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Model of Organic Fertilizer Self-Reliance Governance Based on Circular Economy in Supporting Food Security as a Pillar of Indonesia's National Security

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Abstract: Food security has become a strategic issue closely linked to national security in many countries, including Indonesia. The dependence of the agricultural sector on imported chemical fertilizers exposes Indonesia to global supply chain disruptions, geopolitical tensions, and fluctuations in international commodity prices. This study aims to develop a governance model for organic fertilizer self-reliance based on the circular economy concept to strengthen food security as a pillar of national security. Using a qualitative approach through literature review and policy analysis, this article examines the relationship between circular economy principles, organic fertilizer production, food security, and national security. The findings indicate that organic fertilizer self-reliance contributes significantly to sustainable agricultural production, environmental resilience, economic independence, and social stability. The circular economy approach enables the conversion of agricultural, livestock, and household organic waste into valuable agricultural inputs, reducing dependence on external resources while enhancing soil fertility and ecosystem sustainability. Furthermore, effective governance involving government institutions, local communities, private sectors, and research organizations is essential for achieving sustainable fertilizer independence. The study proposes an integrated governance model that combines circular economy principles, food sovereignty, and national resilience. The model can serve as a policy framework for strengthening Indonesia's food system resilience amid increasing global uncertainties.

Keywords: Circular Economy, Food Security, National Security Governance, Organic Fertilizer, Sustainable Agriculture

A. Introduction

Food security has increasingly become a strategic concern within contemporary national security discourse (Kaiss et al., 2025). Traditional security paradigms primarily focused on military threats; however, contemporary scholars argue that non-traditional security challenges such as food insecurity, climate change, environmental degradation, and resource scarcity pose equally significant threats to national stability (Jyalita, 2023). In the twenty-first century, food security has evolved

into a critical component of national resilience because the inability of a state to ensure adequate food supply may trigger economic instability, social unrest, and political conflict, food security is not merely associated with food production but also with people's capability to access sufficient and nutritious food (D. T. & O. E., 2024). Similarly, argues that food security encompasses availability, accessibility, utilization, and stability, all of which are necessary to maintain sustainable human development (Johnson et al., 2023). Therefore, food security should be considered an integral dimension of national security policy.

Indonesia faces multiple challenges in maintaining sustainable agricultural productivity (Nambassa & Qodir, 2024). Population growth, climate change, land degradation, and excessive dependence on chemical fertilizers have created structural vulnerabilities within the agricultural sector (Bizikova et al., 2015). Data from the Ministry of Agriculture indicate that Indonesia remains dependent on imported raw materials for several fertilizer products, exposing domestic agriculture to external shocks, geopolitical tensions, and fluctuations in global commodity prices (Vyas-Doorgapersad, 2024). Such dependence may undermine national food sovereignty and weaken national resilience during periods of international crisis.

From a governance perspective, emphasizes that sustainable resource management requires collaborative arrangements involving governments, communities, and private stakeholders (Vallino et al., 2020). Effective governance structures become increasingly important when addressing complex and interconnected challenges such as food security and environmental sustainability (Vidar, 2022). further argue that collaborative governance enables diverse stakeholders to coordinate resources, knowledge, and capabilities to achieve collective policy objectives (Trisia et al., 2016). One promising approach to overcoming fertilizer dependency is the adoption of Circular Economy (CE) principles (Nellis Mardhiah et al., 2025). The Circular Economy concept has gained considerable attention among scholars and policymakers as a sustainable alternative to the conventional linear economic model of "take-make-dispose. define circular economy as a regenerative system in which resource input, waste generation, emissions, and energy leakage are minimized through closing, slowing, and narrowing material loops. further explain that circular economy aims to achieve sustainable development by creating environmental quality, economic prosperity, and social equity simultaneously (Wollenberg et al., 2011).

Within agricultural systems, circular economy principles facilitate the transformation of agricultural residues, livestock manure, food waste, and organic household waste into valuable organic fertilizers (Carrad et al., 2022). Nutrient recycling constitutes one of the most strategic applications of circular economy because it simultaneously addresses waste management, environmental sustainability, and agricultural productivity (Sidibé et al., 2018). This approach contributes to reducing dependence on imported fertilizer inputs while promoting ecological sustainability (Chen et al., 2019).

