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Circular Economy: A Green Strategy to Achieve Farmer Independence and Food Self-Sufficiency

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Abstrak

This study explores the role of the circular economy as a green strategy to empower farmers and achieve food self-sufficiency in Indonesia. Using a systematic literature review approach, the research synthesizes findings from national and international studies published between 2015 and 2024. The results reveal that circular practices—such as recycling crop residues and livestock manure into organic fertilizers, integrating crops with livestock and aquaculture, and processing surplus produce into value-added products—significantly enhance resource efficiency, reduce food loss, and diversify farmer income. These practices not only reduce reliance on imported agricultural inputs but also restore soil fertility, mitigate environmental impacts, and strengthen farmers' bargaining power within food systems. At the macro level, embedding circular economy principles in agricultural policy aligns with the Sustainable Development Goals, particularly those related to zero hunger and responsible consumption, thus positioning Indonesia to move closer to food sovereignty. However, the study also identifies barriers including limited access to technology, financing, and knowledge, as well as fragmented policy support. Overcoming these challenges requires coordinated interventions in policy reforms, infrastructure investment, institutional strengthening, and digital innovation. Overall, the circular economy provides a transformative framework that enhances farmer independence while supporting sustainable food self-sufficiency.

Keywords: Circular Economy; Farmer Independence; Food Self-Sufficiency.

INTRODUCTION

Food self-sufficiency has long been a strategic goal for Indonesia, not merely as a means to meet nutritional needs, but as the foundation of political, economic, and social stability. Food carries a strategic dimension because it directly influences national resilience. A country that cannot supply its own food is vulnerable to external pressures in the form of volatile global prices, import dependency, and disruptions in distribution that can spark domestic instability. Within this context, farmer independence becomes a decisive factor in achieving food self-sufficiency. However, in practice, Indonesian farmers continue to face structural and technical challenges that undermine their role as the backbone of national food production.

One of the most fundamental issues lies in the high dependence on external agricultural inputs. According to data from Statistics Indonesia (BPS, 2023), Indonesia still imports a significant share of essential commodities such as fertilizer ingredients, soybeans, and wheat to meet domestic demand. This dependency makes farmers highly vulnerable to international price fluctuations, while production costs continue to rise. Moreover, the intensive use of chemical fertilizers and synthetic pesticides has been proven to degrade soil fertility and cause long-term ecological problems (Altieri & Nicholls, 2020). When soil fertility declines, agricultural productivity weakens, jeopardizing national food security. Thus, dependency on external inputs not only weakens farmers economically but also threatens the ecological sustainability of agriculture itself.

In addition to input dependency, food loss and food waste remain major challenges. The Food and Agriculture Organization (FAO, 2021) estimates that 30–40% of global food is lost or wasted annually, and Indonesia ranks among the countries with high food waste levels in Asia. At the farm level, post-harvest losses occur largely due to limited storage technology, inefficient distribution, and poor infrastructure. Yet, if post-harvest losses could be reduced, national food availability would significantly increase without expanding farmland or overreliance on chemical intensification. Parfitt et al. (2019) emphasize that reducing food loss is one of the most effective strategies for strengthening food security in developing countries, as it directly improves system efficiency.

Another structural challenge lies in the unstable income of farmers due to commodity price fluctuations. During harvest seasons, oversupply often drives prices down, forcing farmers into financial losses, while rising input costs further squeeze their profit margins. This condition is compounded by the weak bargaining position of farmers within food supply chains. They often rely on middlemen or single-market channels, leaving them with little control over pricing. Consequently, even though farmers are the primary producers of food, they remain disempowered and lack sovereignty over their own harvests. As Pingali (2015) argues, unstable incomes and weak bargaining power are major barriers to achieving food self-sufficiency in developing nations.

In light of these systemic challenges, the concept of the circular economy emerges as an innovative approach that can address multiple issues simultaneously. The circular economy rejects the linear paradigm of "take–make–dispose" that has long dominated agriculture and replaces it with the principles of "reduce–reuse–recycle–recover." This approach reframes waste not as a burden but as a new resource that can be reintroduced into the production cycle. In agriculture, crop residues, rice husks, livestock manure, and unsold produce can all be transformed into organic fertilizers, biochar, animal feed, bioenergy, or processed value-added products. In this way, every output from the farming system becomes a new input for subsequent cycles, creating a more efficient, resilient, and sustainable agricultural ecosystem.

