Circular Economy Adoption in the Upstream Agri-food Supply Chain: Understanding the Implications of the Two Theoretical Lenses

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Abstract

This paper investigates the adoption of Circular Economy (CE) in the upstream agri-food supply chain, employing a qualitative multiple case study research. The findings suggest that the CE emerges in the upstream agri-food supply chain and the early stage of development. In particular, these include (1) the elimination of pollution and waste start to be implemented due to the realization of cost-saving initiatives, (2) the need for collaboration in the supply chain and with external stakeholders, (3) technology adoption, in particular digital technology, is beneficial to reduce asymmetric information, and (4) social orientation in the form of diverting crops to secondary markets, donations, and involvement of the local community. Some of the advantages from exploiting interfirm collaboration include the creation of adding value in securing raw materials and acquiring knowledge through asset specificity. Uncertainty, due to the absence of a contract with the customers that can protect the growers, influences ineffective waste elimination. This paper contributes to the literature on CE in the upstream agri-food supply chain. Future research is needed to investigate the CE involving downstream agri-food supply chain. The practical implication for the upstream supply chain actors is in terms of making the supply chain more circular.

Keywords
Agri-food, Circular Economy, Natural resource-based view, Transaction cost economics, Upstream supply chain

1. Introduction
The agricultural sector uses enormous amount of natural resources, causes land degradation and freshwater depletion (Kummu et al. 2012), producing more food than is needed (Beausang et al. 2017). However, many people still face hunger. There are also natural disasters causing crop yields to be disrupted, and food loss and waste, which is a global issue, must be addressed (FAO 2019). Circular Economy (CE) has been introduced as the regenerative system, replacing the current linear system. With limited resources and a growing population, the linear economy will no longer be able to sustain this 'take-make-dispose' (EMF 2013) system which is problematic in all areas: economic, social and environmental. Circular economy has emerged as a new industrial paradigm and a solution to the negative externalities exposed by the linear economy (Murray et al. 2015). Ghisellini et al. (2016) explained that CE is the new paradigm to achieve sustainability. Geissdoerfer et al. (2018) highlighted CE as an economic system that minimizes resource input into waste, emissions, and energy leakage out of the system, which is expected to mitigate negative impacts without jeopardizing growth and prosperity.

2. Literature Review

2.1 Circular Economy in the agri-food supply chain

Since it has been widely introduced, CE has received attention from academia. The previous literature has provided empirical studies of CE in the agri-food supply chain: Paggoto and Halog (2016) researched eco-efficiency performance in the Australian agri-food systems through the use of input-output-oriented approaches; Teigiserova et al. (2020) proposed a framework using a waste hierarchy of food surplus and waste in a closed loop in the whole supply chain; research in the context of Indonesia, using Industry 4.0 technologies in waste management to achieve sustainable goals (Fatimah et al. 2020); the utilization of waste into energy (Ingrao et al. 2018); Maina et al. (2017) designed a roadmap towards a circular and sustainable bioeconomy through waste valorization; Beltran et al. (2021) proposed a mechanism to transition to the circular bioeconomy via sociotechnical configurations; Jurgilevich et al. (2016) outlined CE in the food system consisting of reducing the amount of waste, reuse of food, utilization of by-products and nutrient recycling. We can summarize the key aspects of CE in the agri-food presented by these papers as the minimal use of natural resources, environmentally friendly production design, prevention of waste, and using waste to become nutrients. A considerable number of researches have observed the adoption of CE practices; however, research on CE is still needed to explore to what extent CE has been adopted in the context of developing countries. In this research we use the CE principles which includes cascades orientation, maximization of retained value, leakage minimization, economic optimization, environmental consciousness, and waste elimination (Ripanti and Tjahjono 2019) to assess the adoption of CE.

