

# Sustainability Analysis Of Indonesia's Rice Field Expansion Program: A Literature Review Approach

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**Abstract.** Indonesia's rapid population growth increases national food needs, especially rice, as a primary commodity. To address this challenge, the government initiated the rice field expansion program as part of its food security strategy. This study aims to evaluate the sustainability approach in the implementation of the government's rice field printing program by referring to the Multi-aspect Sustainability Analysis (MSA) method. This study uses a literature review method by searching 33 scientific articles through Google Scholar relevant to rice field expansion, farmer culture, farmer income, and food security. The results of the study indicate that the success of the program is not only determined by technical and economic factors but is also greatly influenced by the integration of local cultural values, institutional strengthening, and cross-sectoral policy support. This study provides a conceptual contribution in developing a framework for evaluating sustainable agricultural development policies, especially in marginal areas, and enriches academic discourse related to the achievement of the Sustainable Development Goals (SDGs) in the food sector.

## 1 Introduction

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Food security is still a significant challenge for many developing countries, including Indonesia [1]. Dependence on one type of major food commodity, such as rice, vulnerability to climate change, land degradation, land contamination and inequality of access to agricultural resources cause food security to become a complex strategic issue. Indonesia, as a country with a large population, must be able to ensure the availability, affordability, and sustainability of food for all its people. Therefore, strengthening the national food system is a priority in the development agenda, in line with the achievement of Sustainable Development Goal (SDG) point 2, namely Zero Hunger.

One of the main strategies to ensure the sustainability of food production is through the expansion of agricultural land, especially the planting of new rice fields. Due to limited productive land and increasing land conversion, extensification efforts are considered essential to meet the growing demand for food [2]. The agricultural land expansion program that has been carried out by the government has become a policy instrument that aims to increase the area of planted land, increase national production, and strengthen food independence. However, its implementation faces multidimensional challenges, ranging from land suitability, infrastructure availability, to social and cultural aspects of local communities. These challenges show that the success of agricultural land expansion programs cannot depend solely on technical approaches, but must also consider complex and interrelated non-technical factors [3].

The aim of this study is to identify the key factors influencing the success of rice field printing programs from various dimensions of sustainability, as well as to evaluate the extent to which the approaches used in previous studies can provide a complete and integrative understanding. This study offers novelty by systematically reviewing various studies related to the sustainability of agricultural land expansion programs using the Multiaspect Sustainability Analysis (MSA) approach. Unlike previous studies that have focused on technical or economic aspects alone, this review emphasizes the importance of integrating social, cultural, institutional, and ecological dimensions in assessing the success of rice field printing programs. The significance of this study lies in its contribution to building a conceptual framework that can be used as a reference for more adaptive, participatory, and sustainable policymaking in supporting national food security, especially in marginalized areas.

## **2 Materials and Methods**

The study method used in this paper is the literature review (LR) method [4]. LR is used to identify, evaluate, and interpret research results relevant to a particular research question, topic area, or phenomenon of concern. This is done based on literature sources through research data collection from 2014 to 2025. The literature search process in this paper uses Google Scholar [5]. The results related to the search that have been sorted obtained as many as 33 journals focusing on rice field printing, the role of farmer culture, farmer income, and food security. The literature in this study contains at least one of these criteria: i) rice field expansion, ii) the role of farmer culture, iii) farmer income, iv) food security.

## **3 Results and Discussion**

### **3.1 Sustainability of people's rice field expansion**

Table 1 contains a summary of a study that evaluates the sustainability of smallholder rice field expansion programs in various regions of Indonesia. These studies reflect a variety of methodological approaches, ranging from qualitative studies (interviews, FGDs), quantitative surveys, to spatial modeling and multidimensional analysis such as MSA (Multiaspect Sustainability Analysis) and MDS (Multidimensional Scaling).

The data patterns in the table show a variety of methods used, ranging from qualitative descriptive to advanced techniques such as Recurrent Neural Network and satellite image

analysis, confirming that the issue of sustainability of rice field expansion is reviewed from various disciplines. The general findings reveal significant constraints such as inefficient irrigation infrastructure, low farmer involvement, and land conflicts and rice field conversion, with only a small number of studies demonstrating the effectiveness of the program.

