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Sustainability Practices in Indonesian Cattle Farming: Insights from the SAFA Framework

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Abstract: This study investigates the sustainability practices employed by cattle farmers in Indonesia, applying the Sustainability Assessment of Food and Agriculture Systems (SAFA) framework. As global concerns surrounding environmental degradation and resource depletion intensify, understanding sustainable agricultural practices, particularly in livestock farming, has become imperative. A qualitative approach was employed, gathering data through interviews and field observations with seven cattle farmers from Boyolali and Salatiga, two districts recognized for their significant cattle farming activities. The analysis focused on four key dimensions of sustainability: environmental integrity, social well-being, economic resilience, and good governance. It was found that while farmers implement various sustainable practices, such as crop rotation and the use of organic fertilizers, significant challenges remain. These include limited access to environmentally friendly technologies, inadequate financial resources, and insufficient government policy support. The selection of participants was based on their ability to provide in-depth insights into sustainability practices in cattle farming, complementing the qualitative data collected. The findings highlight the necessity of improving technological adoption and enhancing community engagement to drive more sustainable outcomes in the sector. Additionally, the study underscores the role of policymakers in fostering more supportive environments for sustainable agriculture. This research fills a critical gap in the literature on the sustainability of cattle farming in Indonesia, offering practical recommendations to stakeholders, including policymakers, to promote more resilient and environmentally sustainable farming practices. By detailing the current practices and challenges encountered by farmers, the study contributes to the development of informed agricultural policies aimed at ensuring long-term sustainability within the cattle farming sector in Indonesia.

Keywords: Sustainability; Cattle farming; Qualitative study; Sustainability Assessment of Food and Agriculture Systems framework; Agricultural practices; Community engagement

1. Introduction

The issue of sustainability in the agricultural sector has become increasingly urgent as global attention to the environmental impacts of agricultural and livestock activities intensifies. In recent years, the focus on sustainability has evolved from merely ensuring sufficient food production to a more holistic understanding of how agricultural practices can affect environmental, social, and economic health (Tilman et al., 2017). The cattle farming sector, as a key component of agricultural systems, plays a crucial role in this regard. Cattle farming not only significantly contributes to the provision of animal protein but also has considerable environmental impacts, such as greenhouse gas emissions, land use, and high water consumption (Gerber et al., 2013). With the increasing global demand for meat products, the sustainability challenges in cattle farming have become more complex and require in-depth attention.

Indonesia, as one of the major agrarian countries in Southeast Asia, has an important cattle farming sector both

economically and socially. Cattle farming in Indonesia not only provides meat as a primary protein source but also serves as a livelihood for many small-scale farmers in rural areas. The economic and social roles of cattle farming in Indonesia make it a key component of the country's agricultural system. However, farming practices in Indonesia often face various challenges regarding sustainability, including land degradation, inefficient water use, and high greenhouse gas emissions (Zaninotto et al., 2020).

1.1 SAFA

In this context, it is essential to have an effective approach to assess and enhance sustainability in cattle farming. One widely used framework for assessing the sustainability of agricultural systems is the SAFA. The SAFA framework, developed by the Food and Agriculture Organization of the United Nations (FAO), offers a comprehensive and holistic approach to evaluating various aspects of sustainability in food and agriculture systems (FAO, 2014). SAFA includes four main dimensions: environmental integrity, social well-being, economic resilience, and good governance, providing useful tools for evaluating and improving sustainability across various agricultural systems (FAO, 2014).

The SAFA framework, introduced by FAO in 2013, serves as a comprehensive tool for assessing the sustainability of agricultural and food systems. It is designed to cover a broad range of sustainability aspects with a specific focus on the agriculture and food sectors. The main components of SAFA include:

a) Economic resilience: Evaluates financial well-being and market access for stakeholders in the agricultural value chain.
b) Environmental integrity: Ensures agricultural practices that maintain soil quality, water resources, biodiversity, and reduce greenhouse gas emissions.
c) Social well-being: Focuses on the social conditions of farmers and communities, including labor rights, health, safety, and gender equity.
d) Good governance: Involves transparency, legitimacy, civil responsibility, and fair resource appropriation (FAO, 2013).

SAFA is different from other sustainability assessment methods as follows:

a) Holistic and multidimensional: SAFA not only assesses sustainability from an environmental perspective but also incorporates economic, social, and governance dimensions, making it more comprehensive.
b) Specific to agriculture and food systems: Unlike general sustainability assessment methods, SAFA is tailored to address the unique complexities of the agricultural and food sectors (FAO, 2014).
c) Tiered approach: SAFA uses a hierarchical approach with more detailed indicators across each dimension, compared to other methods that may have fewer, less nuanced indicators (FAO, 2013).