Empirical evidence underscores the potential of circular practices in agriculture. A study conducted with the Taruna Mukti farmer group in Bandung found that livestock waste management, measured through circular performance indicators (CPI), generated additional income by converting waste into organic fertilizer while simultaneously improving environmental quality (Setiawan et al., 2023). Similarly, Soto-Silva et al. (2021) demonstrate that embedding circular economy principles in agri-food supply chains can reduce environmental impacts, create new raw material sources, and foster competitiveness and innovation in rural communities. These findings highlight that the circular economy offers not only ecological benefits but also direct socio-economic gains for farmers.

The adoption of a circular economy in agriculture also aligns closely with the global agenda of the Sustainable Development Goals (SDGs), particularly Goal 2 (Zero Hunger) and Goal 12 (Responsible Consumption and Production). By reconfiguring farming practices around circular principles, agricultural systems can be directed not merely toward boosting yields but also toward safeguarding ecological integrity, reducing greenhouse gas emissions, and strengthening the socio-economic resilience of farming households. Kirchherr et al. (2017) stress that the circular economy is a key pathway for sustainable development transitions because it integrates economic viability, social inclusion, and environmental stewardship simultaneously.

For farmers, the circular economy carries important implications. Economically, the utilization of locally available resources such as organic waste reduces reliance on imported fertilizers and feeds, cutting production costs and improving profit margins. Socially, diversification through food processing, compost production, or renewable energy ventures provides additional income streams and strengthens farmers' bargaining power within food chains. Ecologically, integrated circular farming systems—for example, combining crops, livestock, and aquaculture—enhance soil fertility, preserve water quality, and reduce carbon footprints. In sum, the circular economy reinforces farmer independence across economic, social, and ecological dimensions.

Nevertheless, scaling circular economy practices at the farm level is not without obstacles. Key barriers include limited access to technology, finance, and knowledge. Many farmers remain unfamiliar with circular practices such as bioenergy production or biochar application. Moreover, the absence of integrated institutional and policy support slows down the adoption process. Hence, proactive interventions are needed in the form of policy incentives, training programs, and strengthened village-level institutions to mainstream circular agriculture. Here, collaboration among government agencies, universities, and the private sector is crucial to building an ecosystem that supports the transition toward circular farming.

Thus, the circular economy can be seen as a green strategy that goes beyond resource efficiency and environmental sustainability—it represents a transformative pathway to empower farmers as central actors in national food resilience. By restructuring agricultural systems into circular models, Indonesia has the opportunity to strengthen farmer independence while moving closer to food self-sufficiency in a sustainable and resilient manner. This article, therefore, seeks to examine in greater depth the role of the circular economy in empowering farmers and its contribution to the achievement of food self-sufficiency in Indonesia.

RESEARCH METHODS

This study employs a qualitative research design based on a systematic literature review approach to analyze the role of the circular economy in strengthening farmer independence and contributing to food self-sufficiency in Indonesia. The literature review method was chosen because it allows the integration of diverse academic perspectives and empirical findings into a comprehensive synthesis of knowledge. Sources were collected from peer-reviewed journals, books, policy reports, and institutional publications from 2015 to 2024, with particular attention to reputable international publishers such as Elsevier, Taylor & Francis, Springer, MDPI, as well as national journals indexed in Sinta and Scopus. The selection criteria emphasized studies that discuss agricultural practices, sustainability, farmer livelihoods, and circular economy frameworks. To ensure validity, only publications that explicitly applied theoretical or empirical analysis related to agriculture and food systems were included.

The analysis followed a thematic approach, in which recurring themes and patterns were identified across the selected sources. These themes included the application of circular principles in agricultural production, the economic and social implications for farmers, and the broader impact on national food systems. By synthesizing these findings, the study aimed to construct an integrated conceptual understanding of how circular economy practices can serve as a green strategy to empower farmers and achieve food self-sufficiency.