2.2 Natural resource-based view

A study of sustainable operations has used NRBV (Miemczyk et al. 2016). The key strategic capabilities are pollution prevention, product stewardship, clean technology, and base of the pyramid (Hart 1997; Hart and Dowell 2011). Firms' payoff in implementing NRBV is a competitive advantage. Pollution prevention aims at the prevention of waste and emissions from the source of production. Product stewardship extends the scope of pollution prevention to include the entire product processes of the company's supply chain or 'life cycle' (Hart and Dowell 2011). Product stewardship allows collaboration within the supply chain to involve product design and the development process. The key resource of product stewardship is stakeholder integration. Greater stakeholder capabilities have been proven by the companies that have more proactive environmental strategies (Sharma and Vredenburg 1998; Ashby 2018). The higher order learning can be done through collaboration with external shareholders such as from institutions and government. A clean technology strategy suggests that firms build competencies in 'tomorrow' technology. Base of the pyramid (BoP) is based on the role of firms to 'meet the needs of the poor'. Firms can gain opportunities from the BoP (Hart and Dowell 2011).

Due to the lack of operationalization of this theory, McDougall et al. (2019) attempted to explain the NRBV in the study of the agri-food supply chain. Their findings suggest that pollution prevention is associated with pollution and waste from the internal operations. Through pollution prevention, firms receive a financial reward. Product stewardship corresponds to sustainable orientation in the supply chain. For instance, selecting suppliers based on the most sustainable ones that are available. Clean technology is related to renewable energy use in producing food, including the use of water technologies, and innovative farming processes. BoP is not featured in their research, instead they propose a new element in the NRBV: local philanthropy. Empirical research using the theoretical lens of NRBV is used to investigate causes of food loss and waste in the agri-food supply chain (Mena et al. 2014; Rodrigues et al. in press). We posit that NRBV shares common principles with CE. Departing from genuine concern for the sustainability of the firms which can be constrained by the firms' interaction with natural resources, NRBV argues that firms should have a proactive environmental strategy. Similarly, CE is concerned with the exploitation of natural resources within the current linear system. For instance, pollution prevention has consequences: waste prevention and preventing negative externalities, which are CE principles. In light of this background, this paper fills the gap in the literature by researching the adoption of CE in the upstream agri-food supply chain using NRBV theory, as research using this theory in CE is lacking (Mishra et al. 2019; Kusumowardani and Tjahjono 2020).

2.3 Transaction cost economics

Transaction cost economics (TCE) was made popular by Williamson (1979). Examples of transaction costs are contract cost, negotiation cost, monitoring cost, information cost. For supply chain management, the economic theory underlying TCE offers significant insights. Using the theoretical framework of TCE, a large number of testable theories concerning supply chain management can be formulated (Hobbs 1996). Due to the high abstraction of TCE, Hobbs (1996) identifies four key concepts of TCE. The first concept is bounded rationality, which indicates that while

people may wish to make a rational choice, bounded rationality prevents them from making a rational decision due to physical limitations. Bounded rationality becomes an issue when there is uncertainty. The second concept is opportunism which has been defined by Williamson (1979) as 'self-interest seeking with guile'. The businesses and individuals will sometimes seek to exploit the situation due to their own interests. The third concept is asset specificity, i.e. when firms collaborate in investing assets in their exchange. The fourth concept is informational asymmetry. Firms recognize that many business exchanges are characterized by imperfect or asymmetrical information that arises from information being available only for selected parties. This suggests that all parties face the uncertainty that leads to behavior opportunism.

According to Liu et al. (2018), TCE potentially can be used to analyze relationships among actors in CE, for example in exchanging their waste into by-products. TCE can also be used to understand how businesses can close material loops effectively and establish close partnerships. These close partnerships enable businesses, along with partner businesses in the value chain, to deal with adaptation and pressures emerging from sustainability issues and increased environmental responsibilities. In these new economic conditions, the creation of contracts that are precise enough for the CE will decide how effective they will be in generating value (Lahti et al. 2018). Arguably, empirical work using TCE in the study of CE is limited. Figure 1 shows the framework used to investigate the implementation of CE using theories of NRBV and TCE.

