Jurnal Ekonomi dan Bisnis, Vol. 14 No. 2 Juni 2025
P - ISSN : 2503-4413
E - ISSN : 2654-5837, Hal 468 – 481

Closed-Loop Sytem In Sarangan Magetan Dairy Farm: Designing A Business Model Canvas For Resource Optimization

Kusnul Ciptanila Yuni K*
Faculty of Economics, Hasyim Asy'ari University Tebuireng Jombang, Indonesia

Nurul Hidayat
Faculty of Economics and Business, Universitas Bahaudin Mudhary Madura, Indonesia

Anita Musfiroh
Faculty of Economics, Hasyim Asy'ari University Tebuireng Jombang, Indonesia

***Corresponding Author**
Kusnul Ciptanila Yuni K
kusnulciptanila@unhasy.ac.id

ARTICLE INFO

Article history :

Received:
11 November 2024
Revised:
07 May 2025
Accepted:
30 May 2025

ABSTRACT

The purpose of this study is to use the Business Model Canvas (BMC) approach for resource optimization in order to build a closed-loop system-based business model for a dairy farm in Sarangan, Magetan. The methodology of this study employs a qualitative approach and descriptive analysis, incorporating field research to understand the operational conditions of the farm and in depth interviews with relevant stakeholders to collect data. This work uses BMC to design a business model that promotes both environmental sustainability and livestock operating efficiency. The findings demonstrate that implementing a closed-loop system can maximize the utilization of organic waste as feed or fertilizer, minimize resource waste, and increase the efficiency of milk production. By implementing BMC, we have discovered a business model that integrates the principles of the circular economy, enhancing value for cattle and their surrounding communities, and fostering sustainability in the long term. Consequently, this study aids in the creation of a cattle business model that is more efficient and ecologically beneficial.

Keywords: Loop System; Business Model Canvas; Resource Optimization; Circular Economy; Dairy Farms.

INTRODUCTION

Given the growing demand for dairy products as a vital component of the community's nutritional needs, Indonesia has significant potential in the dairy sector.(Donner et al., 2020) Magetan Regency, located in East Java Province, is recognized as one of the regions with the highest potential for dairy production. The number of dairy cows in this area has steadily increased over the past five years, according to data from the Magetan Regency Livestock Office. Approximately 1,500 dairy cows were registered in 2018, rising to over 1,700 by 2022. This increase demonstrates a clear trend toward growth in the local dairy industry.(Hariyadi, 2011)

Milk production has risen alongside the expansion of the dairy population.(Shamsuddoha et al., 2023) Data from the Magetan Regency Agriculture and Livestock Office indicate that the region's annual milk production reached approximately 3.5 million liters in 2022, representing an increase of almost 8% over the previous year.(Lestariningsih, 2015) However, alongside this growth, significant challenges remain in waste management, water resource usage, and greenhouse gas emissions, all of which can impact environmental sustainability. Dairy farm waste, especially cow manure and liquid waste, is frequently not properly managed, posing a risk of groundwater contamination and air quality reduction in the area.(Johnson et al., 2018)

The Closed-Loop System presents an innovative solution that dairy farms in Magetan Regency can adopt to address these challenges. This system enables the reuse of resources and materials on the farm, ensuring that waste does not become hazardous.(De Keyser & Mathijs, 2023) By reusing cow manure, wastewater, and leftover feed, the system creates a sustainable cycle that supports agricultural operations. For example, liquid waste can be converted into organic liquid fertilizer for nearby farmland, and cow manure can be transformed into biogas, a renewable energy source.(Ulvenblad et al., 2019)

The following graph, which illustrates the increase in the dairy population in Magetan Regency from 2018 to 2022, can serve as a foundation for developing the Closed-Loop System strategy to promote more sustainable farming practices.