The role of organic fertilizers in sustainable agriculture has also been widely acknowledged (Majlingova & Kádár, 2025). Organic fertilizer application improves soil organic matter, enhances microbial biodiversity, increases water retention capacity, and strengthens long-term soil fertility. Similarly, Organic farming systems supported by organic fertilizers contribute significantly to environmental sustainability while maintaining agricultural productivity. Such improvements are particularly important in developing countries where agricultural resilience directly influences food security outcomes (Arjoo et al., 2022). The relationship between food security and national security has been increasingly discussed within strategic studies literature. States that fail to secure stable food supplies become more vulnerable to political instability and external influence. Identifies food security as a key dimension of human security because disruptions in food systems can generate widespread socioeconomic consequences. Therefore, strengthening domestic agricultural inputs, including organic fertilizer production, should be viewed as a strategic investment in national security (Dorothy, 2024; Jiren et al., 2020).

Despite growing interest in circular economy and sustainable agriculture, limited studies have examined how organic fertilizer self-reliance can contribute to national security through an integrated governance framework. Existing studies tend to focus on environmental or agricultural outcomes without explicitly linking fertilizer governance, food security, and national resilience (Gracino et al., 2021). This gap highlights the need for a comprehensive governance model capable of integrating circular economy principles with food security and national security objectives.

This article aims to develop a Circular Economy-Based Organic Fertilizer Self-Reliance Governance Model to support food security as a pillar of Indonesia's national security (Yusoff et al., 2025). The study contributes to the literature by proposing an integrated framework that connects sustainable agriculture, resource circularity, food sovereignty, and national resilience within a governance perspective. This study contributes to the existing literature by proposing an integrated Circular Economy-Based Organic Fertilizer Self-Reliance Governance Model that bridges environmental sustainability, food security, and national security. Unlike previous studies that primarily focus on agricultural productivity or waste management, this research conceptualizes organic fertilizer self-reliance as a strategic national security instrument (Devi et al., 2022). The study therefore offers a new theoretical perspective by integrating Circular Economy Theory, Collaborative Governance Theory, Food Security Theory, and National Security Theory into a single analytical framework applicable to Indonesia's national resilience agenda.

Organic fertilizer self-reliance based on circular economy principles has the potential to strengthen food sovereignty, reduce import dependency, improve environmental sustainability, and support national resilience (Olabanji & Chitakira, 2025). Consequently, a comprehensive governance model is needed to integrate stakeholders and policies toward achieving sustainable fertilizer independence. This

article seeks to answer the following research question, how can a circular economy-based governance model for organic fertilizer self-reliance strengthen food security as a pillar of Indonesia's national security?

B. Methods

This study employed a qualitative descriptive approach based on a structured literature review, policy analysis, and comparative governance analysis. The literature review was conducted between January and March 2026 using several academic databases, including Scopus, Web of Science, ScienceDirect, Google Scholar, and SpringerLink. The search strategy utilized combinations of keywords such as "organic fertilizer self-reliance," "organic fertilizer governance," "fertilizer policy," "sustainable agriculture," "food security," "agricultural governance," "fertilizer management," and "Indonesia food security," connected using Boolean operators (AND, OR). The review focused on publications published between 2010 and 2025 to capture contemporary developments in agricultural governance and food security policies.

Source selection followed predefined inclusion and exclusion criteria. Included sources were peer-reviewed journal articles, government regulations, policy documents, reports from international organizations (Sietz et al., 2025)and national security literature directly related to organic fertilizer governance, food security, agricultural sustainability, and public policy. Sources were excluded if they lacked relevance to the research objectives, contained insufficient methodological information, were duplicated across databases, or consisted of opinion pieces without empirical or policy foundations.

