FMDB *Transactions on Sustainable Public and Law*

Innovation in Regenerative Agriculture Public Policy: A Study of Food Security and Economic Development

Alexander Phuk Tjilen[1,*], Inez Cara A. Phoek[2]

[1]Department of Public Administration, Faculty of Social and Political Sciences, Musamus University, Merauke, South Papua, Indonesia.
[2]Faculty of Business and Accountancy, Management Study Program, Saint Theresa College of Economics, Merauke, South Papua, Indonesia.
alexander@unmus.ac.id[1], inezphoek@gmail.com[2]

Abstract: This study addresses the limited empirical evidence on how regenerative agriculture can be integrated into public policy to simultaneously strengthen food security and promote regional economic development, particularly in eastern Indonesia. Focusing on Merauke Regency, a region with distinct ecological and socioeconomic characteristics, this research aims to (1) analyze the contribution of regenerative agriculture to food security and economic development and (2) assess the role of local government in promoting its implementation through policy innovation, technology facilitation, and farmer assistance. Using a multidisciplinary approach that combines environmental, agronomic, and development economic perspectives, the study finds that regenerative agriculture enhances food availability, stability, access, and utilization through improved soil fertility, crop diversification, and climate resilience. Economically, it reduces production costs, increases farmer incomes, creates new employment opportunities, and strengthens local supply chains. The findings also highlight key drivers and barriers, including policy support, access to technology, institutional capacity, and market incentives. The study concludes that regenerative agriculture, when supported by adaptive and evidence-based public policy innovations, can serve as a strategic instrument for sustainable food systems and regional economic independence. The results provide practical policy implications for local governments in designing integrated, long-term strategies toward sustainable agricultural transformation in Merauke Regency.

Keywords: Regenerative Agriculture; Public Policy Innovation; Food Security; Development Challenges; Regional Economic Development; Agricultural Sector; Food Production; Agricultural Models.

Received on: 31/05/2025, **Revised on:** 02/08/2025, **Accepted on:** 01/10/2025, **Published on:** 03/03/2026

Journal Homepage: https://www.fmdbpub.com/user/journals/details/FTSPL

DOI: https://doi.org/10.69888/FTSPL.2026.000580

Cite as: A. P. Tjilen and I. C. A. Phoek, "Innovation in Regenerative Agriculture Public Policy: A Study of Food Security and Economic Development," *FMDB Transactions on Sustainable Public and Law*, vol. 1, no. 1, pp. 35–46, 2026.

1. Introduction

The agricultural sector plays a crucial role in Merauke Regency's economy. As a region with extensive agricultural land, Merauke is known as one of the food barns in eastern Indonesia. The agricultural sector's contribution to community income, job creation, and regional food security makes it the backbone of the regional economy. Many people in Merauke Regency

*Corresponding author.

depend on this sector for their livelihoods, whether as farmers, agricultural workers, or actors in the agricultural supply chain [4]. Current development challenges, such as reliance on conventional agricultural models that use synthetic inputs and monoculture systems, threaten the sustainability of food production [6]. In addition, limited infrastructure, access to modern agricultural technology, and fluctuations in agricultural prices are factors that influence the economic stability of farmers and regional food security. In recent decades, food security in Merauke Regency has faced serious challenges due to climate change, land degradation, and the implementation of intensive agricultural systems [12]. Changes in rainfall patterns, rising global temperatures, and the increased frequency of natural disasters such as droughts and floods have impacted agricultural productivity [16]. This threatens food production stability and increases the risk of food insecurity for the community [14]. In addition, intensive agricultural practices that rely on chemical fertilizers and synthetic pesticides have accelerated land degradation. Declining soil fertility, reduced biodiversity, and increased erosion and environmental pollution are consequences of unsustainable agricultural systems [17]. If not addressed immediately, these problems could further worsen farmers' food security and economic situation in Merauke Regency.

Several international studies have shown that implementing regenerative agriculture can improve food security and the sustainability of agricultural systems. By implementing practices such as agroforestry, organic farming, crop rotation, and using agricultural waste as natural fertilizer, Farmers can increase productivity sustainably without damaging the environment [1]. This approach has the potential to open new economic opportunities, such as the development of an organic food industry and increased added value for agricultural products [7]. Tanwar et al. [11] explain that various problems in the food system, including hunger, food poverty, labor inequality, and corporate dominance, cannot be solved simply by changing the food system itself. Therefore, broader changes are needed in the political and economic aspects, with active government involvement. These case studies demonstrate that regenerative agriculture is not merely a theoretical concept but has proven effective in improving food security and agricultural economic sustainability across various regions of the world. In response to the challenges facing the agricultural sector, the concept of regenerative agriculture is gaining increasing attention as a more sustainable alternative. This concept aims not to restore the original ecology and biological functions before agriculture, but rather to harness ecological processes within agricultural systems to improve their health [9]. Regenerative agriculture is an approach that focuses on improving soil ecosystems, increasing natural soil fertility, and implementing environmentally friendly agricultural practices. Key principles of regenerative agriculture include reducing waste, reusing resources, and regenerating natural ecosystems to balance food production with environmental sustainability.