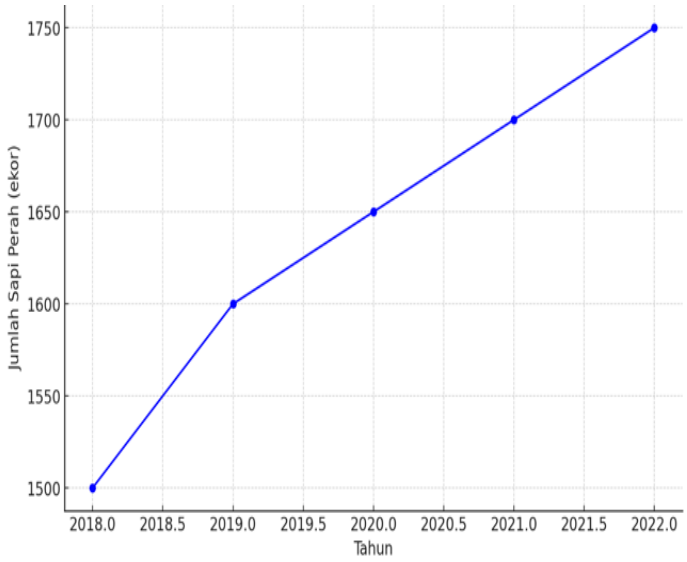

Figure 1. Dairy Cow Population in Magetan Regency (2018-2022)

The population growth of dairy cows in Magetan Regency over the past five years is depicted in this graph. This expansion has led local communities and the government to explore more efficient and environmentally friendly methods for managing waste and animal resources.

Additionally, Magetan Regency, particularly the Sarangan area, is a popular natural tourism destination with unique requirements for maintaining cleanliness and appeal. The Sarangan dairy farm can reduce the negative environmental impacts of livestock operations by implementing the Closed-Loop System, which converts cow manure into biogas and liquid waste into organic fertilizer. This system not only ensures high environmental quality and tourist appeal but also fosters a mutually beneficial ecosystem between the tourism and agricultural sectors.(Johnson et al., 2018)

A comprehensive business model design is necessary to support the successful implementation of the Closed-Loop System.(Dziuba et al., 2021) The Business Model Canvas (BMC) provides a structured approach to planning that ensures resource optimization and incorporates sustainability principles. By identifying key elements such as resources, core operations, important partners, and value propositions, the BMC framework can guide dairy farming practices in Sarangan, Magetan, toward increased sustainability and efficiency.(Ujita et al., 2017) This approach enables farmers to develop energy-saving and waste-management initiatives, boosting the economic competitiveness of livestock production.(Johnson et al., 2018)

In Indonesia, the concept of a closed-loop system within livestock production is still relatively new. Studies from other countries indicate that implementing this system can significantly reduce emissions and waste while generating additional income from byproducts like organic fertilizer and biogas.(Chanthes et al., 2024) In European countries, closed-loop systems are widely adopted in dairy farms, encouraged by government regulations aimed at reducing carbon emissions and environmental impacts from the livestock sector.(Van den Hof, 1998) These systems allow farms to convert animal waste

into biogas for on-site energy use, as well as produce organic fertilizers that improve soil fertility. This method creates a low-waste cycle, ensuring that all waste from livestock operations is repurposed into valuable products.(Shah et al., 2014)

Research on closed-loop systems within Indonesia's livestock industry is still limited. Most Indonesian farms continue to operate using conventional business models that prioritize core output over waste utilization as an additional resource.(Ulvenblad et al., 2019) Few studies have explored the comprehensive integration of closed-loop system components, such as the combined use of organic fertilizers and integrated energy production.(Brehme et al., 2006) Previous research has primarily focused on biogas use to reduce reliance on fossil fuels in farms. This study seeks to fill the gap in the literature by proposing a comprehensive closed-loop system implementation using the Business Model Canvas (BMC) approach.(Purnamasari et al., 2025)

Furthermore, this study's use of BMC offers a unique perspective. While some research has discussed closed-loop applications, few have employed the BMC framework to examine and develop a sustainable business model within the context of cattle farming.(Kara et al., 2022) By using BMC, this study provides a more holistic view of how the farm can improve customer relationships, enhance operational efficiency, and create value for stakeholders, while also identifying opportunities for resource optimization.(Kara et al., 2022)

By integrating the Business Model Canvas with the Closed-Loop System, this study aims to make Sarangan's dairy farm in Magetan a model of environmentally friendly and economically sustainable farming. This project can improve local well-being, promote collaboration between tourism and livestock sectors, and contribute to establishing Magetan as a developed and sustainable region.

