Integrating Reverse Cycle Strategy in Circular Business Model Innovation: A Case Study

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Abstract

This study integrates the Reverse Cycle Strategy (RCS) framework within circular business model innovation, focusing on sugarcane agribusiness as part of an innovative foresight study. Employing a qualitative method, the research utilizes the Business Model Canvas (BMC) to visually articulate and analyze business operations, interactions, and the impact of the RCS's ten principles (10R). These principles aim to facilitate a transition from linear to circular business practices, encompassing R0 – Refuse, R1 – Rethink, R2 – Reduce, R3 – Reuse, R4 – Repair, R5 – Refurbish, R6 – Remanufacture, R7 – Repurpose, R8 – Recycle, and R9 – Recover. The findings reveal that incorporating the full spectrum of the RCS enhances the business models' circularity and significantly influences sustainability outcomes. Unlike previous studies focusing on one to three RCS principles, this research demonstrates that a holistic approach can lead to more substantial environmental and operational improvements. This study offers a robust model for practitioners implementing sustainable business practices under the auspices of the circular economy paradigm.

Keywords: business model innovation; reverse cycle strategy; business model canvas; sugarcane agribusiness; circular economy

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Introduction

In an era of pursuing sustainability and environmental responsibility, business model innovation has emerged as a critical enabler in driving the transformation toward a circular economy (Brenner, Drdla, 2023). The Circular Economy addresses environmental and social concerns by moving away from unsustainable linear economics, focusing on restorative systems, and reducing resource inputs, waste, and emissions (Morseletto, 2023). This shift is crucial given the challenges of global population growth and consumption patterns (Lauten-Weiss, Ramesohl, 2021). Transitioning requires managing changes in technology, resources, costs, and strategies under sustainability indicators, which support the adoption of circular economy principles and holistically pave the way for companies to transition to more sustainable practices (Garza-Reyes et al., 2019). An alternative circular innovation business model framework is provided through this research.

The Circular Economy Framework aims for a closed-loop system, minimizing waste and pollution while maintaining the usefulness of products and regenerating natural systems (Ellen Macarthur Foundation, 2012). The shift toward a circular economic paradigm prompts changes and refinements of strategies. Circular business model innovation is based on changes in opportunities, regulatory encouragement, and shifts in circular strategy (Brenner, Drdla, 2023; Donner, de Vries, 2021; Pollard et al., 2021). The circular strategy has been widely developed by following the Reverse Cycle Strategy (RCS), which consists of ten principles: Refuse, Rethink, Reduce, Reuse, Repair, Refurbish, Remanufacture, Repurpose, Recycle, and Recover (Pegorin et al., 2024), and applied them as a primary driver in innovating the circular business model (Bressanelli et al., 2022; Costanza, 2023; Goyal et al., 2018; Kuzma, Sehnem, 2023; Saleh, Ost, 2023; Valencia et al., 2023; Villalba-Eguiluz et al., 2023).

However, all previous research shows that business model innovation tends to focus only on one or at most three principles (Rethink, Reuse, Recycle), leading to possibly incomplete sustainability outcomes. This results in imperfections in achieving overall sustainability and leaves potential that has not been fully utilized. Therefore, this study integrates the overall RCS as a circular strategy framework. This study offers a more holistic and integrated approach. Integrating ten aspects of circular strategy in the reverse cycle strategy is expected to drive business model innovation toward more circularity and sustainability. It expands the number of principles and increases their interconnectedness and mutual influence. Each principle does not function in isolation but contributes to a synergistic system in which the output of one principle can be an input to another.

With abundant renewable natural resources like plants and animals, agribusiness presents a prime opportunity to foster a circular business model (Nasution et al., 2020). Its reliance upon sustainable raw materials and involvement in regenerative natural systems make it conducive to circular economy principles (Klein et al., 2022). Practices such as recycling organic waste into fertilizers and repurposing agricultural residues for other industries exemplify this potential. Thus, exploring agribusiness through circular business innovation is vital for industry sustainability and global environmental goals.

As the largest agricultural commodity in the world, sugarcane agribusiness is gaining attention as a sector ripe for circular economy initiatives. Its production yields significant by-products, including leaves, tips, pulp, and molasses, which, if managed effectively, can align with Circular Economy objectives (Costa et al., 2014). Adopting circular practices in sugarcane farming involves closing nutrient loops, reducing reliance on external inputs like chemical fertilisers, and minimizing the environmental impact of agricultural waste disposal (Amini et al., 2022). Through innovative business models, sugarcane agribusiness has the potential to lead to more sustainable practices and expedite the shift toward a circular economy.

This study can significantly contribute to developing thinking and practices to achieve more holistic sustainability in a circular business model. This study also contributes significantly to the academic discourse on circular economy practices while providing practical insights for industry practitioners, policymakers, and stakeholders in the agribusiness sector. Through careful analysis of sugarcane agribusiness, it is hoped that broader conversations and steps toward more sustainable and economical practices in the agribusiness landscape could emerge.

Circular Economy Business Model

Adopting circular principles in business models is crucial for implementing the circular economy (Lewandowski, 2016). Business models, which are defined as creating, delivering, and capturing value, offer a comprehensive perspective on organizational activities (Osterwalder, Pigneur, 2010; Schneider, Spieth, 2013). The circular economy business model concept appeared much more recently than the circular economy literature. The concept of circular business models emerged in 2006 and gained traction around 2012-2014 with the dissemination of circular economy ideas (Schwager, Moser, 2006; The Ellen MacArthur Foundation, 2012; WEF, 2014). Scholars like Rashid et al. (2013) emphasize the role of business models in addressing alignment issues for technology uptake in recycling, while Schulte (2013) highlights their importance for the long-term development of the circular economy. Research on circular business models has steadily increased, mirroring the growing shift toward circularity across sectors, as shown in Figure 1.

Cradle-to-cradle (McDonough, Braungart, 2002) and performance economy (Stahel, 2010) have discussed the initial idea of a circular business model before or simultaneously with the emergence of the modern version of the business model concept (Wirtz et al., 2016). Similarly, the subfield of sustainable business model innovation, which emerged in the late 2000s (Birkin et al., 2009; Lüdeke-Freund et al., 2019; Stubbs, Cocklin, 2008) consider circular business models (e.g., creating value from waste) as one of the archetypes or sub-categories of sustainable business models (Bhatnagar et al., 2022; Bocken et al., 2014; Brenner, Drdla, 2023), with a narrower primary focus on environmental and economic outcomes (Geissdoerfer et al., 2018). In their review, Geissdoerfer et al. (2020) define the circular economy business model as recycling, expanding, intensifying, and/or dematerializing material and energy cycles to reduce resource input into and leakage of waste and emissions from organizational systems. It consists of cycling steps, extending the use phase, intensifying, and replacing products with service and software solutions (dematerializing). The Circular Economy Business Model is intended to provide an economically viable circular system that creates commercial value for an organization (Bocken et al., 2018; Ferasso et al., 2020).

Table 1. **Circular Economy Business Model Article Review Distribution**

Journal Name	Scopus Best Quartile 2022	WoS Journal Citation Index 2022	Number of Documents
Journal Articles			
Sustainability	Q1	0.67	4
Business Strategy and the Environment	Q1	2.52	2
British Food Journal	Q2	0.91	1
Resources, Conservation and Recycling	Q1	1.66	1
Science of the Total Environment	Q1	1.68	1
Sustainability Science	Q1	0.99	1
Proceedings Article			
IOP Conference Series: Earth and Environmental Science	—	—	1
Total			**11**

Source: authors.

Circular Economy Business Model (CEBM) in Agricultural Business

Previous research was reviewed to understand how the CEBM is developed in the agricultural or agribusiness sector. As presented in Figure 2, the search step begins with a search to answer the question, "What is the current trend of business models in the agricultural or agribusiness sector?" The search was sourced from the Scopus and Web of Science databases with the keywords: business AND model AND agriculture OR agro-industry OR agroindustry OR agribusiness. This search revealed 527 documents comprising 383 journal articles and 144 proceedings, published from 1989 to early 2023. Bibliometric data from all of them are then analyzed and plotted using thematic maps to understand the research trends on the current agribusiness/agriculture/agroindustry business model.