Its relevance to this study lies in its ability to evaluate sustainability in the agricultural sector by considering economic, environmental, social, and governance aspects. This makes it well-suited for analyzing sustainable practices among cattle farmers in Boyolali and Salatiga, Indonesia.

The application of SAFA in different contexts has shown significant benefits in providing a deep understanding of sustainability. For instance, in Europe, SAFA has been applied to assess sustainability in organic farming, demonstrating improvements in resource efficiency and farmer well-being. However, despite SAFA's widespread use across various countries and sectors, its application in the context of cattle farming in Indonesia remains very limited. This creates a gap in the literature that needs to be filled to provide practical guidance and local relevance in efforts to enhance sustainability (Abson et al., 2017; El Bilali, 2019; Scoones, 2016).

Furthermore, the challenges faced by small-scale cattle farmers in Indonesia are not only technical but also related to policies and government support. Many small farmers encounter barriers to accessing new and practical environmentally friendly technologies and often lack support for adopting better sustainable practices. These factors require special attention in efforts to implement SAFA principles and improve sustainability practices at the local level.

It is crucial to assess in-depth how cattle farmers in Indonesia manage their sustainability practices and the challenges they face. By conducting qualitative analysis through interviews and in-depth observations, this study aims to provide a better understanding of sustainability management among cattle farmers and how the SAFA framework can be effectively applied in the local context (Fraser et al., 2005; O'Brien & Leichenko, 2000). After exploring existing practices and identifying constraints faced by farmers, this study provides insights on how SAFA principles can help enhance sustainability in the cattle farming sector.

Through this analysis, this research aims to not only fill the gap in the literature on cattle farming sustainability in Indonesia but also offer practical suggestions for stakeholders in their efforts to enhance sustainability in this sector. By providing in-depth insights into existing sustainability practices and challenges faced, this study is expected to significantly contribute to the development of more sustainable policies and practices in cattle farming in Indonesia.

Focusing on the application of SAFA and qualitative analysis, this research aims to provide useful guidance for policymakers, farmers, and other stakeholders in their efforts to manage cattle farming practices more sustainably.

This is expected to encourage the adoption of better practices and improve sustainability in Indonesia's cattle farming system, as well as provide a model that can be applied in other countries with similar contexts (Godfray et al., 2018).

Sustainability in agricultural systems refers to the ability of these systems to meet current food needs without compromising the ability of future generations to meet their own needs (Godfray et al., 2018). This concept involves three main dimensions: environmental sustainability, social well-being, and economic viability (FAO, 2020). The environmental dimension encompasses the efficient use of natural resources and the minimization of negative impacts on ecosystems. The social dimension focuses on community welfare, including workers' rights and farmer well-being. Meanwhile, the economic dimension refers to fair profits and financial sustainability for all parties involved (Pretty et al., 2018).

1.2 Sustainability Assessment Approaches

One important approach in sustainability assessment is the SAFA developed by FAO. SAFA provides a comprehensive framework for assessing the sustainability of agricultural systems by considering various relevant indicators across four main dimensions: environmental, social, economic, and governance (FAO, 2014). SAFA allows for a holistic and integrative assessment of various sustainability aspects, which is essential for identifying strengths and weaknesses in agricultural practices.

1.3 Environmental Impacts of Cattle Farming

Cattle farming has significant environmental impacts, including greenhouse gas emissions, land use, and water consumption (Poore & Nemecek, 2018). Methane emissions from cattle digestion processes are a major contributor to climate change. Methanogenic digestion processes produce methane, a greenhouse gas that is more potent than carbon dioxide in the short term (Shindell et al., 2012). Furthermore, cattle farming requires extensive land for feed production, often leading to deforestation and land degradation (Zaninotto et al., 2020). Water use in cattle farming is also significant for both livestock consumption and feed production, impacting local water resources.

1.4 Sustainable Practices in Cattle Farming

Sustainable practices in cattle farming aim to reduce negative environmental impacts and enhance production efficiency. One introduced practice is the use of more efficient feed and waste management technologies that can reduce greenhouse gas emissions and resource usage (Jaakamo et al., 2019). Innovations such as carefully selected plant-based feed systems can help reduce methane emissions and improve productivity. Additionally, waste management technologies such as biogas can mitigate livestock waste impacts and generate renewable energy (Mottet et al., 2017).

1.5 Social and Economic Welfare in Cattle Farming

Social and economic welfare is an essential aspect of sustainability that is often overlooked in farming practices. Social welfare encompasses workers' rights and fair working conditions, while economic welfare involves fair profits for farmers and financial sustainability (de Olde et al., 2016; El Bilali, 2019). In many developing countries, including Indonesia, small farmers often face challenges accessing technologies and markets that can enhance their welfare (Knickel & Renting, 2018). Government support and policies that facilitate the adoption of environmentally friendly technologies and provide training for small farmers can play a crucial role in enhancing social and economic welfare.