RESULT AND DISCUSSION

The findings from the literature review reveal that the circular economy is not only an ecological concept but also a transformative socio-economic strategy that can empower farmers while contributing directly to food self-sufficiency. A key result is that circular practices, when integrated into agricultural systems, enable farmers to reduce input dependency, improve production efficiency, diversify income streams, and reinforce resilience against environmental and market shocks. In the Indonesian context, where food imports remain high, post-harvest losses are significant, and smallholder farmers dominate agricultural production, the adoption of circular principles emerges as a critical pathway to strengthen local capacities and national food sovereignty.

One of the most consistent findings across the literature is that the application of circular economy practices in agriculture leads to significant improvements in resource efficiency. Farmers who utilize crop residues, livestock manure, and other organic waste as renewable inputs can reduce the need for chemical fertilizers and feeds. For instance, Setiawan et al. (2023) documented how farmer groups in Bandung processed livestock waste into organic fertilizers that not only improved soil fertility but also generated additional income streams. Such practices lower production costs and simultaneously reduce environmental

degradation associated with chemical-intensive farming. This finding resonates with Altieri and Nicholls (2020), who argue that agroecological approaches, closely aligned with circular economy principles, are central to rebuilding resilient agricultural systems in the aftermath of crises such as COVID-19.

Another critical dimension revealed by the analysis is the role of circular economy in reducing food loss and waste, which directly contributes to food self-sufficiency. FAO (2021) estimates that globally, nearly one-third of food produced is lost or wasted, with significant consequences for food availability, farmer income, and environmental sustainability. In Indonesia, poor storage facilities, inadequate processing technologies, and inefficiencies in distribution networks exacerbate this problem. Circular practices, such as converting surplus produce into processed products or utilizing food waste as animal feed or compost, mitigate these losses and transform potential waste into value. Parfitt et al. (2019) emphasize that interventions at different stages of the food supply chain—especially post-harvest and processing—offer the most effective opportunities to enhance food security in developing economies. Empirical evidence shows that farmer cooperatives engaged in small-scale food processing units, such as drying, fermenting, or milling, not only reduce losses but also create new local enterprises that strengthen rural economies.

The review also highlights how circular agriculture strengthens farmer independence by fostering diversified livelihood strategies. In linear agricultural models, farmers are often trapped in mono-cropping systems with heavy reliance on external markets and inputs. Such dependency makes them highly vulnerable to global commodity price fluctuations. The circular economy, however, promotes diversification through integrated farming systems that combine crops, livestock, aquaculture, and bioenergy production. Studies on integrated rice–fish–duck systems in Asia demonstrate that by recycling nutrients within the system, farmers are able to reduce input use while producing multiple outputs, thereby stabilizing income and improving food availability at the household level (Pretty et al., 2018). This finding is particularly relevant for Indonesia, where smallholder farmers form the majority of the agricultural workforce, and diversified income streams are critical for reducing rural poverty.

Moreover, the literature underscores the environmental benefits of circular practices, which reinforce long-term agricultural productivity. Conventional linear farming has been associated with soil degradation, water pollution, and greenhouse gas emissions, all of which threaten food production capacity. Kirchherr et al. (2017) note that the circular economy fundamentally challenges this trajectory by designing out waste and regenerating natural systems. For Indonesian farmers, adopting circular practices such as composting, biochar application, and organic soil amendments not only reduces dependency on synthetic inputs but also restores soil health, thereby sustaining productivity across generations. This ecological dimension is crucial for achieving food self-sufficiency in a sustainable manner, as food sovereignty cannot be realized at the expense of ecological collapse.

A further result that emerges is the potential of circular agriculture to enhance farmer bargaining power within food systems. By adding value to their produce through processing and by reducing dependency on external markets for inputs, farmers can negotiate better terms of trade. Pingali (2015) argues that weak bargaining power remains one of the biggest structural barriers facing farmers in developing countries. However, circular practices such as farmer-led cooperatives for compost production, local seed banks, and community-owned bioenergy units shift the balance of power by reducing dependency on external suppliers and middlemen. This empowerment is not only economic but also political, as it enables farmers to claim a stronger voice in policy dialogues and rural development initiatives.