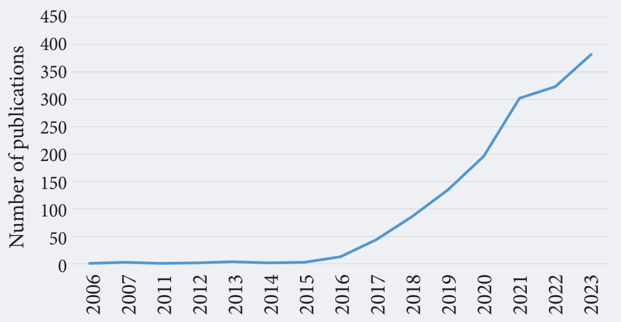
Based on the thematic map in Figure 3, which is built from 527 articles, it was found that the research theme on innovation as a part of more sustainable business models (more friendly to social, economic and environmental aspects) in the influential agricultural and agribusiness sectors today leads to a circular economy. The position in quadrant IV and the novelty map of the theme is relatively recent, indicating that the research theme has not yet been widely explored (the number of documents is low) but significantly influences research (the citation level is high).

Thus, the focus of the search shifted to the circular economy business model in the agricultural or agroindustrial sector. The circular economy is one of the paradigms used to achieve sustainability goals with a focus on creating closed systems where resources are used for as long as possible, waste is minimized, and natural systems are regenerated (Evans et al., 2017; Nosratabadi et al., 2019), then the next search also included the keyword, sustainability. Twenty-two documents were obtained, traced by the abstract and content of the research discussion, and narrowed down to 11 research documents (10 journal articles and one proceedings article), as shown in Table 1 below.

Research in Circular Economy Business Models (CEBM) in agribusiness and agroindustry, particularly concerning sustainability, remains limited. Table 2 summarizes some of them.

This presentation shows that research on circular economy business models in agriculture, agribusiness, and the agroindustry has primarily focused on mapping business models under the circular economy paradigm since the beginning of business operations. Nevertheless, little research still builds business models by moving away from the original linear paradigm to a more innovative circular para-

Figure 1. **The Number of Articles on Circular Business Models**



Source: authors' research results from Scopus database journals and conference articles.

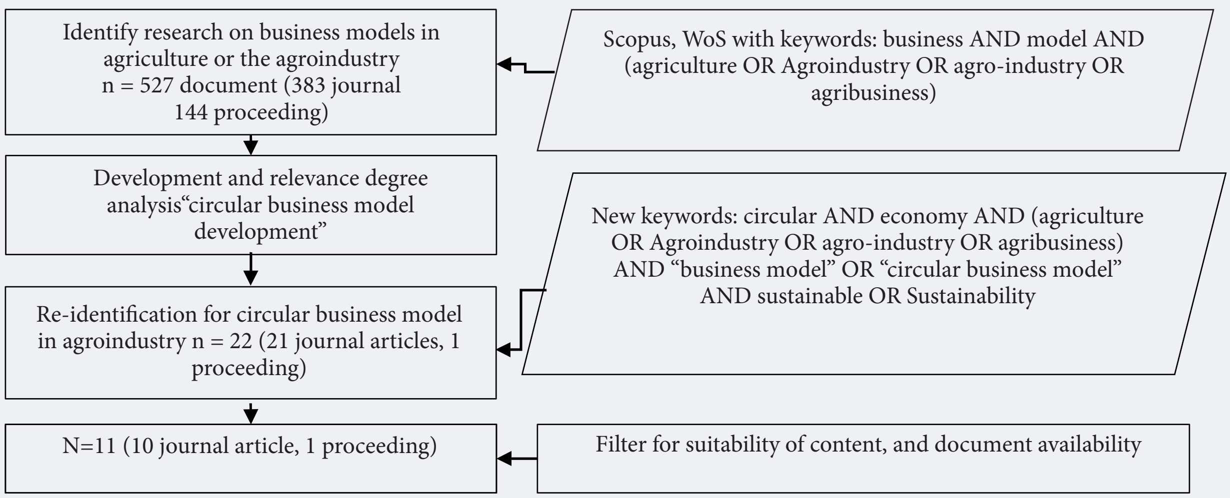
digm, or from an original circular model to a more circular one, especially in agroindustry or sugarcane agribusiness with varying levels of potential even though the circular transformation process becomes critical.

Capturing Circular Value through the 10R Principles in the Reverse Cycle Strategy (RSC)

Minimizing waste and maximizing resource efficiency are critical for sustainable business. Restorative and regenerative flows are essential in the circular economy (Ellen Macarthur Foundation, 2012; Ferasso et al., 2020). Restorative flow involves reintroducing resources into the economic cycle, reducing waste, and restoring value (Zucchella, Previtali, 2019), while regenerative flow focuses on maintaining natural resources and ecosystem sustainability (Morseletto, 2020a; Némethy, 2021). This approach also involves restoring ecosystems affected by human activities. The regenerative reverse cycle in agriculture is crucial due to the organic nature of the commodities. Both flows require a deep understanding of local ecosystems and agricultural practices (Novara et al., 2022). By embracing these concepts, the circular economy can support a more sustainable economic model, particularly in agriculture (Barros et al., 2023; Nasution et al., 2020). The reverse cycle, detailed in the 10R principles derived from the Waste Management Hierarchy, provides a roadmap for achieving these goals.

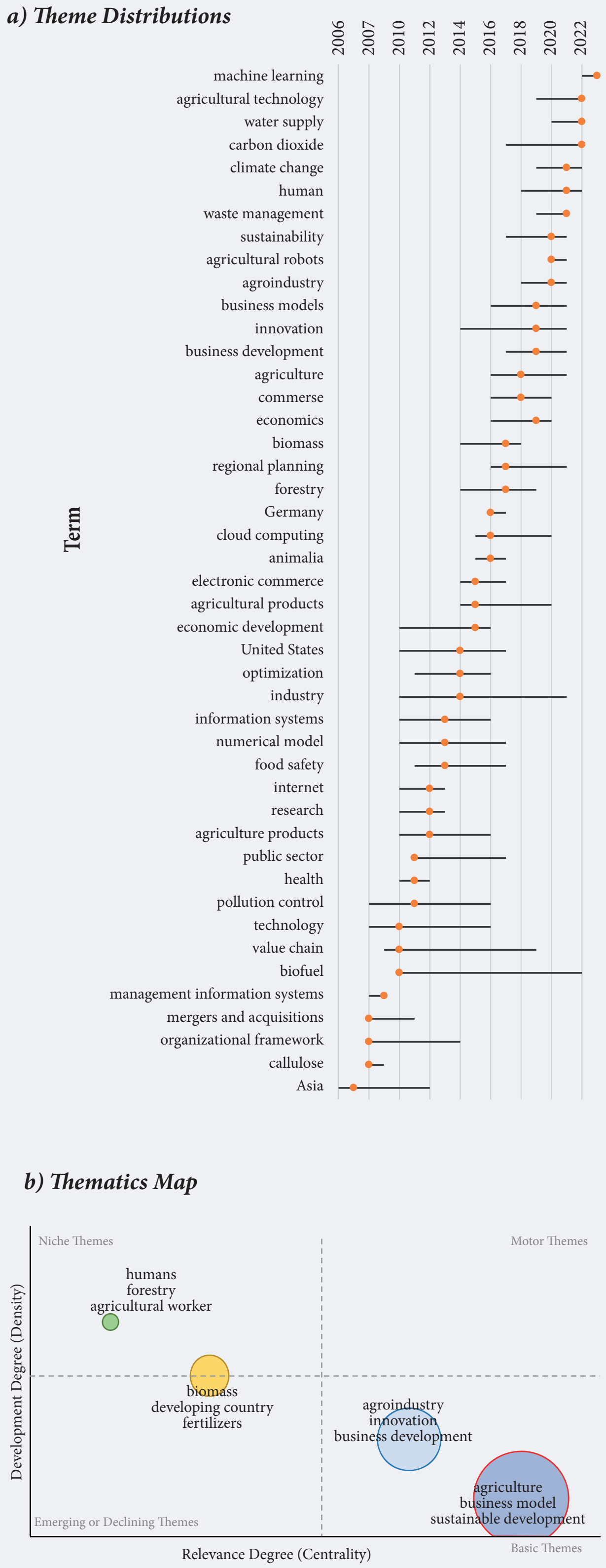
In the 19th and early 20th centuries, environmental concerns arising from the Industrial Revolution led to recognizing the need for better waste management to address air, water, and soil pollution. Originating from the 3R Movement in the mid-20th century, the Waste Management Hierarchy prioritized reducing consumption, reusing goods, and recycling waste (Awino, Apitz, 2024; Van Ewijk, Stegemann, 2016). In the 1970s, the Council of the European Union adopted the "Waste Hierarchy" to guide waste management, initially focusing on Prevention, Recovery, and Disposal, with Prevention akin to the "Refuse" concept in the Waste Management Hierarchy (Nilsen, 2019). By the early 2000s, the "Cradle to Cradle" concept influenced product design and waste management, emphasizing a sustainable product life cycle (McDonough, Braungart, 2002). The Waste Management Hierarchy has evolved to include repair, refurbishing, remanufacturing, and repurposing measures, providing a more comprehensive approach to sustainable waste management (Awino, Apitz, 2024). Global environmental regulations increasingly promote sustainable waste management practices, including recycling targets, bans, and innovation incentives. Public awareness of en-

Figure 2. **Flow Chart of Article Searches on the Circular Business Model in Agribusiness/Agroindustry**



Source: authors.