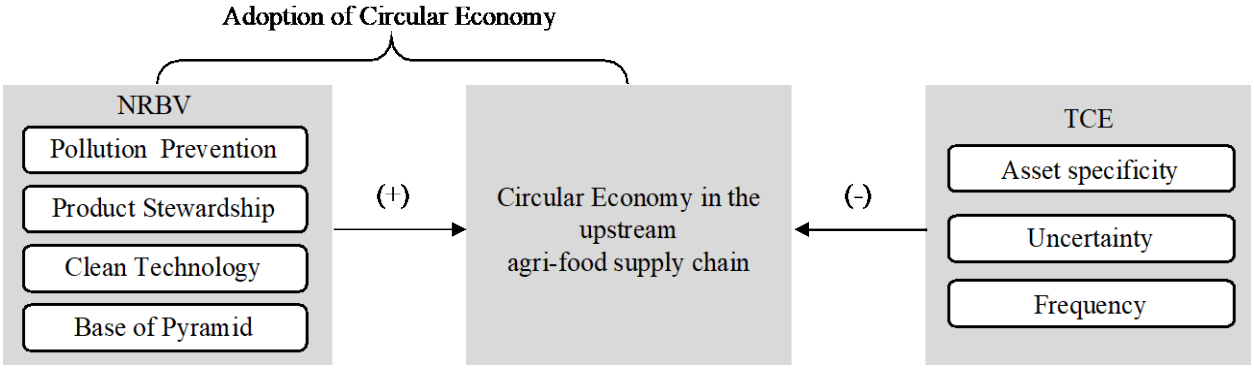

Figure 1. The framework of Circular Economy adoption

3. Methods

This research adopted a critical realism philosophical stance. Critical realism is the branch of philosophy which has relativism epistemology and stratified ontology (Bhaskar 1978). One of the characteristics of the critical realist is that they put reality as the most important philosophical consideration alongside a structural and layered ontology that is seen as crucial (Sayer 2000). Critical realism is based on the belief that there are only two ways to understand the world: 1) There are the sensations and events we experience; and 2) There is mental processing that goes on some time after the experience when we look back (Reed 2005). It is evident that operational research is growing in adopting critical realism which focuses on explanations of underlying mechanisms (Hanna and Jackson 2015).

The research design is a qualitative study using semi-structured interviews, which is appropriate to investigate the phenomenon in the early stages and to be effective in understanding the social phenomenon and expanding theory (Creswell and Poth 2016). Qualitative data in critical realism allows the researcher to obtain rich data and discover the underlying mechanism (Fletcher 2017). Multiple case studies (Yin 2018) are adopted to allow for comparison and to replicate multiple cases to achieve unique and consensus findings.

Data were collected from the case samples selection, using non-probability sampling, involving an upstream agri-food supply chain of ten growers in Java, Indonesia who grow horticultural products and supply to the modern retailers. We chose Java as it is the largest producer of horticulture in Indonesia (Wulandari et al. 2017). The horticulture products range includes banana, spinach, lettuce, zucchini, potato, cabbage and carrot. This research uses multiple data sources, both primary and secondary, and triangulation supports the robustness of the research. The primary data were collected from face to face interviews and visiting farm locations for observations, and the secondary data were

taken from company websites. We interviewed ten growers as cases, represented by one informant from each case (A to J). We also interviewed one of the representative stakeholders in the Chamber of Commerce to ask for their views on CE, that we have coded as case K. In this research, there two types of growers: the first is growers who supply direct to modern retailers (represented by cases A, D, E, G, and J) and the other is using intermediaries (represented by cases B, C, F, H, I). The company's size range includes large, medium and small as variations in company size will provide validity and quality of data. Each interview lasted for 60-90 minutes.

Template analysis, a style of thematic analysis which has flexibility in building the coding structure (King 2012; Tranfield et al. 2003), was adopted in this research. The iterative process in developing the template, allowing deep engagement with data consistent with the philosophical stance of critical realism. The second researcher validated the codes. The template analysis was developed following the key construct of strategic capabilities in NRBV of pollution prevention, product stewardship, clean technology, and base of pyramid and TCE, which consists of four key concepts: bounded rationality, opportunism, asset specificity, and asymmetric information. We use qualitative data analysis NVivo in the coding process.