THEORETICAL FRAMEWORK AND EMPIRICAL STUDIES

In the cattle and agricultural industries, the closed-loop system is becoming an increasingly popular strategy for achieving operational sustainability and resource efficiency.(Shanmugam et al., 2024) By allowing waste or by-products from production processes to be reused, this system minimizes waste and reduces reliance on external raw materials.(Elia & Gnoni, 2015) Closed-loop systems, as shown in circular economy studies, enhance the economic value of resources by promoting longer product lifecycles and minimizing waste. In the dairy farming sector, animal manure and other waste materials can be converted into organic fertilizer or biogas energy, which can then be used to support production processes and other operational activities. This strategy benefits both the economy and the environment by reducing waste and carbon emissions that would otherwise pollute the ecosystem.(Niero et al., 2021)

The Business Model Canvas (BMC) is an effective management tool for designing a sustainable business model with a focus on resource optimization. BMC helps systematically map key business components, such as revenue and cost streams, customer relationships, value propositions, and essential resources. In the context of Sarangan's

dairy farming, BMC is used to incorporate a closed-loop approach, ensuring that every business aspect contributes to sustainability.(Horvath et al., 2018) Several studies have found that combining BMC with circular economy principles can yield a business model that is both cost-effective and environmentally friendly. By leveraging waste and by-products, farms can reduce production costs, improve product quality, and increase competitiveness, ultimately adding customer value.(Romera et al., 2020)

Previous research highlights the significant potential of the closed-loop approach to enhance sustainability in the livestock industry, particularly through more efficient resource use. In dairy farming, the closed-loop system integrates key operations such as milk production, waste management, and livestock feeding into a cohesive cycle. This approach not only reduces waste but also creates a more efficient value chain. Additionally, by positively impacting the environment, this approach can strengthen the farm's relationship with the local community, fostering greater acceptance of agricultural activities.(Widiati, 2015)

The hypothesis of this research, based on theoretical frameworks and prior studies, is that implementing a closed-loop system using the Business Model Canvas at Sarangan dairy farms will lead to a more sustainable and efficient business model with favorable economic and environmental impacts.(Dziuba et al., 2021) The BMC enables optimal mapping of workflows and resource interactions, ensuring that all business components function within an interconnected cycle. This is expected to reduce operating costs, enhance productivity, and create added value for both the farm and the community. By utilizing each element of the BMC including revenue streams, value propositions, and resource management this study anticipates that the closed-loop model will provide a feasible solution to improve competitiveness and long-term sustainability for dairy farms in Sarangan, Magetan.(Suroto & Nugroho, 2019)

RESEARCH METHODS

Using a case study methodology, this research focuses on implementing the Closed-Loop System, developed with the Business Model Canvas, in dairy farms located in Sarangan, Magetan Regency.(Karlsen, 2014) To gain a comprehensive understanding of the farm's conditions, operational procedures, and potential for closed-loop system implementation, the research began with the collection of primary and secondary data. Primary data were gathered through in-depth interviews with farm owners and managers, along with direct field observations, to understand existing production cycles, resource management, and waste treatment practices.(Kristianto & Nadapdap, 2021)

The next stage involves analyzing the farm's waste and resource potential by identifying the types of waste generated, the quantities produced, and current usage patterns.(Luyben, 2002) At this stage, data from interviews and observations are combined with literature on Closed-Loop System techniques and technologies that are suitable for small-scale farming. The aim of this analysis is to identify key components that could be

optimized, such as utilizing animal feed residues, converting liquid waste into organic fertilizer, and using cow manure as a raw material for biogas production.(Daou et al., 2020)

Once the data have been gathered and analyzed, the next step is to design an appropriate Business Model Canvas to support the Closed-Loop System's implementation.(Rebora et al., 2023) Every component of the Business Model Canvas including the value proposition, customer relationships, cost structure, key resources, and key activities is adapted to meet the specific requirements of the farm in terms of sustainable resource management. Each component is assessed from the perspective of resource efficiency and sustainability, considering ways to recycle waste back into the production cycle to create added value for both the farm and the environment.(Donner et al., 2022) (Yurianingsih et al., 2025)

The outcomes of the Business Model Canvas design are then validated through discussions with local stakeholders, including farmers, environmental managers, and experts in sustainable farming. This validation ensures that the developed business model is practical and aligned with the capabilities and resources of Sarangan's farmers. It is anticipated that this study will serve as a reference for future research on circular economy implementation in the livestock sector, while also providing farmers with valuable insights on adopting the Closed-Loop System.

