



Implementation of Circular Economy in Agribusiness SMEs and Its Impact on Business Sustainability: A Case Study

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Abstract

The circular economy has emerged as an important approach to enhancing agribusiness sustainability by shifting production systems from linear models toward regenerative processes that preserve resource value. This study identifies and evaluates the implementation of an integrated livestock farming system in agribusiness micro, small, and medium enterprises through a case study of CV Mitra Tani Farm, an integrated livestock-based enterprise in Indonesia. Circular agribusiness practices were identified using the 9R principles, and the analysis employed the Triple Bottom Line framework to assess sustainability performance across economic, environmental, and social dimensions. The identification results indicate that the integrated farming system implemented at MT Farm operationally reflects the core principles of the circular economy. The evaluation further shows that circular practices such as waste-to-resource conversion, integrated farming systems, and product diversification effectively reduce operational waste, improve resource efficiency, and maintain ecological balance. Socially, these practices promote employment creation, partner capacity building, and the strengthening of rural collaboration. From an economic perspective, circular practices enhance business resilience; however, the economic potential of waste-based activities has not yet been fully optimized, indicating the need for further development to enable the circular economy to play a more effective role in supporting the transformation toward sustainable agribusiness.

Introduction

The linear “take–make–dispose” production model has long characterized agribusiness practices in Indonesia, particularly in livestock-based enterprises that generate substantial volumes of biological waste. In agribusiness systems, waste is not merely an externality but an inherent by-product of biological production processes, including manure, urine, crop residues, and processing by-products. When these outputs are not properly managed, they increase production costs, reduce resource efficiency, and pose environmental risks to surrounding agroecosystems (Padhiary & Kumar, 2024; Wu et al., 2025; Lal, 2010).

In this context, the circular economy emerges not only as an economic concept but as a systemic approach to transforming agribusiness production systems by closing biological nutrient loops, integrating crop and livestock activities, and optimizing resource flows within farming operations (Rodias et al., 2020; Agus et al., 2020). Unlike industrial sectors dominated by technical material cycles, agribusiness relies heavily on renewable biological resources, making circular strategies such as manure recycling, feed substitution, and integrated farming systems particularly relevant for enhancing agribusiness sustainability (Agus et al., 2020; Selvan et al., 2023).

In recent years, the Circular Economy concept has gained increasing attention in Indonesia as an alternative to the linear production system, particularly within agribusiness and small and medium-sized enterprises (SMEs) that are highly dependent on biological resources. In agribusiness systems, circular economy practices offer opportunities to enhance production efficiency, reduce biological waste, and create value added from agricultural and livestock by-products. Kristianto et al. (2021) define the circular economy as an economic concept that integrates sustainability objectives in line with responsible consumption and production. In the agribusiness context, this concept is operationalized through practices such as converting livestock manure into organic fertilizer, utilizing animal hides for value-added products, integrating livestock–crop–aquaculture systems, and diversifying agricultural products. These practices are increasingly viewed as practical solutions to environmental pressures and economic vulnerabilities in agricultural production systems (Urruty et al., 2016; Lawal et al., 2023). Furthermore, the circular economy is widely recognized as a sustainable development model capable of reducing waste and improving resource efficiency by maintaining material circulation within production systems (Kirchherr et al., 2017; Ellen MacArthur Foundation, 2015).

In Indonesia, agribusiness, particularly the food sector, has been identified as one of the priority areas for circular economy development under the Circular Economy Roadmap and National Action Plan 2025–2045. Despite this strategic importance, national assessments indicate that circular economy performance in Indonesia in 2023 remained at a moderate level, with several sectors showing limited observable progress. This condition highlights the need for stronger implementation efforts, especially in agribusiness systems where circular practices have significant potential to improve production resilience, resource efficiency, and long-term sustainability.

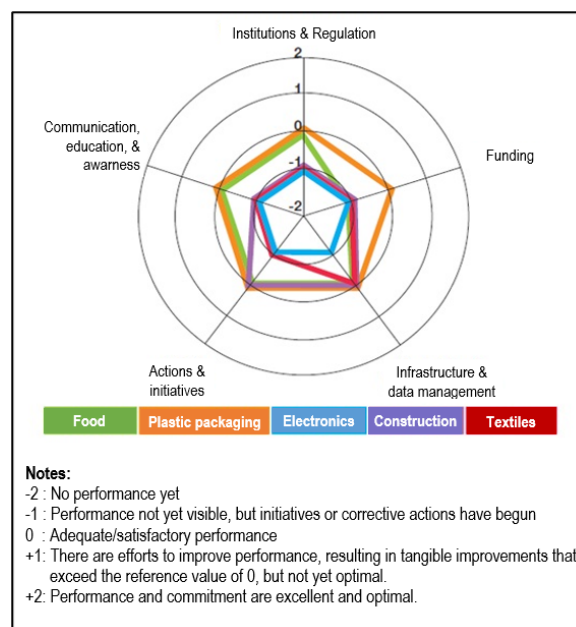


Figure 1. Circular economy performance in Indonesia

Source: Ministry of National Development Planning/Bappenas (2024)

According to Low Carbon Development Indonesia (2024), economic practices in Indonesia remain predominantly characterized by a linear production and consumption model. Within the agribusiness context, this linear approach has contributed to inefficiencies, resource losses, and

increasing environmental pressures along agricultural value chains. The implementation of a circular economy therefore offers significant long-term economic, environmental, and social benefits, including a potential increase in national GDP ranging from IDR 593 to 638 trillion, waste reduction across sectors by 18–52 percent, a reduction of greenhouse gas (GHG) emissions by up to 126 million tons of CO₂, and the creation of approximately 4.4 million new jobs by 2030. Among the priority sectors identified for circular economy development, the food sector, particularly agribusiness, plays a strategic role due to its direct contribution to food security, employment, and rural economic development.

