FINAL REPORT

Study on Low-Carbon Sustainable Rice as Specialty Rice

A RESEARCH STUDY ON LOW-CARBON SUSTAINABLE RICE AS A SPECIALTY RICE

In collaboration with:
People's Coalition for Food Sovereignty (KRKP)
International Research Institute for Social, Economic, and Regional Development (LRI PSEK), IPB University
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A Research Study on Low-Carbon Sustainable Rice as a Specialty Rice

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FOREWORD

We express our deepest gratitude to Almighty God for the completion of the study entitled "Low-Carbon Sustainable Rice as a Specialty Rice," the result of a collaboration between the People's Coalition for Food Sovereignty (KRKP) and the International Research Institute for Social, Economic, and Regional Development (LRI PSEK), IPB University, with support from the European Union through the SWITCH-Asia Programme. This study forms part of KRKP's commitment to strengthening the national food sovereignty agenda by reinforcing the position of smallholder farmers within a sustainable, inclusive, and sovereign food system.

For KRKP, food sovereignty is not merely understood as a nation's capacity to meet its food needs independently, but also as a social, economic, and ecological process that places farmers as the primary actors in the management of food resources. In the context of climate change and increasingly complex global economic dynamics, the sustainability of food systems can only be achieved if smallholder farmers receive adequate protection, incentives, and fair access to resources and markets.

This study focuses on the importance of adopting low-carbon rice cultivation practices based on the Sustainable Rice Platform (SRP) as a strategic instrument to reduce greenhouse gas emissions while simultaneously improving farmers' welfare. The findings indicate that the implementation of SRP practices can generate positive impacts on production cost efficiency, productivity improvement, and the adoption of environmentally friendly technologies. However, the successful adoption of SRP at the farm level is highly dependent on supportive policies and incentive schemes, including specialty rice pricing mechanisms, access to financing, and agricultural innovation support.

KRKP firmly believes that strengthening incentive schemes for small-scale farmers is a crucial step in fostering farmers' motivation and capacity to transition toward sustainable agricultural practices. Such incentives serve not only as economic stimuli but also as recognition of farmers' contributions to maintaining the social and ecological balance that underpins national food sustainability.

We hope that the results of this study will contribute to the development of national policies and strategies to promote the recognition of low-carbon sustainable rice as a specialty rice, and serve as a reference for stakeholders in strengthening collaboration toward a sustainable, inclusive, and sovereign food system.

Bogor, 2025

Koalisi Rakyat untuk Kedaulatan Pangan (KRKP)

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EXECUTIVE SUMMARY

Urgency. Indonesia's rice farming sector faces a dual challenge: it is both highly vulnerable to climate change and a significant contributor to global carbon emissions. Emission mitigation efforts can be pursued through the adoption of low-carbon rice farming practices (Low Carbon Rice Farming/LCRF), one of which is the Sustainable Rice Platform (SRP) approach. The SRP method has been proven to reduce greenhouse gas (GHG) emissions while applying sustainability principles that integrate social, economic, and environmental dimensions.

The Government of Indonesia has begun to prioritize low-carbon agriculture in line with the National Long-Term Development Plan (RPJPN) 2025–2045 and as part of the National Priority Program for the Development of Sustainable Agricultural Production Systems (PN 2) under the National Medium-Term Development Plan (RPJMN) 2025–2029. Sustainable rice farming requires compliance with standards and regulations, including certification or sustainability claims and product traceability. This is particularly important given the growing business potential driven by increasing demand for sustainably produced food products.

However, farmers as key actors face persistent structural constraints, including small landholdings (the majority in Java cultivate less than 0.5 ha), which limit economies of scale. In addition, the adoption of environmentally friendly practices and green technologies requires substantial investment, while smallholder farmers face capital constraints and limited access to financing. Currently, there is no significant price differentiation between conventional rice and SRP rice. To create market incentives and motivate farmers, it is necessary to assess whether SRP rice can be classified as specialty rice. According to the Regulation of the National Food Agency of the Republic of Indonesia No. 2 of 2023, specialty rice includes glutinous rice, red rice, black rice, local varieties, fortified rice, organic rice, geographical indication rice, rice with health claims, and certain rice types not produced domestically.

SRP rice possesses characteristics that are more complex than organic rice, encompassing multidimensional sustainability aspects—environmental, economic, social, technological, institutional, and policy dimensions. Therefore, in-depth research is required to analyze and advocate for the recognition of low-carbon sustainable rice as a formally acknowledged specialty rice category.

Based on the above context, the specific objectives of this study are to: (i) Identify the characteristics, policy framework, and development of specialty rice in Indonesia;(ii) Explore opportunities and challenges for positioning low-carbon sustainable rice as a policy-regulated specialty rice; and (iii) Formulate recommendations and strategies to promote low-carbon sustainable rice as a specialty rice.

Study Area, Data Types, and Sources. The study was conducted in Boyolali and Klaten Regencies, Central Java, as pilot areas for SRP implementation. Both primary and secondary data were used. Primary data were collected through field surveys, in-depth interviews using structured questionnaires, and focus group discussions (FGDs) with SRP-adopting farmers and relevant stakeholders. Secondary data were obtained from literature reviews and official sources, including Statistics Indonesia (BPS), the National Food Agency (BAPANAS), the Ministry of Agriculture, and previous studies on low-carbon sustainable rice development. Data collection methods included literature review, field surveys (to analyze perceptions of opportunities, challenges, and required incentives), and in-depth interviews (to explore opportunities and constraints in positioning LCR rice as specialty rice).

Research Methods. The analytical methods applied include: (i) Qualitative descriptive analysis to identify specialty rice characteristics and formulate strategic recommendations; (ii) Internal Factor Evaluation (IFE) and External Factor Evaluation (EFE) matrix analyses to assess strengths, weaknesses, opportunities, and threats in developing low-carbon sustainable rice as specialty rice; (iii) One-tailed tests to examine the perceived impact of government incentives on sustainable farming performance (improved, worsened, or unchanged); and (iv) Analytical Hierarchy Process (AHP) to determine strategic priorities based on actor and factor criteria validated by key experts.

Key Findings

Characteristics of Specialty Rice and Policy Framework. Consumer purchasing decisions are influenced by product uniqueness, including rice attributes categorized into appearance or physical characteristics (taste, color, price), functional attributes (carbohydrate source, low calorie, specific nutritional content), and benefits (health and convenience). Processing stages from cultivation to post-harvest affect market prices. Existing rice markets recognize various rice types with differentiated prices, such as aromatic rice, texture-based rice, functional rice, colored rice, organic rice, and conventional rice. In Indonesia, specialty rice is regulated under National Food Agency Regulation No. 2 of 2023.

Justification of SRP Rice as Specialty Rice and Market Development. Low-carbon sustainable rice produced under SRP standards exceeds organic rice requirements by incorporating comprehensive sustainability dimensions aimed at improving farmer welfare, ensuring food security, and reducing GHG emissions. This multidimensional uniqueness supports its classification as specialty rice, although a dedicated SRP certification—distinct from organic rice standards—is required. Market incentives, particularly premium pricing, are essential to motivate farmers. Previous studies indicate growing market demand for sustainable rice, driven by increasing consumer awareness—especially among millennials and older consumers—who are willing to pay a premium for healthy, environmentally responsible products that support farmer welfare.