RESULTS AND DISCUSSIONS

According to a study on implementing a closed-loop system using a Business Model Canvas (BMC) design for resource optimization, the Sarangan Dairy Farm in Magetan has effectively incorporated circular economy concepts into its operations. Based on information collected from manager interviews, field observations, and document analysis, it was determined that waste and natural resources are being managed efficiently.(Horvath et al., 2018) One key optimization is the use of organic waste, especially cow dung, which is converted into biogas to replace fossil fuels. Additionally, local agricultural waste is repurposed as animal feed, reducing the need for more costly and less environmentally friendly commercial feed.(Czikkely et al., 2020)

Figure 2. Initial Business Model Canvas (BMC).

The following diagram shows the Business Model Canvas (BMC) for a Closed-Loop System at the Sarangan Dairy Farm in Magetan. It includes components such as customer segmentation, value propositions, revenue streams, and other elements that emphasize resource optimization through sustainable farming practices. Each component is designed to highlight key aspects like fresh milk production, livestock waste as organic fertilizer, and partnerships with local farmers, all aimed at ensuring sustainability and optimizing resource utilization.(Han et al., 2023)

The farm also optimizes agricultural land for both animal feed and organic fertilizer production through cow manure processing. This demonstrates that, in addition to milk production, the farm prioritizes operational sustainability by maximizing local resources. According to the study, Sarangan Dairy Farm in Magetan has adopted circular economy principles across all aspects of its operations, as evidenced by its closed-loop system designed using a Business Model Canvas.(Cantele & Signori, 2023) Field observations, interviews with managers and owners, and relevant literature reviews reveal that the farm maximizes the use of organic waste and local resources to sustain its operations. A prime example is the use of biogas generated from cow manure to replace fossil fuels, which reduces energy costs and the carbon footprint. This process also makes the farm more eco-friendly by directly lowering greenhouse gas emissions from production.(Narwal et al., 2023)

Furthermore, using local agricultural waste as animal feed is one way to reduce feed costs. Sarangan Farm not only achieves significant cost savings but also addresses environmental sustainability. Besides producing animal feed, agricultural land is also used to produce organic fertilizers that are recycled to improve soil quality. As a result, all available resources support each other in a continuous cycle, decreasing reliance on

external inputs and leading to more productive and efficient long-term operations.(Uvarova et al., 2020)

An in depth look into Key Resources reveals that the farm is equipped with the necessary infrastructure, such as efficient milk processing facilities and a biogas system that provides renewable energy, to support the closed-loop concept. While milk processing facilities allow farmers to produce high quality,(Petrounias et al., 2022) marketable dairy products, the biogas system reduces the environmental impact of farm operations. (K et al., 2023) Additionally, the integration of livestock and agricultural systems, which prioritizes organic waste management, shows that farms can create a mutually beneficial ecosystem through a more environmentally friendly production process.(Bachrun et al., 2024)

Sarangan Farm's commitment to sustainability also attracts customers who value high-quality organic products. Fresh dairy products and derivatives, such as cheese and yogurt, appeal to sustainability conscious consumers. However, one of the main challenges is reaching a broader market, especially in larger cities where demand for organic products is higher. Although the local market offers significant potential, product distribution remains a challenge, especially due to high shipping costs to distant areas. Therefore, developing more efficient distribution channels, such as partnerships with major retailers or online marketing, is essential for expanding market reach and increasing revenue.(Boughton & Hovorka, 2021)

In terms of Revenue Streams, the study shows that the farm generates income not only from dairy products but also from the sale of biogas energy. This demonstrates how implementing a closed-loop system can create additional revenue streams, helping the farm diversify its financial resources. By using waste as a source of energy and raw material for other products, the farm has successfully minimized waste and increased cost efficiency.(Torquati et al., 2014) While initial investment costs for biogas management and dairy processing facilities are substantial, the long-term benefits of reduced energy and feed costs can offset these expenses.(Cadioli et al., 2012)

Regarding the Cost Structure, the primary expenses remain cattle raising and milk processing. However, waste management through biogas production and organic fertilizers has allowed the farm to reduce energy and feed costs that were previously dependent on external sources.(de Lauwere et al., 2024) This approach boosts revenue over time and enhances the farm's self-sufficiency and sustainability. By adopting this closed-loop model, farms can not only ensure operational continuity but also develop a more efficient and eco-friendly business model.

