

RESEARCH ARTICLE



Economy Circular Adoption toward Sustainable Business (Study case: Agro-industry Company in Indonesia)

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ABSTRACT

Agro-industry is one of the industrial sectors that is considered important to adopt the Circular Economy (CE) principles due its close relation with agriculture and food system, as well as its significant contribution to the transition of a low-carbon economy. The CE focus on resource efficiency and waste reduction could preserve the use of natural resources like soil, water, and energy while also reducing the dependency of agro-industry on them, and protect the environment. Although the CE approach can bring long-term benefits, the agro-industry faces many challenges and obstacles to overcoming the complexity of integrating business processes, supply chains, and collaboration between stakeholders to align with the corporation's business strategy for implementing CE. The purpose of this study is to analyze CE adoption in the agro-industry by exploring the business process circularity that is being carried out to achieve sustainable business. The results of this study show that CE adoption in the agro-industry is being carried out through the innovation of connecting various production process systems, creating added value, and searching for new business opportunities by focusing on handling agro-waste and valorizing by-products. The study revealed wider insights regarding CE adoption in agro-industry corporate strategies as a transformative business model innovation towards sustainable development.

Introduction

The Circular Economy (CE) term was introduced by David Pearce and Kerry Turner in 1989 [1] as the foundation of the CE concept. The concept emphasizes the significance of economic activities that mimicking natural systems, where resources are continuously recycled and regenerated. The CE concept aims to replace the traditional linear "take-make-dispose" model with a closed-loop system that maximizes resource efficiency and minimizes environmental impact. The CE framework can be applied to various businesses and diverse business models [2]. The transition into the circularity system will depend on each business's characteristics, series of developments that connect the production process system, added-value creation, and ways of finding new business opportunities [3]. The CE adoption on business can pose a win-win solution between economic development aligned with the preservation and regeneration of the environment [4–5]. The results of the global business survey indicate that CE application on business could boost innovation that helps companies become more efficient and competitive in various ways, such as resource management, product development, and production processes [6]. Business as usual is no longer relevant today, and the model also criteria proposed by CE as the sustainable alternative that effectively couples natural with human-made systems [7].

Agro-industry can be defined as economic activities that include production, processing or industrialization, and commercialization of agricultural and forestry products, both for food and non-food purposes [8]. Agro-industry is one of the business sectors that should adopt CE concept, based on agro-industry business characteristics that extract a lot of raw materials and natural resources, and high dependency on nature [9–

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10] and also the large consumption on water and high energy use during the production process [11–12]. Based on these matters, agro-industry should take serious consideration their business process which can lead to serious challenges to the environment. On the other side, the agro-industry supply chain has a good potential for investment and opportunities for achieving sustainable development and circular production and also implementing a closed-loop resource recovery [13] through external resource exchange as complementary activities such as agriculture and animal husbandry [14]. The CE adoption in agro-industry is closely related to agriculture and food systems, which will make a significant contribution to low-carbon economic development [9].

The CE application in agro-industry can be improved by putting attention on restorative design and regenerative processes, which aim to maintain products and components or materials at their highest utility and value [1]. The challenges and opportunities to increase the utilization of agricultural waste and its by-products require attention from a technological perspective [10] and socio-economic aspects [15]. The creation of business added value within a circularity framework is another challenge to the agro-industrial production process, where the nutrient flow and raw materials cannot entirely be recycled but can be increased through circulation by reducing nutrient and material intake and by closing the loop partially [16]. The available indicators for measuring CE at the micro level are limited [17], and in this study, the CE adoption is being assessed using Ellen MacArthur Foundation (EMF) Circulytics 2.0. This tool explores the business's circularity and uses the 10R CE principles as the general CE framework which is often employed. This study examines the CE adoption at micro or business level, with a focus on a case study at agro-company in Indonesia, which has adopted the CE framework in its business operations. This involves following the circularity principle and based on each business characteristics.

The study revealed wider insights regarding CE adoption in the agro-industry corporate strategy as an innovative business model towards sustainable development. This paper aims to provide a better understanding of the key characteristics and perspectives of the agro-industry and to explore the opportunities offered by the CE as a solution to the current need to reduce the environmental impacts of traditional economic systems and contribute to the state-of-the-art of CE in academic discussions. The research assumption is that CE application in the agro-industry revolves around the utilization of agricultural practices that can increase crop yields without threatening the quality of water, soil, and air. The CE adoption in the agro-industry business process focuses on improving the flow of materials and raw materials, increasing water and energy efficiency, and handling waste effectively. The path taken by each company is adjusted to maximize the potential benefits of CE through the waste utilization and valorization into by-products that match with the characteristics of the agro-industrial business [10]. The adoption of CE in business operations can attain sustainability while balancing environmental protection, economic benefits, and social acceptance.