Respondent Characteristics. Survey results show that most SRP farmers are aged 45–54 years and operate small landholdings (<0.5 ha). Production levels are generally below 3 tons, with relatively low productivity during early SRP adoption stages. Labor use is dominated by hired (non-family) labor.

Perceptions of Financing Access. Initial financing for SRP farming relies primarily on self-financing (90.9%), with most farmers never accessing formal financial institutions. Key barriers include lack of collateral, lengthy bureaucratic processes, and perceptions that KUR interest rates (6%) and monthly installments are burdensome.

Perceived Impact of Incentives. Farmers perceive SRP adoption as having positive impacts, with priority incentives including premium pricing and support for biological inputs (fertilizers, seeds, etc.). In Boyolali, all performance indicators showed significant improvement post-SRP adoption, with the highest perceived impacts on productivity and technology adoption. In Klaten, most impacts were significant, except for green investment and sustainable practice adoption, likely due to continued allowance of chemical fertilizers and the absence of dedicated SRP certification.

Opportunities and Challenges in SRP Development. Based on the internal factor analysis, the main strengths of SRP farmers in Boyolali Regency include greater cost efficiency, higher productivity compared to conventional farming, and products that are beneficial for health. However, key weaknesses include limited support from farmer groups (Poktan), the lack of standardized operating procedures (SOPs) for sustainable rice farming, and limited seed self-sufficiency. In Klaten Regency, the main strengths of SRP development relate to cost efficiency, self-sufficiency in organic fertilizers, and independence in the use of biological pesticides. Identified weaknesses include the absence of standardized SOPs for sustainable rice farming, limited support from farmer groups, and farmers' willingness to transition to SRP practices. Consequently, the critical weaknesses that need to be addressed in both regencies are inadequate farmer group support and the lack of standardized SOPs.

From an external perspective, several opportunities and challenges for SRP development were identified. In Boyolali Regency, opportunities include higher prices compared to conventional rice, support from village and local governments, and growing domestic consumer demand. Meanwhile, challenges include low stakeholder perceptions of SRP farmers' welfare, climate change impacts, limited access to financing, and high certification costs with short validity periods. In Klaten Regency, opportunities for SRP development include the availability of abundant raw materials for organic fertilizers and biological pesticides, increasing public awareness of environmental protection, and the presence of local NGOs and multi-stakeholder forums (MSFs). The challenges faced in Klaten are similar to those in Boyolali, particularly high and short-term certification costs, climate change risks, limited financing support, and low stakeholder perceptions of SRP farmers' welfare.

Policy Recommendations and Strategic Directions. Based on the Analytical Hierarchy Process (AHP) analysis, priority actors, supporting factors, and incentive schemes for the development of low-carbon sustainable rice were identified. The Central Government ranks as the highest-priority actor due to its authority in national policymaking, regulation, and budget allocation. The second priority actor is Local Government, which plays a critical role in local implementation, technical support, and inter-agency coordination. Key supporting factors for successful SRP development include multi-stakeholder support—encompassing collaboration among central and local governments, standard-setting bodies, universities, and NGOs—as the top priority, followed by growing consumer demand and public awareness of SRP products, which help create markets and motivate farmers.

Three priority policy incentive schemes are recommended based on the AHP analysis:

1. Specialty Rice Price Incentive Scheme
   This scheme provides direct economic motivation for farmers to adopt SRP practices by compensating for the additional efforts required to implement environmentally friendly farming. Premium pricing reflects the added value of sustainability and contributes to improved farmer welfare. This finding aligns with evidence of consumers' willingness to pay more for sustainable rice.
2. Special Allocation Fund (SAF) Incentive Scheme
   SAF serves as a fiscal policy instrument to strengthen central government support for local governments. These funds should be allocated to strategic activities such as the provision of environmentally friendly infrastructure, farmer training, and, most importantly, facilitation of certification costs for sustainable rice, which currently pose a major barrier for smallholder farmers.
3. SRP Innovation Support Scheme
   Innovation support includes assistance for climate-resilient rice varieties, biological fertilizer and pesticide inputs, and other relevant agricultural innovations to enhance the sustainability and resilience of SRP implementation.

CHAPTER 1
INTRODUCTION

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1.1 Background

Indonesia's rice farming sector is not only one of the sectors affected by climate change but also plays a role as a contributor to the increase in global carbon emissions. Efforts to reduce these emissions can be undertaken through the adoption of low-carbon rice farming practices, one of which is the Sustainable Rice Platform (SRP) approach. This method has been proven to reduce greenhouse gas emissions generated by conventional rice farming practices. The SRP method applies principles that gradually change farmers' cultivation practices. Its implementation takes into account overall impacts, including social, economic, and environmental dimensions. SRP is a platform that promotes the transformation of the national rice system by applying sustainable principles across all stages of production, processing, distribution, consumption, and product waste management as part of sustainable development efforts. Essentially, the utilization of the Sustainable Rice Platform (SRP) is expected to ensure fairness for all actors in the rice sector, maintain economic and environmental sustainability, promote gender equality, respect human rights, value culture and local wisdom, and give due attention to youth and children.

In Indonesia, the government has begun to place special emphasis on the impacts of climate change by advancing a low-carbon agricultural development agenda, including the adoption of sustainable food cultivation practices. This commitment is reflected in the National Long-Term Development Plan (RPJPN) 2025–2045. Sustainable Rice Farming also supports the achievement of food self-sufficiency targets through the National Priority Program for the Development of Sustainable Agricultural Production Systems (PN 2) under the National Medium-Term Development Plan (RPJMN) 2025–2029 (see Figure 1).

Figure 1. Sustainable Rice Farming as Part of the Priority Activities for the Development of Sustainable Agricultural Cultivation Systems in the 2025–2029 National Medium-Term Development Plan (RPJMN)
Source: Kementerian PPN/Bappenas (2025)

Based on Priority Activity (PA) 18, the Development of Sustainable Agricultural Production Systems includes an indicator measuring the compliance index with standards and regulations for sustainable agricultural practices. Accordingly, sustainable rice farming is directed toward compliance with standards and regulations governing sustainable agricultural cultivation practices.