4. Results and Discussion

4.1 Pollution and waste elimination

Unlike the research on CE that considers using samples of large companies which are more established, we found some challenges to discovering CE in practice. This was due to the majority of growers not being familiar with the term. An example is explained by the following response from case H, when the researcher asked about the term CE, *"I am sorry, I do not think that I know that term, can you explain what it is?"* However, we noticed the emerging of CE in the growers by looking at the implementation of CE, such as how they use waste for composting. Case I explained that they did not understand the term CE, but they have done integrated farming, as the following excerpt shows: *"We implement an integrated farming system already, so actually, this is from the local genius of the founding fathers… if you want to be a grower you have to have animal husbandry, because there are vegetable leftovers from agriculture that will be used as feed for livestock and from them, we obtain manure which is useful as fertilizer".*

In terms of pollution, all the cases of growers agree that pollution in the context of agriculture is associated with the use of pesticides that can contaminate crops, soil, wastewater and even the employees themselves. As stated by an informant in case H, *"In my opinion, pollution in agriculture is the use of pesticides"*. The conventional method of using soil as a medium for planting is a prevalent practice, therefore they cannot avoid the use of pesticides. However, food safety compliance has been understood by most growers, especially those growers who supply to the modern markets and have certification; they have received education from the government, their customers (modern retailers) and pesticide producers. The informants explained that even though they use these chemicals for growing plants, they do control the usage, so as not to exceed the maximum residue limit. They also admitted that they were introduced variations of pesticides but used them only when needed.

We also reveal that the understanding of waste is different among growers. Those growers who focus on the modern markets define waste as all the products that fall below specifications, but growers who supply other market segments have different views and associate the understanding of waste with other forms of waste. Case B responded that *"goods that cannot be used again are considered to be waste, like bottles and plastic"*. Cases B, C, D, E, F, and I argue that waste in relation to products is all the products that are unfit for human consumption. Case B is aware of the impact of the agricultural activities they do, first from the use of chemicals such as pesticides, then the use of plastic packaging and styrofoam. *"However, we have certification in Prima 3, in which it is prohibited for the land to have traces of or scattered plastic in the farm, but there is no pesticide in packaging, so it must be clean"*. A wide range of actions to eliminate waste start at the farms by using superior seeds, implementing best practice cultivation, and improving harvesting techniques and post-harvest management.

From the perspective of TCE, the influence of uncertainty contributes to creating waste for the growers. The growers do not have a guaranteed contract with their customers. There are a few cases between growers and their customers when the products are rejected because they are considered to be below specifications. High transaction cost occurs for those growers who supply direct to modern retailers. Case J explained, *"Sometimes retailers send the purchase order to us, then when we send products, but they are rejected with the reason given that they still have stock which then becomes waste"*.

4.2 Collaboration in the supply chain for Circular Economy

Stakeholders need to collaborate and support each other in the enactment of CE. The growers have realized the importance of collaborating with the stakeholders in the supply chain. The growers admitted there are complex challenges and some are posed by natural disasters. Therefore, they attempt to minimize risk by ensuring the important source of raw materials as being the key, which is seeds. The growers work together with seed producers to keep their harvest optimal. They also provide a small portion of land as a demo plot to test the performance of seed, as the informant in case J explained: *"The seed producer collaborates with us in testing the seed; we provide a demo plot before we plant on a large scale"*. In the TCE, the assets specificity concept appears in how growers collaborate with seed producers to protect the interests of growers in obtaining superior seeds. Collaboration also helps the growers to divert their crops to other channels. Market diversion is one of the efforts made in the ten cases who had experienced off-grade specifications. That is why the network is an important resource to have, as stated by an informant in case C. People who come to traditional markets are less demanding for perfect specifications; instead they are considered to be price sensitive, as suggested by informant case D. This suggests the importance of effective information flow in the supply chain when considering the perishable characteristics of products. However, for growers there is still a potential risk from opportunistic behaviors from the customers that arise from diverting products to other channels.