A total of 87 documents were reviewed, comprising 52 peer-reviewed journal articles, 18 government regulations and policy documents, 9 FAO and other international organization reports, and 8 books and national security references. The credibility of sources was assessed through publication quality, institutional authority, citation relevance, and methodological rigor. Priority was given to peer-reviewed publications indexed in recognized databases and official documents issued by government agencies and international organizations.

Data analysis employed thematic content analysis. The analysis process consisted of four stages: (1) data familiarization through repeated reading of selected documents; (2) open coding to identify key governance factors related to organic fertilizer self-reliance; (3) categorization and clustering of codes into broader themes; and (4) interpretation and synthesis of themes to develop governance insights and policy implications. The coding process was assisted by NVivo 14 software to facilitate data organization, coding consistency, and thematic mapping. To enhance analytical reliability, coding results were reviewed iteratively and cross-checked against the research objectives and theoretical framework (Ayodeji, 2025). This study

acknowledges several limitations inherent in literature review methods. First, publication bias may exist because studies reporting significant findings are more likely to be published. Second, language bias may occur as the review primarily included English-language and Indonesian-language publications. Third, the findings depend on the availability and quality of existing literature and policy documents, which may limit the comprehensiveness of evidence in certain contexts.

C. Results and Discussion

Table 1. Literature Clustering Results

Cluster	Main Theme	Key Findings from Literature	Key References
Cluster 1	Food Security and National Security	Food security is increasingly recognized as a component of national security because food disruptions can trigger social instability, economic crises, and political conflict.	Buzan (2014); UNDP (2022); FAO (2024)
Cluster 2	Circular Economy in Agriculture	Circular economy promotes resource efficiency, waste reduction, nutrient recycling, and sustainable agricultural production through closed-loop systems.	Cahyadi et al. (2024); FAO (2024); Wicke et al. (2026)
Cluster 3	Organic Fertilizer and Sustainable Agriculture	Organic fertilizers improve soil fertility, biodiversity, water retention, and long-term agricultural productivity while reducing environmental impacts.	Krause et al. (2024); Sakrabani (2024)
Cluster 4	Governance and Stakeholder Collaboration	Successful implementation requires collaborative governance involving government, private sector, communities, universities, and farmer organizations.	Donner et al. (2024); Putnam (2020)
Cluster 5	Strategic Resilience and National Security	Domestic fertilizer self-reliance strengthens economic resilience, environmental security, food sovereignty, and national resilience.	Thompson et al. (2024); FAO (2025)

Cluster 1: Food Security and National Security

The literature consistently demonstrates that food security has evolved beyond an agricultural issue and is increasingly viewed as a critical component of national security. Several studies indicate that disruptions in food supply can generate economic instability, social unrest, political tensions, and national vulnerability. Food availability, accessibility, utilization, and stability are therefore considered strategic determinants of state resilience. FAO (2024) and UNDP (2022) emphasize that sustainable food systems contribute directly to societal stability and national development (Iqbal et al., 2025). The reviewed literature further suggests that strengthening domestic agricultural production capacity reduces dependence on external supply chains and enhances strategic autonomy.

Cluster 2: Circular Economy in Agriculture

The second cluster highlights the growing role of circular economy principles in

agricultural development. The literature emphasizes the transformation of agricultural and household organic waste into valuable resources through recycling and nutrient recovery processes (Tursunbayeva et al., 2024). Circular economy practices reduce environmental burdens, minimize waste generation, improve resource efficiency, and support sustainable agricultural production systems. Several studies identify organic waste management as a strategic opportunity to create closed-loop agricultural systems capable of generating economic and environmental benefits simultaneously. This finding indicates that circular economy principles provide an important foundation for organic fertilizer governance.

Cluster 3: Organic Fertilizer and Sustainable Agriculture

The third cluster focuses on the contribution of organic fertilizers to sustainable agricultural development. The reviewed literature shows that organic fertilizers improve soil structure, increase biodiversity, enhance water retention capacity, and support long-term soil fertility (Romero-Lopez et al., 2020). Compared with excessive reliance on chemical fertilizers, organic fertilizers contribute to environmental sustainability while maintaining agricultural productivity. Several studies also report that local organic fertilizer production can reduce production costs and strengthen farmers' independence. These findings suggest that organic fertilizer utilization represents both an environmental and strategic agricultural intervention.