1.6 Policy Implementation and Government Support

Government policies and support have a significant impact on the sustainability of farming systems. Governments can provide incentives for adopting environmentally friendly technologies and support small farmers through training and resource access. Policies that encourage innovation in farming practices and environmental protection can help reduce the negative impacts of cattle farming and enhance the overall sustainability of agricultural systems. However, existing policies often do not fully accommodate the specific needs of small farmers or adequately support sustainability enhancement efforts (Altieri & Nicholls, 2017).

1.7 Innovation and Technology in Sustainability

Innovation and technology play a vital role in enhancing sustainability in cattle farming. New technologies in feed and waste management can reduce environmental impacts from farming and increase production efficiency.

Agroforestry systems and crop-livestock integration are innovative approaches that can improve sustainability by leveraging synergies between crops and livestock. Additionally, data-driven approaches and information technology can assist in monitoring and managing agricultural systems more effectively (Jaakamo et al., 2019).

2. Methodology

2.1 Research Design

This study employs a qualitative method to explore and uncover sustainability activities in cattle farming practices in Indonesia. The qualitative method was chosen because of its ability to provide in-depth understanding of farmers' experiences, perspectives, and practices in the context of sustainability (Cresswell & Poth, 2016). This research aims to identify and analyze how cattle farmers in Indonesia implement sustainability principles, using the SAFA as a framework (FAO, 2014).

2.2 Location and Participants

Boyolali and Salatiga were chosen for their reputations in significant cattle farming practices and the diversity of methods used. The research was conducted in these two locations, which are known for their substantial cattle farming activities. The selection of these locations is based on criteria such as farming intensity and the diversity of farming practices in both districts (Yin, 2018). From these two locations, a total of seven cattle farmers were purposively selected to provide a comprehensive overview of sustainability practices in cattle farming (Palinkas et al., 2015).

Although the sample size is only seven, this qualitative approach allows for an in-depth exploration of how cattle farmers apply sustainability principles locally. Qualitative research does not aim for generalization but seeks to understand phenomena deeply and contextually. Moreover, it is emphasized that in case studies, a small sample size is often sufficient as long as the data obtained is rich and relevant (Yin, 2018). Therefore, a small sample can provide deeper insights into sustainability dynamics at the local level (Patton, 2015). As for the selection of participants, individuals deemed capable of providing in-depth and relevant information about sustainability practices in cattle farming were chosen to complement the data collected (Shieh et al., 2020).

2.3 Data Collection Techniques

Observations in this study were conducted biweekly over a six-month period. Each observation session lasted 2-4 hours, focusing on the routine activities of cattle farmers and the implementation of sustainability practices. The biweekly frequency was chosen to ensure consistent documentation of changes in livestock management practices, resource utilization, and waste management. This approach provided rich and in-depth data on the sustainability dynamics among cattle farmers in Boyolali and Salatiga.

2.3.1 In-depth interviews

In-depth interviews were conducted with cattle farmers and farm managers in Boyolali and Salatiga to understand the sustainability practices implemented, the challenges faced, and the impacts of these practices on the environment and social welfare (DiCicco-Bloom & Crabtree, 2006). The interviews were semi-structured, guided by key topics related to sustainability according to the SAFA dimensions. Interviews were recorded, and transcripts were analyzed to identify key themes (Britten et al., 2017).

2.3.2 Field observations

Observations were made at farming locations in both districts to directly observe the practices and technologies used in cattle farming. This observation aimed to complement the information obtained from interviews and provide clearer context about the sustainability practices implemented (Angrosino, 2007).

2.3.3 Documentary studies

Documents such as annual reports, internal farm policies, and government policies related to cattle farming were utilized to gather additional information regarding the implementation of sustainability principles and existing policy support (Bowen, 2013). These documents help in understanding the policy context and strategies applied in the farming sector.

2.4 Data Analysis Techniques

Data obtained from interviews, observations, and documentary studies were analyzed using a thematic analysis approach (Braun & Clarke, 2006). The analysis process was conducted in several stages as follows:

a) Coding: Transcript data from interviews and observation notes were coded to identify key themes related to cattle farming sustainability. Coding was performed using a qualitative method. Table 1 shows the codes used in this study.