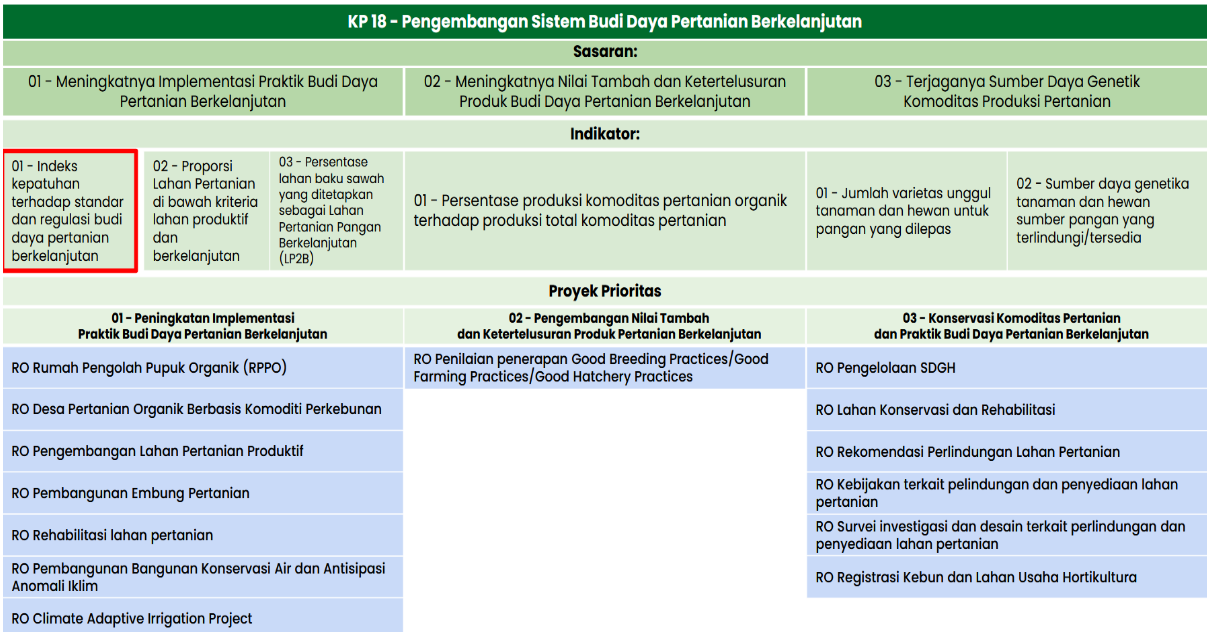

Figure 2. Targets, Indicators, and Priority Projects of KP 18
Source: Kementerian PPN/Bappenas (2025)

Specifically, low-carbon sustainable rice produced using the Sustainable Rice Platform (SRP) method also requires assurance in the form of certification or sustainability claims that are aligned with the results of farmers' rice cultivation standards, as well as rice traceability that benefits consumers by ensuring that the rice products they consume comply with the sustainability claims stated on the product. This requirement is essential given the significant business potential, as trade in low-carbon sustainable rice is projected to increase in line with rising demand for products whose production processes take sustainability as well as social and economic aspects into account.

Although rice is a staple food commodity with consistently high demand, farmers—as the main actors in rice production—continue to face challenges in ensuring adequate supply. Several constraints faced by farmers are primarily related to limited land ownership, access to markets, and price fluctuations. Based on a research report by KRKP (2024), the majority of rice farmers in major production centers in Central Java and East Java are smallholder farmers with landholdings of less than 0.5 ha, accounting for 63% of farmers. With such limited land size, it is difficult for rice farmers to achieve economies of scale, which in turn affects their income levels and overall welfare. Other challenges faced by farmers include the risk of crop failure due to climate change impacts, floods, droughts, pest and disease outbreaks, as well as difficulties in accessing productive resources. This situation indicates that farmers still have limited control over productive resources essential to supporting their farming activities, making this a critical concern for all stakeholders.

Several studies indicate that producing environmentally friendly products or services that contribute to the reduction of global carbon emissions requires substantial investment to introduce new innovations and technologies, including the use of low-emission energy sources. Meanwhile, farmers operating on landholdings below 0.5 ha fall into the micro, small, and medium enterprise (MSME) category and face persistent constraints related to limited capital and restricted access to financing. At an immature stage of the product life cycle, product prices also tend to be less competitive, further underscoring the need for facilitation to improve MSMEs' access to financing. For example, the adoption of environmentally friendly practices by MSMEs in the Philippines requires an investment in green equipment of approximately IDR 62.5 million. However, over the long term, such green practices can result in cost savings of up to IDR 146.8 million (Bank Indonesia, 2021). Financial constraints hindering MSMEs from adopting environmentally friendly practices have also been identified by Lee (2009), who highlighted internal barriers such as low awareness, limited expertise, skills, financial capacity, and human resources needed to implement changes required for sustainability. In addition, the scale and characteristics of MSMEs themselves present challenges to sustainable practices. Financing constraints make it difficult for MSMEs to undertake green innovation. This is consistent with the findings of Creech et al. (2014), which show that MSMEs face obstacles in contributing to environmentally friendly economic development due to limited access to research and technical partner support.

From a price incentive perspective, there is currently no significant price differentiation between conventional rice and SRP rice. Some rice products are differentiated due to unique characteristics, such as soft texture, fragrant aroma, environmentally friendly cultivation methods (organic), or consideration of social, economic, and environmental aspects, as in the case of SRP rice. According to Engel et al. (1994), product uniqueness can easily attract consumer or customer attention. Product uniqueness can be observed through the attributes inherent in a product, including rice products. Thus, rice product attributes function as evaluative criteria in consumer decision-making, depending on the type and purpose of the rice product. Rice product attributes can be classified into three types: features, functions, and benefits.

Feature attributes may include size, shape, product characteristics (taste, color, price), components or parts, raw materials, manufacturing processes, services, appearance, price structure, composition, trademarks, and branding. Functional attributes may include being a source of carbohydrates or protein, low-calorie properties for people with diabetes, or specific nutritional content. Benefit attributes include usability, sensory pleasure, and non-material benefits such as health, convenience, and comfort. In rice trade, various types of rice with different price levels are commonly recognized, including: (a) aromatic rice, which produces fragrant cooked rice such as Pandan Wangi, Cianjur Rice, Jasmine Rice, and Hom Mali Rice; (b) rice with different textures, such as non-sticky (pera) rice (e.g., Siam Unus Rice and Barek Solok Rice) and soft or sticky (pulen) rice (e.g., Rojolele Rice, Cianjur Rice, Japonica Rice, and glutinous rice); (c) functional rice such as parboiled rice, commonly consumed by individuals with Diabetes Mellitus (DM); (d) colored rice, such as red rice and black rice; (e) organic rice, which is cultivated using organic systems without synthetic inorganic inputs; and (f) conventional rice, which is commonly traded in markets with prices determined by quality (Hermanto and Saptana, 2017).

SRP rice differs from organic rice. Organic rice emphasizes the use of natural methods without synthetic chemical inputs, whereas SRP rice adopts a broader approach that encompasses sustainable practices covering social, economic, and environmental aspects, including reduced pesticide use and water-efficient farming practices. The cultivation of SRP rice also faces several challenges, including farmers' reluctance to transition their business models to SRP rice, the need for investment and financing to support the transition, limited farmer knowledge, and, importantly, pricing issues. Therefore, both government and market mechanisms need to provide incentives to ensure the availability of SRP rice supply.

In addition to financing, market incentives in the form of competitive pricing are essential to motivate farmers to cultivate SRP rice. This raises the question of whether SRP rice can be classified as specialty rice. According to Regulation of the National Food Agency of the Republic of Indonesia No. 2 of 2023 on rice quality and labeling requirements, specialty rice includes glutinous rice, red rice, black rice, local variety rice, fortified rice, organic rice, geographical indication rice, rice with health claims, and certain rice types that cannot be produced domestically.