The issue of multidimensional sustainability is seen in the study of Ardianto, et al. [6], which highlights the economic aspect as the strongest, while the cultural and institutional elements are still weak. The threat of land conversion is also prominent, with a study by Hakim [7] showing that more than half of rice fields are changing their function due to development pressures. In addition, the gap between planning and program realization can be seen in the study of Mangisu, et al. [8], where the realization of the rice field planting target is only 5% of the target of 200 ha due to constraints on forest and irrigation status. Overall, Table 1 illustrates that the sustainability of rice paddy printing programs in Indonesia is still in the medium to low category, with unresolved structural and institutional challenges, emphasizing the need for a comprehensive evaluation based on a multidimensional approach to improve program effectiveness going forward.

**Table 1.** Sustainability of people's rice field expansion

Ref	Method	Research result
[6]	Qualitative with FGD and interviews	The connectivity of new rice fields with irrigation is not yet effective; there are differences in perception between stakeholders, and the achievement of connectivity goals is not yet optimal.
	Recurrent Neural Network (RNN) with GRU and Ridge Regression	Projections for 2045 show that rice production will not be sufficient to meet national consumption without the rapid and massive adoption of disruptive food production technologies.
	Mixed methods (survey, FGD, interview)	Food Estate increases income, but there are challenges of technology adaptation, market access, and environmental degradation. A sustainable approach is recommended.
	Qualitative constructivist	The Food Estate Program repeats the mistakes of the New Order's PLG, lacking adaptation to local conditions and minimal farmer participation.
[7]	Sentinel-2 satellite image analysis (LSWI)	As much as 57.1% of rice fields have changed function to non-rice fields due to high land wetness related to high rainfall.
	Survey and Spearman Rank	Adoption of innovative technologies is positively correlated with farmer food security; farmers who adopt innovation more intensively have better food security.
	SWOT, IFE, EFE, QSPM	The main internal factor is the commitment of regional leaders, while the external factor is strategic location; it is recommended to increase triple helix cooperation.
	Qualitative study	Food Estates cause social and environmental conflicts and lack proper planning; a dialogical approach involving local communities is recommended.
	Conceptual and implementation evaluation.	Sustainable development (including agriculture) is a national commitment. Previous implementations focused on the economy, leading to degradation. A sustainable approach integrates economic, social, and environmental concerns. Obstacles include conflicts of interest between sectors.
	Evaluation of implementation.	The location of new rice paddies in West Kalimantan meets program objectives (rice paddies established, farmers available, water sources available). Improvements are needed in the planning (SI&D) from the previous year.

Ref	Method	Research result
	RAP-FARM (MDS), interview with 41 respondents, FGD	Sustainability index 54.30 (somewhat sustainable); incomes rose 11.6% but were not sufficient to improve well-being.
[6]	Multiaspect Sustainability Analysis (MSA)	Sustainability status is sufficient (index 52.05); the highest is the economic aspect (72.86), the lowest is the cultural aspect (27.14).
[8]	Stages of survey, investigation, evaluation and reporting	Only 10 ha of the 200 ha target (5%) was realized; constraints: forest status, irrigation not yet available; solutions: additional PPL, infrastructure.
	Primary and secondary data from BPS, BPN, etc.	The number of members in the respondent farmer's household did not differ for the three research locations, with an average of five people.
	The multidimensional scale (MDS) uses 43 attributes from 5 dimensions (ecological, social, economic, technological, and legal & institutional), followed by prospective analysis.	Rice field land use in Karawang is less sustainable. Sustainability can be improved through interventions and performance improvements across 16 sensitive attributes identified by the leverage analysis. Priority policies are directed at five key factors identified in the prospective study.

Overall, this research table depicts a dynamic yet challenging agricultural development landscape in Indonesia. Programs such as rice field development and food estates have the potential to increase production and income, but are often hampered by inadequate planning, a lack of adaptation to local conditions, minimal farmer participation, and poorly managed social and environmental impacts. Sustainability is key, requiring the integration of economic, social, and ecological aspects, as well as attention to cultural dimensions.

Technology adoption has proven crucial for food security, but it needs to be accompanied by strategies that consider farmers' capacities and perceptions. Achieving sustainable food security requires a holistic approach involving all stakeholders, based on robust data and analysis, and considering the specific characteristics of each region.

### 3.2 The impact of rice field expansion on farmers' income

Table 2 presents an analysis of the impact of rice field expansion on farmers' income through research with various methodological approaches and key findings. The data pattern shows that most of the studies use quantitative methods such as multiple linear regression, R/C ratio analysis, and comparative surveys, while some others are more qualitative or do not mention the methods in detail.

