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Ecoregion-Based Food System Transformation and Ecological Justice In Merauke, Indonesia

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ABSTRACT

Merauke Regency in South Papua is currently at a critical intersection of ecological crises and social injustice caused by the implementation of the National Strategic Project (PSN) Food Estate. This top-down program targets the conversion of 1.2 million hectares of ancestral lands into monoculture rice fields, which ecologically contradicts Merauke's seasonal water deficit constraints. This paper presents "SAGU PRIMA" (Sistem Agroforestri dan Umbi Pangan Rakyat Indigenous Merauke Adaptif) as a transformative alternative. Utilizing the Knowledge-to-Policy (K2P) methodological approach, this study synthesizes secondary data and policy contexts to formulate sustainable interventions. The proposed framework is structured around three core pillars: constructing ecoregion-based Local Food Agriculture Centers (PPPL), empowering human resources through Organic Farmer Certification (SPOPL), and developing inclusive local supply chains. The framework aligns with agroecology, food sovereignty, and ecoregion-based planning theories to reconcile the tensions between national food security goals and local socio-ecological survival.

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1. INTRODUCTION

Merauke is the largest regency in Indonesia, covering an area of 45,071 at the southern tip of South Papua, bordering Papua New Guinea and Australia. Geographically, the landscape is heavily dominated by unique tropical wetland ecosystems consisting of peatlands, swamps, and savannas that possess high biodiversity and significant carbon

reserves. Within this specific environmental context, the indigenous Marind people have established a sustainable subsistence food system centered on sago (*Metroxylon sagu*) for centuries. For the Marind community, sago forests are not merely an agricultural source of nutrition, but they also serve as the structural foundation for their cultural identity and collective spirituality. However, since the 2010s, Merauke has become the target of large-scale agricultural expansions under the Merauke Integrated Food and Energy Estate (MIFEE) policy, which has recently been reinforced through the National Strategic Project (PSN) Food Estate to meet national food security targets.

The current state-led food estate policy aims to convert 1.2 million hectares of land for the mass production of rice, sugarcane, and other export commodities. Nevertheless, its empirical implementation has triggered severe ecological, social, and cultural ramifications. Environmentally, technical data indicates that intensive rice cultivation requires an average water supply of 1,637.02 whereas Merauke's local hydrological conditions experience structural water deficits during several months of the year. Consequently, monoculture rice fields in Merauke can only sustain two harvests per year, underperforming significantly compared to the natural potential of local ecoregions if optimized for native wet-adapted sago and dry-adapted tubers. Socially and culturally, the Marind people have experienced massive land dispossessions of their customary ulayat territories without proper Free, Prior, and Informed Consent (FPIC) mechanisms. This top-down land acquisition has been accompanied by military intimidation against dissenting locals, the systematic erosion of the Marind Customary Council's (LMA Marind) authority, and the destruction of the ancestral sago ecosystems that sustained local livelihoods.

This structural crisis is further compounded by institutional human resource failures and severe public health deficits. While Papua encompasses 71,214 Agricultural Business Households (RTUP) divided into 35,907 crop-focused and 36,342 horticulture-focused units agricultural development policies remain highly centralized and partial. This approach leaves a vast gap between macro-economic targets and local capacity development, resulting in low farmer technical capacity, minimal field assistance, and fragile local supply chains. Moreover, standalone digitalization initiatives driven by the Papua Agricultural Modernization and Assembly Center (BRMP) are entirely disconnected from local agricultural infrastructure. The urgency to address these systemic issues is underscored by three critical realities: the degradation of Papua's tropical forests which compromises Indonesia's NDC emission reduction target of 31.89% by 2030 and the Indonesian Biodiversity Strategy and Action Plan (IBSAP) 2025–2045; an ongoing nutritional crisis where stunting in Merauke has soared to 34.8% due to the loss of food sovereignty; and clear violations of international frameworks like UNDRIP, the Papua Special Autonomy Law, and the Indonesian Constitution. Therefore, this study aims to systematically analyze these structural food system failures and formulate an alternative, ecologically just, and evidence-based framework through the SAGU PRIMA program.

2. METHOD

This study employs a qualitative approach rooted in the Knowledge-to-Policy (K2P) methodological framework to convert empirical evidence and socio-ecological data into actionable structural recommendations. The research procedure is operationalized through a chronological four-stage process to ensure academic rigor and localized relevance. The first stage is knowledge identification, which entails a comprehensive review of secondary data obtained from legal regulations, academic literature, and investigative field reports concerning the Merauke Food Estate. The second stage is knowledge synthesis, wherein a problem tree analysis is applied to isolate the core

systemic root causes, including the dominance of centralized rice-centric paradigms, agrarian governance failures, and weak local institutional capacities. The third stage involves policy translation, transforming the synthesized empirical proof into the specific architectural design of the SAGU PRIMA program. The final stage is policy validation, adjusting the proposed policy mechanisms to ensure they remain highly measurable, feasible, and compliant with the socio-political reality of South Papua.