Material and Methods

Study Area

The article is based on a case study conducted at an agro-company, hereinafter called "AgroCrop" that located on third largest island in Indonesia. AgroCrop has integrated CE principles in its business strategy and has a vast land for growing fresh fruits and other rotational crops. They produce canned fruit products and juice concentrates that are exported to other countries. The field research for the study involved direct observation and interviews with research informants. The location of AgroCrop can be seen on Figure 1 of the map.

Data Collection

The research data was obtained through semi-structured interviews as primary data, and supported by secondary data that has been resourced from the internal company data related to CE implementation, corporate public reports, corporate documentation, presentations, and scientific article. The informants who were interviewed for the research were the internal stakeholders of the company who provided insights on CE adoption at the company. These internal stakeholders included representatives from top management, middle management, and the operational team. To understand this complex reality and the meaning of actions in a given context, the study used a qualitative research approach [18]. The case study method is used as an empirical research that explores the context of CE within its real-life context [10,19]. The focus of this

research is on the micro level or business context, with the aim of observing the integration of CE adoption at AgroCrop.

This study concentrated on business operations from the production stage until processing or industrialization. The observation and learning from the literature review and interview results will describe the adoption of the CE concept in business that promote sustainable practices such as reducing waste, optimizing resource use on energy and water, maximizing material flow, and other important considerations through innovations. To evaluate the circularity principle implemented in AgroCrop, the 10R concept, which stands for Refuse, Rethink, Reduce, Reuse, Repurpose, Remanufacture, Refurbish, Repair, Recycle, and Recover [20,21], used as a basic assessment of the general CE framework. This concept serves as fundamental assesment of the general CE framework and helps overcome the challenges from existing pressures on the environment [22]. The research questions regarding CE implementation in AgroCrop were answered through descriptive analysis.