1.1. Research Novelty

This research has significant novelty that makes it relevant and important in the context of sustainable agricultural development, especially from a policy innovation perspective:

- First, this research specifically focuses on Merauke Regency, an area that has not been widely studied in the context of regenerative agriculture. Unlike previous studies, which have generally been conducted in areas with different ecological conditions, such as Java or other countries, this research will examine the application of regenerative agriculture practices in Merauke, which has unique ecological and socioeconomic characteristics.
- Second, the approach used in this study is multidisciplinary, combining environmental, agronomic, and development economic perspectives. The focus is not only on food security but also on how regenerative agriculture can stimulate regional economic growth, increase farmer incomes, and create new jobs.
- Third, this research will also analyze in depth the driving factors and barriers to the implementation of regenerative agriculture. Many previous studies have highlighted only the benefits, without identifying the real challenges farmers face, such as limited access to technology, policy support, and local socioeconomic conditions. Therefore, this research will comprehensively explore these aspects.
- Fourth, the results of this study are not merely academic; they are also designed to generate evidence-based policy recommendations for local governments, businesses, and farming communities. These recommendations are expected to serve as a foundation for formulating transition strategies toward a more sustainable, adaptive regenerative agricultural system to address environmental changes and future economic challenges.

1.2. Research Purposes

Taking into account the above challenges and opportunities, the main objectives of this research are:

- Analyzing the extent to which regenerative agriculture can contribute to improving food security and economic development in Merauke Regency.
- Assessing the role of local governments in encouraging the implementation of regenerative agriculture in the region, particularly in terms of policy innovation, technology facilitation, and assistance to farmers.

2. Literature Review

2.1. Theoretical Concept

In an effort to understand the dynamics of sustainable agricultural development, various contemporary theories and approaches provide a robust analytical framework for examining how the agricultural sector can contribute to food security and regional economic growth. Numerous studies emphasize that modern agricultural transformation depends not only on increased productivity but also on the ability of agricultural systems to adapt to environmental changes and utilize natural resources responsibly. Therefore, the following discussion outlines key theoretical concepts, from bioeconomy, green economy, circular economy, to agroecology, which serve as essential foundations for formulating regenerative agricultural strategies in Merauke Regency and other agrarian regions. Conceptual framework: Regenerative Agriculture for food security is described, and the literature review is structured as follows (Figure 1).

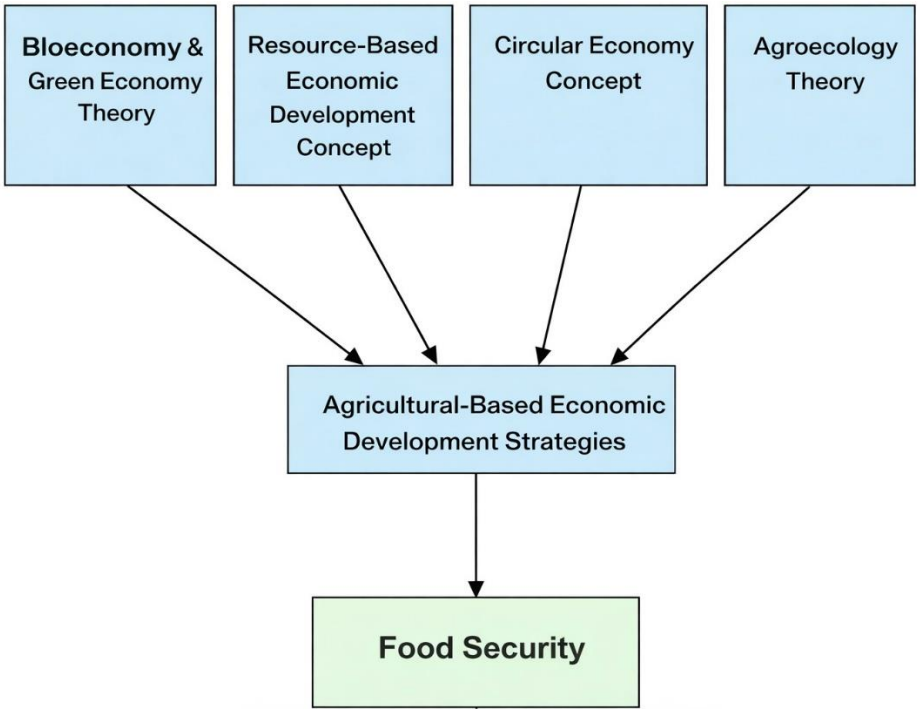

Figure 1: Sustainable agriculture framework diagram

- **Bioeconomic Theory and Green Economy:** D'amato and Korhonen [2] emphasize the role of the agricultural sector in creating economic value through the sustainable use of biological resources. A study by Gollin [5] demonstrates that modern agricultural transformation is closely linked to sustainable productivity gains, with regenerative agricultural technologies enhancing food security and accelerating economic growth in rural areas. In this context, agroecological and bioeconomic strategies are key approaches to increasing food production efficiency without damaging ecosystems.
- **Draft:** Resource-Based Economic Development emphasizes that sustainable economic growth in agrarian-based areas, such as Merauke Regency, must consider ecological capacity and innovation in natural resource utilization [10]. This means that regenerative agriculture, with its principles of soil conservation and increased biodiversity, can be a key factor in strengthening the local economy. Furthermore, the Theory of Innovation in the Agricultural Sector highlights the importance of adopting sustainable technologies and evidence-based policies to accelerate the transformation of the agricultural sector towards a more resilient agriculture in the face of climate change [8].
- **Circular Economy Concept:** In recent years, it has become a focal point in discussions on sustainable development, particularly in the agricultural sector. Velasco-Muñoz et al. [19] define the circular economy as an economic model focused on efficient resource use, waste reduction, and the creation of regenerative production cycles. In practice, this approach promotes a waste-free agricultural system that efficiently utilizes production inputs, with three main strategies for implementing a circular economy. First, agricultural waste reduction is achieved through biomass management and the conversion of organic waste into natural fertilizers, as explained by Tanwar et al. [13]. Second, the use of digital technologies and smart farming, such as precision irrigation and artificial intelligence (AI)-based pest control, can increase the efficiency of water, fertiliser, and pesticide use. Third, integrating agriculture and

renewable energy is a crucial solution, for example, through the use of bioenergy derived from agricultural waste, which can add economic value and reduce dependence on fossil fuels.

