns by providing several benefits, including:

1. Shared resources: By pooling resources and working together, farmer groups could access resources such as equipment, inputs, and land that were not available to individual farmers, leading to more sustainable operations.
2. Improved knowledge and technology transfer: Farmer groups provided a platform for knowledge sharing and technology transfer, enabling farmers to learn from each other and adopt sustainable practices more effectively.
3. Joint marketing and negotiation: Farmer groups could negotiate better prices and access markets more effectively as a collective, leading to more sustainable and profitable community food barn operations.
4. Risk management: Farmer groups shared risk and provided support to each other during challenging times, such as weather events or market fluctuations, leading to more resilient and sustainable community food barn operations.
5. Environmental stewardship: Farmer groups could work together to adopt and implement sustainable practices that protected the environment and natural resources, such as conservation tillage and integrated pest management.

In summary, farmer group activities played a significant role in improving the sustainability of community food barns by promoting cooperation, knowledge sharing, and the adoption of sustainable practices.

Economic Dimension

The results of the MDS on the economic dimension showed a value of 58.26 on a scale of 0-100 (Figure 5). These results indicated that in this dimension the sustainability of traditional food storage belonged to the 'quo' criteria. This suggested that the sustainability status of the current community food barns could not progress naturally to another state without intervention. Model feasibility analysis on this dimension revealed a stress value of 0.137 and a R^2 of 0.962. Therefore, the MDS analysis on the economic dimension was appropriate to be used as an evaluation of sustainability measurements.

Figure 6 showed the leverage or sensitivity of economic attributes. The attribute that had the greatest leverage value or the most sensitive factor for the sustainability of traditional barns on the economic dimension was the 'scale of farming' with a value of 1.34. Those that had the next big impact were "potential consumers of agricultural commodities", "cost of handling yields", "access to marketing", "increasing tourism value", and "availability of agricultural production facilities".

The scale of farming played a significant role in determining the economic viability and productivity of traditional barns. This finding was consistent with the study by Frison et al., (2011), which emphasized the importance of agricultural biodiversity in enhancing yields and reducing production costs, thereby contributing to economic sustainability. Furthermore, access to marketing and potential consumers of agricultural commodities were crucial factors that directly influenced the economic dimension of traditional barns' sustainability. Liu et al., (2013), discussed the framing of sustainability in a telecoupled world, emphasizing the interconnectedness of distant places and their influence on

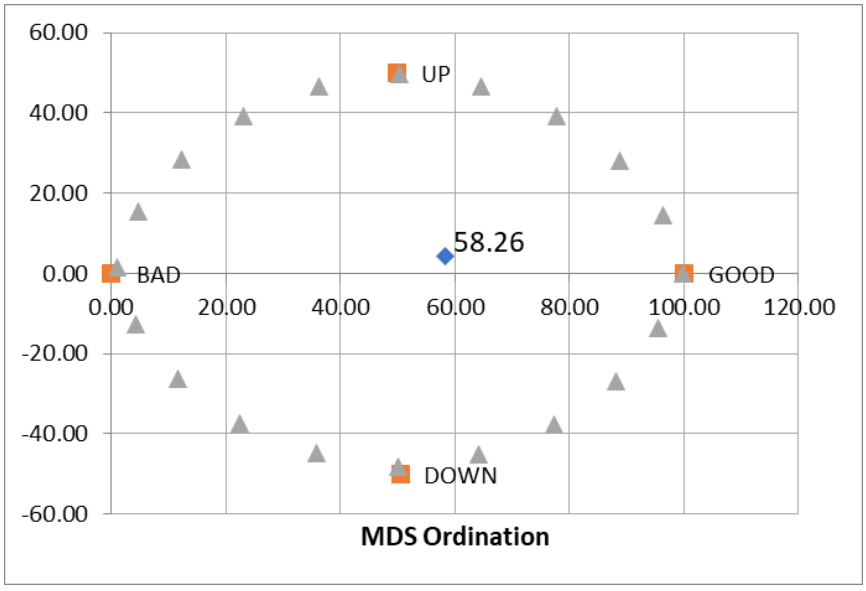

Figure 5. Economic dimension sustainability ordination

agricultural outcomes and economic sustainability. Moreover, the potential for increasing tourism value and the availability of agricultural production facilities were important for diversifying income sources and improving the economic resilience of traditional barns. These findings were consistent with Marston & Konar, 2017, which explored the impacts of climate change on agricultural water use and its implications for economic sustainability. Furthermore, the study by Baryshnikova et al. (2022) emphasized the rapid adoption of agricultural innovations by efficient farms and indicated the link between technological advancements and economic sustainability in agriculture.