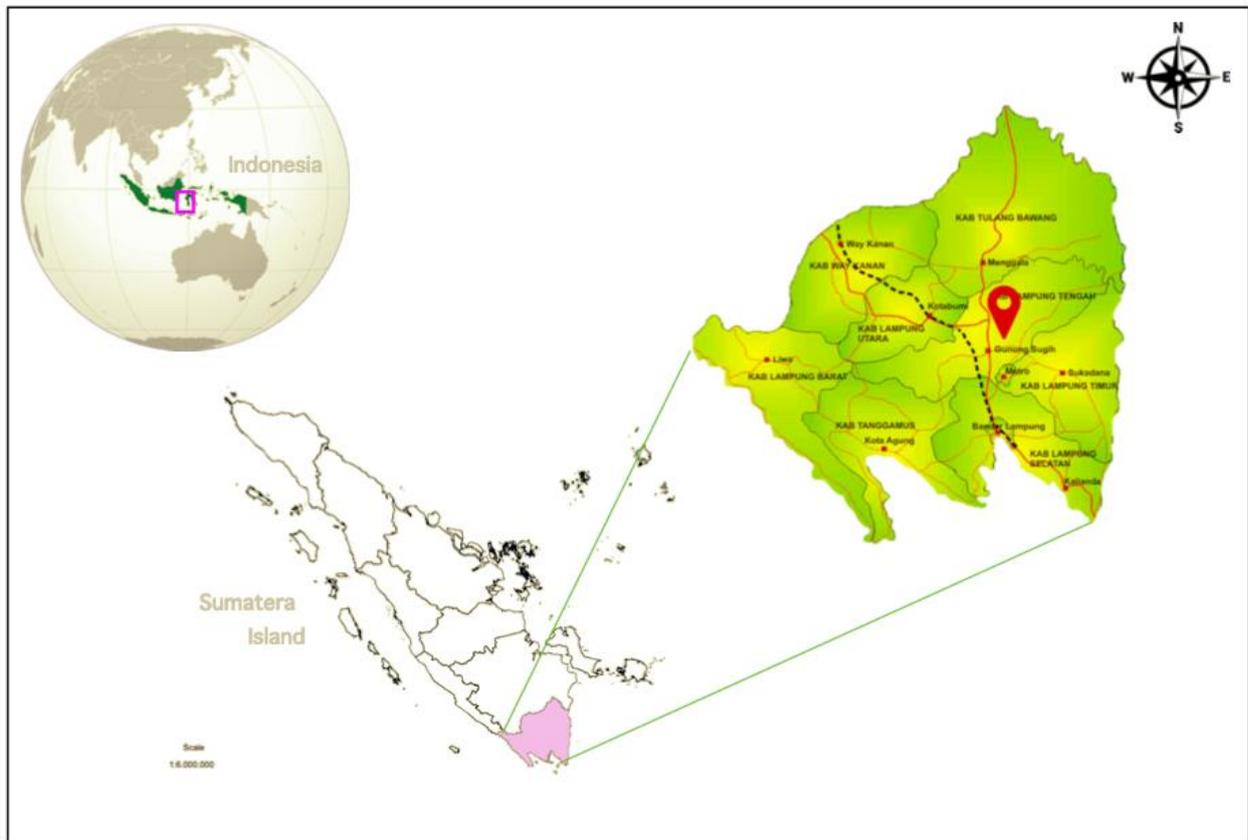


Figure 1. Map location of AgroCrop.

Results and Discussion

AgroCrop's business activities are in line with common agro-industry practices, from production processes to industrialization and commercialization of agricultural products for both food and non-food purposes. AgroCrop has adopted a CE approach, focusing on waste management and valorization. This description is consistent with the characteristics of agro-industrial business that implement CE applications [10]. CE implementation at AgroCrop has evolved around the implementation of agricultural practices by increasing crop yields without threatening water, soil, and air quality [1]. The AgroCrop business process has adopted the concept of CE with a focus on four key areas. Firstly, they focus to improve the flow of materials and raw materials from fresh fruit production. Secondly, they strive to increase water and energy efficiency in their production process. Thirdly, they are utilizing renewable energy from biogas. Lastly, they are implementing waste handling of organic waste, solid waste, and plastic waste. AgroCrop has put the CE framework on their early days of operations with initial attention on handling their organic waste and efforts to put CE strategies integrated with the company's long-term business strategy. Figure 2 depicts the CE by AgroCorp.

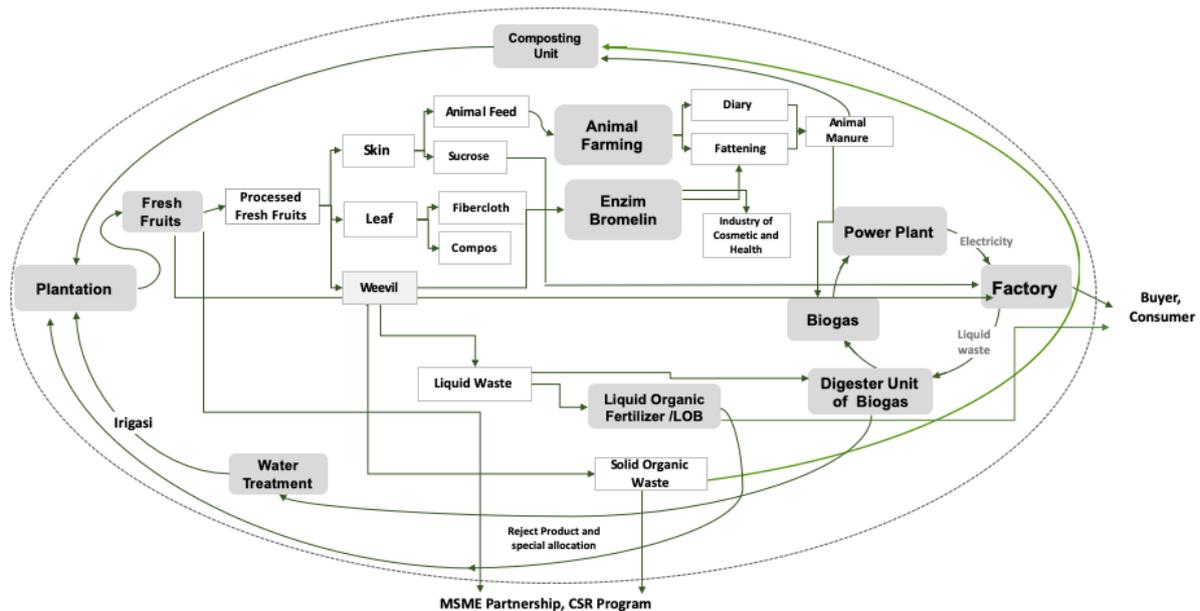


Figure 2. Circular economy adoption in AgroCrop business models (by author).