- **Agroecology Theory:** A circular-economy approach also provides an important foundation for sustainable agriculture. Diwan [15] suggests that agroecology, including regenerative agricultural practices, can improve food security by mimicking natural ecological processes, increasing crop diversification, and optimizing interactions between organisms within agricultural ecosystems. This approach focuses not only on crop yields but also on ecosystem health and long-term sustainability. In the context of Merauke Regency, the application of circular economy and agroecological principles is increasingly important given the real challenges, such as land degradation and the impact of climate change on food security [3].

By adopting these theoretical concepts and strategies, local agricultural systems can not only sustainably increase productivity but also maintain ecological balance. This will ultimately strengthen community food security and make a significant contribution to sustainable regional economic development.

2.2. Food Security Concept

Food security is a fundamental concept in sustainable development. The Food and Agriculture Organization defines it as a condition in which the entire population has adequate physical, social, and economic access to safe and nutritious food to meet their nutritional needs and food preferences for an active and healthy life. Food security is not only about food availability but also encompasses aspects of distribution, consumption, and the stability of the food system as a whole. David et al. [3] identify four main dimensions of food security:

- Food availability, namely the extent to which food is available through domestic production, imports, and food reserves.
- Food access, including households' economic capacity and supporting infrastructure, is necessary to ensure equal access to food.
- Food utilization refers to how food is consumed in relation to health, sanitation, and nutritional fulfillment.
- Food stability, namely the ability of the food system to provide consistent access to food, including during crises such as those caused by climate change or disasters.

Furthermore, the Global Food Security Index (GFSI) released by The Economist Intelligence Unit is also an important reference for assessing a region's food security. This index uses three main pillars: affordability, availability, and food quality and safety, which respectively reflect economic conditions, production capacity, and the assurance of food quality consumed by the public. In Merauke Regency, food security faces various structural and ecological challenges. Several factors, including limited agricultural infrastructure, land degradation from unsustainable cultivation practices, and reliance on conventional agricultural systems that are less adaptive to environmental change, are key obstacles [18]. Therefore, implementing regenerative agriculture strategies is highly relevant for strengthening long-term food security in this region. This approach not only naturally improves land productivity but also increases food self-sufficiency and reduces the risk of dependence on external inputs, which are vulnerable to global fluctuations. Climate change has become a significant threat to the sustainability of global food systems, including in local contexts like Merauke Regency. The IPCC report shows that rising global average temperatures, changing rainfall patterns, and the increasing frequency of extreme weather events, such as droughts and floods, directly affect agricultural productivity.

Rising temperatures, for example, disrupt photosynthesis and accelerate evapotranspiration, reducing yields of staple crops like rice and corn. Furthermore, irregular rainfall triggers erosion and the leaching of essential soil nutrients, ultimately reducing land fertility. Another equally significant impact is increased pest and plant disease attacks. Warmer temperatures create a favorable environment for the development of pathogens and insect pests, thereby increasing the risk of crop failure. Furthermore, pressure on water resources is increasing due to the more frequent droughts, leading to limited water for irrigation. Unstable production output due to climate change also contributes to fluctuating food prices, which, in turn, threaten food access for vulnerable populations. This situation is particularly relevant to Merauke Regency, where agricultural systems still rely on conventional methods that are vulnerable to climate change. Changing rainfall patterns and rising temperatures have accelerated evaporation from agricultural land, making it difficult for farmers to determine the optimal planting season. Therefore, adaptation strategies are needed that are oriented not only toward increasing productivity but also toward long-term ecological sustainability. One approach that can be implemented is regenerative agriculture, which includes practices such as agroforestry and crop rotation to maintain soil structure and fertility, and to reduce the use of synthetic fertilizers and pesticides to protect soil ecosystems.

Furthermore, selecting crop varieties that are more resistant to extreme conditions is also a strategic step in increasing the resilience of agricultural systems to climate change. Thus, adaptation based on regenerative agriculture is expected to strengthen

local food security and maintain ecological balance amid increasingly complex climate challenges. Regenerative agriculture is an innovative approach to food production systems that focuses not only on increasing crop yields but also on restoring the entire agricultural ecosystem. According to Babaniyi et al. [1], regenerative agriculture aims to improve degraded soil conditions by prioritizing ecologically based practices, such as intensive no-till land management and the use of natural organic matter. This approach differs significantly from conventional agricultural systems because it goes beyond maintaining soil quality to actively revitalizing its biological functions and structure. Gollin [5] defines regenerative agriculture as a farming system that holistically integrates ecological principles, including reducing synthetic inputs, enhancing biodiversity, and conserving water resources. These principles were further explained by Djibran et al. [4], who emphasize five main elements in regenerative agricultural practices, which are explained as follows:

- Increasing soil fertility is achieved by reducing mechanical soil disturbance (e.g., with a no-till system) and adding organic material through compost and natural fertilizers.
- Biodiversity is strengthened through the implementation of agroforestry systems, crop rotation, and livestock integration, which create healthy ecological interactions among agricultural elements.
- The use of chemical inputs is minimized to maintain the balance of soil microbes and prevent pollution of water and the surrounding environment.
- Water conservation is a major focus through the use of mulch, precision irrigation, and cover crops that can increase water retention and reduce evaporation rates.
- Agricultural systems are designed to be more resilient to the pressures of climate change by utilizing extreme-weather-resistant crop varieties and diversifying cropping patterns.