Figure 3. **Theme Distribution and Thematic Maps (Keyword Plus Title) Research on Business Models in the Agricultural Sector**



Source: authors' output from a bibliometrics analysis using R-biblioshiny.

vironmental issues and climate change has been crucial in shaping the Waste Management Hierarchy. The emergence of the 10R principles highlights the value of the reverse cycle in creating a sustainable economic model (Potting et al., 2017), enabling companies to integrate sustainability principles throughout the product life cycle, focusing on waste reduction and resource efficiency (Nilsen, 2019; Pires, Martinho, 2019).

Capturing value through the 10R principles in developing a circular business model is crucial for sustainability innovation (Morseletto, 2020b), including in the agricultural sector (Ciccullo et al., 2021). Circular business strategies with R0-Refuse enable the evaluation and rejection of unsustainable materials or processes. R1-Rethink facilitates a revolution in product design and production processes for efficiency and environmental friendliness. R2-Reduce focuses on lessening resource usage, and R3-Reuse and R4-Repair emphasize product reuse and repair, instead of buying a new item. R5-Refurbish and R6-Remanufacture involve updating and restoring products, and R7-Repurpose encourages creativity in reusing products or materials in different contexts. R8-Recycle and R9-Recover create opportunities to generate value through reprocessing and extracting value from waste (Potting et al., 2017). These strategies align with the circular economic paradigm's values of waste reduction, resource efficiency, innovation, environmental responsibility, and sustainable economic growth (Aguilar-Rivera, 2022; Ellen Macarthur Foundation, 2012).

Previous studies have partially utilized reverse cycle strategies to promote more circular business models. For example, rethink strategies focus on social contributions to the business model (Valencia et al., 2023), reuse strategies adapt circular business models for cultural heritage (Saleh, Ost, 2023), and remanufacture drives business model innovation (Bressanelli et al., 2022; Koop et al., 2021; Souza, 2019). Recycle strategies have been emphasized (Costanza, 2023; Parte, Alberca, 2023), along with recovery strategies (Kuzma, Sehnem, 2023). Refuse, Rethink, and Reduce are used in designing integrated circular business models (Villalba-Eguiluz et al., 2023), and reduce, reuse, and recycle drive business model shifts in developing countries (Goyal et al., 2018). However, these partial approaches may overlook the circular potential of business model innovation. Hence, this study proposes integrating the 10R strategies into a circular business model innovation framework. By doing so, agribusiness players can create a sustainable economic environment, enhance operational efficiency, and meet consumer demands for eco-friendly products and services while fostering innovation in products, services, and business methods for long-term sustainability.

Reverse Cycle Driven Circular Business Model Innovation Framework

Adopting a circular economy in agribusiness involves strategic steps with far-reaching implications. This process drives fundamental changes in value orientation within industrial systems or organizations, leading to strategic business model transformations (Uvarova et al., 2020). Most agricultural land is in developing countries.[1] Farmers in developing countries are predominantly poorly educated (FAO, 2017; Zhang et al., 2023); for example, more than 60% of farmers in Indonesia did not graduate from elementary school.[2] It is necessary to describe a business model that farmers can easily understand as the primary entity in agribusiness.

The Business Model Canvas (BMC) by Osterwalder and Pigneur (2010) is used to model the circular business in this study. BMC is widely used for CEBM modeling (Donner et al., 2020; Franceschelli et al., 2018; Klein et al., 2022; Lewandowski, 2016; Nußholz, 2017; Pollard et al., 2021). BMC simplifies key business elements into an easily understandable format. It offers a clear overview of business interconnections. It uses visual representations for quick comprehension by various stakeholders, including farmers (Braun et al., 2021). BMC's flexibility allows stakeholders to adapt business elements to agribusiness contexts, accommodating changes in agricultural practices, production, marketing, and circular economy adoption.

As illustrated in the schematic in Figure 4, the first stage of this study involves visualizing the ongoing business using the BMC, which comprises nine building blocks covering the essential aspects of the business. This process comprehensively depicts the business's operations and interactions with the surrounding environment. Information about each BMC building block, including market segmentation, value proposition, distribution channels, customer relationships, revenue sources, key resources, key activities, and key partnerships, is compiled into a representative BMC for the sugarcane agribusiness. The identification and canvasing process includes brainstorming sessions or Focus Group Discussions (FGDs) with sugarcane agribusiness leaders at the strategic level to gain insights into various aspects of the business. Collaboration during these sessions lays the foundation for creating a comprehensive BMC. The innovation process considers internal and external factors categorized by Lewandowski (2016). Internal factors relate to the organization's readiness for circular economy adoption. In contrast, external factors encompass technological, political, sociocultural, and economic aspects. Brenner and Drdla (2023) and Pollard et al. (2021) elaborate on factors such as changes in business strategy, circular business model challenges and opportunities, government regulations, and circularity indicators, which drive business model innovation in this study.

The second stage of this study is identifying factors driving innovation in circular sugarcane agribusi-

Table 2. **Review of Business Models Used in Circular Economy Business Models (CEBM) in Agribusiness and Agroindustry**

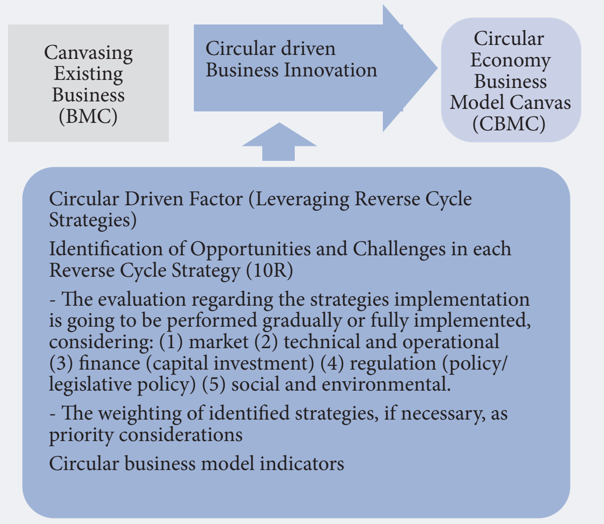
Sources	Summary of findings
Barth et al., 2017	Implemented a systematic literature review to outline business models in the agro-food industry, emphasizing sustainability as a strategic approach.
Franceschelli et al., 2018	Analyzed innovations in food start-up business models, focusing on enhancing social and environmental performance
Nosratabadi et al., 2019	Highlighted technological innovation's role in sustainable business models.
Zucchella, Previtali, 2019	Presented circular business model cases in Italian agribusiness
Donner et al., 2020	Identified six circular business models in agricultural waste valorization, emphasizing waste as a resource
Uvarova et al., 2020	Discussed CEBM application in the Latvian milk processing industry, showcasing waste recycling for value-added products
Donner, de Vries, 2021	Stressed the need for new business models to support the circular economy transition.
Hamam et al., 2021	Reviewed circular economy models in agro-food, highlighting their significance in agro-food system organizations
Dagevos, Lauwere 2021	Examined farmers' perceptions of circular agriculture in the Netherlands, emphasizing policymakers' role in integrating the circular economy into agricultural business models
Klein et al., 2022	Discussed CEBM development in the potato agroindustry, focusing on waste reduction, global sustainability, and supply chain collaboration

Source: authors.

[1] https://www.worldbank.org/en/topic/agriculture/overview, accessed 13.03.2024.

[2] https://satudata.pertanian.go.id/assets/docs/publikasi/Statistik_Ketenagakerjaan_Sektor_Pertanian_(Februari_2023).pdf, accessed 06.06.2024 (in Indonesian).