Based on the above discussion, in-depth research is required to analyze low-carbon sustainable rice as a specialty rice category. The development of a comprehensive research conceptual framework will be an important step in producing academic manuscripts and policy papers that can serve as a basis for advocacy to achieve broad recognition of low-carbon sustainable rice as a specialty rice category at international, national, and local levels. Ultimately, this effort is expected to contribute to advancing the rice agriculture sector toward a more inclusive and sustainable future for all relevant stakeholders.

1.2 Objectives

1.2.1 General Objective

This study aims to promote the development of low-carbon sustainable rice based on Sustainable Rice Platform (SRP) cultivation standards as a pathway to strengthening farmers' household capacity and economic resilience.

1.2.2 Spesific Objectives

1. To identify the characteristics, policy framework, and development of specialty rice in Indonesia.
2. To explore the opportunities and challenges of positioning low-carbon sustainable rice as a specialty rice category regulated under government policy.
3. To formulate recommendations and strategies to promote low-carbon sustainable rice as a specialty rice.

1.3 Output

The expected output of this study is a research report and a set of strategic recommendations for positioning low-carbon sustainable rice as a specialty rice.

1.4 Key Benefits of the Study

The findings of this study are expected to strengthen the position of low-carbon sustainable rice as a specialty rice. Consequently, the market reach of sustainable rice is expected to expand, leading to increased farmer income.

CHAPTER 2
LITERATURE REVIEW

CHAPTER 2
LITERATURE REVIEW

2.1 Low Carbon Rice Farming

Rice production is fundamental to meeting human needs for food and nutrition. At the same time, however, rice production also plays a significant role in anthropogenic climate change (FAO, 2020). Greenhouse gas (GHG) emissions arise from rice cultivation activities both directly and indirectly. Direct emissions originate from fossil fuel use and processes during the cultivation phase, particularly the generation of methane and nitrous oxide as the main GHGs (Chakraborty et al., 2017; Wang et al., 2018; Nikolaisen et al., 2023). In addition, rice cultivation relies heavily on large amounts of non-energy inputs, such as chemical fertilizers, whose production processes also generate indirect GHG emissions (Menegat et al., 2022). Although increasing agricultural production is essential to ensure food security, addressing emissions from rice production is equally important given its tangible contribution to global climate change, thereby necessitating a balance between its positive and negative impacts (Long & Stähler, 2012).

In contrast to conventional cultivation practices that rely on chemical fertilizers and pesticides to maximize rice yields, low-carbon rice (LCR) refers to rice cultivation systems that achieve high yields with low emissions and high efficiency (Cao & Li, 2014; Chen et al., 2021). Conventional rice farming practices currently adopted by many Indonesian farmers continue to depend on inputs that contribute to GHG emissions. Such practices are also characterized by high labor costs and high agricultural input costs. Consequently, the high carbon emissions generated by conventional rice cultivation exert environmental pressures that are not conducive to sustainable agricultural development (Poulton et al., 2016; Liang et al., 2021; Gangopadhyay et al., 2022; Wu et al., 2022). Low-carbon rice cultivation can be achieved by reducing agricultural input use, lowering carbon emissions, promoting resource recycling, and enhancing carbon sequestration. These practices include soil-specific fertilization, the application of organic fertilizers, crop rotation, the return of rice straw to fields, conservation tillage techniques, ecological farming models, and other sustainable rice farming techniques (Figure 3)

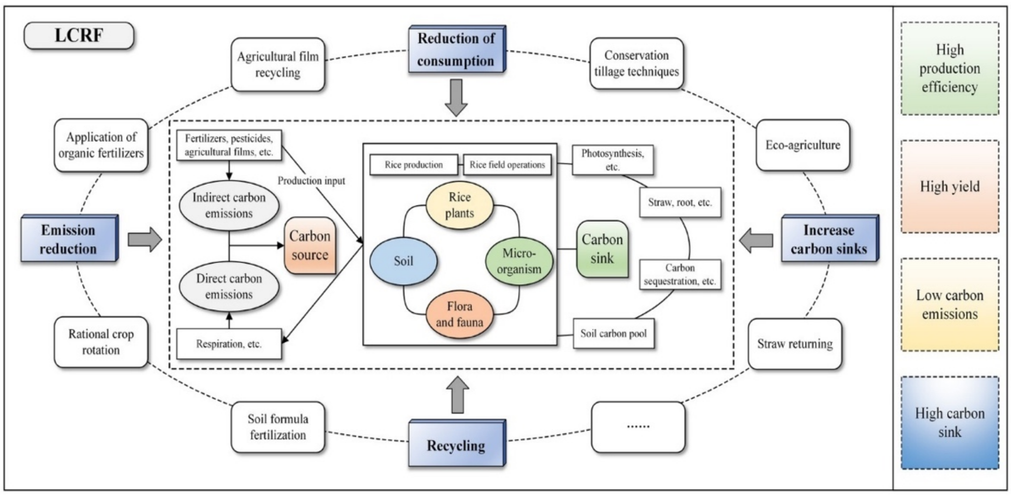

Figure 3. Theoretical Analysis of Low-Carbon Rice Farming Technology (LCRF)
Source: Huang et al. (2023)

Fertilization practices can also be optimized by determining fertilizer ratios based on the specific nutrient requirements of rice cultivation. By controlling the amount of nitrogen applied through fertilizers, nitrous oxide (N_2O) emissions can be reduced, which ultimately improves soil quality and contributes to higher yields and lower emissions (Zhang et al., 2014, 2016; Tao et al., 2019; Li & Ju, 2020). Furthermore, the application of organic fertilizers can improve soil fertility and enhance productivity. At the same time, organic fertilizer use can inhibit nitrification and the mineralization of organic nitrogen in soils, thereby reducing soil N_2O emissions and contributing to soil carbon sequestration and overall emission reductions (Maillard & Angers, 2014; Jiang et al., 2018; Lin et al., 2019; Tang et al., 2022). Crop rotation can also improve soil structure and mitigate the adverse impacts of continuous rice cultivation by enhancing soil fertility and farmland quality, thereby increasing food production (Cha-un et al., 2017; Sun et al., 2019; Liu et al., 2021b; Yang et al., 2022).

Rice straw is a renewable resource with multiple uses and represents a significant carbon sink in rice-based systems. The return of rice straw to fields helps reduce the use of chemical fertilizers, improve soil fertility in paddy ecosystems, increase soil organic carbon content, enhance soil quality, and increase rice yields (Liu et al., 2014; Chen et al., 2017; Zhang et al., 2021). Environmentally friendly farming models enhance the economic, ecological, and social benefits of rice farming through sustainable cycles that integrate other components, such as rice–duck and rice–fish systems, into the cultivation process (Zheng et al., 2019). In such integrated farming systems, methane (CH_4) can be reduced through animal activity, thereby lowering CH_4 emissions, improving soil quality, and ensuring stable rice production (Ying et al., 2014; Nayak et al., 2015; Wan et al., 2019; Sun et al., 2021).