Table 1. Code list

Main Code	Sub-Code	Description
Environmental Integrity	Atmosphere	Efforts to reduce air pollution from farming activities.
	Water	Conservation and management of water resources.
	Soil	Maintenance and improvement of soil quality through agricultural practices.
	Biodiversity	Efforts to preserve biodiversity in the surrounding farming environment.
	Raw materials and energy	Efficient management of raw materials and energy resources.
	Animal welfare	Animal welfare in farming practices, such as providing space and care.
Economic Resilience	Investment	Investment activities to improve facilities or purchase new livestock.
	Vulnerability	Strategies to address business vulnerabilities and maintain product quality.
	Feed quality and information	Focus on feed quality and access to information about feed.
	Local economy	The role of farming in supporting the local economy.
Social Well-being	Decent livelihood	Efforts to improve farmers' living standards through training and support.
	Fair trade practices	Fair trade practices, including pricing that benefits farmers.
	Worker rights	Respect for workers' rights, such as no forced or child labor.
	Justice	Implementation of justice within the farming community, including gender and racial equality.
	Cultural diversity	Appreciation for cultural diversity within the farming community.
Good Governance	Corporate ethics	Awareness of corporate ethics even without formal policies.
	Accountability	Accountability systems related to environmental management and sustainability.
	Participation	Participation in training and interactions with stakeholders, such as the government.
	Legal compliance	Compliance with applicable regulations, particularly those related to the environment.

b) Categorization: The generated codes were grouped into main categories reflecting the dimensions of sustainability according to SAFA: environmental, social, economic, and governance (FAO, 2014).
c) Thematic analysis: The main themes were analyzed to identify patterns, relationships, and differences in sustainability practices between different locations. This analysis helps in understanding how sustainability principles are applied in real practices and the challenges faced by farmers (Braun & Clarke, 2006).
d) Triangulation: Data from various sources (interviews, observations, and documentation) were compared and combined to enhance the validity and reliability of the findings. Triangulation was performed to ensure that the research results reflect a comprehensive and accurate picture of sustainability practices in cattle farming in Indonesia (Flick, 2018).

2.5 Validity and Reliability

To ensure the validity and reliability of this study, the following steps were taken:
a) Member check: The analysis results and preliminary findings were confirmed with participants to ensure the accuracy and consistency of the information obtained (Lincoln & Guba, 1985). These findings can assist stakeholders in developing policies that support sustainability in cattle farming.
b) Triangulation: The use of various data collection techniques and sources of information to verify findings and enhance the accuracy of research results (Denzin, 2012).
c) Documenting the research process: The entire research process, including data collection, analysis, and interpretation, was documented in detail to ensure transparency and reproducibility of research results (Cresswell & Poth, 2016).

2.6 Research Ethics

This research adheres to ethical principles by ensuring that all participants provide informed consent before their

participation (Office for Human Research Protections, 1979). The confidentiality of personal information and data obtained has been strictly maintained, and participants have the opportunity to withdraw from the study at any time without negative consequences (Shamoo & Resnik, 2015).

3. Results

Interviews, observations, and documentation were conducted based on the SAFA dimensions, which include environmental integrity, social well-being, economic resilience, and good governance, at two locations, Boyolali and Salatiga. The informants of this study included A and B, who represent the parent cooperative of dairy farmers, and C, D, E, F, and G, who are small-scale dairy entrepreneurs and cooperative members.

3.1 SAFA Dimensions

3.1.1 Environmental integrity

a) Atmosphere: The dairy farming community has adopted several practices aimed at reducing air pollution. For instance, Farmer A shared that they had constructed biogas facilities to manage livestock waste, which helps minimize emissions. Similarly, Farmer B emphasized the importance of air circulation in their semi-open barns. Farmers C, D, E, F, and G collectively acknowledged their responsibility to reduce air pollution, recognizing that their farms were situated within a community context.

b) Water: Water conservation is a key focus for these farmers. Farmer A noted that they strove to maintain water quality as it is crucial for their operations. While Farmer B explained how they treated water mixed with waste for biogas and then used the clean water for irrigating grass. This commitment to water management was echoed by Farmers C, D, E, F, and G, who received guidance on efficient water use, ensuring that treated wastewater is effectively utilized for irrigation.

c) Soil: Efforts to maintain soil quality are evident across the community. Farmer A remarked on how they used land for growing grass and fertilized it with manure, while Farmer B highlighted the benefits of this practice for soil health. Farmers C, D, E, F, and G shared this approach and stated that they had received training on land management, which encourages the use of manure to enhance soil quality.

d) Biodiversity: Preserving biodiversity is another critical aspect of their farming practices. Farmer A explained that they understood the importance of ecosystem balance and avoided using chemical fertilizers. This sentiment was shared by Farmer B, who noted the diversity of crops grown alongside grass, such as cassava and coffee. Farmers C, D, E, F, and G also contributed by planting vegetables for their daily needs, showcasing their commitment to maintaining biodiversity despite land limitations.