Overall, regenerative agriculture prioritizes ecological sustainability and long-term food security, creating a resilient, healthy, and environmentally friendly agricultural system to support the needs of current and future generations (Table 1).

Table 1: Comparison table between conventional farming and regenerative farming

Aspect	Conventional Farming	Regenerative Agriculture
The main purpose	Increase production results to the maximum	Restoring and improving the health of agricultural ecosystems
Land Management	Intensive cultivation (plowing, deep tillage)	Minimal soil disturbance (no-till or low-till)
Fertilizer Use	Synthetic chemical fertilizers	Organic fertilizer and natural compost
Pest Control	Synthetic pesticides	Natural pesticides and biological approaches
Biodiversity	Monoculture	Crop diversification, agroforestry, and livestock integration
Water Resources	Excessive irrigation, less efficient	Precision irrigation, mulch, ground cover crops
Environmental Impact	Soil erosion, land degradation, and water pollution	Improving soil quality, water conservation, and maintaining biodiversity
Climate Resilience	Vulnerable to extreme weather	Adaptive to climate change
Production Cycle	Linear (plant–harvest–dispose of waste)	Circular (waste is reprocessed as a resource)
Input Dependence	High to external inputs (fertilizers, pesticides, seeds)	Low, more use of local resources

Based on this comparison, regenerative agriculture offers a more environmentally friendly and sustainable approach than conventional agriculture.

3. Discussion

3.1. Dynamics of Food Production and Adoption of Regenerative Agriculture

Food security in Merauke Regency exhibits complex dynamics, influenced by factors including food production, public access to food, distribution systems, and the increasingly pronounced impacts of climate change. Food production trends in the region have shifted significantly in recent years. Rice production, a key commodity, has experienced significant fluctuations. This is primarily due to erratic rainfall patterns and land degradation, which affect productivity. Amid these challenges, there has been increasing adoption of regenerative agricultural systems, particularly among farmers experiencing declining soil fertility and water efficiency issues. In addition to rice, farmers have begun cultivating other commodities, such as corn and soybeans, using regenerative approaches to increase food diversity and reduce dependence on a single crop. Interestingly, after an initial adaptation period, the productivity of land managed with regenerative agricultural systems has shown an increasing trend compared to conventionally managed land.

3.1.1. Strengthening Food Security Through the Regenerative Dimension

The food security level of the Merauke community shows a striking difference between households that implement PR and those that still use conventional methods. The food security analysis is measured through four main indicators (availability, access, utilization, and stability), highlighting the integral role of PR:

- **Food Availability and Stability:** PR practices directly contribute to increasing local, more sustainable production. Farmers who adopt these methods tend to produce more stable amounts of food throughout the year, as PR systems increase the resilience of land ecosystems. Food stability is better maintained among regenerative farmers because the methods they use are less dependent on external inputs such as chemical fertilizers and synthetic pesticides, thereby reducing the risk of supply disruptions from global market fluctuations. Production diversification also significantly reduces the risk of single-crop failures caused by environmental factors.
- **Food Access and Utilization:** The impact of PR extends to socioeconomic aspects. Regarding food access, household incomes of regenerative farmers increased, resulting in greater purchasing power for food, both from their own harvests and purchases. Input cost efficiencies and the potential for premium prices supported this increase in income. Meanwhile, crop diversity in polyculture systems encouraged better food utilization, as people could consume a more balanced, diverse diet. These findings confirm that PR not only impacts the environment but also directly strengthens the socioeconomic foundations of food security in Merauke.

The local government is beginning to demonstrate its commitment through policies and training programs that support sustainable agriculture, as well as providing incentives for farmers who implement environmentally friendly methods. Increasing consumer awareness of the importance of healthy, sustainable food products is opening a potential market for regenerative agricultural products. Furthermore, opportunities for collaboration with research institutions, academics, non-governmental organizations, and the private sector can accelerate technology transfer and innovation in this agricultural system. The potential for exporting sustainable agricultural products is also increasing, which could increase the competitiveness of Merauke products in both domestic and international markets, if adoption of this system continues to be encouraged and expanded. By capitalizing on these opportunities while addressing existing challenges, regenerative agriculture in Merauke can become a key pillar in achieving sustainable food security.

3.2. Implementation Practices and Resource Efficiency

The implementation of regenerative agriculture in Merauke Regency strengthens food security by improving soil quality, production efficiency, and local food self-sufficiency. This approach also reduces dependence on external supplies and supports environmental sustainability and farmer well-being. Interviews with local farmers, local government, and agricultural organizations identified several key practices implemented in the field:

- **Increasing Soil Fertility:** Key practices include crop rotation and polyculture systems, which improve soil fertility while reducing reliance on synthetic chemical fertilizers. Furthermore, the adoption of no-till farming techniques has become popular to minimize erosion and increase water retention capacity.
- **Natural Input Management:** The main alternative is the use of organic fertilizers and compost, utilizing agricultural and livestock waste as sources of natural materials to fertilize the soil.
- **Ecological Adaptation:** Agroforestry practices are being introduced, combining crops with tree planting to enrich biodiversity and protect against the impacts of climate change.
- **Sustainable Water Management:** Attention is focused on sustainable water management, particularly through the implementation of drip irrigation systems and rainwater harvesting, which can reduce water consumption by 30–50 percent compared to conventional methods.