Despite its strategic importance, a review of existing academic literature reveals a lack of comprehensive empirical studies in Indonesia that specifically examine the implementation of circular economy practices within agribusiness SMEs. Most available studies remain conceptual or focus primarily on environmental outcomes, while integrated evaluations of economic performance, social impacts, and overall business sustainability, especially at the micro and small enterprise levels, are still very limited. This gap is particularly critical given that the majority of agribusiness activities in Indonesia are dominated by SME actors who operate at the intersection of production efficiency, livelihood security, and environmental management.

This study seeks to address this research gap through an in-depth case study of CV Mitra Tani Farm, an integrated agribusiness SME in Indonesia. Using the Triple Bottom Line (TBL) framework, which encompasses economic, social, and environmental dimensions, this research evaluates how circular economy implementation influences business sustainability, partner welfare, and environmental preservation within agribusiness operations. In line with the Ministry of National Development Planning/Bappenas (2024), this comprehensive approach is essential for advancing circular economy practices that are both economically viable and socially inclusive. The findings of this study are expected to provide empirical insights that support agribusiness practitioners and policymakers in accelerating the transition toward sustainable agribusiness models in Indonesia.

Literature Review

Circular Economy

The circular economy is a production and resource management model that aims to maintain the value of products, materials, and resources within the production cycle for as long as possible while minimizing waste, particularly in resource-intensive sectors such as agribusiness (Ellen MacArthur Foundation, 2015). In agribusiness systems, which are highly dependent on biological resources, the circular economy emerges as an alternative to the linear “take–make–dispose” approach by emphasizing strategies such as reduce, reuse, repair, remanufacture, and recycle to enhance resource efficiency and production sustainability (Ghisellini et al., 2016; Chaturvedi et al., 2023; Kalisetty, 2023).

Academically, the circular economy was first introduced by Pearce and Turner (1990), who integrated ecological and economic perspectives to mitigate environmental impacts arising from production activities. Within the agribusiness context, this conceptual foundation has evolved beyond efforts to reduce Food Loss and Waste (FLW), contributing more broadly to food security, nutrient cycling, and the long-term sustainability of agricultural production systems (Kusumowardani et al., 2022; Stathers & Lamboll, 2023; Sengupta et al., 2024).

Kirchherr, Reike, and Hekkert (2017) argue that the circular economy involves not only technological innovation but also transformation of business models and social engagement, all of which are highly relevant to agribusiness SMEs that operate within complex value chains.

Furthermore, Kristianto et al. (2021) emphasize that the circular economy supports the achievement of the Sustainable Development Goals (SDGs), particularly Goal 12 on responsible consumption and production, which is closely linked to sustainable agricultural and food systems.

In agribusiness systems, circular economy implementation is closely associated with biological cycles and agro-ecological processes, where nutrients, biomass, and organic residues are continuously circulated within the production system (Braamhaar, 2025; Herrera-Cabrera et al., 2025). Circular agribusiness practices include crop–livestock integration, manure-based soil fertility management, reuse of agricultural residues as animal feed, and downstream processing to reduce food loss and waste. Therefore, the success of circular economy implementation in agribusiness is not measured solely by economic efficiency, but by the system’s capacity to sustain production stability, resource availability, and ecological balance over time.

According to Strielkowski (2016), circular economy principles are commonly summarized within the 3R framework (Reduce, Reuse, Recycle), which promotes efficient use of natural resources to minimize exploitation, environmental pollution, and waste generation. In agribusiness, these principles are operationalized through sustainable farming practices, efficient input management, and the utilization of organic waste streams. Murray et al. (2017) further describe the circular economy as a model in which planning, resource management, procurement, production, and reprocessing activities are designed to maximize ecosystem functions and human well-being objectives that align strongly with sustainable agribusiness development.

The circular economy aims to optimize the use of materials and recover resources at the end of their lifecycle through environmentally friendly technological innovation (Marino & Pariso, 2016). Its adoption in agribusiness has the potential to enhance environmental sustainability, improve rural community welfare, reduce environmental degradation, generate added value from agricultural by-products, and support green economic growth in line with sustainable development goals (Lakshmi et al., 2020; Sarker & Kaparaju, 2024; Gemil et al., 2024). In Indonesia, the circular economy is prioritized in five key sectors, with the food sector particularly agribusiness identified as having substantial potential to improve resource efficiency, reduce organic waste, and create added value through circular production practices (Ministry of National Development Planning/Bappenas, 2024).

Potting et al. (2017) summarize the circular economy framework through the 9R framework, consisting of strategies ranging from R0 to R9. These strategies can be grouped into three main categories: smarter product production and use (refuse, rethink, reduce), extending product lifespan (reuse, repair, refurbish, remanufacture, repurpose), and extracting additional value from materials through recycling and recovery. In agribusiness, this framework provides a practical foundation for designing circular production systems that integrate upstream and downstream agricultural activities.

R0 (Refuse): Avoid producing products that are no longer necessary because existing products can still perform the same function, thereby eliminating the need for new production.

R1 (Rethink): Use products more intensively, such as through product sharing or multifunctional product design.

R2 (Reduce): Improve production efficiency by using fewer materials.

R3 (Reuse): Reuse products that are still functional.

R4 (Repair): Repair damaged products to extend their usability.

R5 (Refurbish): Restore old products so they can function again.

R6 (Remanufacture): Use parts from non-functional products in new products with the same function.

R7 (Repurpose): Use parts from non-functional products in new products with different functions.

R8 (Recycle): Process materials to produce new materials of the same or lower quality.

R9 (Recover): Recover energy from materials through thermal processes such as incineration.