Resource Efficiency

In order to achieve business circularity, AgroCrop focuses on optimizing processes to minimize resource use [23]. Resource efficiency has become a major concern in management decision-making, with economic considerations ensuring greater added value and maintaining resources within the production system for as long as possible [16]. AgroCrop has implemented the circular model adapted to the agricultural context, based on principles that pursue system-wide efficiency by maximizing the value of resources at all stages of the business process and enhancing soil health as their natural capital through the use of renewable resources. AgroCrop has optimized its entire production process toward optimization, both to maximize resource efficiency and minimize the waste generation. The company has also taken measures to prevent any leaks of resources and emissions. CE strategies offer various options for building circular models, ranging from narrowing and slowing down resource loops to completely closing them and regenerating resource flows [24].

AgroCrop initiatives are encompassed within this framework, aiming to close resource loops through an integrated sustainable farming program and zero-waste target. AgroCrop’s sustainable farming program involves different innovations that promote eco-friendly farming practices. These innovations include the use of compost organic fertilizer and liquid organic biofertilizer (LOB) instead of using chemical fertilizers to enhance soil health. Additionally, the program focuses on improving soil conservation by growing bamboo along tributaries and practicing crop rotation using legume cover crop. Finally, the program includes a germplasm preservation initiative through bamboo germplasm.

Waste Management

AgroCrop produces an average of 2,500 tons of fresh fruits for canning and juice production every day. This production generates approximately 2,000 cubic meters of liquid and solid waste. This amount of waste can pose a significant issue for both their business and the environment [25]. AgroCrop strives to implement integrated waste management as part of their operations. Their waste management (as shown in Figure 2) involves several processes. Firstly, solid waste from the extraction of fresh fruit is processed into animal feed, while animal manure is turned into compost for organic fertilizer. The solid waste is further utilized using fermentation technology in biogas digesters to produce biogas for generating electricity for plantations.

This helps reduce the use of fossil fuels for thermal boilers and cogen boilers, and also reduces methane emissions by burning excess gas. Weevil waste is processed into bromelain enzyme products that are sold to the cosmetic and health industries. Secondly, the wastewater is recycled for watering plants and washing the factory machinery. Thirdly, liquid waste from fresh fruit factories is converted into Liquid Organic Biofertilizer/LOB for internal use and also sold to farmers as customers. Lastly, plastic waste generated from

business operational activities, such as drums used for fertilizers and pesticides, fresh fruit packaging plastics, and net foam for fruits, is recycled using their own recycling unit. The plastic waste is recycled into materials to create plastic angles or elbows on packaging.

Energy Efficiency and Renewable Energy

AgroCrop has set a corporate target to reduce its fossil fuel consumption by 30% and replace it with renewable energy. All managerial and AgroCrop employees are taking various actions like optimizing the use of biogas power plants, turning off lights and electronic devices when not in use, and replacing TL lamps with LEDs. The company also applies energy management systems, like steam flowmeters, kwh meters, electric motors, compressors, and steam traps, to achieve energy efficiency and significant energy savings. They have also implemented ISO 50001 Energy Management System and carbon footprint calculation, which helped save 1,212 megawatts of electrical energy through various electricity-saving programs. To achieve their renewable energy goals, AgroCorp is focusing on bioenergy sources, particularly biogas. The waste-to-energy program is being held through the construction of a Biogas Plant, where liquid waste from fresh fruits is treated to reduce pollutants and produce biogas.

Water Management

Water Management is a crucial requirement for a company's operations, especially in plantation areas. Therefore, in addition to the use of groundwater, AgroCrop implement water management using rainwater [26] that collected from more than 200 reservoirs spread around the plantation areas. The company also recycles water in its factories, with a volume of 146,000 cubic meters. The factory also applies the 3R principle (reduce, reuse, recycle) by reusing RO water from the Cogen Plant.

Material Flow, Supply Chain and Product Design

AgroCorp produces and processes fruit crops which are categorized as renewable materials, with focus on waste utilization. To operate efficiently, AgroCrop collaborates with suppliers for goods and services [27]. To obtain good quality and trusted suppliers, the company has established company policy to manage supplier selection, procurement, and performance assessment to ensure that only good quality and reliable suppliers are chosen. AgroCorp also strives to optimize local suppliers while adhering to the company specifications. The company does not give much attention to product design as packaging materials such as tinsplate and label paper can be recycled, and their products are mostly sold for export.