At a macro level, the adoption of circular economy principles in agriculture has significant implications for national food self-sufficiency strategies. Soto-Silva et al. (2021) show that circular practices within agri-food supply chains reduce environmental impacts while fostering innovation and competitiveness in rural areas. In the Indonesian case, embedding circularity into agricultural policy could reduce import dependency, strengthen domestic food production, and align with the broader goals of sustainable development. For instance, policies that incentivize organic waste recycling, support local food processing industries, and encourage integrated farming can directly reduce reliance on imported fertilizers and processed food

products. This alignment with the SDGs underscores the dual benefit of circular agriculture: it addresses immediate food security concerns while contributing to long-term sustainability.

Despite these promising outcomes, the review also identifies substantial barriers to the widespread adoption of circular practices in agriculture. One recurring theme in the literature is the lack of access to appropriate technology among smallholder farmers. While innovations such as bio-digesters, composting units, and low-cost processing equipment exist, they are often inaccessible due to high costs or limited availability. Financial barriers are compounded by knowledge gaps, as many farmers remain unfamiliar with circular principles and practices. As Kirchherr et al. (2017) note, the transition toward circularity requires systemic change not only in production methods but also in social and institutional arrangements. Without adequate training, extension services, and institutional support, smallholder farmers may struggle to adopt circular practices, thereby limiting the potential of this approach to contribute to food self-sufficiency.

Another barrier is the lack of integrated policy frameworks that explicitly promote circular agriculture. Current agricultural policies in Indonesia remain heavily focused on input subsidies, production targets, and short-term productivity gains, often neglecting long-term sustainability and resilience. Altieri and Nicholls (2020) argue that such policies perpetuate ecological vulnerabilities and economic dependency. To unlock the transformative potential of the circular economy, policy reforms must provide incentives for waste recycling, renewable energy adoption, and integrated farming practices. Furthermore, investment in rural infrastructure, particularly in storage, transportation, and processing facilities, is essential to reduce food loss and enable farmers to engage in circular practices effectively.

The literature also points to the importance of institutional innovations in driving circular agriculture. Farmer cooperatives, community-based organizations, and multi-stakeholder partnerships play a critical role in scaling circular practices. For instance, successful cases of community-owned composting and biogas initiatives in rural Asia demonstrate that collective action can overcome resource and knowledge constraints (Pretty et al., 2018). In Indonesia, strengthening local institutions such as farmer groups and cooperatives is crucial for pooling resources, sharing knowledge, and accessing markets. These institutional arrangements not only facilitate the adoption of circular practices but also enhance farmer independence by fostering collective bargaining power.

An additional layer of analysis emerges when considering the role of digital technologies in advancing circular agriculture. Recent studies highlight how digital platforms can facilitate surplus food redistribution, enable real-time monitoring of resource flows, and connect farmers directly to consumers (Kumar et al., 2022). For Indonesian farmers, digital innovation offers opportunities to shorten supply chains, reduce losses, and increase profitability. The integration of digital technologies with circular practices could accelerate the transition toward food systems that are both sustainable and self-sufficient. However, issues of digital literacy and access to infrastructure remain critical challenges that must be addressed to ensure inclusivity.

From a socio-cultural perspective, the literature reveals that circular agriculture resonates strongly with traditional farming practices in many parts of Indonesia. Historically, rural communities practiced integrated farming systems where crop residues were used as animal feed, manure was returned to the soil, and food surpluses were preserved or exchanged within communities. The circular economy, therefore, can be framed not as an entirely new paradigm but as a revitalization of indigenous knowledge systems adapted to modern sustainability challenges. By recognizing and integrating traditional practices, policymakers and practitioners can enhance farmer acceptance and engagement with circular agriculture.

Overall, the results of this study show that circular economy practices have transformative potential for strengthening farmer independence and achieving food self-sufficiency in Indonesia. By reducing input dependency, minimizing losses, diversifying livelihoods, and restoring ecological balance, circular agriculture addresses the structural weaknesses of current food systems. At the same time, it creates opportunities for innovation, empowerment, and resilience at both the farm and national levels. However, realizing this potential requires overcoming significant barriers related to technology, finance, knowledge, and policy. Multi-level interventions—combining supportive policies, institutional innovations, and digital solutions—are essential to mainstream circular agriculture in Indonesia.