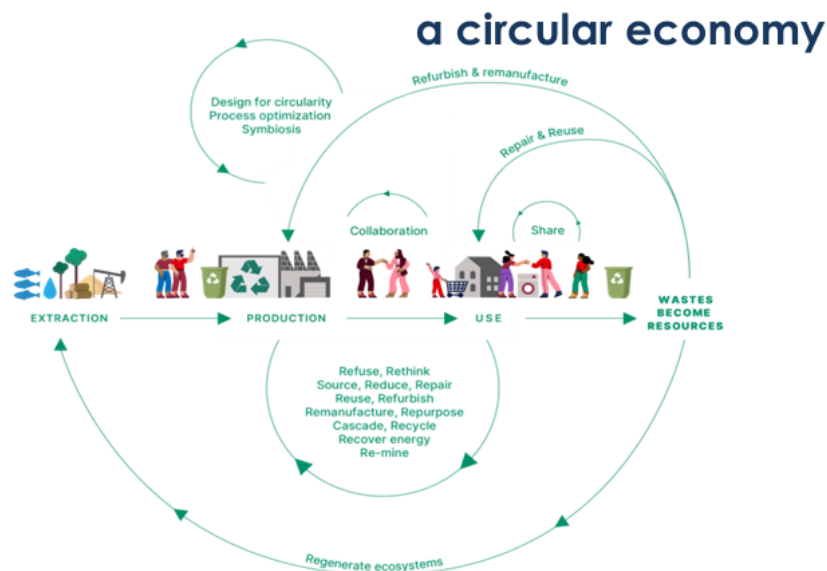


Figure 2. Visualization of the implementation of the 9R principles

Source: National Standardization Agency of Indonesia (BSN), 2025, slide 2

Triple Bottom Line (TBL)

The Triple Bottom Line (TBL) is a sustainability framework that evaluates business performance across three interconnected dimensions: people, planet, and profit (IBM, 2023; Elkington, 2018). In the context of circular economy implementation, TBL provides an integrated approach to assess how business activities generate economic value while simultaneously delivering social benefits and minimizing environmental impacts. For agribusiness enterprises, particularly small and medium-sized operations, the TBL framework is highly relevant because sustainability outcomes are closely linked to farmer livelihoods, ecological systems, and long-term production viability.

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Figure 3. Sustainability aspects

Source: John Elkington (2018)

The people dimension assesses how circular economy practices influence the social conditions and well-being of partner farmers and livestock breeders within agribusiness value chains. Circular agribusiness models are expected to improve community welfare through stable employment, inclusive partnership arrangements, and capacity building for local producers. For instance, empowering smallholder farmers or rural women as production partners enables agribusiness firms to secure sustainable raw materials while strengthening equitable and resilient socio-economic networks (Mia et al., 2021, in Aditi et al., 2025).

The planet dimension focuses on environmental sustainability and encourages agribusinesses to adopt environmentally responsible practices, such as energy efficiency, water conservation, waste reduction and utilization, and the use of renewable inputs. Practices including organic farming, integrated crop–livestock systems, agroforestry, and circular production models represent concrete applications of the planet dimension in agribusiness. These approaches enhance environmental resilience and increase agribusiness adaptability to green regulations and environmentally conscious markets (Santoso et al., 2022, in Aditi et al., 2025).

The profit dimension refers not only to short-term financial performance but also to the long-term economic viability of agribusiness operations (Rahmasari & Abidin, 2025; Kayani et al., 2024). In circular agribusiness systems, profit is generated through value-added processing, cost efficiency, and innovation derived from optimized resource use. Consequently, profit is viewed as the outcome of a continuous value-creation process involving multiple stakeholders rather than as an isolated financial objective (Kolk & Rivera-Santos, 2020, in Aditi et al., 2025).

Aditi et al. (2025) explain that the interaction among the three TBL dimensions produces sustainability outcomes described as bearable (people–planet), equitable (people–profit), and viable (planet profit). At the intersection of these dimensions lies sustainability, which in agribusiness contexts can only be achieved when social welfare, environmental integrity, and economic performance are managed in a balanced and integrated manner. The TBL Venn diagram illustrates this dynamic relationship and highlights that sustainable agribusiness development cannot be attained by prioritizing a single dimension alone.

Methods

This study employed a mixed-methods approach to capture the multidimensional impacts of circular economy implementation within an integrated agribusiness system. This approach was selected to provide a comprehensive understanding of economic, social, and environmental outcomes in accordance with the TBL framework, which is particularly suitable for evaluating sustainability performance in agribusiness contexts characterized by biological cycles and close interactions between production, community, and the environment. Quantitative data were used to measure sustainability performance, while qualitative data enriched the interpretation of results by incorporating the experiences and perceptions of both internal and external stakeholders.

The study was conducted at MT Farm, an integrated agribusiness SME located in Tegal Waru Village, Bogor Regency, West Java. Data collection was carried out from January to July 2025 through field observations, in-depth interviews, and questionnaire distribution. Respondents were selected using purposive sampling based on their level of involvement and knowledge of circular economy practices implemented within the agribusiness operations of MT Farm. The respondents consisted of business owners and top management, internal operational staff, local community representatives, and livestock-farming partners, all of whom play distinct roles within the agribusiness value chain.

The TBL framework was employed to evaluate the sustainability performance of MT Farm across three dimensions: economic, social, and environmental. Within the agribusiness context, this analytical framework provides a holistic assessment of how circular economy practices influence business viability, partner welfare, and environmental stewardship. The analytical procedures were structured as follows. The analytical steps using TBL are as follows:

Profit: The profit dimension measured the economic impacts of circular economy implementation in agribusiness operations, including improvements in operational efficiency, reductions in production costs, and the creation of value-added products such as organic fertilizer, leather-based products, and processed livestock products. Economic performance was assessed using indicators such as profit margins, sales volume, and operational efficiency.