2.2 Sustainable Rice Platform (SRP)

In 2015, the Sustainable Rice Platform (SRP) was first launched as the world’s first Standard for Sustainable Rice Cultivation, together with a set of Performance Indicators designed to enable objective benchmarking and comparison of the sustainability of rice cultivation systems worldwide. Together, these two tools serve as an operational definition of sustainable rice production.

To facilitate the monitoring of progress and impacts, SRP provides policymakers and actors along the global rice value chain with a range of proven instruments to promote the widespread adoption of sustainable practices in the rice sector, including the following three closely interrelated instruments:

1. SRP Standard for Sustainable Rice Cultivation
   The SRP Standard for Sustainable Rice Cultivation provides a normative framework that can serve as a basis for supporting sustainability performance claims along the rice value chain. Throughout its development and revision processes, stakeholders emphasized the importance of keeping the standard concise and inclusive, enabling its broad application by practitioners to promote the adoption of climate-resilient sustainable best practices among smallholder farmers. The SRP released Version 2.0 of the SRP Standard in January 2019, comprising 41 requirements across eight main themes. Version 2.1 was launched in January 2020.

2. SRP Performance Indicators for Sustainable Rice Cultivation
   The SRP Performance Indicators for Sustainable Rice Cultivation provide quantitative measurement and assessment of the sustainability impacts resulting from the adoption of recommended practices at the field level. These indicators enable implementing partners and researchers to collect benchmark data and to consistently communicate

field-level results using 12 core indicators. Version 1.0 of the SRP Performance Indicators was released in April 2015. The SRP reviewed and revised the indicators in 2018 and subsequently released Version 2.0 in January 2019, followed by Version 2.1 in January 2020.

3. SRP Assurance Scheme
   The SRP Assurance Scheme enables actors along the rice value chain to demonstrate compliance with the SRP Standard, as well as the impacts measured through the SRP Performance Indicators. The scheme offers three levels of assurance to accommodate different production models and includes farmer registration in the central SRP database, self-assessment, and farmer group verification through an internal control system. External verification and accredited certification are available as additional options. A globally recognized assurance service provider (GLOBALG.A.P.) oversees and manages the implementation of the scheme. The SRP Assurance Scheme was launched in 2019 following an intensive development process conducted within the SRP Working Groups on Farmer Support, Performance Measurement, and Assurance.

This standard applies to all processes at the farm level in rice production, including post-harvest activities that are under the control of farmers. It can be applied by individual farmers, small-scale farmer groups, as well as large-scale farms, with a focus on ensuring relevance, practicality, and impact—particularly for smallholder farmers in developing countries. When implemented by smallholder farmer groups, the standard requires the establishment of an Internal Management System (IMS) to support farmers in applying the standard, measuring performance, and identifying actions for continuous improvement. The standard comprises 41 indicators organized into eight thematic areas, as illustrated in Figure 4.

Figure 4. Themes and Requirements in the SRP Standard for Sustainable Rice Cultivation
Source: UNEP (2023)

This standard allows for phased implementation to encourage and recognize progress toward full compliance. Each requirement includes multiple levels of compliance, enabling the standard to function both as an assessment tool and as a stepwise improvement mechanism to promote farmer adoption. These differentiated compliance levels acknowledge that improving farmer compliance takes time and can be a challenging process. The presence of multiple compliance levels helps guide continuous improvement and provides recognition for incremental progress through higher scores. The relative weighting by theme is presented in Figure 5, indicating that the highest weights within the SRP Standard are assigned to labor rights (16%) and harvest and post-harvest practices (16%).

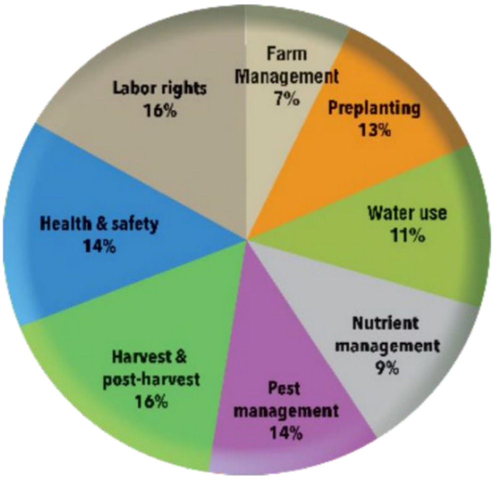

Figure 5. Weighting of SRP Standards by Theme
Sumber: UNEP (2023)

The SRP Standard enables the evaluation of farmers based on the level of implementation of sustainable rice cultivation practices they apply. This evaluation serves two primary purposes, namely:

1. The SRP Standard provides a framework that enables users to claim that their rice is sustainably cultivated or sourced. Such claims must be based on a high and verifiable level of overall compliance. SRP has established minimum scores and mandatory compliance levels (thresholds) that must be achieved for each requirement in order to substantiate claims of sustainably produced rice.

2. SRP recognizes that many farmers are already in the process of transitioning toward sustainable rice cultivation and that improvements in sustainability performance occur gradually. Therefore, SRP has established minimum scores and a set of mandatory compliance levels (thresholds) that must be achieved in order to meet claims of sustainable rice cultivation.

2.3 Overview of the Rice Sector and Rice Policy in Indonesia

Food is a basic human need that must be fulfilled. Law No. 18 of 2012 on Food stipulates that food provision is the responsibility of the state and must be implemented based on the principles of food sovereignty, self-reliance, and food security, in order to create healthy, active, and productive human resources. Food provision must take into account the three pillars of food security, namely availability, distribution, accessibility, and utilization. Within the utilization pillar, it is emphasized that food made available to the public must be fit for consumption by ensuring adequate quantity, balanced nutrition, quality, and safety. To guarantee food safety and quality, supporting instruments are required, one of which is regulation in the form of policies and standards.

Rice is one of Indonesia's main food commodities and is consumed by nearly the entire population. The high level of rice consumption makes it a strategic food commodity and a key focus of government policy, particularly in ensuring supply stability, price control, food safety, and quality. Under Presidential Regulation No. 66 of 2021, the National Food Agency is mandated to formulate standards for the safety and quality of fresh food, including rice. As a follow-up to this mandate, National Food Agency Regulation No. 2 of 2023 on Rice Quality Requirements and Labeling was issued, replacing previous regulations. This regulation stipulates provisions on general rice requirements, quality classification and grading, as well as labeling requirements for rice products circulating in the market.

According to BAPANAS (2023), rice produced domestically or imported for distribution must comply with minimum requirements, including:

1. Free from pests, as determined through visual inspection.
2. Free from musty, sour, or other foreign odors, as determined through organoleptic testing.
3. Food safety requirements, including:
   - Maximum residue limits (MRLs). The maximum residue limits referred to are pesticide residues in accordance with prevailing laws and regulations governing permissible pesticide residue levels.
   - Use of food additives. Food additives are substances added to food to affect its characteristics or form. Food additives may be used provided they are not prohibited under the applicable regulations governing food additive use.
   - Maximum contamination limits. Contaminants in rice include heavy metal contamination, microbial contamination, and mycotoxin contamination, with maximum permissible levels in accordance with prevailing regulations on contamination limits.
   - Application of good handling practices. Compliance with good handling practices for rice may be demonstrated through a Certificate of Good Handling Practices for Fresh Food of Plant Origin (SPPBPSAT) or through a hygiene and sanitation certificate issued prior to the application for a business license (PD, PL, or PDUK), in accordance with applicable business licensing regulations.