A higher-order learning process through collaboration with external stakeholders is also apparent in how growers acquire knowledge to improve their performance. This learning style, to a large extent, was akin to what was deliberated by Moreira and Tjahjono (2016), though the industry sector was slightly different. One company is working jointly with third parties who provide guidance in better practice cultivation, as case D alluded, *"We are also accompanied in doing cultivation and applying technology to agriculture, by NGOs from the Netherlands and Japan, so we receive a lot of transfer of knowledge from them"*. Support from the university was also perceived to be very beneficial for case I who had been provided with a gondola to carry harvest and materials from one site to another and had been helped to improve their knowledge.

We find one perspective from informants is regarding the need to collaborate with higher stakeholders in order for CE to be fully implemented. As such, stakeholders who are considered to be able to accelerate the implementation of CE are universities and government. Bounded rationality appears to be a barrier to the implementation of CE because of a lack of understanding about this system. Case I alluded that the implementation of CE needs stakeholder integration, *"We need knowledge on how to implement CE because we do not know how to do that; maybe we need support from the university, a person like you"*. Case H explained in detail, *"One of the big companies in Indonesia that was successful in implementing this [CE] was managed by an integrated system… but again it is hard to implement if we do not collaborate because we have different interests; however, if the management is under one roof it is easier to implement. Maybe we need a government who can actualize this system"*. A fundamental change is also required in order to adopt CE. One of the informants from the stakeholders, stated that CE is possible to be implemented in Indonesia; however, the future is in the hands of the younger generation of millennials who are willing to learn, are fast learners, and more knowledgeable in terms of technology. As the following excerpt indicates, *"We rely on the young, millennials, they are adaptive to technology, fast learners, they are really the agents of change. The older generation is not keen to adopt new knowledge"* (case K).

4.3. Technology adoption in supporting Circular Economy

In this study, discussing technology adoption is related to one of the NRBV strategies, that is clean technology; this includes the tools, machinery, cultivation system, and water management system. Most of the actors who use a conventional technique (on soil) rely on the basic tools, whilst growers who use greenhouses have adopted more advanced technology in their watering system using a nutrient film technique (NFT). Case A in the following excerpt states, *"Currently, we are using an NFT system but still have a conventional system using soil planting. In the future, we would like to use full NFT on our farm because it is easy to manage and faster in terms of the turnover"*. Another technology application is a water system using drip irrigation that was adopted due to the motives for conserving natural resources. In addition, it helps growers to manage their plants by applying centralized fertilizer in one place so that the application is in the same proportion for each plant.

Although technology has been extensively used in other contexts in order to have efficient operational routines that support CE, we identified that growers are not finding it easy to adopt technology – referring to the tools and machinery in the farms. This phenomenon was also revealed by Tjahjono (2009) who observed the adoption of (new) technologies in the shop floors posing various challenges to the workers, if the technologies do not fit the tasks (Greenough and

Tjahjono, 2007). Some trade-off of adopting technology has been acknowledged as in the example given by one informant: *"We are very keen to adopt technology to help us to be more efficient but technology is also still expensive; we have to be realistic, so yes, we still rely on being labor-intensive"*. We found that bounded rationality prevents growers from adopting technology that requires significant investment, although technology enables the process to be more efficient. Growers also experience a lack of capability in providing facilities to process waste to become nutrients. The investment has to be measured by the return on investment, and the growers have to be realistic regarding affordability. Besides the financial constraints, we found the practical challenges of finding suitable technology at the farm also prevented growers from adopting the technology. The representative of Case B commented, *"Actually, we can use a machine, but in considering its ability, because the terrain is a bit tilted, this area is small, so from an efficiency level it is better to use a machine"*.