People: The people dimension assessed the social impacts of circular economy practices on agribusiness stakeholders, particularly partner farmers and surrounding communities. Indicators included local community empowerment, capacity building of livestock-farming partners, and the company's contributions to social welfare through training programs, livestock distribution for religious festivities, and MSME development. Data for this dimension were obtained through interviews and questionnaires capturing partners' perceptions of the social benefits generated by the agribusiness.

Planet: The planet dimension analyzed the environmental impacts of circular economy implementation within agribusiness activities, including livestock waste management into organic fertilizer, the utilization of biogas as a renewable energy source, and efforts to reduce the carbon footprint. Environmental performance was evaluated through indicators such as waste reduction levels, recycled water utilization, and the proportion of renewable energy usage.

Within the TBL framework, higher scores across the economic, social, and environmental dimensions indicate stronger sustainability performance of the agribusiness (Diligent, 2023). Data analysis was conducted through field observations, interviews, and internal document review. Each circular economy activity was evaluated based on its level of achievement and expressed as a percentage to represent the extent of implementation.

Subsequently, the assessment was conducted through field observations, interviews with the business owner and livestock-farming partners, and internal documentation review. Each activity was evaluated based on its level of achievement, expressed as a percentage to represent the degree of success in implementing circular economy practices. The use of 20% intervals for each category was chosen to maintain a balance between analytical sensitivity and ease of interpretation, allowing clear differentiation of implementation levels without producing overly detailed classifications that are difficult to verify qualitatively. All achievement percentages were then mapped onto an implementation-level assessment scale. In this study, the level of implementation was operationalized into five categories: not implemented, initial implementation, partially implemented, mostly implemented, and fully implemented, each represented by a corresponding percentage range.

After the achievement percentage for each circular economy activity was determined, the next step involved normalizing the values to a 0–100 scale. This normalization aimed to standardize the measurement units, enabling consistent comparison of assessment results across indicators and across pillars within the analytical framework used:

$$N_i = \frac{X_i - X_{min}}{X_{max} - X_{min}} \times 100$$

After normalization, the score for each pillar was calculated as the average of the indicators included within that pillar:

$$\text{Score}_{\text{pillar}} = \frac{\sum_{i=1}^n N_i}{n}$$

where n represents the number of indicators within the respective pillar. The scores of the Economic, Social, and Environmental pillars were then aggregated to obtain an overall sustainability measure. Under an equal-weighting scheme:

$$\text{Sustainability Score} = \frac{\text{Score}_{pr} + \text{Score}_{pe} + \text{Score}_{pl}}{3}$$

The interpretation of the results was conducted with reference to sustainability assessment categories to identify which sustainability pillars of the agribusiness have performed strongly and which require further improvement strategies. Within this context, the TBL analysis provides a measurable overview of how the implementation of circular economy practices contributes to the sustainability performance of MT Farm as an integrated agribusiness system, encompassing economic viability, social partnerships, and environmental management.

To obtain primary data on the implementation of circular economy practices within MT Farm's agribusiness partnership network, a structured questionnaire was distributed to six livestock-farming partners actively collaborating with MT Farm. The questionnaire was designed to capture the perceived economic, social, and environmental impacts of circular economy practices on farm-level operations and partnership relationships, as well as to identify areas requiring improvement. The scores obtained from the questionnaire were subsequently processed using an interval scale to determine the level of circular economy implementation based on predefined categories. Mean values were calculated for each indicator to obtain average scores for the economic, social, and environmental aspects, which were then compared with the interval categories to determine the level of circular economy implementation for each sustainability dimension within the agribusiness context.

Results and Discussion

Company Overview

MT Farm is an agribusiness micro, small, and medium enterprise established in 2002 by three graduates of animal science from IPB University and located in Tegal Waru Village, Bogor Regency. Initially operating as a goat and sheep fattening enterprise, MT Farm has progressively transformed into an integrated livestock-based agribusiness system through the adoption of circular economy principles. This transformation is reflected in the integration of production, processing, and waste utilization activities within a closed-loop system. In addition to employing local labor, MT Farm actively collaborates with surrounding farmers and livestock breeders as part of its community-based agribusiness empowerment strategy.

Along with its business expansion, MT Farm has diversified its agribusiness portfolio to include cattle fattening, goat and sheep breeding, aqiqah services (Salamah Aqiqah), canned meat products, sterilized goat milk, and leather-based handicrafts. From a circular agribusiness perspective, livestock waste is systematically processed into solid and liquid organic fertilizers, while biogas utilization has been initiated to support renewable energy use within farm operations. These practices demonstrate the application of resource efficiency and value retention across agribusiness activities.

MT Farm manages its upstream and downstream agribusiness processes through an integrated “from farm to table” concept, encompassing fodder production, livestock operations, and complementary food commodities such as fisheries and vegetable cultivation to enhance income diversification. The company further strengthens its agribusiness capacity through research collaboration and competency development with academic and research institutions, including IPB University and the Indonesian Institute of Sciences (LIPI). Guided by its vision to become a nationally scaled livestock-based agribusiness hub, MT Farm continues to embed sustainability and circular economy principles into its operational and strategic development.

Implementation of Circular Economy Practices at MT Farm

Based on interviews with five staff members, two owners of MT Farm, and one community representative, supported by field observations conducted over approximately four months, the implementation of circular economy practices at MT Farm can be systematically identified and quantified. Within the agribusiness system, livestock waste management represents a key circularity mechanism. Solid livestock waste is fully reutilized (100%) as organic fertilizer, while 50% of liquid waste (urine) has been utilized. In addition, kitchen waste and forage residues are reused as feed for fish and poultry, thereby reducing organic waste with potential environmental impacts. In terms of energy use, renewable energy adoption through biogas has been officially implemented since June 20, 2025, contributing approximately 30% of total on-farm energy consumption, while the remaining 70% still relies on conventional energy sources.