e) Raw materials and energy: Effective management of raw materials and energy was prioritized by these farmers. Farmer A mentioned that they grew grass around the farm, and it was processed into concentrate for livestock feed, highlighting the dual benefit of feed production and energy efficiency through practices like using Light Emitting Diode (LED) lighting and open barn designs. Farmers C, D, E, F, and G corroborated this, emphasizing their reliance on cooperatives for sourcing raw materials and their own cultivation efforts.

f) Animal welfare: Animal welfare is a central concern among these farmers. Farmer A explained the importance of maintaining hygiene by bathing cows daily and ensuring adequate space for comfort. Similarly, Farmer B noted their collaboration with local livestock health departments for vaccinations. This commitment to animal welfare was echoed by Farmers C, D, E, F, and G, who prioritized reducing stress for their cows by allowing access to larger grazing fields.

3.1.2 Economic resilience

a) Investment: Investment in resources is crucial for these farmers. As noted by Farmer A, their cooperative reinvested profits into purchasing productive cows and improving feed production facilities. Farmers C, D, E, F, and G, despite being small-scale, emphasized their commitment to setting aside funds for new dairy cows and participating in training offered by the cooperative.

b) Vulnerability: To address vulnerabilities in their business, Farmer A highlighted the importance of maintaining good relationships with the industry to ensure milk quality. Farmer B supported this notion, explaining how they benefited from industry-sponsored training. Farmers C, D, E, F, and G similarly adhered to cooperative guidance to ensure the sustainability of their operations.

c) Feed quality and information: Maintaining high-quality feed is a priority for these farmers. Farmer A indicated that they produced much of the feed themselves and participated in training to ensure quality, while Farmer B mentioned purchasing grass from other cooperative members to guarantee a steady supply. Farmers C, D, E, F, and G agreed and stated that they bought quality feed from the cooperative, which aids in managing their costs efficiently.

d) Local economy: The local economy benefits from their efforts. Farmer A explained how their cooperative supported local farmers and developed dairy products, although they faced challenges in attracting younger generations to farming. Farmers C, D, E, F, and G reiterated the significance of dairy farming for their family

economy and expressed a desire to encourage the next generation to continue this legacy.

3.1.3 Social well-being

a) Decent livelihood: Ensuring a decent livelihood is a shared goal among farmers. Farmer A highlighted the access to training and resources provided by their cooperative, while Farmer B mentioned the industry's involvement in skill improvement. Farmers C, D, E, F, and G conveyed their contentment with current living conditions, illustrating the impact of these initiatives.

b) Fair trade practices: Fair trade practices are upheld within the community. Farmer A explained that the industry still ensured profits for farmers after setting the price. This perspective was echoed by Farmers C, D, E, F, and G, who relied on the cooperative for price information to cover production costs.

c) Worker rights: Worker rights are respected throughout the cooperative. Farmers A and B noted their commitment to avoiding forced or child labor. Farmers C, D, E, F, and G affirmed that any issues were resolved collaboratively, demonstrating a strong sense of community.

d) Justice: Equality is emphasized within the farming communities. Farmers A and B explained their practice of treating employees equally, regardless of background, while Farmers C, D, E, F, and G noted that women often managed livestock in their families, highlighting a progressive approach to gender roles.

e) Cultural diversity: Cultural diversity is celebrated within the community. Farmer A acknowledged the respect for various religious backgrounds, while Farmers C, D, E, F, and G reinforced this sentiment by emphasizing mutual respect among diverse community members.

3.1.4 Good governance

a) Corporate ethics: Although formal corporate ethics policies were lacking, Farmers A and B were committed to considering the environmental, economic, and social impacts of their activities. Farmers C, D, E, F, and G affirmed their mindfulness of these impacts despite not having written policies.

b) Accountability: The farmers have not conducted formal audits but are responsive to environmental incidents. Farmers A and B highlighted their proactive approach to managing such situations, while Farmers C, D, E, F, and G followed cooperative guidance on environmental management.

c) Participation: Engagement with stakeholders is evident, as Farmers A and B participated in training and provided feedback. However, decision-making typically occurs internally. Farmers C, D, E, F, and G followed the cooperative's guidance when interacting with external stakeholders.

d) Legal compliance: Farmers ensure they comply with regulations set by local authorities, particularly regarding environmental standards and food safety. Table 2 summarizes the findings.