The empirical data and alternative calculations are processed through three complementary theoretical lenses to justify the proposed departure from monoculture farming. First, the agroecology framework is utilized to evaluate how integrating indigenous environmental knowledge can reconstruct total food systems sustainably. This lens validates the agronomical efficiency of sago, which yields 300 kg of dry starch per tree while consuming substantially less water than rice. Second, the food sovereignty theory is integrated to reposition the indigenous Marind community as active subjects of development rather than passive objects, reclaiming their rights to define their localized food models. Third, ecoregion-based planning principles are adopted to shift the planning boundaries from rigid administrative lines to natural ecological thresholds. This theoretical integration forms the baseline for analyzing a wide array of stakeholders, categorizing their positions across civil society (LMA Marind), state regulators (Bapanas, Ministry of Agriculture, Regency Government), legislative bodies, private corporate agribusinesses, academic institutions (UNIPA, IPB), and non-governmental international organizations (FAO).

3. RESULTS AND DISCUSSION

The empirical findings demonstrate that the ongoing rice-centric Food Estate model in Merauke produces suboptimal agricultural yields, averaging only 4.5 tons/ha compared to national standards of 5–8 tons/ha, due to high soil acidity and pyrite indicators. To resolve this ecological mismatch, the SAGU PRIMA framework shifts the agricultural paradigm from destructive monoculture exploitation to a model of co-evolution between humans and ecosystems. This alternative policy framework is operationalized through three deeply integrated, non-partial strategic intervention pillars.

The first pillar establishes an Ecoregion-Based Land Use Optimization model by constructing 12 units of Local Food Agriculture Centers (PPPL) distributed across Merauke Regency. This spatial structure addresses environmental thresholds through a three-layered ecological zoning mechanism. The Wet-Adapted Sago Zone covers areas representing 86.75% of regional water-regulation functions, introducing a multi-strata agroforestry system that integrates native sago palms, aquaculture, and endemic vegetables. This configuration replicates the ancient structural integrity of natural sago forests while maximizing ecosystem service values through vertical diversification. The Adaptive Dryland Tuber Zone spans 30,000 hectares, implementing advanced soil-water conservation techniques and crop rotation methods engineered to match Merauke's severe dry seasons, thereby alleviating the regional water deficit. The Customary Food Forest Conservation Zone encompasses 100,000 hectares managed entirely by the LMA Marind under customary law. Each PPPL is designed as an infrastructure hub, equipped with post-harvest processing facilities, organic quality testing laboratories, agroforestry demonstration plots, and regional cold storage systems. The total capital investment for these 12 PPPL centers is calculated at IDR 240 billion (IDR 20 billion per unit), funded through the combination of Regional Allocation Funds (DAK), Papua Special Autonomy funds, corporate CSR, and international grants.

The second pillar targets Human Capacity Development to overcome institutional deficits and enhance local technological adoption. The strategy establishes the Organic

Farmer Certification (SPOPL), administered by the BRMP Papua in direct collaboration with the International Federation of Organic Agriculture Movements (IFOAM), targeting 3,500 certified indigenous farmers within the first five years. The localized capacity curriculum embeds technical training in organic sago-tuber cultivation, ecoregion water management, and digital literacy to access data platforms. Simultaneously, the framework introduces the Merauke Local Food Youth (PPLM) program, recruiting and training 100 young extension workers specializing in agroecology from regional universities. To bridge the existing technological disconnect, the framework deploys the Merauke Local Food Information System (SIPLM) as a unified digital platform to track real-time agricultural production, market prices, regional stocks, and weather shifts, ensuring data transparency across the supply chain.

The third pillar revitalizes the Agricultural Supply Chain to secure economic viability, counteract the 25–35% post-harvest loss rates, and capture formal regional and national markets. This economic ecosystem provides direct working capital and fast-tracked Halal-BPOM certifications to 50 local food-processing micro, small, and medium enterprises (MSMEs). To institutionalize market demand, the strategy mandates the construction of 30 local food-based public markets combined with a mandatory public procurement policy. This regulation enforces that public schools, regional hospitals, and government offices must source at least 30% of their institutional food supplies directly from local organic farmers, replicating successful institutional feeding models implemented in Thailand and Brazil. Structurally, the supply chain is physically secured through the rehabilitation of 50 kilometers of agricultural logistics roads connecting production centers to public markets, alongside the strategic deployment of 5 regional cold storage facilities.

4. CONCLUSION

The food system crisis in Merauke is not merely an agronomical technical issue, but rather a reflection of flawed policy paradigms that disregard ecological compatibility, customary justice, and local human capacities. The rice-centric Food Estate model has proven to be environmentally unviable, socially disruptive to the Marind people, and counterproductive to genuine national food security goals. As a structural alternative, the SAGU PRIMA program offers an evidence-based, contextual, and ecologically just framework that successfully shifts the agricultural paradigm toward long-term sustainability.

To ensure operational viability, a multi-stakeholder implementation model must be established. Central regulators must incorporate SAGU PRIMA as a pilot model for food estate transformation, altering national budgeting to allocate specific DAK funding for ecoregion PPPL infrastructure. Locally, the Merauke Regency Government must pass a dedicated Regional Regulation (Perda) on Ecoregion-Based Local Food Systems to legally protect the 100,000-hectare Customary Food Forest Conservation Zone within the official Regional Spatial Plan (RTRW). The LMA Marind must be legally integrated as primary partners in all planning and evaluation processes through formal representation in the PPPL steering committees via standardized FPIC protocols. Academic institutions (UNIPA, IPB, BRIN) are tasked with driving applied research on adaptive seed varieties and post-harvest engineering, while private corporations must realign their investment models with Environmental, Social, and Governance (ESG) criteria by partnering directly with SPOPL-certified local MSMEs.

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