Figure 4. **Business Model Innovation Scheme with the Reverse Cycle Strategy (10R) as the Main Driving Factor)**



Source: authors.

ness models and considering feasibility. The business strategy uses the reverse cycle (10R) framework as the main trigger for innovation. Identifying opportunities and challenges follows these principles, where each "R-Strategy" is evaluated to identify possible or feasible opportunities. Brainstorming sessions and FGDs are also employed at this stage. Furthermore, each identified strategy is then assessed to see whether it can be done immediately or gradually. Studies have shown that aspects of feasibility studies are directly related to the successful implementation of business strategies (Chen, 2021). Thus, various aspects of business feasibility are considered, which consist of market, technical and operational, finance-capital investment (Laverty, Littel, 2020), regulation, and social environment factors (Bansal, 2023). These considerations inform the implementation approach for new business strategies, facilitating informed decisions. Agribusiness leaders, often with expert assistance, meticulously analyze each aspect of the business, including varying potentials of primary products and by-products. In the agribusiness context, the primary product is the one resulting from the main process of agricultural production that has direct economic value and is the primary goal of production activities (Hussain et al., 2022). Meanwhile the products produced as a by-product of the primary production process or the valorization of waste can have added value with further processing are considered secondary products (Yadav et al., 2020). Potential 10R strategies are compared pairwise to establish priority weighting and guiding strategy implementation. This data-driven approach ensures the careful selection of strategies, maximizing the potential for the successful integration of circular business models.

Once the drivers of circular business innovation are identified, the next step is visualizing circular business innovation in the Business Model Canvas (BMC). At this stage, each identified reverse strategy/10R is analyzed to map the impact of the change on each building block in the business canvas. Next, the results of this analysis are added to the BMC from the first stage.

The final stage of this research involves validating the circular business model canvas by reviewing circularity indicators across all canvas blocks. Circularity indicators are essential metrics used to assess the sustainability and efficiency of business models in a circular economy. These indicators help businesses evaluate their practices regarding resource use, waste management, collaboration, and technology integration. Table 3 provides an overview of these indicators and refers to various official sources, highlighting their importance and widespread recognition.

Table 3. **Circularity Indicators on Business Model Innovation**

Circularity indicator in Business model	Sources					
	(Ellen MacArthur Foundation, 2012)	(Lewandowski, 2016)	(Rossi et al., 2020)	(Geissdoerfer et al., 2020)	(Pollard et al., 2021)	(Rukundo et al., 2021)
Material or energy backflow in the business system (reverse cycle flow)	√	√	√	√	√	√
Collaborative action (including the sharing economy)	√	—	√	√	√	√
The use of information technology in the flow of the production process and after-sales (dematerializing)	√	√	—	√	√	—
Waste management	√	√	—	—	—	√
Non/slow renewable resource reductions	√	√	√	—	—	√
Circular investment	—	√	√	—	—	—

Source: authors.

Material or energy backflow in a business system (CI-1) measures the extent to which materials and energy are reintegrated into the production cycle. CI-1 demonstrates effective circular practices, reducing waste and dependence upon raw materials. Creating a closed-loop system where products and materials are continuously reutilized is fundamental. The comprehensive referencing across multiple sources underscores its critical role in achieving circularity. Collaborative Actions (including the sharing economy) (CI-2) evaluates the level of collaboration and sharing economy practices in business models, including partnerships, resource sharing, and collaborative consumption. It drives resource efficiency and innovation. By sharing resources and collaborating, businesses can reduce costs and environmental impacts. The consistent recognition of this indicator by multiple sources highlights its importance in harnessing collective efforts to achieve sustainability. Information Technology in the Flow of the Production Process and After-Sales (CI-3) measures the integration of information technology to optimize production and after-sales processes, thereby reducing material use and improving operational efficiency. Using IT in the production process can result in significant dematerialization, reducing the need for physical resources and increasing efficiency. Including this indicator in several key references emphasizes the transformative potential of digital technologies in achieving circular economy goals. Waste Management (CI-4) focuses on the effectiveness of waste management strategies. Effective waste management is essential to minimize the environmental impact and conserve resources. The presence of this indicator in various sources reflects this importance in a circular economy, where waste is seen as a resource that must be managed and utilized efficiently. No/Slow Renewable Resource Reduction (CI-5) evaluates efforts to reduce non-renewable or slow renewable resources and encourages the sustainable use of materials. Reducing one's reliance on non-renewable resources is critical for sustainability. High performance in CI-5 demonstrates a commitment to long-term resource sustainability and reduced environmental impacts. The recognition of this indicator by various sources highlights its importance. Circular Investment (CI-6) assesses the level of investments in circular practices and technologies which support the transition to more sustainable business models. Investments in circular economy practices and technologies is critical to driving innovation and scaling up sustainable business models. Including this indicator in references indicates the need for a financial commitment to achieve substantial progress in circularity. Using circularity indicators in the business model is an initial validator of its qualification as a circular economy business model (Pollard et al., 2021).

This research was conducted by studying the sugarcane agribusiness in East Java, the largest sugarcane-producing province in Indonesia. Smallholder sugarcane farmers are the leading agribusiness, and in 2022, 86.96% of the 14.2 million tons of sugarcane came from plantations managed by smallholder farmers. It is far greater than that produced on private and government estates, which only account for 0.21% and 12.83%, respectively.[3] In East Java, each smallholder sugarcane farmer manages an average of 10 hectares. There is a uniqueness in the smallholder sugarcane agribusiness: sugarcane becomes a sugar product, and various by-products/waste is still in the hands of farmers until they are sold at auction. Sugar mills are in a position to provide services for processing sugarcane into sugar. Smallholder sugarcane farmers in East Java practice sugarcane cultivation from planting to harvesting and engage in business affairs related to derivative products from the commodities grown.

Results and Discussion

In this study, three people representing the Sugarcane Farmers Association participated in FGDs relevant to smallholder sugarcane agribusiness in East Java. With over 25 years of experience in the region, each manages their own sugarcane fields: one with 15 hectares, another with 20 hectares, and the third with two hectares. As owners and controllers of their sugarcane agribusinesses, they possess deep insights into the challenges and opportunities faced by sugarcane farming communities in East Java. The researcher moderated the discussions, benefiting from their expertise to gain insights into industry dynamics and potential solutions to enhance smallholder sugarcane farmers' welfare.

Stage 1 provides an overview of the sugarcane agribusiness in East Java, covering operations from planting to sugar auctions while introducing reverse cycle strategies and identifying existing principles. An initial business model canvas is created. In Stage 2, the FGDs identify challenges and opportunities for reverse cycle strategies, assessing their feasibility for gradual or direct implementation and assigning priority weights through pairwise comparison. Stage 3 updates the initial BMC with additional content, resulting in an innovative BMC. Stage 4 assesses the circularity of the innovated BMC.

Stage 1: Initial Sugarcane Agribusiness Model Canvasing

Sugarcane agribusiness in East Java, Indonesia, led by smallholder farmers, is vital to the regional economy. These farmers typically own plots of land

[3] https://www.bps.go.id/en/statistics-table/2/NzY4IzI=/production-of-smallholder-estate-crops-by-type-of-crop.html, accessed 12.06.2024.

ranging from 0.5 to 20 hectares and rely on inherited knowledge for crop management. Despite limited formal education, they strive for optimal yields. Tasks such as planting, cultivation, harvesting, and transportation to processing factories are managed independently or with community assistance. Challenges include limited access to capital and market price fluctuations. After processing, sugarcane is auctioned based on market prices. Despite challenges, these farmers are crucial in supplying raw materials for the sugar industry while preserving sustainable practices. With improved support, such as education and technology access, sugarcane agribusiness in East Java can enhance regional economic development and farmers' welfare.

In the context of the reverse cycle strategy, although the slogan has not mentioned its application, in the sugarcane agribusiness, several applications of operations are found that are in line with several principles in the Reverse Cycle Strategy. As shown in Table 4, in R0-Refuse, because the characteristics of the land are different, some plots have abundant water sources and some are dry, during the planting period the farmers have refused the use of seeds that are not compatible with the conditions of the land. Furthermore, reusing agricultural equipment from the previous cultivation cycle mirrors the R3-Reuse strategy.