Table 2. Summary of findings

Dimension	Sub-Dimension	Farmer Practices	Remarks
Environmental Integrity	Atmosphere	Farmer A: Constructed biogas facilities to manage livestock waste. Farmer B: Emphasized air circulation in semi-open barns. Farmers C, D, E, F, G: Acknowledge responsibility to reduce air pollution in community context.	Reducing air pollution with community approaches
	Water	Farmer A: Maintains water quality for operations. Farmer B: Treats wastewater for biogas and uses clean water for irrigation. Farmers C, D, E, F, G: Follow guidance on efficient water use and treat wastewater for irrigation	Focus on conservation and efficient water management
	Soil	Farmer A: Uses manure for fertilizing land. Farmer B: Highlights the benefits of this practice for soil health. Farmers C, D, E, F, G: Received training on land management and use manure to enhance soil quality.	Efforts to enhance soil quality through training.
	Biodiversity	Farmer A: Avoids chemical fertilizers. Farmer B: Grows various crops alongside grass, such as cassava and coffee. Farmers C, D, E, F, G: Plant vegetables for daily needs, contributing to biodiversity.	Commitment to maintaining biodiversity on limited land

Economic Resilience	Raw materials and energy	Farmer A: Grows grass for livestock feed. Farmer B: Uses LED lighting and open barn designs for energy efficiency. Farmers C, D, E, F, G: Rely on cooperatives for sourcing raw materials and their own cultivation efforts.	Efficient management of energy and raw materials.
	Animal welfare	Farmer A: Ensures daily hygiene and comfort for cows. Farmer B: Collaborates with local livestock health departments for vaccinations. Farmers C, D, E, F, G: Prioritize reducing stress for cows by allowing larger grazing fields.	Focus on animal welfare through good management.
	Investment	Farmer A: Reinvests profits into purchasing productive cows. Farmer B: Sets aside funds for new dairy cows. Farmers C, D, E, F, G: Emphasize saving for new dairy cows and participate in cooperative training.	Importance of investment for sustainability.
	Vulnerability	Farmer A: Maintains good industry relationships to ensure milk quality. Farmer B: Benefits from industry-sponsored training. Farmers C, D, E, F, G: Follow cooperative guidance to ensure operational sustainability.	Addressing vulnerabilities through training and industry relationships.
	Feed quality and information	Farmer A: Produces most feed themselves and participates in training. Farmer B: Purchases grass from cooperative members. Farmers C, D, E, F, G: Buy quality feed from the cooperative for cost management.	Importance of feed quality in cost management.
	Local economy	Farmer A: Cooperative supports local farmers and dairy product development. Farmer B: Faces challenges in attracting younger generations. Farmers C, D, E, F, G: Emphasize dairy farming's significance for family economy and future generations.	Positive impact on the local economy and sustainability for future generations.
Social Well-being	Decent livelihood	Farmer A: Access to training and resources provided by cooperative. Farmer B: Industry involvement in skill improvement. Farmers C, D, E, F, G: Express contentment with current living conditions.	Efforts to ensure farmers' well-being.
	Fair trade practices	Farmer A: Industry sets prices but ensures farmer profits. Farmers B, C, D, E, F, G: Rely on cooperative for price information covering production costs.	Fair trading practices within the community.
	Worker rights	Farmers A and B: Commitment to avoiding forced or child labor. Farmers C, D, E, F, G: Affirm collaborative resolution of any issues.	Respect for worker rights within the cooperative.
	Justice	Farmers A and B: Treat employees equally regardless of background. Farmers C, D, E, F, G: Highlight women managing livestock in families	Progressive approach to gender roles.
	Cultural diversity	Farmer A and B: Respects various religious backgrounds. Farmers C, D, E, F, G: Emphasize mutual respect among community members.	Celebrating cultural diversity within the community
Good Governance	Corporate ethics	Farmers A and B: Consider environmental, economic, and social	Unwritten but valued corporate ethics.

	impacts.	
Accountability	Farmers C, D, E, F, G: Mindful of impacts without written policies. Farmers do not conduct formal audits but are responsive to incidents. Farmers A and B: Highlight proactive management of environmental situations.	Responsibility in environmental management.
Participation	Farmers A and B: Participate in training and provide feedback. Farmers C, D, E, F, G: Follow cooperative guidance for external stakeholder interactions.	Engagement with stakeholders.
Legal compliance	Ensure compliance with local regulations, particularly regarding environmental standards and food safety.	Legal compliance in farming practices

4. Discussion

4.1 SAFA Dimensions

4.1.1 Environmental integrity

a) Atmosphere: In this dimension, farmers strive to reduce air emissions from dairy farming activities by utilizing biogas technology to manage livestock waste (informants A and B). Additionally, the semi-open barn construction allows for better air circulation, reducing air pollution in the surrounding environment (informant B). Several studies support the effectiveness of biogas utilization and semi-open barn designs in reducing greenhouse gas emissions (Amon et al., 2006; Tao et al., 2012).

b) Water: Farmers in both locations demonstrate a high awareness of water conservation, as shown by the reuse of wastewater to irrigate forage crops (informants A and B). Efficient water use and the treatment of liquid waste into biogas align with sustainable water management principles (Liu et al., 2018).