Cluster 4: Governance and Stakeholder Collaboration

The literature consistently identifies governance and stakeholder collaboration as essential determinants of successful implementation. Studies reveal that government agencies alone cannot effectively manage agricultural sustainability programs without support from other actors (OECD, 2018). Effective governance requires coordination among national and local governments, farmer organizations, universities, private enterprises, and community groups. The literature further indicates that collaborative governance improves policy coherence, facilitates resource mobilization, enhances knowledge transfer, and increases program legitimacy. Therefore, multi-stakeholder collaboration emerges as a critical governance mechanism for organic fertilizer self-reliance initiatives.

Cluster 5: Strategic Resilience and National Security

The final cluster highlights the strategic relationship between fertilizer self-reliance and national resilience. The literature indicates that dependence on imported agricultural inputs creates vulnerabilities to global market fluctuations, geopolitical tensions, and supply chain disruptions (Nandini Jagannarayan et al., 2025). Strengthening domestic fertilizer production capacity enhances food sovereignty, economic resilience, and environmental security. Several studies argue that strategic resilience is strengthened when countries possess sufficient internal capacity to

support agricultural production during periods of external uncertainty. Consequently, fertilizer self-reliance is increasingly recognized as an important component of broader national resilience strategies.

Synthesis of Governance Components

The findings from the five thematic clusters were synthesized to identify the governance components necessary for achieving organic fertilizer self-reliance. The synthesis matrix presented in Table 2 demonstrates how each literature theme contributes to specific governance components and expected policy outcomes.

The Circular Economy cluster supports the development of waste collection and recycling systems aimed at improving resource efficiency. The Organic Fertilizer cluster emphasizes the establishment of local production centers to strengthen fertilizer self-reliance. The Governance and Stakeholder Collaboration cluster highlights the need for multi-stakeholder coordination mechanisms to ensure effective implementation. The Food Security cluster contributes to sustainable agricultural production systems that enhance food availability and stability. Finally, the Strategic Resilience and National Security cluster underscores the importance of strengthening national resilience through reduced external dependence and increased food sovereignty.

Table 2. Synthesis Matrix of Literature and Governance Components

Literature Theme	Governance Component	Expected Outcome
Circular Economy	Waste Collection & Recycling	Resource Efficiency
Organic Fertilizer	Production Centers	Fertilizer Self-Reliance
Collaborative Governance	Multi-stakeholder Coordination	Effective Implementation
Food Security	Sustainable Production	Food Availability
National Security	National Resilience	Strategic Stability

Table 2 presents the synthesis of the literature review and thematic analysis that forms the foundation of the proposed governance model for organic fertilizer self-reliance. The matrix demonstrates how key concepts identified in the literature are translated into specific governance components and expected policy outcomes. The first theme, Circular Economy, is operationalized through waste collection and recycling systems aimed at improving resource efficiency by transforming organic waste into productive agricultural inputs (Koval et al., 2020). The second theme, Organic Fertilizer, emphasizes the establishment of production centers as a mechanism for achieving fertilizer self-reliance and reducing dependence on imported chemical fertilizers.

Furthermore, the theme of Collaborative Governance highlights the importance of multi-stakeholder coordination involving government institutions, local communities, farmer organizations, universities, and the private sector to ensure effective policy implementation (Kotseva-Tikova, 2022). The Food Security theme is reflected in sustainable agricultural production systems that contribute to food

availability and long-term agricultural resilience. Finally, the National Security theme underscores the strategic importance of strengthening national resilience through enhanced food sovereignty, reduced external dependency, and improved capacity to withstand global disruptions. Collectively, these interconnected components provide the conceptual basis for the Circular Economy-Based Organic Fertilizer Self-Reliance Governance Model proposed in this study.