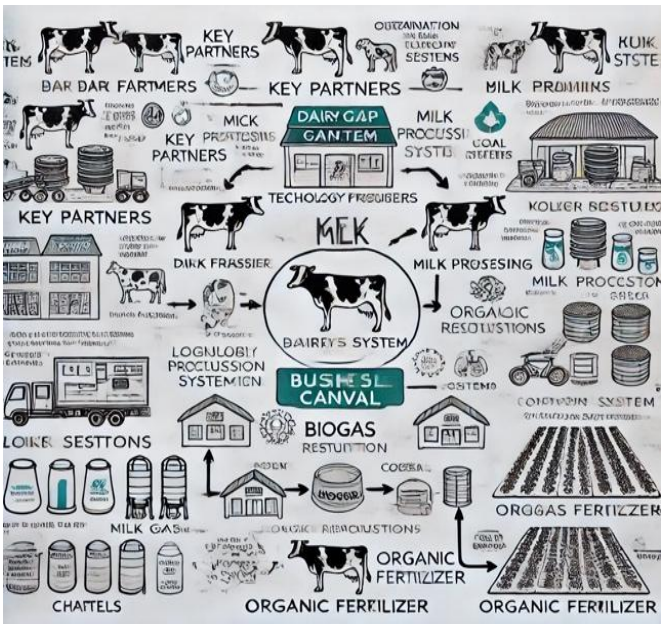

Figure 3. Business Model Canvas (BMC)

The schematic below illustrates the Business Model Canvas (BMC) for the resource-optimization closed-loop system at the Sarangan Dairy Farm in Magetan. Key components such as partners, activities, resources, value propositions, and customer relationships are depicted, all emphasizing resource optimization.

In summary, this analysis shows that Sarangan Dairy Farm's application of the Business Model Canvas, based on the closed-loop system, has succeeded in creating a sustainable business model that maximizes the use of waste and natural resources. While challenges remain in distribution and market expansion, this business model has significant potential to improve operational efficiency and financial sustainability. Sarangan Farm can serve as a model for other farms seeking to incorporate sustainability principles into their operations and demonstrates the application of the circular economy in the livestock and agricultural sectors.(Cadioli et al., 2012)

CONCLUSION, SUGGESTION, AND LIMITATION

According to the study's findings, Sarangan Dairy Farm in Magetan has successfully incorporated circular economy principles into its operations by implementing a closed-loop system through a Business Model Canvas (BMC) design for resource optimization. By utilizing organic waste, such as cow dung, to produce biogas and organic fertilizers, the farm reduces its environmental impact and lowers operational costs associated with energy and animal feed. Additionally, using local resources, including agricultural waste, provides further benefits in terms of cost-effectiveness and production sustainability.

By implementing BMC, Sarangan Dairy Farm enhances its value by producing high quality dairy products that appeal to sustainability-conscious consumers. The revenue generated from the sale of dairy products and byproducts, such as organic fertilizers and biogas, demonstrates that this business model can create multiple profitable revenue

streams. Despite challenges in expanding the market and distribution especially to larger cities the potential within the local market remains promising.(Cheng & Shahin, 2016)

Overall, the adoption of this closed-loop system demonstrates that farmers can create a profitable and environmentally sustainable cycle through the right business model design that integrates operational efficiency with environmental sustainability. Sarangan Dairy Farm serves as a valuable model for other farms seeking to adopt circular economy principles in the development of sustainable business models within the livestock and agricultural sectors.(Weaver & Hirsch, 2018).

ACKNOWLEDGMENT

We extend our heartfelt gratitude to the Ministry of Education, Culture, Research, and Technology for their funding support, which has made this program possible. Our sincere appreciation also goes to the Research and Community Service Institute (LPPM) of Hasyim Asy'ari University, Tebuireng, for their guidance and support throughout the implementation of this program. We are also grateful to all other parties who have contributed to the success of this program, though they cannot be mentioned individually.

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