The circular agribusiness model applied at MT Farm is operationalized through the integration of three main land-use components: forage production land, livestock farming land, and commodity cultivation land. Forage land supplies animal feed, with soil fertility maintained through manure-based organic fertilizer generated from livestock activities. Similarly, commodity cultivation areas, including rice fields and vegetable plots, utilize organic fertilizer derived from livestock waste. This integration is further reinforced through the reuse of rice straw from harvesting activities as livestock feed, forming a closed-loop interaction between crop production and livestock farming.

On the livestock farming land, MT Farm raises sheep, goats, and cattle, generating multiple agribusiness outputs such as meat, bones, hides, milk, offal, heads, feet, and tails. These outputs are marketed in both fresh and processed forms. A portion of the meat, bones, milk, and offal is processed into canned products, while hides are commercialized either as semi-finished materials or transformed into final products, including bags, jackets, shoes, and accessories. Hide processing is conducted through partnerships with external tanneries, followed by collaboration with local tailoring MSMEs in Tegal Waru, thereby extending value creation beyond the farm level.

Milk from goats and cattle is also utilized as part of MT Farm’s agribusiness diversification strategy, either sold as fresh milk or processed into pasteurized milk and yogurt. Manure management constitutes a central pillar of circular economy implementation, with approximately 70% of total manure processed into organic fertilizer for internal use and external sales, while the remaining 30% is allocated for biogas production to support renewable energy generation. Furthermore, by-products from the meat canning process, such as residual bones and offal, are repurposed as feed for catfish, which are later supplied to MT Farm’s restaurant. Through this integrated upstream–downstream agribusiness system, MT Farm is able to optimize resource flows, minimize waste generation, and create added value across multiple production stages. The overall flow of resource utilization within this circular agribusiness system is illustrated in Figure 4.

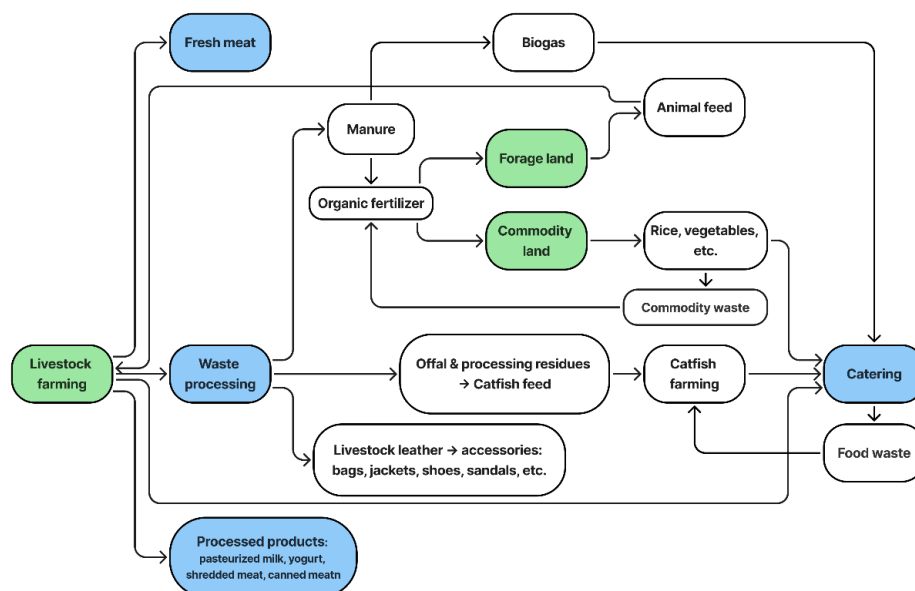


Figure 4. Flowchart of the Upstream–Downstream

Circular Economy Implementation at MT Farm

To provide a clearer overview of how circular economy principles are implemented at CV MT Farm, the results of field observations and interviews are mapped into an identification table. This mapping aims to show the relationship between MT Farm’s operational activities and the circular economy principles being applied, starting from the production stage, waste processing, to the distribution of derivative products, which can be seen in Table 1.

Table 1. Identification of Circular Economy Principle Implementation at MT Farm

9R Principle	Principle Description	Form of Implementation at MT Farm	Implementation Remarks
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R0 – Refuse	Avoid production or activities that may generate waste from the upstream stage	<p>Limitation of fresh meat production based on market absorption capacity.</p> <p>Early conversion of fresh meat into canned products during the low season.</p> <p>No disposal of livestock waste (feces, urine, and wastewater from barn cleaning).</p> <p>No disposal of offal, bones, and canning residues.</p>	Demonstrates rejection of a linear production system and proactive waste prevention from the early stages of production
R1 – Rethink	Redesign material and product flows to be more circular	<p>Integration of barns–kitchens–processing units–fish ponds–forage land.</p> <p>Integration of livestock, forage, and commodity lands (crops and aquaculture).</p> <p>Product diversification: fresh, processed, and canned products.</p> <p>Product distribution through Smart Qurban, catering services, and local SMEs.</p> <p>Wastewater from barn cleaning channeled to forage and commodity lands.</p>	Redesign of the business system from linear to circular through upstream–downstream and cross-sector integration
R2 – Reduce	Reduce the use of materials, energy, and production losses	<p>Livestock feed sourced from self-produced forage and tofu waste.</p> <p>Meat canning to reduce the risk of unsold products.</p> <p>Shredded meat (abon) production to reduce food loss.</p> <p>Use of organic fertilizer and liquid organic fertilizer (LOF) without chemical inputs.</p> <p>Utilization of biogas to reduce LPG consumption.</p>	Reduction of external inputs, production losses, and emissions through resource efficiency