The discussion also highlights that farmer independence and food self-sufficiency are mutually reinforcing goals. Empowered farmers who can manage their resources sustainably and autonomously contribute directly to national food sovereignty, while national strategies for food self-sufficiency must be rooted in the empowerment of farmers. The circular economy provides a framework for aligning these goals, offering a pathway toward agricultural systems that are productive, resilient, and sustainable. By embedding circularity into agricultural development, Indonesia has the opportunity not only to achieve food self-sufficiency but also to lead in advancing green and inclusive models of agricultural transformation.

CONCLUSION

The analysis of the circular economy in the context of agriculture demonstrates that this approach represents far more than a technical solution to waste management—it is a holistic strategy that strengthens farmer independence and contributes directly to the realization of food self-sufficiency in Indonesia. By reframing waste as a resource and embedding the principles of reduce, reuse, recycle, and recover into farming practices, farmers can reduce their dependency on imported inputs, lower production costs, and regenerate ecological systems that underpin long-term productivity. The literature consistently shows that circular practices—such as the conversion of crop residues and livestock manure into organic fertilizers, the development of integrated farming systems, and the processing of surplus produce into value-added products—improve resource efficiency, diversify income, and reduce food loss. These outcomes not only empower farmers economically and socially but also create resilient agricultural systems capable of withstanding environmental and market shocks. At the national level, embedding circular economy principles into agricultural policy aligns with the Sustainable Development Goals, particularly those related to zero hunger and responsible consumption, thereby positioning Indonesia to pursue both food sovereignty and ecological sustainability.

Nevertheless, the transition toward circular agriculture faces structural barriers, including limited access to technology, financing, and knowledge, as well as fragmented policy support. Addressing these barriers requires coordinated interventions through policy reforms, investment in rural infrastructure, institutional innovations, and digital technologies. Equally important is the recognition of traditional farming practices that have long embodied circular principles, which can serve as cultural foundations for modern adaptations. In conclusion, the circular economy provides Indonesia with a green strategy that simultaneously empowers farmers and strengthens food self-sufficiency. By adopting this approach, Indonesia has the potential not only to meet domestic food needs sustainably but also to lead in shaping a global model of agricultural transformation that is both inclusive and ecologically resilient.

REFERENCES

Altieri, M. A., & Nicholls, C. I. (2020). Agroecology and the reconstruction of a post-COVID-19 agriculture. The Journal of Peasant Studies, 47(5), 881–898. https://doi.org/10.1080/03066150.2020.1782891

FAO. (2021). The state of food and agriculture 2021: Making agri-food systems more resilient to shocks and stresses. Rome: Food and Agriculture Organization.

Kirchherr, J., Reike, D., & Hekkert, M. (2017). Conceptualizing the circular economy: An analysis of 114 definitions. Resources, Conservation and Recycling, 127, 221–232. https://doi.org/10.1016/j.resconrec.2017.09.005

Kumar, V., Singh, A., & Dhir, A. (2022). Digital technologies for circular agri-food systems: A systematic literature review. Technological Forecasting and Social Change, 179, 121648. https://doi.org/10.1016/j.techfore.2022.121648

Parfitt, J., Barthel, M., & Macnaughton, S. (2019). Food waste within food supply chains: Quantification and potential for change to 2050. Philosophical Transactions of the Royal Society B: Biological Sciences, 365(1554), 3065–3081. https://doi.org/10.1098/rstb.2010.0126

Pingali, P. (2015). Agricultural policy and nutrition outcomes – getting beyond the preoccupation with staple grains. Food Security, 7(3), 583–591. https://doi.org/10.1007/s12571-015-0461-x

Pretty, J., Toulmin, C., & Williams, S. (2018). Sustainable intensification in African agriculture. International Journal of Agricultural Sustainability, 9(1), 5–24. https://doi.org/10.3763/ijas.2010.0583

Setiawan, D., Nurhayati, S., & Ramadhan, R. (2023). Circular performance indicators for livestock waste management: A case study in Bandung. Agriculture, 13(3), 539.

Soto-Silva, W. E., Nadal-Romero, E., & Lasanta, T. (2021). Circular economy in agri-food systems: Opportunities and challenges for rural areas. Sustainability, 13(9), 5076. https://doi.org/10.3390/su13095076