In addition, the R4-Repair strategy is reflected in the improvement at a certain point when abnormal growth is found without replacing entire plants. The implementation of R6-Remanufacture strategy is seen through the practice of "*bongkaratun*", a local term which describes the process of dismantling sugarcane plantation land and replacing all sugarcane weevils to their roots every three harvests. The R7-Repurpose strategy was identified as intercropping by planting chili plants and updating soil quality by planting other commodities, such as corn and rice. Furthermore, the R8-Recycle strategy is reflected in collecting pesticide bottles by scrap collectors to be recycled and producing sugarcane seeds from the best sugarcane crop harvest every harvest cycle.

The results of canvasing the business model of smallholder sugarcane agribusiness are shown in Table 5. In the dynamics of smallholder sugarcane agribusiness in East Java, partnerships with stakeholders are an integral element supporting this sector's operational continuity and growth. The involvement of sugar mills, sugarcane farmer's associations, fertilizer and herbicide suppliers, trucking service providers, cooperatives, and land owners allows for mutually beneficial cooperation. This collaboration enables the implementation of several key activities covering various stages, from land preparation to the final product marketing process. Land preparation includes preparing planting areas, selecting sugarcane seedlings in line with land conditions, and preparing necessary irrigation infrastructure.

Table 4. **Identification of Reverse Cycle Strategy Practices (R0-R9) in the Initial Sugarcane Agribusiness**

a) Essence of strategies

Reverse Cycle Strategy	Definition
R0 – Refuse	Refusal of unnecessary or non-environmental-friendly use of goods or services.
R1 – Rethink	The search for more sustainable solutions by revisiting the mindsets and habits of consumers and producers.
R2 – Reduce	Reduction of consumption of goods and resources to reduce waste.
R3 – Reuse	Reuse of goods or components that can still be used.
R4 – Repair	Repair damaged items rather than replace them.
R5 – Refurbish	Cleaning, repairing, or updating items to look and function like new.
R6 – Remanufacture	Fabricate components from unused products to create new products.
R7 – Repurpose	Transfer of use of goods or materials for different purposes.
R8 – Recycle	Recycling products into raw materials
R9 – Recover	Retrieval of nutrients, organic matter, or energy from waste or agricultural products

b) Strategies Already Running

Strategy	Area of use
R0	Do not use seedlings that are not suitable for field conditions
R1	—
R2	—
R3	The use of agricultural equipment from the previous cultivation cycle
R4	Repair at a particular point of the field when abnormal growth is found; not all are replaced.
R5	—
R6	*Bongkaratun*
R7	• Intercrop with chilli plants • The field is planted with corn or rice commodities every three harvests to restore soil quality
R8	• Pesticide bottles picked up by scrap collectors to be recycled • Sugarcane seeds are produced from the best sugarcane crop harvested every harvest cycle
R9	—

Source: authors.

The process of planting and cultivating sugarcane is carried out with due observance of agronomic principles, including selecting fertilization techniques, pest and weed control, and using appropriate herbicides and fertilizers. It is important to note that the practice of "*Bongkaratun*" is an integrated strategy to maintain soil fertility and increase land productivity by utilizing internal resources. In addition, intercropping with chili plants demonstrates a sustainable approach to optimizing land use and diversifying the sources of income for sugarcane farmers.

The sugarcane harvesting process ensures a high-quality yield, which is vital for producing large quantities of sugar and clean cane stalks and enhancing final product quality. Sugar auctions maintain partnerships with sugar mills (70:30), catering to customer segments such as white crystal sugar wholesalers, flavoring manufacturers, and molasses brokers, ensuring a steady income stream for farmers. Key resources include sugarcane plantation land, carefully selected seeds, and using fertilizers, herbicides, and appropriate agricultural equipment to boost productivity and quality. Distribution channels, primarily via trucks transporting harvested sugarcane to sugar mills, facilitate the connection between production and end consumers. However, operational costs, including land rental, cultivation expenses, seedling purchases, labor, equipment rentals, and transportation, significantly impact financial management. Revenue primarily stems from sugar and molasses sales, supplemented by income from supporting recyclers. Diversification in revenue sources underscores the resilience of the sugarcane agribusiness ecosystem. Success in running smallholder sugarcane agribusiness in East Java hinges on strong integration among partners, resources, activities, and customer relationships. Table 5 highlights the reverse cycle strategies in the initial business model canvas.

Stage 2. Identification of Circular-Driven Factors Based on Reverse Cycle Strategies (RCS)

At this stage, circular improvement opportunities that may be carried out by sugarcane agribusiness are identified using the Reverse Cycle Strategies. Each strategy is studied, including the opportunities and challenges. The identified strategies are then listed in Table 6 below.

Table 6 summarizes the results of identifying potential RCS strategies with unique codes, which was carried out through FGDs with farmers as the main actors in the sugarcane agribusiness. This participatory method combines direct knowledge from key stakeholders. RCS strategies are developed by considering the available resources, challenges faced, and strategies that can be applied in the sugarcane agribusiness. In contrast, the opportunities and challenges associated with each strategy are presented comprehensively. The strategies cover critical aspects of the circular sugarcane agribusiness, from the use of organic fertilizers and herbicides to the application of technologies such as the use of drones for fertilizer spraying. The “Opportunity” column provides an overview of the opportunities that arise from each strategy, including increased market demand for organic products or additional revenue potential from product diversification. Meanwhile, the “Challenges” column details the challenges that must be overcome, such as limited access to technology or cost issues associated with repairing agricultural equipment.

Table 5. **BMC for Smallholder Sugarcane Agribusiness in East Java**

Key Partners (KP)
Sugar Mill Sugarcane Farmers Association Fertilizer Supplier Herbicides Supplier Trucking Service Provider Cooperative (Cooperation) Land Owner
Key Activities (KA)
Land preparation Planting Cultivating (Shredding, Irrigating, fertilizing, weeds controlling) • Improvement of sugarcane plants that are not good growth is carried out partially (R1 – Rethink) • Intercrop with chili plants (R7 – Repurpose) • *Bongkaratun* is carried out after three harvest cycles (R3 – Reuse), with seedlings prepared from the plants, not from others (R5 - Refurbish). • *Bongkaratun* Interspersed with rice/corn commodities (R7 – Repurpose) Harvesting
Key Resources (KR)
Sugarcane plantation land Sugarcane seeds • The type of seedling is selected according to the condition of the land (R0 – Refuse) Fertilizer Herbicides Farmworkers Truck carrier Irrigation water Agricultural equipment and supplies (R6 – Remanufacture) • Tractors rented from cooperatives • Farm light equipment does not have to be new in every cycle
Value Propositions (VP)
High sugarcane yield produces more sugar Clean cane stalks produce clean white crystal sugar The volume of sugarcane (tonnage) harvested per hectare is high
Customer Relationships (CR)
The auction process for sugar produced from farmers’ sugarcane
Channels (C)
The mechanism of transporting harvested sugarcane to the sugar mill using trucks
Customer Segment (CuS)
White crystal sugar wholesaler Flavoring manufacturing companies Molasses broker
Cost Structure (CS)
Land rental costs Sugarcane cultivation/production costs (seeds, herbicides, fertilizers, labor costs, tractor rental costs, irrigation costs) Transportation costs of transporting sugarcane to the mill
Revenue Streams (RS)
Sugar Sales (profit sharing with sugar factories — 70% farmers: 30% sugar factories as sugar processing services) Sales of molasses (80% by volume of molasses produced by sugar mills) Extra income from recycler bottles or jerrycans used for herbicides and pesticides (R8 – Recycle).
Source: authors.

Although all the potential of the 10R principles have been reviewed, in this agribusiness, there are some principles whose potential has not been identified for several reasons. For example, the Refurbish (R5) is less feasible because the refurbishing process is usually more suitable for industrial products than agricultural crops. Although the new potential of the Remanufacture (R6) and Recycle (R8) principles has not been identified, farmers have been implementing it from the beginning through "Bongkaratun" and "Pesticide bottles picked up by scrap collectors to be recycled," which will continue to be practiced.

The holistic approach can be seen where each principle is interrelated and mutually reinforcing. For example, Rethink (R1) to evaluate the use of chemical fertilizers leads to a reduction (R2) of its use, which in turn facilitates the Recovery (R9) of organic waste combined with manure from cattle that fed on sugarcane shoots (strategy repurpose R7) as a sustainable fertilizer. The fertilizers used for sugarcane cultivation are a substitute for chemical fertilizer reduction. This integration decreases the environmental impact and lowers production costs, creating a positive feedback loop. In addition, Repair (R4) and Remanufacturing (R6) agricultural equipment ensure resource optimization and extend the life cycle of machinery. At the same time, Repurposing (R7) sugarcane by-products for energy production creates new revenue streams and reduces waste. These interrelated strategies collectively improve the sustainability and efficiency of the overall agribusiness model.