R3 – Reuse	Reuse products or materials without major processing	Wastewater from barn cleaning reused for irrigating rice fields, vegetables, and green areas. Rice straw reused as livestock feed. Raw manure sold or used without further processing. Hides tanned and sold as semi-finished materials. Repeated use of containers and auxiliary equipment (crates, drums, buckets, trolleys) in storage, distribution, and processing.	Direct reuse of resources to extend their usage cycles
R4 – Repair	Repair products to extend their lifespan	Routine maintenance and repair of barn facilities. Repair of water installations and biogas systems. Maintenance and repair of can seamers, sterilization equipment (retorts), heating burners, and weighing scales to ensure operational feasibility and longevity.	Extension of production asset lifespan and reduction of new procurement needs
R5 – Refurbish	Restore functionality without replacing the main unit	Reorganization of processing facility layouts. Reinforcement and tidying of compost drying racks. Improvement of drainage systems and product storage racks.	Enhancement of facility functionality and efficiency without replacing core units
R6 – Remanufacture	Rebuild used components to restore original functions	Reassembly of racks and trolleys using old frames. Replacement of damaged wheels, hinges, and metal plates. Refinishing of equipment to ensure usability.	Reprocessing old components into reusable production equipment
R7 – Repurpose	Convert residual materials into new functions	Tofu waste reused as livestock feed. Kitchen waste and processing trimmings used as catfish feed.	Conversion of waste into new functions across integrated sectors to create added value

		<p>Offal waste and canning residues converted into catfish feed.</p> <p>Livestock hides processed into fashion products (bags, shoes, jackets, accessories).</p> <p>Sheep wool utilized as planting media.</p> <p>Animal manure processed into organic fertilizer.</p>	
R8 – Recycle	Recycle materials, including biological materials	<p>A portion of livestock manure processed into organic fertilizer.</p> <p>Livestock urine processed into liquid organic fertilizer (LOF).</p> <p>Organic fertilizer applied to forage and commodity lands.</p> <p>Part of the organic fertilizer marketed to consumers.</p>	Closing nutrient cycles through the recycling of biological materials
R9 – Recover	Recover energy from residual materials	<p>A portion of livestock manure used as feedstock for biogas production.</p> <p>Biogas utilized as a substitute for LPG in operations.</p> <p>Biogas system has been operational since June 2025 through collaboration with Pertamina.</p>	Utilization of residues as renewable energy sources to support operational efficiency

Source: Interviews and field observations, 2025

The steps above refer to the 9R Framework, where the 9R principles represent the most comprehensive resource management strategies in the circular economy. By placing the Main Production Process at the center of the cycle and linking it to each R, this diagram illustrates how MT Farm translates theoretical concepts into practical field applications, in accordance with the recommendations of the 9R literature (Potting et al., 2017).

Triple Bottom Line (TBL) Analysis

To strengthen the analytical depth, the TBL framework was employed to evaluate the performance of MT Farm as an integrated agribusiness system across three interrelated dimensions: economic, environmental, and social. This framework enables a holistic assessment by capturing not only financial outcomes but also agribusiness-related social contributions to partner farmers and surrounding communities, as well as environmental impacts arising from circular production practices. In the context of agribusiness, the TBL

approach is particularly relevant because business sustainability depends on the balanced interaction between production efficiency, social partnerships, and ecological resource management. To clarify the extent to which circular economy principles are embedded within MT Farm’s agribusiness operations, the analysis is presented in the form of an identification table structured according to the TBL framework.

The economic dimension was assessed using alternative quantitative indicators (proxies) due to the unavailability of disclosed nominal financial data from MT Farm. Accordingly, the agribusiness economic analysis focused on: (1) the percentage contribution of revenue from each agribusiness business line, (2) the proportion of production waste converted into value-added agribusiness products as an indicator of cost efficiency and resource optimization, and (3) production volume as a proxy for value creation derived from product diversification. These indicators were obtained through field observations and operational interviews, providing a quantitative representation of agribusiness economic performance consistent with the TBL framework.

Table 2. Contribution of MT Farm’s Diversified Business Activities to Annual Revenue

Business Type	Quantity	Unit	Contribution Percentage (%)
Aqiqah services	1,200	Heads of livestock	13
Roasted goat (spit-roasted)	600	Heads of livestock	6
Livestock sales (primarily for Qurban)	4,600	Heads of livestock	48
Canned products	2,900	Products	30
Integrated products (hides, retail canned products, fertilizer, feed)	300	Units/products	3
Total	9,600		100

Source: MT Farm 2025

The social dimension of circular economy implementation at MT Farm indicates that sustainability practices extend beyond resource efficiency and are closely linked to agribusiness-based social welfare and partnership development. In line with the Triple Bottom Line principle, MT Farm integrates economic objectives with social responsibility by establishing mutually beneficial partnerships with local farmers and livestock breeders. Through training, education, and community empowerment programs, these initiatives contribute not only to increased partner income but also to strengthened social cohesion, expanded employment opportunities, and improved quality of life within the surrounding agribusiness community.

The environmental dimension of circular economy implementation at MT Farm focuses on sustainable natural resource management and the reduction of ecological impacts arising from agribusiness production activities. Core circular economy principles, reduce, reuse, recycle, and recover, serve as operational guidelines, particularly in the management of livestock waste to prevent environmental pollution. MT Farm applies a closed-loop agribusiness system in which outputs from one production process are reutilized as inputs for other activities, thereby reducing waste generation, lowering emissions, enhancing energy efficiency, and maintaining ecological balance within the farming environment.

To evaluate the extent of circular economy implementation within MT Farm’s agribusiness system, an assessment was conducted using the TBL framework encompassing economic, social, and environmental dimensions. The percentage level of implementation was determined through a combination of field observations and in-depth interviews with business owners, production unit managers, and partner actors involved in waste utilization activities. Each agribusiness activity was analyzed to identify the degree to which circular principles were practically applied, and the results were subsequently validated through structured interviews with key informants. These achievement percentages represent not only the level of implementation but also the effectiveness of circular agribusiness practices in generating economic value, social benefits, and environmental improvements.