Farm-scale support was a major component of community food barns' sustainability, as it affected the overall production and management of the farm. Larger farm scales could provide several benefits that contributed to the sustainability of community food barns, such as:

1. Increased efficiency: Larger farm scales allowed for more efficient use of resources, such as land, labor, and equipment, leading to reduced costs and increased production.
2. Improved technology adoption: Larger farm scales had more financial resources to invest in technology and infrastructure, such as drip irrigation systems, greenhouses, and controlled environment agriculture, which could improve the sustainability of community food barns.
3. Reduced environmental impact: By consolidating production and reducing the need for transportation, larger farm scales reduced the carbon footprint of food barns and minimized their impact on the environment.
4. Better risk management: Larger farm scales had more financial stability and could better manage risks, such as weather events, market fluctuations, and supply chain disruptions, leading to more sustainable operations.

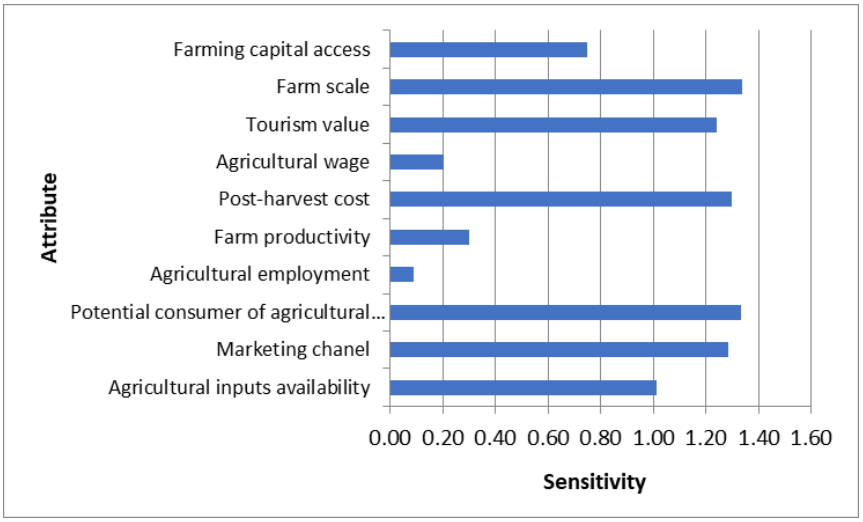

Figure 6. Leverage value (sensitivity) of Economic attributes

CONCLUSION AND SUGGESTION

In conclusion, the sustainability of traditional community food barns was a multifaceted and complex issue that was influenced by various dimensions, including socio-cultural, institutional, and economic factors. The findings emphasized the significant role of women in community food barn management, the existence of farmer groups in barn activities, and the scale of farming as critical attributes with the greatest leverage value for sustainability on the socio-cultural, institutional, as well as economic dimensions, respectively. Furthermore, attributes such as integration with local organizational activities, partnerships with business units, potential consumers of agricultural commodities, and access to marketing also significantly impact the sustainability of traditional community food barns. These findings emphasized the interconnectedness of traditional community food barns with broader socio-cultural, institutional, and economic systems, indicating the need for holistic and collaborative approaches to ensure their sustainability. Moreover, the significance of community engagement, collective action, and diversified income sources emerged as key themes in promoting the sustainability of traditional community food barns across different dimensions.

The findings from the attributes influencing the sustainability of traditional community food barns on the economic dimension, particularly the significance of the scale of farming, potential consumers of agricultural commodities, cost of handling yields, access to marketing, increasing tourism value, and availability of agricultural production facilities, had important policy implications for the state government. These implications were important for formulating effective policies to support the economic sustainability of traditional community food barns and agricultural practices.

Initially, the state government must consider policies that support and incentivize small-scale and diversified farming practices. This included providing financial support, technical assistance, and access to resources for small-scale farmers to enhance their productivity and economic viability. Furthermore, the government must focus on promoting local agricultural products to potential consumers, both domestically and internationally, to create market opportunities and increase the economic sustainability of traditional community food barns.

Policies aimed at reducing the cost of handling yields, improving access to marketing channels, and enhancing the tourism value of traditional community food barns contributed to their economic sustainability. This involved investment in infrastructure, marketing initiatives, and tourism development programs to attract visitors and promote the cultural as well as economic value of traditional agricultural practices.

The state government must prioritize the availability of agricultural production facilities and infrastructure to support the efficient

and sustainable production of agricultural commodities. This included investments in storage facilities, processing centers, and transportation networks to ensure the smooth flow of agricultural products to markets and consumers.

Overall, the state government must consider a comprehensive policy framework that addressed the diverse economic dimensions influencing the sustainability of traditional community food barns. By focusing on small-scale farming, market access, cost-effective handling, tourism promotion, and infrastructure development, the government could contribute to ensuring the economic sustainability of traditional agricultural practices, thereby preserving cultural heritage and supporting rural economies.

Further investigation into policy impact assessments must be conducted to determine how government policies influenced the operational efficiency and resilience of community food barns, as well as social dynamics, particularly gender roles and community engagement, which offered deeper insights into fostering collective action and strengthening local food systems. These recommendations could help bridge existing knowledge gaps and support the development of effective, evidence-based strategies.

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