A capability analysis of each identified strategy is carried out to determine whether it can be implemented directly in full or gradually in stages. Table 7 shows the results of the capability analysis. All identified strategies (S1-S7) were studied from several aspects of consideration: marketing, technical operations, finance (capital investment), regulations, and the socioenvironment aspects. "Gradually implemented" refers to strategies implemented gradually or with slow progression. The strategy is not implemented instantaneously but through successive stages or with gradual adoption over time. Meanwhile, "Fully implemented" indicates that the strategy is fully adopted or implemented without any progressive stages. It means that the strategy is implemented directly and without delay, thus reaching full or maximum conditions from the beginning of its implementation.

Table 6. **Potential Strategies and their Challenges and Opportunities through the RCS Framework**

Opportunities (RCS)		Challenges	Potential Strategy Identified (PSI)
R0-A	Refuse to use chemical fertilizers and herbicides	• Limitations of organic fertilizer alternatives • Farmworkers' knowledge • Plant quality	Use of organic fertilizers and herbicides
R1-A	Use of organic herbicides	• Limitations of organic herbicides • Farmworkers' knowledge • Plant quality	Use of organic fertilizers and herbicides
R1-B	The use of drone providers for agriculture in spraying fertilizer	• Limited availability of service providers • Cost per hectare compared to manual.	Use of fertilizer spray services with drones
R2	Reduced use of chemicals	• Limitations of organic herbicides • Farmworkers' knowledge • Plant quality and productivity	Use of organic fertilizers and herbicides
R3	Reuse of Polybag when implementing "Bongkaratun"	• Quality of Polybag	The utilization of polybags for multi-planting
R4	Scheduled equipment repairs before the harvesting period	• Availability of spare parts • Repairman technical support • Cost and quality of repair	Scheduling repairs for harvesting equipment before the cutting season
R7-A	Diversion of sugarcane to be processed into Javanese brown sugar	• Market and demand for brown sugar • Production process and technology • Budgeting processing facilities investment	Sugarcane is processed by itself into Javanese brown sugar
R7-B	Sugarcane shoots after harvest for animal feed	• Limited uptake by cattle farmers in East Java • Processing or storage, if needed	Sugarcane shoots for cattle feed
R9-A	Utilization of waste from crops to be processed into fertilizer	• Processing fertilizer from the leaves and sugarcane stalks • Investment in fertilizer processing facilities • Standardization of the composition of fertilizer processing from crop-waste • Addition of labor functions	Production of organic fertilizers based on sugarcane agricultural waste
R9-B	The use of the remaining pieces of sugarcane seedlings as fertilizer	• Processing fertilizer from the remaining pieces of sugarcane • Investment in fertilizer processing facilities • Standardization of the composition of fertilizer processing from crop-waste • Addition of labor functions	Production of organic fertilizers based on sugarcane agricultural waste

Source: authors.

If resources are limited, then the implementation of the strategy should be carried out on a priority scale. Major sugarcane agribusiness players can use pairwise comparison with a scale of 1-9 to identify their priorities. Table 8 summarizes the prioritization results among the seven identified strategies.

Table 8 shows that the first strategic priority for innovation is the processing of sugarcane into brown sugar (S5). It received the highest priority weight for several reasons. Among them, because the glycemic brown sugar index is lower than crystal white (Azlan et al., 2022), this strategy provides an extensive market opportunity because Javanese brown sugar has a high demand among households and the food-beverage industry as consumption patterns shift toward healthier options. By producing brown sugar, farmers can significantly increase the added value of their products. In addition, brown sugar production can be done gradually, minimizing the need for initial investments and making it easier for farmers to start this business without the need for complicated and expensive equipment. This strategy also does not violate existing regulations but requires caution when honoring cooperation contracts with sugar mills. In addition, S5 opens up new opportunities for employment for the surrounding community, strengthens the local economy, and supports social sustainability.

This priority step not only expands the market for the final product but also increases the product's added value, opens up business expansion opportunities, and increases profitability significantly. The strategic innovation that also received significant attention was scheduling equipment repairs and the maintenance of harvesting equipment before the harvesting period (S4). Efficient repair scheduling increases equipment availability, reduces the likelihood of operational disruptions, and increases productivity and efficiency. The third most prioritized strategy is using a drone fertilizer services provider (S2). This technology offers cost-effective, scalable solutions that enhance crop monitoring, reduce environmental impact, and improve farm safety.

Stage 3: Innovated Circular Agribusiness Sugarcane Model Visualization

At this stage, the identified potential Reverse Cycle Strategy is analyzed and translated into every key element of the BMC building blocks as a circular business innovation. BMC's elements include all nine building blocks. An analysis of the impact of the Reverse Cycle Strategy on each element of the BMC enables an in-depth understanding of how the strategy affects overall business operations and the potential for improving the performance and sustainability of the sugarcane agribusiness.

Table 9 illustrates the various implementation paths for key BMC elements in each identified strategy. One standout strategy, "Brown Sugar (S5)," comprehensively covers critical BMC elements, offering high-quality Javanese sugar with natural flavors and textures from cultivation to distribution. Essential resources like processing locations and labor support these activities, while potential partners aid product distribution. However, some strategies may not fully impact BMC elements due to an internal focus or innovation on internal business aspects. For instance, strategies like "Use of Organic Fertilizers and Herbicides" may not directly influence customer segments or relationships. Evaluating such strategies requires considering their context and objectives relative to the BMC elements.

The key elements that have been translated into the identified reverse cycle innovations are then merged into the initial business model canvas and made into a new, more circular business model canvas, as described in Table 10. Integrating reverse cycle innovations into a new business model canvas offers a holistic approach to business model development. Each BMC element is examined in relation to the others, emphasizing how they interconnect and influence one another. For instance, incorporating the "Use of Organic Fertilizers and Herbicides" strategy directly aligns "Key Activities" and "Key Resources" with "Value Proposition" and "Customer Segments," allowing businesses to focus on delivering unique

Table 7. **Implementation of Capabilities of Identified Potential Reverse Cycle Strategies**

a) Basic indicators of potential reverse cycle strategies

Potential Strategies Identified (PSI)	RCS's element	Planned implementation
S1 - Use of organic-based fertilizers and herbicides	R0-A, R1-A, R2	Gradual
S2 - Use of fertilizer spray services with drones	R1-B	Full
S3 - The utilization of polybags for multi-planting	R3	Gradual
S4 - Scheduling repairs to harvesting equipment before the cutting/harvesting period	R4	Full
S5 - Sugarcane is processed into Javanese brown sugar	R7-A	Gradual
S6 - Sugarcane shoots for animal feed	R7-B	Gradual
S7 - Production of organic fertilizers based on sugarcane agricultural waste	R9-A, R9-B	Gradual
Source: authors.		

Table 7 continued

b) Dimensions of Implementation Capabilities for the Potential Reverse Cycle Strategies