Achievement percentages were calculated by comparing the proportion of reused or recovered resources against their maximum potential utilization. Observational findings were cross-validated through interviews to ensure data consistency and interpretative accuracy. As each indicator exhibited different achievement ranges, a normalization process was applied to standardize the assessment scale and enable objective comparison across dimensions. The values were normalized to a 0–100 scale using the Min–Max normalization method.

Table 3. Evaluation of Circular Economy Implementation at MT Farm Using the Triple Bottom Line Framework

Activity	Aspect	Achievement Percentage (%)	Maximum Range (%)	Normalized Score (0–100)
Production of organic fertilizer and biogas from livestock waste	Economic	85	100	85
Handicraft products derived from livestock waste	Economic	50	100	50
Use of alternative feed materials	Economic	70	100	70
Integrated farming system	Economic	80	100	80
Maintaining product quality and shelf life	Economic	75	100	75
Partnerships with local livestock farmers	Social	30	100	30
Training and empowerment of SME partners	Social	95	100	95
Local employment absorption	Social	90	100	90
Social contributions and local community development	Social	95	100	95
Community empowerment through livestock mentoring programs	Social	80	100	80

Processing livestock waste into value-added products	Environmental	100	100	100
Use of recycled water	Environmental	60	100	60
Reduction of organic waste from catering activities	Environmental	80	100	80
Utilization of organic fertilizer and productive crops	Environmental	100	100	100
Utilization of livestock manure for biogas	Environmental	30	100	30

Based on the normalized results presented in Table 3, the performance of MT Farm in implementing circular economy practices within its integrated agribusiness system demonstrates varying levels of achievement across the three TBL dimensions. The results indicate strong performance in the environmental dimension and selected social aspects, reflecting the effectiveness of circular agribusiness practices related to waste utilization and community partnerships. Conversely, the economic dimension and the utilization of renewable energy exhibit relatively lower achievement levels, suggesting opportunities for further improvement in enhancing value creation and energy efficiency within the agribusiness system.

Table 4. Mean Sustainability Scores of MT Farm Based on the Triple Bottom Line

Aspect	Number of Indicators	Total Normalized Score	Average Score (0–100)	Sustainability Category
Economic	5	360	72.00	High
Social	5	390	78.00	High
Environmental	5	370	74.00	High
Overall Sustainability Score (Equal Weight)	—	—	74.67	High

Based on the summary presented in Table 4, the average normalized scores for each sustainability dimension were calculated using an equal-weighting approach across indicators and across the TBL pillars. This calculation represents a synthesis of the circular agribusiness practice achievements identified in Table 4.3, which were normalized and subsequently averaged to provide an integrated depiction of MT Farm’s agribusiness sustainability performance.

In the economic dimension, five indicators generated a total normalized score of 360, resulting in an average score of 72,00, classified within the high category. This result indicates that the implementation of circular economy practices within MT Farm’s agribusiness system has contributed to value creation through livestock waste utilization, integration of upstream–downstream business activities, and improvements in product quality and shelf life. Nevertheless, several agribusiness activities, particularly the development of handicraft products derived from livestock by-products and the optimization of alternative feed sources, remain underdeveloped, suggesting opportunities to further strengthen the economic sustainability of the agribusiness system.

In the social dimension, the total normalized score reached 390, producing an average score of 78,00, which represents the highest achievement among the three dimensions. This outcome reflects MT Farm's strong performance in empowering SME partners, absorbing local labor, and contributing to community-based agribusiness development. However, the relatively lower score associated with partnerships with local livestock farmers indicates the need to reinforce collaborative agribusiness models to ensure that social benefits are distributed more equitably and sustained over the long term.

In the environmental dimension, a total normalized score of 370 resulted in an average score of 74,00, also classified within the high category. This performance was primarily driven by circular agribusiness practices such as converting livestock waste into organic fertilizer, applying organic inputs in crop cultivation, and reducing organic waste from catering activities. Conversely, lower scores related to manure utilization for biogas production and recycled water use highlight ongoing challenges in optimizing renewable energy adoption and resource efficiency within the agribusiness system.

Overall, MT Farm achieved an average sustainability score of 74,67 based on equal weighting across the TBL dimensions, placing the enterprise in the high sustainability category. These findings suggest that circular economy implementation at MT Farm has been relatively effective and moderately balanced across economic, social, and environmental aspects. Nevertheless, variations in achievement across indicators indicate that agribusiness sustainability remains dynamic and requires continuous improvement to ensure long-term resilience and consistency.

Based on the sustainability score summary presented in Table 4.4, although all TBL dimensions fall within the high category, the economic dimension records the lowest average score compared to the social and environmental dimensions. This finding indicates that the circular economy performance of MT Farm's agribusiness system still has substantial potential for further strengthening. Within the economic dimension, indicators with relatively lower achievement levels are primarily related to the production of organic fertilizer and biogas from livestock waste, as well as the development of handicraft products derived from livestock by-products, which have not yet fully captured the value-added potential of agribusiness waste streams. Key constraints include biogas production capacity that has not yet met total LPG demand, the continued sale of livestock manure in raw form, and suboptimal marketing performance of organic fertilizer and waste-based products due to limited utilization of digital marketing platforms and social media channels.

These economic findings are closely aligned with the results of the environmental dimension assessment, in which manure utilization for biogas production also emerges as the lowest-performing indicator. This condition suggests that the potential of livestock waste as a renewable energy source within the agribusiness system has not been fully optimized, particularly in terms of technological readiness, infrastructure availability, and investment capacity. The linkage between relatively lower achievements in the economic and environmental dimensions highlights manure-based biogas development as a strategic leverage point for improving both economic value creation and environmental performance within MT Farm's circular agribusiness system.