The main findings are divided into three patterns: (a) Dominant production factors, where land area and production costs have a significant effect on income [9], (b) Profit and efficiency, with an R/C ratio >1 indicating profitable farming [10], and (c) The impact of programs/interventions, such as increased productivity and income after the rice field printing program or the effectiveness of training. Other studies highlight alternative strategies such as business diversification and cultivation technology to increase revenue. However, there were

limited data in the study that did not clearly list methods or results. Overall, this table confirms that rice field expansion can increase farmers' incomes, but its success depends heavily on the management of production factors, business efficiency, and measurable program support.

**Table 2.** Impact of rice field expansion on farmers' income

Ref	Method	Research result
[9]	Multiple linear regression	Land area and production costs have a positive and significant effect on farmer income; labor has an impact, but it is not significant.
[10]	Case study, R/C ratio analysis	Rice farming is profitable ( $R/C > 1$ ); the contribution of rice income varies from 12%-100%; most farmers are semi-commercial.
	Survey, comparison before and after the program	Productivity increased from 4.00 tons/ha to 4.24 tons/ha; income increased from Rp 15–18 million to Rp 27.5–30 million.
	Survey of 66 farmers, cost-revenue and efficiency analysis ( $R/C$ and $\pi/C$ )	$R/C$ ratio: 2.59 and $\pi/C$ : 0.94, meaning the farming business is profitable and efficient.
	Literature and conceptual studies	Diversifying agricultural businesses can increase income and food security; it requires training, support, and market access.
	Pre-test and post-test (pre-experiment), two farmer groups	Leaflets were effective in one group (56.25%) and ineffective in the other (32.67%).
	Multiple linear regression and optimization test	Planted area and Phonska fertilizer had a positive effect on cassava production, while SP-36 fertilizer had a negative effect. To achieve maximum production, farmers need to reduce SP-36 fertilizer and increase Phonska fertilizer.

Overall, this table not only confirms the positive relationship between rice field expansion and increased farmers' incomes but also reveals the complexity of the factors that influence it. To maximize the positive impact of rice field expansion, a holistic approach is needed that combines optimization of production factors, increasing farming efficiency, supporting sustainable government programs, and developing alternative strategies such as diversification and technology adoption. These findings also confirm that increasing farmers' income cannot rely solely on land expansion, but must be supported by improvements in cultivation systems, farm management, and policies that favor smallholders.

### 3.3 The role of farming culture

The research presented specifically highlights the role of farmer culture in agricultural practices, modernity, and their responses to development programs (Table 3). The studies in this table reveal the complex interactions between tradition, innovation, and external factors in determining the success of the agricultural sector. Limpo, et al. [11] examined the "tudang sipulung/appalili" culture in South Sulawesi and found that this traditional deliberation plays a crucial role in determining minimum profit margins for farmers. These findings demonstrate how local wisdom and traditional social systems can serve as important economic governance mechanisms, even in modern agricultural contexts. They also suggest that integrating this culture with formal farming institutions, such as Village Unit Cooperatives, could further enhance its role.

**Table 3.** The role and dynamics of farmer culture

Ref	Method	Research result
[11]	Quantitative and qualitative descriptive (survey), descriptive analysis and scoring (Likert scale and simple linear regression).	The role of farmer groups has been quite successful, but there are obstacles (lack of knowledge, farmer awareness, PPL information, and market guarantees). Farmers' perceptions of product price guarantee significantly influence participation.
	Quantitative (survey) with interviews and questionnaires. Modernity was measured using a Likert scale and descriptive statistical analysis.	Rice farmers have a high level of modernity (average index 69.95%). Modernization occurs when farmers observe the use of modern technology in other areas. Structural and cultural barriers exist.
	The research was conducted from July to November 2019. (Other specific methods were not mentioned)	Many farmers in Bangka's newly established rice paddies leave their land fallow. The study aims to identify strengths, weaknesses, opportunities, threats (SWOT) and empowerment strategies to increase income.
	Qualitative-descriptive, interviews and observations	The culture of cooperation has transformed into a wage system; traditional social values are diminishing.
[11]	Observation, interviews, and Focus Group Discussions (FGDs)	The "tudang sipulung/appalili" culture plays a role in determining the minimum profit margin for farmers. This role can be enhanced by integration with farming institutions such as Village Unit Cooperatives. Factors influencing this shift in local culture include social change, technological values, technological advancements, shifting societal paradigms, new innovations, and religious norms.