The use of regenerative methods, such as organic fertilizers, crop rotation, and no-till techniques, has sustainably increased soil fertility, thereby driving long-term increases in crop yields. This system also encourages diversification of food production by developing a range of crops beyond rice, which has been dominant in conventional monoculture farming. This diversification not only strengthens household food security but also reduces the risk of crop failure due to environmental factors and unpredictable climate change. Another positive impact is seen in farmers' welfare, where reduced dependence on synthetic fertilizers and pesticides can significantly reduce production costs.

Farmers who adopt regenerative agriculture also gain access to markets for sustainable products that offer premium prices, thereby increasing their incomes. Furthermore, the implemented agroecological systems, including agroforestry and efficient irrigation technologies, strengthen farmers' resilience to the negative impacts of climate change, such as drought and flooding, thereby maintaining stable crop yields amid extreme weather conditions.

3.2.1. Ecological Efficiency

In terms of resource efficiency, regenerative agriculture demonstrates clear advantages. Optimizing water use through drip irrigation and rainwater harvesting can save up to 30–50 percent compared to conventional methods, which is crucial given increasingly erratic rainfall patterns. Naturally restoring soil fertility through cover crop planting and crop rotation also increases sustainable productivity while reducing the risk of land degradation. Furthermore, this method plays a crucial role in climate change mitigation by enhancing the soil's ability to absorb carbon, thus reducing greenhouse gas emissions compared to conventional agricultural practices that rely on synthetic fertilizers and land burning. Economically, implementing regenerative agriculture can reduce operational costs by 20–40 percent within the first five years, providing an added incentive for farmers to continue the practice. While productivity may decrease during the initial transition phase, over the long term, regenerative systems can produce more stable, increasing yields thanks to the restoration of soil ecosystems and plant health.

Thus, regenerative agriculture not only strengthens food security technically and ecologically but also improves the socio-economic welfare of farmers across Merauke Regency. Regenerative agriculture not only contributes significantly to food security and environmental sustainability but also plays a crucial role in driving economic development in Merauke Regency. With its significant agricultural potential, regenerative agriculture approaches can be leveraged to improve farmers' welfare by increasing product added value and creating new, sustainable jobs. Farmers who implement these methods often gain access to premium markets that value sustainable products, resulting in higher selling prices for organic and regenerative agricultural products compared to conventional products. Furthermore, sustainable agriculture certification opens export opportunities and attracts increasingly environmentally conscious consumers, thereby contributing to higher farmer incomes.

3.2.2. Production Cost Efficiency

Production cost efficiency is another key factor strengthening the economics of regenerative agriculture. Reducing reliance on chemical fertilizers and pesticides—which have historically been among the largest cost components in conventional farming—strategically lowers operational costs. With lower production costs while maintaining optimal yields, farmers' profit margins increase significantly. Furthermore, adopting regenerative farming systems opens up new job opportunities, not only in the direct agricultural sector but also in related sectors. Examples include compost management and organic fertilizer production, which are growing along with the reduced use of chemical fertilizers. Furthermore, agrotourism based on regenerative farming is emerging in several regions, creating new business opportunities for local communities and raising public awareness of sustainable agricultural practices. Implementing regenerative farming also requires the support of experts and facilitators throughout the training process and during the transition period, as they mentor farmers. This creates additional job opportunities that support broader community empowerment. Recent studies have shown that adopting this system can increase labor absorption by 20–30 percent compared to conventional farming, as regenerative practices rely more on human labor and expertise than on machinery and chemicals. Thus, regenerative agriculture not only strengthens food and ecological security but also promotes inclusive and sustainable economic development in Merauke Regency.

3.3. Contribution of Regenerative Agriculture to Economic Development

Regenerative agriculture in Merauke Regency plays a crucial role in strengthening regional economic independence by improving food security, supply chain efficiency, and reducing dependence on external suppliers. This approach not only preserves the environment but also improves the competitiveness of local products and the well-being of farmers by enabling shorter, fairer distribution chains. Furthermore, its successful implementation has attracted green investment and opened up opportunities for the development of agricultural processing industries, thereby increasing the regional economy's added value. Regenerative agriculture has a significant impact on strengthening the agricultural supply chain and the local economy in Merauke Regency. By leveraging the region's immense potential as a national food barn, the application of regenerative agriculture can strengthen regional economic independence. Food security built through this method not only preserves the environment but also reduces dependence on imported food from outside the region, thereby increasing the competitiveness of local products in national and international markets. Furthermore, supply chains based on regenerative agriculture tend to be shorter and more efficient, with farmers selling more of their crops directly to consumers or through agricultural cooperatives. This directly reduces the role of intermediaries, who have traditionally absorbed farmers' profit margins, thereby improving their welfare through fairer, more stable selling prices:

- **Economic Independence:** Strengthening regional economic independence by reducing dependence on food imports from outside the region, thereby increasing the competitiveness of local products.
- **Efficient Supply Chain:** Supply chains based on these tend to be shorter and more efficient, with farmers selling their crops directly to consumers or through cooperatives. This reduces the role of intermediaries who absorb margins, thereby improving farmer welfare through fairer, more stable selling prices.

- **Diversification of Local Industries:** Increased yields from regenerative systems enable the development of a diverse local food-processing industry (organic flour, natural oils, fermented products). These processed products increase the added value of agricultural produce and open up opportunities for the production of natural raw materials for other industries (cosmetics, bioenergy, organic animal feed).