Further discussion about technology revealed that all cases admitted that the adoption of digital technology has had a tremendous impact on them. They can exchange information and communicate using a smartphone, which helps their operational activities. Growers rely on information exchange to upgrade their knowledge about farming techniques which ultimately contributes to the best practice of the growers. Case G exemplified, *"I learn knowledge and trends from other growers, through social media; many people upload, and I can learn from them"*. The information is also important for price information to prevent opportunistic behavior from other actors. Sometimes the middleman still plays and tries to take advantage of the state of asymmetric information. If compared to the past, growers have suffered greatly from the price game played by intermediaries when they supply to the traditional markets, but now they admitted the price is more visible with the information sharing between growers. Information exchange is also important to help growers in making decisions regarding the diversion of any products that do not meet the specifications of modern retailers.

4.4 Social orientation towards Circular Economy

In line with NRBV which argues that firms have an important role in alleviating social ills, the social aspect is also important in CE. The original concept of BoP posits that the growth of firms can be achieved by creating a new segment for the low-end consumers. The background to this thinking is the firm's efforts to find opportunities by creating other markets that can bring revenue to the company because of the saturated market. Instead of creating a new segment bringing potential revenue, the selling price becomes lower. This is because most growers are focusing on fulfilling the main market segment, i.e. modern retailers that buy their commodities at a higher price than traditional markets. Most modern retailers have market segmentation from medium to high class, i.e. products that are required to have a perfect cosmetic appearance. The form of BoP that we found is by diverting fresh produce to secondary markets, such as to the foodservice industry and traditional markets who do not stress the importance of specifications. The following statement from case J supports this, *"We do not produce for the low segment market because it is not our main market, but if there are products that are below the specifications, we sell them to the secondary markets"*.

We identify the negotiation price arises when the growers divert to other channels, especially if the growers do not have routine and regular transactions with the alternative channels. The characteristics of perishable products also mean that growers have no option but to save products from being wasted. Case A illustrates this: *"We have a special task force for fast selling, we call everyone to push selling out, rather than the products becoming waste"*. This corresponds to the study of Kistruck et al. (2013) who illustrates how BoP is constrained by the presence of the middleman who is trying to make a profit. Therefore, firms need to have good negotiation capabilities. This suggests the role of information flow becomes very important to avoid high transaction costs.

We also found BoP in the form of food donations, i.e. to give food that is suitable for human consumption to the employees; in fact, they are not integrated into the company's strategy or given their serious attention. Cases A and J explained that they give the products that are still edible to their employees, and they do that when there is surplus production. *"Yes, when the demand for vegetables decreased but the product has been overproduced"* (Case A). Another comment from case B about BoP was that *"We have a community of growers here, joined in one group and what we do must consider their welfare."* Similarly, case C involved the local community as part of their employees. Informant case C commented that by empowering and involving the people nearby that farming is supporting the economics of local people. One interesting finding is that there is a cultural barrier in donating to the community, as the informant from case E stated, *"If you want to donate products to the community, you should give the good ones not imperfect products"*.

In Figure 2, we summarize the adoption of CE in the upstream agri-food supply chain based on the theoretical lenses of NRBV and TCE.