c) Soil: Applying manure to improve soil quality is a common practice among farmers. Utilizing vacant land around the farm to grow grass for livestock feed is also considered an effective strategy for maintaining soil fertility (informants C, D, E, F, and G). The use of organic manure has been proven to improve soil quality and fertility, as well as reduce dependence on chemical fertilizers (Hagos et al., 2017).

d) Biodiversity: Farmers show concern for biodiversity by planting various crops on vacant land, including grass for animal feed and food crops such as cassava and coffee (informants A and B). This practice supports local ecosystem diversity, which is in line with research highlighting the importance of crop diversification for enhancing agricultural sustainability (Lin, 2011).

e) Raw materials and energy: Energy is saved through the use of open barns that allow sunlight to enter during the day, as well as the use of LED lights to reduce electricity consumption at night (informants C, D, E, F, and G). Additionally, farmers strive to produce their own livestock feed, demonstrating self-sufficiency in raw material usage (Kruger, 2017).

f) Animal welfare: Farmers prioritize animal welfare by bathing the cows daily and maintaining enough space between cows in the barn to avoid overcrowding (informants A and B). Previous studies have shown that these practices can reduce stress in livestock, leading to increased productivity (Franco et al., 2016).

4.1.2 Economic resilience

a) Investment: Farmers, especially those in cooperatives, allocate part of their profits to investment in the form of purchasing new cows, processing livestock feed, and improving milk storage facilities (informants A and B). These investments ensure long-term business sustainability and align with literature indicating that investment diversification can reduce economic risks in the livestock sector.

b) Vulnerability: Good relationships between cooperatives and the dairy industry provide assurance for the continuity of livestock businesses, particularly regarding product quality and resilience against economic fluctuations (informants C, D, E, F, and G). Financial literacy and training provided by cooperatives also help farmers manage risks (Beckmann & Czudaj, 2014).

c) Feed quality and information: Farmers ensure feed quality through self-production and ongoing training provided by cooperatives (informants A and B). Research supports the importance of feed quality standards to maintain the health and productivity of dairy cows.

d) Local economy: Dairy cooperatives in Boyolali and Salatiga play a vital role in local economic development. Some local dairy products have even been marketed outside the region, increasing farmers' incomes (informants A and B). Empowering the local economy through dairy product processing is an essential aspect of promoting regional economic growth (Fytopoulou et al., 2021).

4.1.3 Social well-being

a) Decent living: Farmers feel that their lives are adequate, with basic needs such as food, education, and housing being met (informants C, D, E, F, and G). Access to training and investment in farm infrastructure also supports their efforts to achieve a better life (Tendall & Gaillard, 2015).

b) Fair trade practices: Dairy farmers, through cooperatives, receive fair prices for their milk products. This ensures that farmers continue to make a profit despite market price fluctuations (informants A and B). Fair trade is a mechanism that supports the well-being of small farmers in various agricultural sectors (Guzman et al., 2018).

c) Labor rights: Dairy cooperatives ensure that no child labor or forced labor is used in their environment. The relationship between farmers and workers is based on mutual respect (informants A and B). Protection of labor rights is crucial in creating a fair and sustainable working environment (Pinto et al., 2020).

4.1.4 Good governance

a) Corporate ethics: There are no written documents explicitly regulating sustainability policies among farmers. However, they demonstrate a commitment to sustainability principles through daily practices, even though they are not supported by formal policies (informants A and B). Sustainable corporate ethics are essential for realizing sustainability in the livestock sector (Szczepankiewicz et al., 2021).

b) Participation: Farmers actively seek to engage with various parties, such as the government, industry, and universities, to improve product quality and environmental management (informants A and B). The participation of various stakeholders in sustainability efforts has proven effective in promoting better practices in agriculture (Koesling et al., 2017).

4.2 The Relationships Between the Four Dimensions

The relationships between the four dimensions can be observed in Figure 1.