3.3.1. Investment Opportunities

The successful implementation of regenerative agriculture in Merauke has also attracted the interest of various investors, both from the private sector and financial institutions focused on sustainable investment. Green financing initiatives and sustainable agricultural bonds are being developed as supporting instruments for farmers transitioning to regenerative systems. This opens up opportunities for greater and more sustainable investment in the regional agricultural sector. Furthermore, increased production from regenerative systems offers opportunities to develop diverse local food processing industries, including organic flour, natural oils, and fermented products. These processed products not only increase the added value of agricultural produce but also open up opportunities to produce natural raw materials for other industries, such as plant-based cosmetics, bioenergy, and organic animal feed. Contributing to broader and more sustainable local economic diversification. Based on the results of Focus Group Discussions (FGDs) with relevant agencies and researchers from Musamus University, several policy implications have been formulated to encourage the adoption of regenerative agriculture in Merauke Regency. These policy strategies encompass various efforts, ranging from increasing outreach and strengthening incentives for farmers to local government support through training programs and financing. With appropriate policies and stakeholder synergy, it is hoped that regenerative agriculture can develop optimally and have a broad, positive impact on food security, the local economy, and environmental sustainability in Merauke. The contribution of regenerative agriculture in opening up new, labor-intensive job opportunities, not only in the direct agricultural sector but also in related sectors, can be explained as follows:

- **Supporting Sectors:** The growth of compost management and organic fertilizer production, along with reduced use of chemical fertilizers, has created new jobs.
- **Agrotourism and Training:** PR-based agrotourism is emerging, creating new business opportunities for local communities and raising public awareness. PR implementation also requires the support of experts and facilitators, creating additional job opportunities in farmer training and mentoring.
- **Increase in Labor Force Quantitative Data:** Adoption of this system can increase labor absorption by 20–30 percent compared to conventional farming.
- **Government Support:** Local governments are increasingly demonstrating commitment through policies and training programs that support sustainable agriculture, including the provision of incentives.
- **Market Demand:** Increasing consumer awareness of the importance of healthy and sustainable food products opens up a potential premium market for PR products.
- **Collaboration:** Opportunities for collaboration with research institutions, academics, non-governmental organizations, and the private sector can accelerate technology transfer and innovation.
- **Export Potential:** The potential for exporting sustainable agricultural products is increasingly open, which can increase the competitiveness of Merauke products in both domestic and international markets.

3.4. Public Policy Innovations to Support Regenerative Agriculture

The research findings confirm that the success of regenerative agriculture in Merauke is highly dependent on structured public policy innovations. Overall, the findings from Merauke Regency confirm that Regenerative Agriculture is a vital, multidimensional strategy that offers technical solutions to address land degradation and climate vulnerability while also serving as a pillar of inclusive economic development. Appropriate policy innovation and stakeholder synergy are expected to develop optimally and deliver broad, positive impacts on food security, the local economy, and environmental sustainability in Merauke, thereby realizing future-oriented public policy innovation. public policy innovation table, systematically compiled based on research variables, key findings, and strategic policy implications (public innovation). Table 2 summarizes the entire substance of the discussion, arranged as follows:

Table 2: Regenerative agriculture public policy innovations in Merauke Regency

No.	Research Variables	Key Findings	Policy Implications (Public Innovation)
1	Dynamics of Food Production and Adoption of Regenerative Agriculture	• Rice production fluctuates due to climate change and land degradation. • Increasing adoption of regenerative agriculture	• Regenerative-based climate adaptation policies, such as the development of drought-resistant production zones and adaptive varieties. • A gradual conversion program from conventional systems to regenerative agriculture through fiscal

		(polyculture, crop rotation, no-till). • Food diversification (rice, corn, soybeans). • Regenerative land shows a trend of better productivity. • PR improves food availability, stability, access, and utilization.	incentives, organic input subsidies, and equipment assistance. • Strengthening regional food diversification through Regent regulations on priority commodities. • Integration of PR in the RPJMD and the Department of Agriculture's Strategic Plan as a long-term food security strategy. • Development of a premium market for regenerative products with local certification "Merauke Regenerative".
2	Implementation Practices and Resource Efficiency	• Increased soil fertility through polyculture, cover crops, and no-till. • Use of natural inputs (compost, organic fertilizer). • Agroforestry reduces the impact of climate change. • Water efficiency of up to 30–50% through drip irrigation and rainwater harvesting. • Production cost reduction of up to 20–40% in 5 years. • Increased farmer income through premium markets and reduced synthetic inputs.	• Regenerative Village Program: a model village for PR practice, complete with mentoring, demonstration plots, and learning centers. • Water-saving irrigation incentive policies, such as microfinance for drip irrigation installations. • Strengthening the local organic input industry, including BUMDes-based compost houses. • A low-interest Regenerative Business Credit Scheme (KUR-Green) for transitional farmers. • The Merauke Agroforestry Movement as a regional policy for land rehabilitation and climate mitigation. • A regenerative price guarantee program to protect farmers from market fluctuations.
3	Production Cost Efficiency and Economic Impact	• Reduced operational costs due to reduced use of chemical fertilizers. • Increased added value through organic products and access to premium markets. • Increased job creation by 20–30% (compost production, mentoring, agrotourism).	• Development of regenerative economic clusters, including compost, organic fertilizer, agrotourism, and processing industries. • Downstream industry incentives for local organic products (organic flour, natural oils, fermentation). • Certification program for regenerative agricultural experts in collaboration with universities and training institutions. • Strengthening regenerative agricultural cooperatives to shorten the supply chain and improve farmers' bargaining power.
4	Regional Economic Independence	• PR strengthens the local supply chain, cuts out mediators, and increases farmers' selling prices. • Reduces dependence on food imports. • Increases the competitiveness of Merauke products. • Increases interest in green investments (green bonds, sustainable financing). • Increases the potential of the local food processing industry and bioindustry raw materials.	• Merauke's Green Supply Chain Policy, regulating PR-based food distribution through cooperatives and local digital platforms. • Establishment of the Regional Green Investment Agency (BIHD) to manage green bonds and attract sustainable investors. • Development of a regenerative product-based processing industry center. • Supply chain digitization (Merauke's regenerative agriculture e-commerce platform). • Local product protection policy through promotion, regional branding, and modern market partnerships.