Dimension	Description
	S1 - Use of organic fertilizers and herbicides
Market	There is no encouragement or resistance from the sugar market regarding using organics in East Java.
Technical And Operational	Feasible for the same or more straightforward application process. Gradually because non-chemical suppliers are limited.
Financial (Capital Investment)	The most significant expense of farmers after labor costs is fertilizer; it does not matter if the price is the same or cheaper
Regulation	Not violating regulations in East Java
Social And Environment	Because of its organic nature, it is safe for human and animal safety. It minimizes environmental degradation due to chemical materials.
	S2 - Use of fertilizer spray services with drones
Market	There is no encouragement or resistance from the sugar market regarding drone spray services.
Technical And Operational	Several farmers in 2023 are already getting trials on some of their sugarcane fields, a faster process.
Financial (Capital Investment)	In total, the cost is lower than that of manual labor.
Regulation	Not violating regulations, and drones flying as high as 1-2 meters from sugarcane shoots do not interfere with flight regulations.
Social And Environment	The drone is operated by a vendor (certified drone pilot) and is relatively safe in terms of work safety.
	***S3 - The utilization of polybags for multi-plantin**g*
Market	There is no encouragement or resistance from the sugar market regarding the use of polybags during hatchery.
Technical And Operational	Gradual, especially because farm workers must understand how to treat polybags after planting seedlings. Polybags have a service life of 2-3 years.
Financial (Capital Investment)	Although not significant, it can save more polybag procurement costs
Regulation	Not violating regulations
Social And Environment	Positive impact on the environment by reducing plastic waste
	S4 - Scheduling repairs for harvesting equipment before the cutting/harvesting period
Market	There is no encouragement or resistance from the sugar market regarding scheduling repairs.
Technical And Operational	It is possible to overhaul a thorough check for all fixtures and equipment. It can increase equipment and equipment utilization.
Financial (Capital Investment)	Less expensive than corrective maintenance
Regulation	Not violating regulations
Social And Environment	Technicians' schedules are more organized, and there is no pressure to rush.
	S5 - Sugarcane is processed into Javanese brown sugar
Market	The market for brown sugar is wide open. The people of East Java need this type of sugar, not to mention the potential of the food and beverage industry that is increasingly massive using brown sugar ingredients.
Technical And Operational	It must be implemented gradually, considering multi-year contracts bind some farmers to sugar mills.
Financial (Capital Investment)	It is possible to do it gradually because it requires uncomplicated and inexpensive equipment.
Regulation	Not violating regulations; it is only necessary to be careful to respect the relationship of cooperation contracts with sugar mill factories.
Social And Environment	Opening new job potential for residents
	S6 - Sugarcane shoots for animal feed
Market	Market absorption of sugarcane shoots allows for areas near large cattle farms. For areas where the type of feed needs to be arranged gradually.
Technical And Operational	It is feasible but needs to be pre-processed before cattle consumption (chopping/ boiling). It can be done gradually, including considering the existence of cattle farms that present potential clients.
Financial (Capital Investment)	It is possible to do it gradually because it requires uncomplicated and inexpensive equipment.
Regulation	Not violating regulations
Social And Environment	Unlocking the potential of cattle farming by sugarcane farmers or residents. Reduce the volume of waste burned from the harvest.
	S7 - Production of organic fertilizers based on sugarcane agricultural waste
Market	It will be beneficial if the fertilizer matches the characteristics of sugarcane growing soil environment. If intended for wood/field plants in general, it can potentially be absorbed by ornamental plant traders/field services or horticultural farmers
Technical And Operational	Long-term application may be possible, but it seems challenging to make changes in the subsequent one to three cycles. As a fertilizer, it is necessary to prepare the land for fermentation and provide knowledge to farmers of efficient organic fertilizer processing techniques.
Financial (Capital Investment)	Requires cost allowance budgeting
Regulation	There are no regulatory obstacles
Social And Environment	Previously collected and burned, it is better if it is processed and fermented into fertilizer.
Source: authors.	

value while considering resource needs. This updated BMC reflects a more robust integration of reverse cycle innovations and the overall business strategy, providing a holistic view of the business model.

With regard to value proposition, the focus on phased movement to organic options highlights a shift in value toward reducing agricultural waste and maximizing natural resources. It aligns with the reverse cycle principles, where agricultural waste is reused, for example as fodder or fertilizer. Introducing brown sugar as an alternative product expands the market and meets broader consumer needs. In the Key Activities section, reusing polybags for seedlings demonstrates efficiency and recycling, while processing agricultural waste into organic fertilizers reflects resource utilization efforts. Incorporating sugarcane processing for Javanese brown sugar diversifies products and adds value. Drone-based fertilizer spraying is applied to improve efficiency (Wadod, Mohammed, 2023). A challenge faced here is the lack of affordable drone service providers, which can be overcome by working with drone technology providers for pilot and training programs for farmers. In the Key Partners (KP) section, collaboration is carried out with sugar mills and sugarcane farmers' associations. The possibility of difficulties in coordination and communication between partners can be minimized by establishing regular communication forums and using information technology to facilitate coordination. In the Cost Structure (CS) section, cost reduction innovations are carried out using organic materials and repairing equipment before harvest. In the context of this sugarcane agribusiness, at the level of innovation implementation, besides the immense potential benefits, it could face several obstacles, such as limited access to technology, regulatory barriers, and lack of knowledge among farmers. Applicable solutions include building strategic partnerships, accessing support funds from governments or international organizations, and training for farmers to adopt new practices. Overall, the BMC innovation aims to adopt sustainable circular practices and minimize negative environmental impacts in sugarcane agribusiness.

Stage 4. Validation Using Circular Business Indicators

At this stage, a validation process is carried out to determine whether the business model built is circular or not. Validation was carried out by identifying business models before and after the innovation of the reverse cycle strategies. Table 11 shows how the circularity changes between the two.

Table 11 indicates that the set of indicators identified from various studies, consisting of six business model circular indicators, proved capable of capturing the interventions resulting from the change from the current business model to the innovative RSC business model. In the initial BMC, two indicators were identified: material and/or energy backflow in the business system and collaborative action (including the sharing economy), which were spread across key elements such as Key Activities, Key Resources, Key Partnerships, and Revenue Streams. The initial BMC also implemented circularity practices in its business model.

In the updated, innovative BMC, six indicators of all key elements were identified. First, Reverse Cycle Flow was noted in seven potential proposed strategies. Second, Collaborative Action is strengthened by expanding collaborative relationships with cooperatives and sugar mills and adding collaborations with agricultural drone service providers, equipment workshop service providers, organic fertilizer processing experts, and farmers as potential customers for sugarcane shoots. Third, information technology emerged as an effort to develop potential marketing channels for different products, such as brown sugar. Fourth, Waste Management would be improved by innovation in the processing of leaf waste into organic fertilizer and using sugarcane shoots as a component of cattle feed. Fifth, Circular Investment is seen in the commitment to gradual investment allocation in agribusiness toward producing different products and gradual investment in constructing agricultural waste processing facilities for the production of organic fertilizers that have commercial value. Based on these indicators, it can be concluded that the innovated BMC can be considered more circular than the initial BMC. Thus, the evolution of BMC through a reverse cycle strategy represents a significant step forward in realizing a more adabtable, sustainable, and technology-oriented business model with reverse cycle flow as the backbone of innovation. The implementation of this BMC would demonstrate a solid commitment to innovation, improved business performance, and environmental sustainability.

Several important lessons can be applied in other segments of the agricultural sector, national economy, and the global economy. First, the collaboration between various stakeholders is essential for successfully implementing circular business models. Second, providing adequate education and training for farmers and workers to adopt new technologies and circular practices is crucial. Knowledgeable agricultural instructors can liaise with researchers and farmers, providing the necessary knowledge through live demonstrations and visual media. In addition, cooperation with educational institutions and non-governmental organizations can provide functional literacy programs and vocational training. Third, policies and regulations that support circular practices can accelerate the transition to a

Table 8. **Identified Strategic Priorities**

Potential Strategies Identified (PSI)	Priority Weight
S1	0.07
S2	0.14
S3	0.07
S4	0.20
S5	0.36
S6	0.06
S7	0.10

Source: authors.

Table 9. **Reverse Cycle Strategy Innovations that Have Been Identified in Every Key Element of the Building Blocks**