For rice classified as medium and premium quality, whose Retail Price Ceiling (Harga Eceran Tertinggi/HET) is regulated under National Food Agency regulations, the HET must be clearly stated on the product packaging. The determination of the HET is stipulated in National Food Agency Regulation No. 5 of 2024, as follows:

Table 1. Maximum Retail Prices of Medium and Premium Rice in 2024

No	Region	Maximum Retail Price of Medium Rice (IDR/kg)	Maximum Retail Price of Premium Rice (IDR/kg)
1.	Jawa, Lampung, dan Sumatera Selatan	12,500	14,900
2.	Aceh, Sumatera Utara, Sumatera Barat, Bengkulu, Riau, Kepulauan Riau, Jambi, dan Kepulauan Bangka Belitung	13,100	15,400
3.	Bali dan Nusa Tenggara Barat	12,500	14,900
4.	Nusa Tenggara Timur	13,100	15,400

No	Region	Maximum Retail Price of Medium Rice (IDR/kg)	Maximum Retail Price of Premium Rice (IDR/kg)
5.	Sulawesi	12,500	14,900
6.	Kalimantan	13,100	15,400
7.	Maluku	13,500	15,800
8.	Papua	13,500	15,800

Source: National Food Agency of Indonesia (2024)

Sustainable agricultural development in Indonesia is regulated under Law No. 22 of 2019 on the Sustainable Agricultural Cultivation System. This regulation defines the system as an effort to manage biological natural resources in order to produce agricultural commodities that meet human needs optimally and continuously, while maintaining environmental sustainability. The concept of sustainable agriculture is an integral part of sustainable development, which is based on three main pillars: environmental, economic, and social dimensions. These three pillars are interrelated and mutually influential, making balance among them essential. Therefore, a development process, including in the agricultural sector, cannot be considered sustainable if one of these dimensions lags behind or exhibits a lower level of sustainability than the others (Rivai, 2011). In addition, two further dimensions—technological and institutional dimensions—complement these core pillars in supporting sustainable agricultural cultivation.

2.4 Previous Studies

Several studies on low-carbon rice have been conducted, including research in Boyolali Regency, Indonesia, carried out by the People's Coalition for Food Sovereignty (KRKP) (2024). Key outcomes of the Low Carbon Rice (LCR) Project interventions in Boyolali Regency include: (1) Support for rice-specific agriculture and the implementation of a Regent Regulation on Farmer Protection and Empowerment (2023), through which the Boyolali local government financed Rice Farming Insurance (AUTP) for 11,922 farmers, covering a cultivated area of 4,000 hectares across 14 rice-producing sub-districts; (2) From a regulatory perspective, the LCR Program initiated and encouraged the Boyolali local government to enact a Regent Regulation on Farmer Protection and Empowerment, particularly concerning mutually beneficial partnerships between farmers, small-scale rice mills, and private actors; (3) From the rice milling perspective, restructuring of Rice Milling Units (RMUs) has begun, including equipment revitalization by transitioning from diesel fuel to electricity, up to the stage of registration with the national electricity provider (PLN).

Adetama et al. (2021) argue that rice cultivation development has largely followed a business-as-usual (BAU) scenario, measured primarily by economic growth indicators without adequately accounting for environmental impacts. Problems arise when imbalances emerge between economic dimensions and environmental impacts, particularly greenhouse gas (GHG) emissions. Using Multidimensional Scaling (MDS) analysis, the study found that farmer terms of trade, rice consumption, rice production, illiteracy rates, population distribution, poverty rates, land expansion for rice fields, rainfall, temperature, information technology, water pumps, rice milling units, organic fertilizer use, low-carbon regulations, and GHG emissions are sensitive attributes influencing sustainable national development. Removing any of these attributes would affect overall sustainability status. The study concludes that existing BAU-based development with low-carbon considerations remains predominantly at the "less sustainable" to "moderately sustainable" levels across provinces, indicating the need for government-led transformation policies toward low-carbon agricultural development that support both agricultural productivity and national sustainability goals.

He and He (2023), in their study conducted in China, recommend several measures to promote low-carbon agricultural technologies and reduce methane emissions from paddy fields. First, accelerating the promotion of new cultivation methods is essential. Tillage practices under the System of Rice Intensification (SRI) should be widely disseminated. Techniques such as alternate wetting and drying (AWD) irrigation allow paddy soils to periodically dry and aerate, thereby reducing methane emissions. Second, farmer participation should be enhanced through increased investment in research and development (R&D) and the promotion of high-quality, low-carbon rice varieties to improve yields, quality, and production efficiency. Third, large-scale demonstrations of low-carbon rice cultivation should be encouraged. To support this, land tenure transfer and land trusteeship systems in China need to be strengthened to facilitate smoother land management transitions.

In Vietnam, local government programs—particularly in the Mekong Delta—that align with SRP Standard requirements have resulted in reduced use of agricultural chemicals and lower production costs (Connor et al., 2022). Low GHG emissions in rice production can be achieved through reduced application of chemical fertilizers and pesticides, with emission reductions of up to 50–60% achievable by complying with the eight thematic areas of the SRP Standard (Connor et al., 2022; Wassmann et al., 2000). As a platform, the Sustainable Rice Platform (SRP) promotes resource efficiency and sustainability in the global rice sector through a multi-level approach, ranging from increased adoption of best sustainable practices at the farm level to the formation of global alliances involving public and private stakeholders that link research, policy, production, trade, and consumption (Mungkung et al., 2022). Additional benefits include reduced input costs through fertilizer reduction (up to 100 kg/ha), improved water-use efficiency (saving approximately 13.9% compared to conventional farming), and the potential for premium price increases of approximately +500 VND/kg.

A recent study in Vietnam by Chung and The (2025) focuses on the application of the Sustainable Rice Platform (SRP), which comprises 12 sustainability impact indicators linked to the Sustainable Development Goals (SDGs) and serves as a best-practice framework to support sustainable rice production. The study provides empirical evidence on the benefits of SRP adoption and explores factors influencing its implementation. Surveys and focus group discussions (FGDs) were conducted with 243 rice farmers in Dong Thap Province, and data were analyzed using t-tests and logistic regression. The results indicate that farmers perceive positive benefits from SRP adoption, including reduced input costs and increased income. Regression analysis reveals that socioeconomic, cognitive, and technical farming factors significantly influence SRP adoption. From a socioeconomic perspective, both age and education level have a positive and statistically significant effect on SRP adoption. Older farmers are more likely to adopt SRP, possibly because they have participated in SRP training and possess better knowledge of its application. Each additional year of age increases the probability of SRP adoption by 2.3%, holding other variables constant. Education also plays a crucial role; each additional year of schooling increases the probability of SRP adoption by approximately 3%, consistent with findings by Dung and Tuan (2024).