Table 2 provides a comprehensive overview of the policy implications needed to support the adoption of regenerative agriculture and improve farmer welfare in Merauke Regency. The research findings confirm that accelerating the implementation of regenerative agriculture requires an integrated, collaborative, and evidence-based approach that focuses not only on productivity and resource efficiency but also on farmer empowerment, strengthening supply chains, and increasing regional economic value-added. Through strong institutional support, well-targeted incentives, and collaboration between

government, academia, farming communities, and the private sector, the transformation towards a sustainable food system can be achieved more quickly and inclusively. With adaptive, long-term policies, Merauke has the potential to become a national model for regenerative agriculture, strengthening food security, economic independence, and environmental sustainability.

3.5. Challenges and Opportunities in Implementing Regenerative Agriculture

The challenges and opportunities in implementing regenerative agriculture in Merauke demonstrate that, while this approach has significant potential, various obstacles remain to be overcome to achieve optimal results. The structural and technical challenges faced by farmers, coupled with emerging strategic opportunities in policy, market, and innovation, provide a crucial basis for understanding the direction of sustainable development of this practice. These are explained as follows:

- **Limitations of Knowledge:** The main obstacle is a lack of understanding and awareness of PR concepts and practices. Many farmers remain tied to conventional systems due to limited information and old habits.
- **Access to Capital and Technology:** Limited access to capital and technology is a significant obstacle. The initial investment in procuring superior seeds, environmentally friendly agricultural equipment, and water-efficient irrigation technology is substantial and not readily accessible to small-scale farmers.
- **Input Dependence:** The continued high reliance on synthetic fertilizers and pesticides slows the transition to more environmentally friendly methods.
- **Transition Risk:** Unpredictable climate and weather variability, although manageable with PR, still poses a risk to productivity in the early stages of implementation.

The challenges and opportunities arising from implementing regenerative agriculture in Merauke demonstrate that the transition to a more sustainable agricultural system requires a comprehensive understanding of the structural conditions and local-level farmer capacities. Barriers such as limited knowledge, limited access to modern agricultural technology, and continued reliance on synthetic inputs are key factors hindering changes in practices. These challenges are further complicated by transition risks stemming from unpredictable climate variability, which often affects productivity in the early stages of implementation. These conditions emphasize the need for planned support efforts, including ongoing education, more accessible capital, and the availability of environmentally friendly technologies tailored to the needs of small-scale farmers.

Strategic opportunities provide a strong foundation for accelerating the adoption of regenerative agriculture in Merauke. Government policy support, rising market demand for healthy and sustainable products, and opportunities for collaboration with research institutions and the private sector are driving positive momentum toward transforming the local agricultural system. Furthermore, the export potential for sustainable agricultural products further strengthens the economic value that can be achieved if regenerative principles are consistently applied. The combination of these opportunities and efforts to strengthen farmer capacity paves the way for the development of regenerative agriculture that not only increases productivity but also maintains ecological balance and long-term food security in Merauke.

4. Conclusion

Regenerative agriculture plays a strategic role in strengthening food security while driving economic development in Merauke Regency. Through an approach that emphasizes sustainability, natural resource conservation, and local community empowerment, regenerative agriculture not only increases productivity but also enhances community well-being. This practice is a crucial pillar in supporting the region's sustainable development agenda. From a food security perspective, the application of regenerative agriculture has proven effective in creating sustainable food production. It increases soil fertility, reduces land degradation, and increases crop yields in the long term. This system encourages crop diversification, thereby enriching food availability, increasing consumption diversity, and reducing the risk of crop failure from reliance on a single commodity. Farmers who adopt regenerative practices also demonstrate improved purchasing power due to increased incomes, while strengthening food security by reducing dependence on external inputs such as chemical fertilizers and pesticides. From an economic development perspective, regenerative agriculture significantly increases farmers' incomes. The resulting products have a higher selling value and have the potential to enter premium markets, including exports. This system has also proven to be more efficient in the long term, as it reduces production costs by reducing the use of synthetic chemicals, thereby increasing profit margins.

Furthermore, the labor-intensive nature of regenerative agriculture creates new jobs in supporting sectors such as organic fertilizer production, farmer training, and agro-tourism development. Other positive impacts include strengthening local supply chains and increasing regional food self-sufficiency, which, in turn, attracts green investment and government policy support. Overall, these findings confirm that regenerative agriculture is not only a technical solution to increase agricultural yields but also an integral approach capable of building resilient agricultural systems, improving farmer welfare, and accelerating sustainable local economic growth in Merauke Regency. Future research could explore the social impacts of regenerative

agriculture, particularly on farmer well-being and community dynamics. Furthermore, a more in-depth analysis of the technologies used in regenerative agricultural systems, such as sustainable irrigation and soil biotechnology, is needed to improve their effectiveness. Long-term studies on the productivity and sustainability of regenerative agriculture are also crucial for understanding yield stability and ecosystem balance. Economically, research on market opportunities and supply chains for regenerative products can help improve competitiveness and access to premium markets. Further policy research is needed to design incentive strategies, regulations, and partnership models that encourage broader and more sustainable adoption of regenerative agriculture.

Acknowledgment: The authors sincerely acknowledge Musamus University and Saint Theresa College of Economics for providing valuable academic support and an enriching research environment that contributed to the successful completion of this work.