Item	Description
	S1 – Use of organic fertilizers and herbicides
VP	Organic matter-based operations
KA	Gradually use organic fertilizers and herbicides
KR	Organic fertilizers and herbicides
KP	Vendors of Organic Herbicides and Fertilizers
CuS	—
CR	—
C	—
CS	Cost of organic herbicides and pesticides
RS	—
	S2 – Use of fertilizer spray services with drones
VP	Efficient and high productivity
KA	Spraying fertilizer with drones
KR	—
KP	Drone service provider for agriculture
CuS	—
CR	—
C	—
CS	The cost of spraying drones
RS	—
	S3 – The utilization of polybags for multi-planting
VP	Reduction of non-renewable materials
KA	Reuse of polybags that can still be used for seedlings
KR	Polybag
KP	Polybag seller
CuS	—
CR	—
C	—
CS	Reduced costs for new polybags
RS	—
	S4 – Scheduling repairs to harvesting equipment before the cutting/harvesting period
VP	Efficient and high productivity
KA	Repair and overhaul of equipment before harvest
KR	Truck and other spare parts
KP	Cooperation with workshops/technicians
CuS	—
CR	—
C	—
CS	Planned maintenance costs
RS	—
	S5 – Sugarcane is processed into Javanese brown sugar
VP	High-quality Javanese brown sugar with a natural taste and texture
KA	(1) Javanese sugar processing, including cooking and refining. (2) Stock management and product distribution.
KR	Processing location, sap squeezer, furnace, pan, processing labor
KP	(1) Distributors (2) Cooperation with restaurants, cafes, or the food and beverage industry for the use of products in their recipes
CuS	(1) Retailers and connoisseurs of brown sugar (2) Restaurants, cafes, and food and beverage industries looking for high-quality ingredients for their products
CR	Build awareness and understanding of the benefits and uniqueness of brown sugar.
C	(1) Direct sales to consumers through online or offline stores. (2) Distribution through local food shops or traditional markets.
CS	Operational, marketing, and distribution costs.
RS	Sales of brown sugar to consumers and businesses
	S6 – Sugarcane shoots for animal feed
VP	(1) Sugarcane shoots as high-quality forage for cattle. (2) Reduce agricultural waste.
KA	Harvesting
KR	Farm labor
KP	—
CuS	Farm owner or rancher
CR	Long-term partnerships with farms or ranchers
C	—
CS	—
RS	Sales of sugarcane shoots for animal/cattle feed
	S7 – Production of organic fertilizers based on sugarcane agricultural waste
VP	Reduce agricultural waste by turning waste into valuable products.
KA	(1) Collection and processing of crop waste into organic fertilizer. (2) Packaging and distribution of organic fertilizer products.
KR	(1) Waste from crop residues (leaves and stem tips). (2) Treatment facilities to process waste into organic fertilizer. (3) Manpower in waste management and organic fertilizer production.
KP	(1) Partnership with farmers to supply waste from crop residue. (2) Partnerships with agricultural stores or distributors for product distribution.
CuS	Farmers looking for an alternative to organic fertilizers
CR	(1) Customer service that provides information about the benefits and how to use organic fertilizers. (2) Long-term partnerships with farmers to understand their needs and provide suitable solutions.
C	Direct sales to farmers or via online marketplaces
CS	(1) Production and packaging costs (2) Marketing and distribution costs.
RS	Direct sale of organic fertilizers to farmers (both sugarcane and non-sugarcane)

Items: VP — Value Proposition; KA — Key Activities; KR — Key Resources; KP — Key Partners; CuS — Customer Segments; CR — Customer Relationship; C — Channel; CS — Cost Structures; RS — Revenue Stream.

Source: authors.

Table 10. **Circular Business Model Canvas Innovated with the Use of Reverse Cycle Strategies**

Item	Contents
Key Partners (KP)	• Sugarcane Mill • Sugarcane Farmers Association • Fertilizer Supplier • Herbicide supplier • Transporter Service Provider • KUD • Landowners • Drone service provider for agriculture • Workshop / Truck technician • Academics who understand how to process agricultural waste into organic fertilizer
Key Activities (KA)	• Land preparation • Planting ○ Reuse of polybags that can still be used as seedling beds (R3 – Reuse) • Cultivating (shredding, irrigating, fertilizing, weed controlling) ○ Gradual fertilization using organic matter (from agricultural waste recovery) (R8 – Recycle) ○ Improvement of crops while waiting for harvest is carried out partially (R9 –Recovery). ○ Intercrop with chili plants (R7 – Repurpose) ○ "*Bongkaratun*" is carried out after three harvesting cycles, which will later prepare seedlings from the plants themselves (R6 – Remanufacture, R8 – Recycle). ○ Field production interspersed with rice/corn commodities (R7 – Repurpose) ○ Gradual weed controlling and fertilizing using organic matter and spraying with drones (R2 – Reduce, R4 – Repair) • Harvesting • Equipment repair before harvest (preventive maintenance) (R9 – Recovery) • Processing of sugarcane into Javanese brown sugar (R7 – Repurpose) • Processing of sugarcane agricultural waste into organic fertilizer (R5 – Refurbish)
Key Resources (KR)	• Sugarcane plantation land • Sugarcane seeds ○ The type of seedling is selected according to the condition of the land (R0 – Refuse) • Fertilizer • Herbicides • Farmworker • Agricultural equipment and supplies (Reuse) ○ tractors rented from cooperatives ○ Farm light equipment does not have to be new in every cycle • Transport truck • Irrigation water • Facilities of processing sugarcane into Javanese sugar • Agricultural waste processing facilities into organic fertilizers
Value Propositions (VP)	• High sugarcane yield produces more sugar • Clean cane stalks produce clean white crystal sugar • The volume of sugarcane (tonnage) harvested per hectare is high (high productivity) • Phased operation oriented to organic matter (R6 - Remanufacture) • High-quality Javanese sugar (brown sugar) with a natural taste and texture (R7 – Repurpose) • Reduce agricultural waste and efficient use of resources (R2 – Reduce) • Reduction of non-renewable materials (R3 – Reuse)
Customer Relationships (CR)	• The auction process for sugar produced from farmers' sugarcane • Build awareness and understanding of the benefits and uniqueness of Javanese brown sugar.
Channels (C)	• The mechanism of transporting harvested sugarcane to sugar processing factories using open-bed trucks • Sales of Javanese sugar directly to consumers through online or offline stores. • Distribution through local food shops or traditional markets.
Customer Segment (CuS)	• Granulated white crystal sugar merchant • Granulated white crystal sugar broker • Flavoring manufacturing companies • Molasses broker • Retailers and connoisseurs of Javanese sugar • Restaurants, cafes, and food and beverage industries that are looking for high-quality Javanese sugar raw materials for their products
Cost Structure (CS)	• Land rental fees • Sugarcane cultivation/production costs (seeds, herbicides, fertilizers, labor costs, tractor rental costs, drone spraying costs, irrigation costs) • Planned equipment maintenance costs • Costs of transporting sugarcane to the mill • Cost of processing sugarcane into sugar palm • Cost of processing sugarcane waste into organic fertilizer
Revenue Streams (RS)	• Sugar sales (profit sharing with sugar mills — 70% farmers: 30% sugar mills) • Sales of molasses (80% by volume of drops produced by sugar mills) • Income from recycled bottles or *jirigen* used for herbicides and pesticides (R8 – Recycle). • Sales of Javanese sugar to consumers and businesses

Source: authors.

Table 11. **Comparison of Circularity Indicators Before and After the Reverse Cycle Innovation in the Sugarcane Agribusiness Model**

Initial BMC of the sugarcane agribusiness									Circularity indicator in business model	BMC of circular innovated sugarcane agribusiness								
VP	KA	KR	KP	CuS	CR	C	CS	RS		VP	KA	KR	KP	CuS	CR	C	CS	RS
—	√	√	—	—	—	—	—	√	CI-1	√	√	√	—	—	—	—	—	√
—	—	√	√	—	—	—	—	–	CI-2	—	—	√	√	—	√	—	—	—
—	—	—	—	—	—	—	—	–	CI-3	—	—	—	—	—	—	√	—	—
—	—	—	—	—	—	—	—	–	CI-4	√	√	√	√	—	—	—	—	—
—	—	—	—	—	—	—	—	–	CI-5	√	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	–	CI-6	—	—	—	—	—	—	—	√	—

Source: authors.

circular economy. Fourth, innovation must be sustainable and responsive to environmental and market changes. Fifth, access to funds and investments for new technologies and practices is essential for effective implementation.

Conclusion

This study confirms that the innovations are crucial for developing sustainable business models in the sugarcane agribusiness sector. The integration of ten aspects of the reverse cycle strategy has successfully transformed the business model into a circular one. The findings highlight evidence that this framework could help move existing agricultural operations toward more circularity.

Integrating the 10R principles into the reverse cycle strategy as a critical innovation driver has identified significant potential changes, ranging from micro-operating adjustments (polybag reuse) to optimizing efficiency to capturing the potential for revenue increases through product differentiation (brown sugar) and waste management. The significance of these findings should not be overlooked, especially given the global challenges in achieving environmental and social sustainability. By providing a conceptual and practical framework for applying circular economy principles in the sugarcane agribusiness, this research paves the way for further transformations in this sector and others.

The potential applications of these findings are vast. They can be applied in various industrial sectors, including agribusiness, manufacturing, technology, and services. Thus, this study contributes to the academic literature on circular economy and provides practical guidance for industry practitioners, policymakers, and other stakeholders to drive the transformation toward a more sustainable business.

Future research can expand the scope of this study by applying the same framework to other industry contexts and evaluating the impact and effectiveness of the resulting business models. In addition, further research can also explore the integration of other aspects of the circular economy and how more circular business models in the sugarcane agribusiness can help achieve global sustainability goals.

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