Level of Innovation

AgroCorp's innovation in the CE framework interconnects various aspects of its initiatives. The company's main objectives for developing technological innovations is to increase resource efficiency, reduce waste, and lower greenhouse gas emissions. This approach helps the company achieve a balance of economic development while protecting the environment and natural resources [28,29], as well as enhancing social acceptance. The innovation of CE adoption in AgroCrop leads to cost reduction in production, and even becomes new revenue stream for the company. Various levels of innovation have been implemented within companies through corporate targets, programs, and focus. Apart from technical innovation in agriculture practice, AgroCorp also focuses on improving social programs by enhancing educational programs for employees and community capacity building such as training for sewing, fish, and livestock farming, and simple techniques for biogas creation. AgroCorp also conducts the Micro & Small Medium Enterprise (MSME) partnership programs, such as fruit chip production, cattle farmer partnerships, and stitching orders for employee uniforms.

AgroCrop Circularity Assessment

Refer to 10R strategy assessment that stands for Refuse, Rethink, Reduce, Reuse, Repurpose, Remanufacture, Refurbish, Repair, Recycle and Recover [30,21], AgroCorp has implemented 4 basic circular strategies; Reduce, Recover, Recycle and Repurpose (refer to Table 1). The principle of Reduce comes out as the most CE circularity principle implemented by AgroCorp. It involves increasing business operational efficiency by reducing and converting waste into resources, which in turn can reduce negative impacts on the environment [21]. For instance, AgroCorp uses fruit weevil as organic waste, extracts bromelain enzyme from it, and also using the extraction of weevil pulp for additional material for of livestock manure and then further utilized in organic fertilizer production. The company also recycles organic material by incinerating it into the biogas digester unit, which produces methane gas as the fuel in the power generation units for factories and companies.

Table 1. AgroCrop CE adoption refers to 10R circularity principles.

REDUCE	Reducing waste from the production process Reducing the usage of raw materials Reducing emissions through energy efficiency Reducing fossil fuel dependency by using renewable energy
RECOVER	Recover waste into other materials or products Recover waste water to be reused again
RECYCLE	Recycle the fruit wrapping net-form at Recycle Unit Recycle of used drums and containers at Recycle Unit Recycle waste productions
REPURPOSE	Utilization of sub-par fruits becomes MSME products Utilization of organic waste becomes fish-feeding

Additionally, the company processes effluent produced from biogas digesters to meet the quality standards through wastewater treatment plants and reuses in the company's production process as the water source for the plantation irrigation. On Recycle strategy, AgroCrop reuse the wastewater of their production plants to wash their machines in the factory. They work together with surrounding communities to handle solid wastes from their daily operations before disposing of it to the landfill / *Tempat Pembuangan Akhir* (TPA). In their Repurpose strategy, the company uses under graded fresh fruit products that are still consumable but cannot be sold. They empower MSMEs to produce fruit chips as the Corporate Social Responsibility (CSR) program. Additionally, they also develop community development programs focused on maggot farms for koi fish feed using the organic waste of fresh fruit products.

The CE application in AgroCrop has been implemented in a way that aligns with the characteristics of the agro-industry business, taking into account the existing conditions, problems and risk mitigation measures. The outcomes demonstrated that AgroCrop has determined its capabilities and targets to minimize resource extraction and waste materials. The circularity principle is evaluated as the circular innovation carried out by the company [31] based on; cooperation and coordination, experiments and platformization. Their cooperation and coordination are based on observing how AgroCrop works together with stakeholders, both internally and externally, to implement CE adoption. AgroCrop manages the experimental process through research and development (R&D) and makes it the basic reference for their business planning and further recommendation. AgroCorp utilizes various platforms to facilitate social and economic interactions, which allows for increased circulation. This platformization strategy creates opportunities with external parties such as the surrounding community, government, academics and NGOs [32] to establish a broader ecosystem for applying the CE concept [31]. The CE adoption in AgroCrop is integrated into their management system, requiring adjustments, adaptations that impact the economic, environmental and social aspects of business. The focus is on long-term solution through a shared learning process, which ultimately contributes to sustainable business practices.

Conclusion

The CE implementation in the AgroCrop case study demonstrates how CE strategies are integrated into their business process as the transition towards a sustainable production model. They focus on resource management by using resources and energy efficiently, managing waste and material flows and reducing negative externalities from business operations such as environmental damage and social problems. The CE adoption path carried out by AgroCrop is adjusted to their potential path of CE, by using waste and valorization by-products, which aligns with the characteristics of the application of the CE in the agro-industrial business. A wider insight regarding the innovation CE adoption AgroCrop has led to a reduction in the production costs, and even improved as the new revenue stream for the company. Various levels of innovation have been carried out within the company through corporate targets, programs and focus as a solution to the need to reduce the environmental impacts and enhance social acceptance by doing business more than 'usual'.

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