Discussion

The findings indicate that organic fertilizer self-reliance should be viewed not merely as an agricultural intervention but as a strategic governance mechanism that links food security, environmental sustainability, and national resilience. The synthesis of literature demonstrates that fertilizer dependency represents a structural vulnerability within food systems because disruptions in global supply chains, geopolitical tensions, or fluctuations in international fertilizer markets can directly affect domestic agricultural production (Durrani et al., 2014). Therefore, strengthening domestic organic fertilizer production through circular economy approaches can reduce external dependency while enhancing national food sovereignty. This finding reinforces the broader security perspective that food systems constitute a critical component of national resilience and strategic stability.

The results are consistent with previous studies that position food security as an integral element of national security. Earlier research has emphasized that food insecurity can trigger economic instability, social unrest, and political vulnerability. The present study extends this perspective by identifying fertilizer self-reliance as an upstream factor that contributes to food security outcomes (Ayodeji, 2025). While previous studies primarily focused on food availability and agricultural productivity, this study highlights the strategic importance of controlling agricultural inputs as a prerequisite for sustainable food sovereignty. Consequently, the study contributes to the literature by establishing a stronger conceptual linkage between fertilizer governance, food sovereignty, and national security.

The findings also support existing circular economy literature emphasizing the importance of resource efficiency and nutrient recycling in sustainable agriculture. Previous studies have demonstrated that agricultural residues, livestock manure, and household organic waste can be transformed into productive resources through closed-loop systems. The present study confirms these findings and further suggests that circular economy practices should be incorporated into national agricultural governance frameworks rather than being treated solely as environmental management initiatives. This broader governance perspective represents an important contribution because it integrates environmental objectives with food security and resilience considerations.

Another important interpretation concerns the role of collaborative governance.

Consistent with prior governance studies, the findings reveal that organic fertilizer self-reliance cannot be achieved through government intervention alone. Effective implementation requires coordination among central and local governments, universities, research institutions, private enterprises, farmer organizations, and local communities (Yusoff et al., 2025). However, unlike previous studies that often focus on individual stakeholder roles, this study proposes an integrated governance framework that explicitly links stakeholder collaboration with circular economy implementation and national resilience objectives. This finding suggests that governance effectiveness depends not only on stakeholder participation but also on the institutional mechanisms that facilitate coordination, resource sharing, and knowledge transfer.

From the Indonesian perspective, the findings have several important policy implications. First, Indonesia possesses substantial organic waste resources derived from agriculture, livestock, plantations, food industries, and households that remain underutilized. The development of village-based and region-based organic fertilizer production systems could transform these resources into strategic agricultural inputs while simultaneously reducing environmental burdens. Second, the findings suggest that fertilizer policy should move beyond subsidy-oriented approaches toward the development of sustainable local production ecosystems. Third, national food security policies should incorporate circular economy principles to strengthen resilience against global market disruptions and geopolitical uncertainties. Such integration would support Indonesia's long-term objectives related to food sovereignty, sustainable development, and national resilience.

The findings further imply that local governments can play a critical role in facilitating decentralized organic fertilizer production systems. Through institutional support, training programs, financial incentives, and community empowerment initiatives, local authorities can encourage farmer participation and strengthen rural economic resilience. This approach aligns with Indonesia's broader agenda of strengthening village economies, promoting environmental sustainability, and reducing regional development disparities. Consequently, the proposed governance model offers practical guidance for policymakers seeking to integrate agricultural, environmental, and security objectives within a unified policy framework.

Despite these contributions, several limitations should be acknowledged. First, the study is based exclusively on a literature review and therefore relies on the availability and quality of existing publications and policy documents. Second, the analysis focuses primarily on English-language and Indonesian-language sources, which may introduce language bias and exclude relevant evidence from other regions. Third, the proposed governance model has not yet been empirically validated through field studies, stakeholder interviews, or quantitative assessment. Future research should therefore test the applicability of the model in different regional contexts within Indonesia and evaluate its effectiveness using empirical data. Comparative studies

involving provinces with different agricultural characteristics would also provide valuable insights for refining and operationalizing the proposed governance framework.