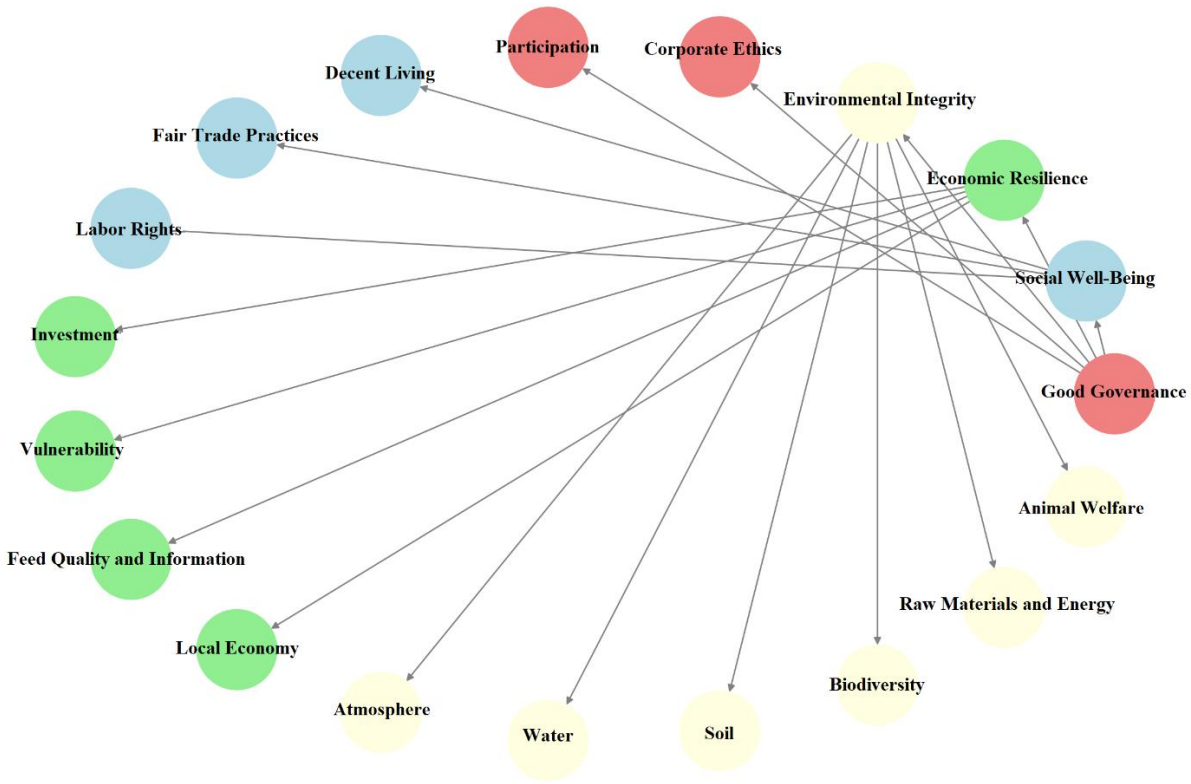

Figure 1. Interconnections among sustainability dimensions

4.2.1 Good governance

The figure positions good governance at the center, illustrating its role as the most influential dimension in the sustainability of dairy farming. Transparent, accountable, and participatory policies drive the implementation of sustainable practices in the other dimensions. Good governance facilitates communication between farmers, the government, and the industry, thus influencing social well-being and economic resilience.

4.2.2 Social well-being

This dimension focuses on workers' rights, social justice, and quality of life. Strong social well-being supports community stability and encourages active participation in sustainability practices. Enhanced social well-being strengthens good governance, as a prosperous society is more likely to engage in decision-making that affects sustainability.

4.2.3 Economic resilience

This dimension includes the system's ability to endure and thrive in the face of economic changes. Investment and income diversification are key to improving economic resilience. Strong economic resilience provides a foundation for social well-being and supports good governance, as farmers have more resources to invest in sustainable practices.

4.2.4 Environmental integrity

This dimension focuses on sustainable natural resource management and reducing the environmental impact of farming practices. Environmental integrity contributes to economic resilience by ensuring that resources remain available and supports social well-being by creating a healthy environment for the community.

Figure 1 emphasizes that the four sustainability dimensions are interconnected and mutually influential. Good governance, as the most influential dimension, acts as the main driver in promoting sustainable practices across social well-being, economic resilience, and environmental integrity. Understanding these interconnections allows stakeholders to design more effective strategies to enhance sustainability in farming systems, especially within the context of the study in Boyolali and Salatiga.

5. Conclusions

This study highlights the sustainability practices implemented by cattle farmers in Boyolali and Salatiga, Indonesia, utilizing the SAFA framework. The findings reveal that while various sustainable practices are in place, challenges remain in areas such as access to environmentally friendly technologies and government support. The key dimensions, i.e., environmental integrity, social well-being, economic resilience, and good governance, show the interconnectedness of sustainability factors. Farmers demonstrate awareness and efforts to enhance sustainability through biogas utilization, water conservation, and animal welfare practices. However, significant gaps remain in policy implementation and technological adoption. This study provides valuable insights for policymakers, cooperatives, and farmers, offering recommendations to improve sustainability in the cattle farming sector in Indonesia. Enhanced collaboration, training, and support for adopting sustainable technologies are critical for achieving long-term sustainability goals.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

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Conflicts of Interest

The authors declare no conflict of interest.

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