Furthermore, the evaluation of circular economy implementation among MT Farm's livestock partners was conducted using the TBL approach. This analysis aims to assess the extent to which circular economy practices implemented by MT Farm have generated integrated economic, social, and environmental benefits for partner agribusiness actors within the supply

chain. The results of the TBL analysis based on partner questionnaire responses are presented in the following diagram.

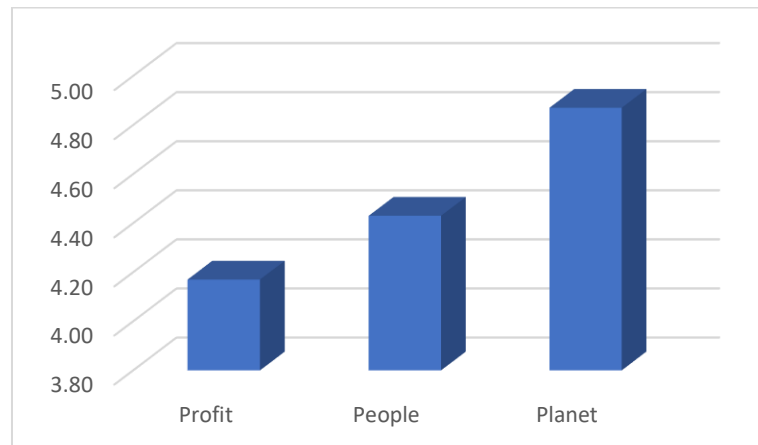


Figure 5. Average perception score diagram

Source: Questionnaire results from all independent MT Farm partners (2025) Based on the evaluation results presented in Figure 5, the environmental aspect achieved the highest average score of 4.87, classified as very high. This finding indicates that agribusiness partners perceive the implementation of circular economy practices by MT Farm as particularly effective in terms of efficient natural resource management, waste reduction, and environmental conservation within agricultural production activities. The social aspect ranked second, with an average score of 4.43, also categorized as very high. This result reflects the positive social outcomes generated through agribusiness partnerships, including improved partner welfare, strengthened human resource capacity, and inclusive collaboration between CV Mitra Tani Farm and the surrounding farming community.

The economic aspect recorded an average score of 4.17, categorized as high. This suggests that while agribusiness partners have already experienced economic benefits from circular economy implementation, such as improved cost efficiency and increased value of agricultural products, there remains considerable potential for improvement, particularly in optimizing production scale and upgrading waste-derived products into higher-value agribusiness outputs. Overall, these results demonstrate that MT Farm's circular economy implementation has generated strong positive impacts across all Triple Bottom Line dimensions at the partner level, with primary strengths in environmental and social performance, in alignment with sustainability-oriented agribusiness principles.

The evaluation of circular economy implementation using the TBL framework, covering economic, social, and environmental aspects, was conducted through a partner-based questionnaire survey and analyzed using a Likert scale. The results indicate consistently positive outcomes, with all dimensions achieving average scores above 4.00, reflecting the substantial benefits of circular agribusiness practices for partner enterprises. These benefits include increased income stability, expanded agribusiness opportunities, and improved community welfare. Through circular practices, partners are able to optimize waste utilization, reduce production costs, and enhance product value added, while simultaneously strengthening their integration within the agribusiness supply chain.

Nevertheless, the high scores across the three TBL dimensions do not imply that circular economy implementation at the partner level has fully translated into optimal profitability. The relatively lower economic score compared to the social and environmental dimensions suggests

that economic benefits perceived by partners are still largely associated with cost efficiency and business resilience rather than sustained profit growth. This condition indicates that existing circular agribusiness practices primarily function as risk-mitigation and cost-reduction mechanisms, while the potential for profit enhancement through downstream product development, improved market access, and increased value addition from waste-based products has not yet been fully realized. Accordingly, the key challenge moving forward lies in strengthening the capacity of circular agribusiness practices to generate competitive and long-term economic returns for partner enterprises.

Conclusion

This study demonstrates that the implementation of circular economy practices at MT Farm has facilitated the development of an integrated agribusiness production system, in which the outputs of one activity are systematically reutilized as inputs for other activities. This integration is reflected in the utilization of livestock waste, kitchen waste, and production residues as raw materials for organic fertilizer, alternative feed, biogas, and various value-added agribusiness derivative products. Through these practices, MT Farm has successfully operationalized the principle of closing the loop within its agribusiness activities.

Based on the TBL analysis, MT Farm's sustainability performance is classified within the high category across all three dimensions: economic, social, and environmental. The strongest performance is observed in the social and environmental dimensions, supported by the empowerment of local labor and business partners, effective waste reduction initiatives, and the integration of livestock farming, agriculture, and aquaculture systems, which collectively reduce environmental impacts. These findings indicate that, within the agribusiness context, the circular economy functions not only as a resource-efficiency strategy but also as a mechanism for strengthening social sustainability.

Nevertheless, the economic dimension remains a relative constraint in the implementation of the circular economy at MT Farm. Although value creation has been achieved through product diversification and cost efficiency, the transformation of waste into significant and scalable revenue streams has not yet been fully optimized. This limitation is evident in the low conversion rate of livestock manure into biogas, as well as the limited production scale and market penetration of waste-based products. This condition suggests that achievements in environmental circularity have not yet been fully translated into optimal economic performance.

The evaluation of MT Farm's livestock partners further reinforces these findings, indicating that environmental and social impacts are perceived as very high, while economic benefits, although categorized as high, remain relatively lower. This pattern suggests that the primary challenge of circular economy implementation in agribusiness SMEs does not lie in the availability of circular practices, but rather in downstream product development, the strengthening of technological capacity, and more robust market integration.

Overall, MT Farm can be positioned as a functional and context-specific example of circular economy implementation in Indonesian agribusiness SMEs. However, to achieve a more balanced and resilient form of sustainability, further strengthening of circular strategies within the agribusiness system is required so that material and energy flows that are already ecologically closed can also generate more competitive, scalable, and sustainable economic performance.

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