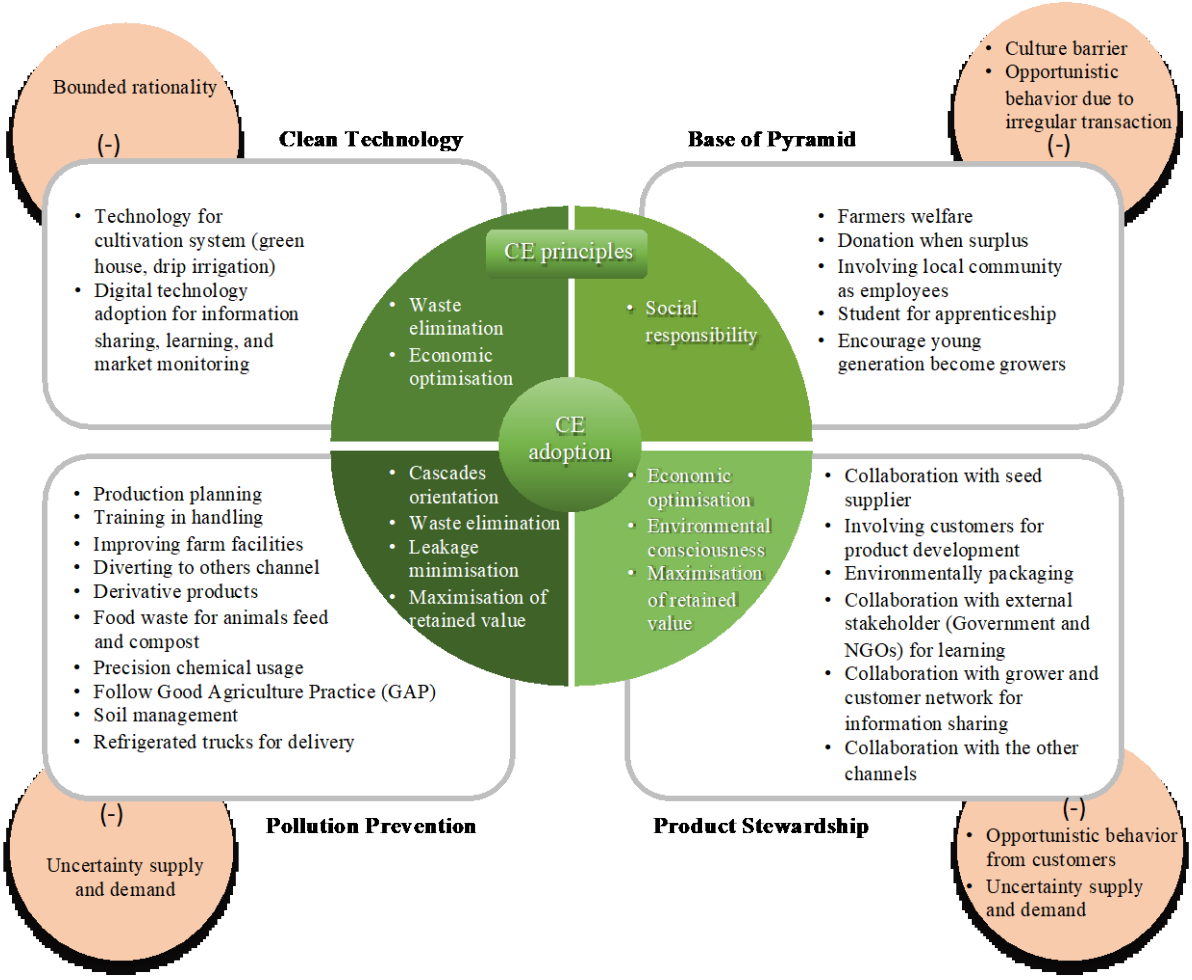

Figure 2. Operational level of Circular Economy adoption in the upstream agri-food supply chain

5. Conclusion

This research has answered the research question on the implementation of CE in the agri-food supply chain. The application of CE in Indonesia in the upstream agri-food supply chain is still in the early stages of development. Our investigation of pollution and waste elimination is realized because of growers' awareness of wasted resources and cost reduction. Collaboration becomes an enabler for the growers to secure raw materials and acquire knowledge. The adoption of technology is diverse amongst growers considering the heterogeneous resources and capabilities of growers. Social orientation has appeared by diversion to other channels, donation to employees, and local community involvement. The research contributes to the broader literature on CE in the upstream agri-food supply chain and extends the theories of NRBV and TCE in the upstream supply chain. The implications for future research include the need to investigate the capability required to fully implement CE using larger samples. Although this research was conducted in the upstream supply chain, it is possible to replicate the methods and same queries to the downstream agri-food supply chain. The practical implications of this research are better management of natural resources and references for implementing CE.

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