Interestingly, farmers' experience can have either a positive or a negative influence on the adoption of new technologies (Mutyasira et al., 2018; Dung & Tuan, 2024; Mariano et al., 2012). In this study, experience was found to have a negative effect on the adoption of the Sustainable Rice Platform (SRP) by rice farmers. This is because many rice farmers come from families that have long practiced traditional rice production; therefore, they may be more risk-averse and less motivated to adopt SRP practices. Furthermore, this finding demonstrates that farmers with extensive experience in rice production are not necessarily more likely to adopt new agricultural technologies, thus providing relevant insights for policymakers in designing agricultural policies to expand SRP adoption in the future. This result contradicts the findings of Dung and Tuan (2024).

Moreover, the study also examined other variables related to the constraints faced by farmers in adopting SRP. The findings of Chung and The (2025) indicate that rice farmers face several barriers in adopting SRP, including a lack of knowledge, low paddy prices, low SRP rice prices, farmers' inability to sell SRP rice, high input costs, and lack of access to credit, all of which influence farmers' decisions to adopt SRP. The regression results show that lack of knowledge, low paddy prices, low SRP rice prices, and farmers' inability to sell SRP rice have a negative and statistically significant effect on SRP adoption. This implies that when farmers encounter these constraints, their likelihood of adopting SRP decreases.

In addition, input costs—particularly for fertilizers, pesticides, and fungicides—play an important role in rice production. Surprisingly, the study found that input costs have a positive effect on SRP adoption. A 1% increase in input costs increases the probability of SRP adoption by 19.5%. This suggests that when farmers incur higher production costs, they tend to seek higher selling prices to cover their investment costs. SRP rice can help them achieve this objective. This finding is consistent with previous studies by Alam et al. (2024) and Tran et al. (2020), which indicate that farmers are more likely to adopt new technologies when they face challenges related to rising input costs. One of the policy recommendations proposed by this study is the need for training, provision of market information, and access to credit for rice farmers adopting SRP.

Table 2. Chung and The (2025) Study: Regression Results on Factors Influencing Farmers' Adoption of SRP in Vietnam

	Coef.	*Robudt Std. Err.*	*P-value*	*Dy/dx*	*Robust Std. Err.*	*P-value*
Socioeconomic Factors						
Age	0.568***	0.165	0.001	0.023***	0.005	0.000
Experience	-0.32***	0.146	0.028	-0.013**	0.005	0.011
Education of farmers	0.749***	0.186	0.000	0.030***	0.005	0.000
Household size	-0.478	0.378	0.206	-0.019	0.015	0.200
Farming Techniques						
Rice land	0.47	0.393	0.231	0.019	0.016	0.240
Duration land preparation	-0.01	0.073	0.889	-0.000	0.003	0.889
Pre-germinated blower	-0.886***	2.307	0.000	-0.353***	0.072	0.000
Pre-germinated drum	-0.598***	2.082	0.000	-0.302***	0.064	0.000
Flooding time	0.391***	0.133	0.003	0.016***	0.005	0.003
Following market price	5.526**	2.236	0.013	0.219***	0.069	0.001
Premium	-0.007**	0.003	0.017	-0.000***	0.000	0.012
Cooperative membership	15.771***	3.943	0.000	0.626***	0.109	0.000
incentive	-0.933***	1.712	0.001	-0.236***	0.051	0.000
Cognitive Factors						
CC perception of rice farmers	5.177***	1.792	0.004	0.206***	0.058	0.000
SRP perception	3.528**	1.377	0.010	0.140***	0.044	0.001
CC Impacts	-4.733***	1.747	0.007	-0.188***	0.060	0.002
Saving water perception	5.786***	1.461	0.000	0.230***	0.045	0.000
Institutional Factors						
Loan	2.501*	1.332	0.060	0.099*	0.046	0.032
SRP training	3.657***	1.342	0.006	0.145**	0.052	0.005
Poor equality rice seed	-6.677***	2.207	0.002	-0.265***	0.069	0.000
Constraint Factors						
Lack of credit	0.669	1.06	0.528	0.027	0.042	0.527
Lack of knowledge	-4.369***	1.497	0.004	-0.173***	0.057	0.002
Low price of rice (in general)	2.382*	1.367	0.081	0.095**	0.047	0.046
Low SRP rice price	-16.388***	3.908	0.000	-0.651***	0.105	0.000
Cannot sell SRP rice	-4.631**	2.13	0.030	-0.184**	0.075	0.014
Input price	4.911***	1.858	0.008	0.195***	0.053	0.000
Constant	-35.388***	9.909	0.000			
Mean dependent var	0.695					
SD dependent var	0.461					
Pseudo r-squared	0.801					
Number of observations	243					
Chi-square	50.575					
Prob > chi2	0.003					
Akaike crit. (AIC)	113.386					
Bayesian crit. (BIC)	207.699					
****p<.01,**p<.05,*p<.1*						

Source: Author Calculation (2022)

CHAPTER 3
RESEARCH METHODOLOGY

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RESEARCH METHODOLOGY

3.1 Location, Type, and Data Sources

The research location is one of the provinces designated as an SRP pilot area, namely Central Java, specifically Boyolali and Klaten Regencies. The data used in this study consist of primary and secondary data. Primary data were collected through in-depth interviews using questionnaires with farmers who have implemented SRP in the province, as well as through Focus Group Discussions (FGDs).

Secondary data were obtained through literature studies conducted via internet searches and from relevant institutions such as the Coalition of the People for Food Sovereignty (KRKP), Bank Indonesia, Statistics Indonesia (BPS), the National Food Agency (BAPANAS), the National Standardization Agency (BSN), and the Ministry of Agriculture. In addition, secondary data were also sourced from previous studies related to the development of sustainable low-carbon rice.

3.2 Data Collection Techniques

The techniques for collecting primary and secondary data in this study employ the following approaches:

3.2.1 Study Literature

A review of previous research related to the characteristics of sustainable low-carbon rice, the implementation of SRP, special rice policies, and their development in Indonesia.

3.2.2 Field Survey

Field surveys were conducted with farmers in Boyolali and Klaten Regencies who have implemented SRP. This activity aims to identify farmers' characteristics, farming practices, and the implementation of SRP. Perception analysis was also used to identify opportunities and challenges, as well as the needs and incentives required to ensure the sustainable adoption of SRP by farmers.

3.2.3 In-depth Interview

Structured questionnaires were used in the in-depth interview process, which was conducted individually. These in-depth interviews were carried out to obtain information on the opportunities and challenges of positioning sustainable low-carbon rice as special rice that can be regulated through government policies.

The relationship between the research objectives, the data, and the analytical methods can be seen in Table 3.