However, culture can also shift or become a barrier. Limpo, et al. [11] identified a shift in the cultural values of "Motiayo" (cooperation) in Gorontalo, where the traditional cooperation system has been transformed into a wage system, which in turn has diminished traditional social values. This shift, as also mentioned by Limpo, et al. [11], can be caused by social change, the introduction of technology, developments in the times, shifts in societal paradigms, new innovations, and even religious norms. This suggests that agricultural development programs must be sensitive to social and cultural dynamics to avoid eroding the foundations of farming communities.

### 3.4 Expansion of people's rice fields supports food security

The study presented examines various aspects related to the rice field and food estate programs in supporting food security in Indonesia (Table 4). These results clearly demonstrate that while the rice field and food estate programs have significant potential, their implementation on the ground still faces several obstacles that must be addressed to optimally achieve national food security goals. The smallholder rice field program has the potential to support national food security by expanding land and increasing production. However, realizing this potential requires more thorough planning and adaptation to local conditions. Key challenges include the availability of suitable land (especially land that does not conflict with forest areas), infrastructure needs (irrigation, farm roads), capital, and increasing farmer capacity and knowledge.

In addition to extensification, intensification of existing land remains a crucial strategy. The food estate concept, as part of this effort, must consider lessons learned from past failures and prioritize the empowerment of local agriculture. Ultimately, achieving sustainable food security in Indonesia is not only a matter of national production but also of strengthening capacity and

food security at the regional level, with the support of integrated policies and the active participation of various stakeholders.

**Table 4.** Contribution of people's rice fields to food security

Ref	Method	Research result
[12]	Spatial analysis using various maps (land cover, peat, permits, forest areas, etc.).	Only about 7.9 million hectares of abandoned land have the potential for agricultural expansion, far below the need (5.3-10.3 million hectares). The primary strategy must be to intensify existing land use and control land conversion.
[13]	Qualitative.	The implementation of the rice field printing program by Korem 174/ATW in Merauke is strategic. The results are expected to provide input for future optimization.
[14]	Descriptive analysis, resource-focused approach to the energy potential of agricultural residues.	Indonesia has abundant natural resources for food security and bioenergy from agricultural residues. Rice waste has the potential to generate more than 1,300 TJ of energy. Intensification of marginal land (food estates) is relevant post-COVID-19.
[15]	Policy analysis.	Indonesia remains a food importer despite being an agricultural country. Food security is vital and must encompass availability, accessibility, and affordability. Food policy must be integrated with national development.
	Regression analysis. Population: farming households in Klaten; Sample: 30 farmers from food self-sufficient villages and agricultural clinics.	Food is a basic need related to food security (security, affordability). (Specific results of the regression analysis are not available in the relevant snippet.)
	Program evaluation and sustainability analysis (MDS)	The rice field printing program is quite sustainable (index 52.94); constraints: capital, farm roads, irrigation facilities, and farmer knowledge.

From the results of the compilation above, the studies are grouped into four main themes: (i) Environmental constraints are often a dominant issue, especially on marginal lands that lack irrigation infrastructure or experience seasonal drought. (ii) Socio-cultural aspects play an important role in the long-term success of the project, particularly regarding the suitability of new agricultural practices with local traditions. (iii) Institutional support is often fragmented due to weak local governance, limited outreach, and overlapping authority between agencies. (iv) Farmer incomes vary widely across regions, depending on market access, security of land rights, and input subsidy support. Measuring farmers' happiness in the emotional dimension provides deep insight into their emotional well-being. This dimension shows that farmers often experience positive emotions, with happiness scores of 90.55 and anxiety scores of 86.14. These results suggest an optimistic emotional state, possibly supported by close community interactions and a spiritual life. However, the pressure/stress indicator has a lower score (79.66), which may reflect financial uncertainty or market-related stress.

## 4 Conclusion

This study confirms that the sustainability of agricultural land expansion in Indonesia is determined by a complex interaction between ecological, socio-cultural, economic, and institutional factors. Projects such as Rumbia Extension and the Kalimantan Food Estate

demonstrate that success depends not only on infrastructure investment but also on farmer participation, institutional coordination, and cultural adaptation. The application of the MSA framework has proven effective in assessing the long-term viability of agricultural expansion programs.

Based on the results of the literature review, the following are several recommendations to improve the sustainability of agricultural land expansion programs in Indonesia: Conduct a thorough environmental assessment prior to land conversion to ensure agroecological suitability. Prioritize participatory planning that involves farmers' local knowledge, culture, and wisdom. Strengthening institutional coordination between central and regional governments to avoid overlapping policies and increase program efficiency. Improving rural infrastructure and market access to support farmer welfare.

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