Data Availability Statement: The data associated with this research are available from the corresponding author upon reasonable request, subject to institutional policies and ethical considerations.

Funding Statement: This research was conducted independently by the authors and did not receive financial support from any external funding agencies or organizations.

Conflicts of Interest Statement: The authors declare that there are no conflicts of interest that could have influenced the research outcomes, and all referenced materials have been appropriately cited.

Ethics and Consent Statement: The authors confirm that the study was conducted in accordance with established ethical standards and that informed consent was obtained from all participants.

References

1. G. G. Babaniyi, F. Ibrahim, U. J. Akor, and O. E. Daramola, "Regenerative agriculture for food security," in *Prospects for Soil Regeneration and Its Impact on Environmental Protection*, Springer, Cham, Switzerland, 2024.
2. D. D'Amato and J. Korhonen, "Integrating the green economy, circular economy and bioeconomy in a strategic sustainability framework," *Ecological Economics*, vol. 188, no. 10, pp. 1–12, 2021.
3. O. S. David, R. Didi, P. T. Alex, and M. Mahyuddin, "Policy strategies in planning adaptation of the sustainable palm oil industry in Merauke Regency, Papua Province of Indonesia," *African Journal of Food, Agriculture, Nutrition and Development*, vol. 23, no. 8, pp. 24317–24345, 2023.
4. M. M. Djibran, P. Andiani, D. P. Nurhasanah, and M. M. Mokoginta, "Analysis of the development of a sustainable agricultural model that takes into account social and economic aspects in Central Java," *Multidisciplinary Journal of West Science,* vol. 2, no. 10, pp. 847–857, 2023.
5. D. Gollin, "Agricultural productivity and structural transformation: Evidence and questions for African development," *Oxford Development Studies*, vol. 51, no. 4, pp. 375–396, 2023.
6. I. Hanafi, H. Hartati, L. Judijanto, H. Syofya, and A. F. Wijaya, "Agricultural Development," *PT MAFY Media Literacy Publishing*, Solok, Indonesia, 2023.
7. C. C. Jaworski, A. Krzywoszynska, J. R. Leake, and L. V. Dicks, "Sustainable soil management in the United Kingdom: A survey of current practices and how they relate to the principles of regenerative agriculture," *Soil Use and Management*, vol. 40, no. 1, p. e12908, 2023.
8. N. I. Kamalrulzaman, A. Ahmad, A. M. Ariff, and M. S. Muda, "Innovation capabilities and performance of Malaysian agricultural SMEs: The moderating role of strategic alliance," *International Journal of Business and Society*, vol. 22, no. 2, pp. 675–695, 2021.
9. R. Khangura, D. Ferris, C. Wagg, and J. Bowyer, "Regenerative agriculture—a literature review on the practices and mechanisms used to improve soil health," *Sustainability*, vol. 15, no. 3, p. 2338, 2023.
10. B. H. Mohamed, I. Ari, M. bin S. Al-Sada, and M. Koç, "Strategizing human development for a country in transition from a resource-based to a knowledge-based economy," *Sustainability*, vol. 13, no. 24, p. 13750, 2021.
11. N. K. Tanwar, A. Joshi, and A. S. Bist, "A comparative study of MBart and alternative transformer models for Kumauni language translation," *Asian Journal of Mathematics and Computer Research*, vol. 32, no. 3, pp. 147–161, 2025.
12. H. Lail, M. Asyrofi, and S. Suryanto, "Factors affecting farmers' decision making in adaptation of climate change," *Journal of Watershed Management Research*, vol. 4, no. 2, pp. 121–136, 2020.
13. N. K. Tanwar, A. Joshi, and A. S. Bist, "AI-powered analysis and comprehensive review of the decline of Kumaoni culture and language preservation initiatives," *Asian Journal of Mathematics and Computer Research*, vol. 32, no. 3, pp. 162–174, 2025.

14. N. Rachma and A. S. Umam, "Organic farming as a solution for sustainable agriculture in the new normal era," *Journal of Community Empowerment Learning (JP2M),* vol. 1, no. 4, p. 328, 2021.
15. S. Diwan, "The role of judicial review in UK constitutional jurisprudence," *International Journal for Legal Research and Analysis*, vol. 2, no. 8, pp. 4–7, 2025.
16. G. A. M. Nora, A. Alberton, and D. H. F. Ayala, "Stakeholder theory and actor-network theory: The stakeholder engagement in energy transitions," *Business Strategy and the Environment*, vol. 32, no. 1, pp. 673–685, 2022.
17. M. L. Sheepo, Z. G. Thungo, and J. Sibiya, "Socio-economic factors and cropping systems in sweet potato (Ipomoea batatas) cultivation among north-central regions of Namibia," *Journal of Agriculture and Food Research*, vol. 21, no. 7, p. 101879, 2025.
18. K. Mrunalini, B. Behera, S. Jayaraman, P. C. Abhilash, P. K. Dubey, G. N. Swamy, J. V. N. S. Prasad, K. V. Rao, P. Krishnan, G. Pratibha, and C. S. Rao, "Nature-based solutions in soil restoration for improving agricultural productivity," *Land Degradation & Development*, vol. 33, no. 8, pp. 1269–1289, 2022.
19. J. F. Velasco-Muñoz, J. M. F. Mendoza, J. A. Aznar-Sánchez, and A. Gallego-Schmid, "Circular economy implementation in the agricultural sector: Definition, strategies and indicators," *Resources, Conservation and Recycling*, vol. 170, no. 7, p. 105618, 2021.