Overall, the study demonstrates that organic fertilizer self-reliance can function as a strategic policy instrument that simultaneously strengthens food security, environmental sustainability, and national resilience. By integrating circular economy principles with collaborative governance mechanisms, Indonesia has the opportunity to reduce dependence on external agricultural inputs while enhancing long-term food sovereignty and sustainable development. These findings suggest that future agricultural policies should adopt a more integrated approach that recognizes the interdependence of environmental, economic, and security dimensions in achieving national resilience.

Finally, the proposed governance model illustrates the strategic linkage between circular economy implementation, food security enhancement, and national security strengthening. By establishing a continuous cycle of waste collection, fertilizer production, agricultural utilization, and nutrient recovery, the model creates a resilient food production system capable of adapting to future uncertainties (Devi et al., 2022). Strengthened food security enhances national resilience by reducing vulnerabilities to food shortages, economic disruptions, and external pressures. Therefore, organic fertilizer self-reliance should be incorporated into Indonesia's long-term national development agenda as part of a comprehensive strategy for achieving food sovereignty, sustainable development, and national security. The findings suggest that future policies should integrate agricultural, environmental, and security perspectives to maximize the contribution of circular economy practices to Indonesia's national resilience.

D. Conclusions

This study developed a Circular Economy-Based Organic Fertilizer Self-Reliance Governance Model as a strategic framework for strengthening food security and national resilience in Indonesia. The model was derived from a synthesis of literature on food security, circular economy, sustainable agriculture, collaborative governance, and national security. Three major conclusions can be drawn from this study. First, Indonesia's dependence on imported chemical fertilizers creates strategic vulnerabilities that may threaten food production, agricultural sustainability, and national resilience. The utilization of agricultural residues, livestock manure, and household organic waste through circular economy mechanisms provides an alternative pathway for reducing external dependency while improving environmental sustainability. Second, the findings indicate that effective implementation of organic fertilizer self-reliance requires an integrated governance framework consisting of four key components: (1) waste collection and recycling systems to ensure a continuous supply of organic raw materials; (2) decentralized

village-based organic fertilizer production centers to strengthen local production capacity; (3) supportive policy and regulatory frameworks including standards, incentives, certification, and quality assurance mechanisms; and (4) monitoring and evaluation systems linked to food security, environmental sustainability, and national resilience indicators. Third, the proposed governance model demonstrates that organic fertilizer self-reliance should be positioned not merely as an agricultural policy but as a strategic instrument that simultaneously advances food sovereignty, environmental security, economic resilience, and national security. The model integrates circular economy principles with collaborative governance mechanisms to create a sustainable and resilient agricultural system.

This study contributes to the literature by bridging four previously fragmented fields of research: circular economy, sustainable agriculture, food security, and national security. The study proposes an integrated analytical framework demonstrating how fertilizer self-reliance functions as a connecting mechanism between environmental sustainability and national resilience. This integration extends existing literature by positioning agricultural input governance as a strategic dimension of national security. For the Ministry of Agriculture, the findings suggest prioritizing the development of village-based organic fertilizer production units and strengthening farmer capacity-building programs. For Bappenas, organic fertilizer self-reliance indicators should be incorporated into the National Medium-Term Development Plan (RPJMN) as part of Indonesia's food security strategy. For the Ministry of Environment and Forestry, greater emphasis should be placed on strengthening organic waste segregation, collection, and recycling systems to support circular economy implementation. Local governments should facilitate community participation, establish regional production centers, and integrate organic fertilizer initiatives into local development programs. This study is limited by its reliance on literature review and policy analysis, without empirical testing of the proposed governance model. The findings therefore depend on the availability, quality, and scope of existing publications and policy documents. Future studies should empirically validate the proposed governance model through case studies, pilot projects, and stakeholder-based assessments in different regions of Indonesia. Comparative studies involving other Southeast Asian countries may also provide valuable insights into best practices for organic fertilizer governance. Additionally, economic feasibility and cost-benefit analyses are needed to evaluate the long-term effectiveness of organic fertilizer systems compared with conventional fertilizer approaches.

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