Table 3. Linkages between Research Objectives, Data, and Analytical Methods

Objectives	Data	Data Sources	Data Collection Techniques	Analysis
Identifying the characteristics, policies, and development of specialty rice in Indonesia	Secondary	Secondary data from BPS, relevant ministries/agencies, BSN, and BAPANAS	Internet searches and review of previous studies/documents	• Qualitative descriptive analysis • Regional regulatory/policy mapping
Exploring opportunities and challenges of low-carbon sustainable rice as specialty rice regulated by government policy	Primary	Respondents	*Interviews and in-depth interviews*	• Qualitative descriptive analysis • IFE-EFE Matrix
Formulating recommendations and strategies to promote low-carbon sustainable rice as specialty rice	Primary and secondary data	Respondents, journals, and previous studies	Literature review and interviews	• Qualitative descriptive analysis • One-way test • Analytical Hierarcy Process (AHP)

Qualitative descriptive analysis and regulatory/policy mapping are used to address the first research objective concerning the characteristics, regional policies, and development of specialty rice in Indonesia. IFE and EFE analyses, along with the feasibility analysis of farming enterprises that have implemented SRP, are used to address the second objective regarding the opportunities and challenges of positioning low-carbon rice as specialty rice regulated by government policy. To address the third objective, namely formulating recommendations and strategies to promote low-carbon sustainable rice as specialty rice, qualitative descriptive analysis is employed.

3.3 Methods of Analysis

3.3.1 Qualitative Descriptive Analysis

Qualitative descriptive analysis involves presenting and explaining field findings supported by arguments. This analysis is used to elaborate qualitative data or information. Meanwhile, quantitative data may be presented in tabulated form prior to being analyzed descriptively.

3.3.2 IFE-EFE Matrix Analysis

The IFE–EFE matrix analysis is conducted to identify internal strengths and weaknesses as well as external opportunities and threats in the development of low-carbon sustainable rice into specialty rice regulated by government policy. An internal audit is carried out to identify key internal forces in order to determine strengths and weaknesses. The analytical tool used is the Internal Factor Evaluation (IFE) Matrix. The Internal Factor Evaluation (IFE) Matrix is presented in Table 4. The IFE Matrix is developed through the following steps:

a. Compiling a list of critical success factors derived from the internal audit process.
b. Assigning a weight to each factor ranging from 0.0 (not important) to 1.0 (very important). The importance value of each factor is associated with the achievement of objectives. The total weight of all factors (strengths and weaknesses) must equal 1.0.
c. Assigning a rating ranging from 1 to 4 for each factor, where a rating of 1 indicates a major weakness, 2 indicates a minor weakness, 3 indicates a minor strength, and 4 indicates a major strength.
d. Multiplying the weight by the rating for each factor to obtain the weighted score.
e. Summing the weighted scores of all factors to obtain the total overall score.

Table 4. Internal Factor Evaluation Matrix

Critical Success Factor	**Weight**	**Rating**	**Weighted Score**
Strengths			
1.			
2.			
3.			
4.			
5. etc.			
Weaknesses			
1.			
2.			
3.			
4.			
5. etc.			

The internal factors used to evaluate the development of low-carbon sustainable rice in this study are as follows:

1. Farmers' willingness to shift to sustainable rice farming practices
2. Support from farmer groups
3. The resulting products are beneficial for human health
4. Higher productivity compared to conventional farming systems
5. More cost-efficient production
6. Seed self-sufficiency
7. Organic fertilizer self-sufficiency
8. Bio-pesticide self-sufficiency
9. Availability of standard operating procedures (SOPs) for sustainable rice farming
10. Availability of farmer human resources with the capacity to implement sustainable rice cultivation practices across environmental, economic, social, technological, and institutional–policy dimensions

The next stage involves conducting an external audit to identify the opportunities and challenges faced in developing sustainable rice into a specialty rice under government policy. The analytical tool used is the External Factor Evaluation (EFE) Matrix. The External Factor Evaluation (EFE) Matrix is constructed through the following steps:

a. Compiling a list of critical success factors derived from the external audit process.

b. Assigning a weight to each factor, ranging from 0.0 (not important) to 1.0 (very important). The weight of each factor is associated with the achievement of the objectives. The total combined weight of all factors (opportunities and challenges) must equal 1.0.
c. Assigning a rating ranging from 1 to 4 for each factor, where a rating of 4 indicates that the current strategy responds very effectively, 3 indicates an above-average response, 2 indicates an average response, and 1 indicates a weak response.
d. Multiplying the weight by the rating for each factor to determine the weighted score.
e. Summing the weighted scores of all factors to obtain the overall total score.

The External Factor Evaluation (EFE) Matrix is presented in Table 5.

Table 5. External Factor Evaluation Matrix

Critical Success Factor	Weight	Rating	Weighted Score
Opportunities			
1.			
2.			
3.			
4. etc.			
Threats			
1.			
2.			
3.			
4. etc.			

The external factors used in evaluating the development of low-carbon sustainable rice include

1. Support from village governments.
2. Support from local governments.
3. Support from relevant ministries.
4. Corporate Social Responsibility (CSR) support from companies.
5. Financial support from financial institutions (bank and non-bank).
6. Presence of non-governmental organizations (NGOs).
7. Existence of multi-stakeholder forums (MSFs) at the regional level.
8. Research on low-carbon rice as well as cultivation and technological innovations from universities and research institutions.
9. Abundant availability of raw materials for organic fertilizers and bio-pesticides.
10. Demand from domestic consumers for low-carbon rice.
11. Demand from international consumers for low-carbon rice.
12. Higher prices compared to conventional rice.
13. Climate change.
14. High certification costs and short certification validity periods (if SRP certification is implemented).
15. Low stakeholder perceptions regarding the empowerment, health, and safety of SRP farmers.
16. Increasing public awareness of healthy lifestyles.
17. Growing public awareness and willingness to participate in environmental protection.

3.3.3 One-tailed test

A one-tailed test was employed to address the question of whether there was an improvement in agricultural business performance after receiving government incentives related to low-carbon sustainable rice, based on the perceptions of farmer respondents in Boyolali Regency and Klaten Regency. The impacts measured following the receipt of low-carbon sustainable rice incentives are associated with improvements in the following indicators:

1. Production capacity
2. Productivity
3. Income
4. Assets
5. Profit
6. Employment generation
7. Employment of persons with disabilities
8. Employment of women
9. Technology adoption
10. Green investment
11. Implementation of sustainable, environmentally friendly practices

Furthermore, farmer respondents selected their answers based on a 1–5 Likert scale, explained as follows:

1 = Much worse
2 = Worse
3 = No change
4 = Better
5 = Much better

The hypotheses for the one-tailed test applied to farmer respondents are as follows:

H_0: m £ 3 (there is no impact/change for farmers)
H_1: m > 3 (there is an impact/change for farmers)

3.3.4 Analytical Hierarchy Process

Based on the various existing strategic alternatives, several proposed strategies were formulated according to the actors and factors involved in the development of low-carbon sustainable rice as a specialty rice. Priority strategies were determined based on the criteria values provided by expert respondents.

The stages of the AHP method are as follows:

1. **Selection of expert respondents**. The criteria for expert involvement refer to individuals who have a thorough understanding of the issues under consideration, experience the impacts of the issues, or have a vested interest in them. Expert respondents in this study included farmers, local government representatives, and central ministries/agencies with knowledge of rice sector conditions in Indonesia.
2. Determination of strategic alternatives, actor (stakeholder) criteria, and factor criteria based on a literature review, which were then verified by expert respondents through expert judgment during focus group discussions (FGDs). The results are presented in a tree diagram, as shown in Figure 6.

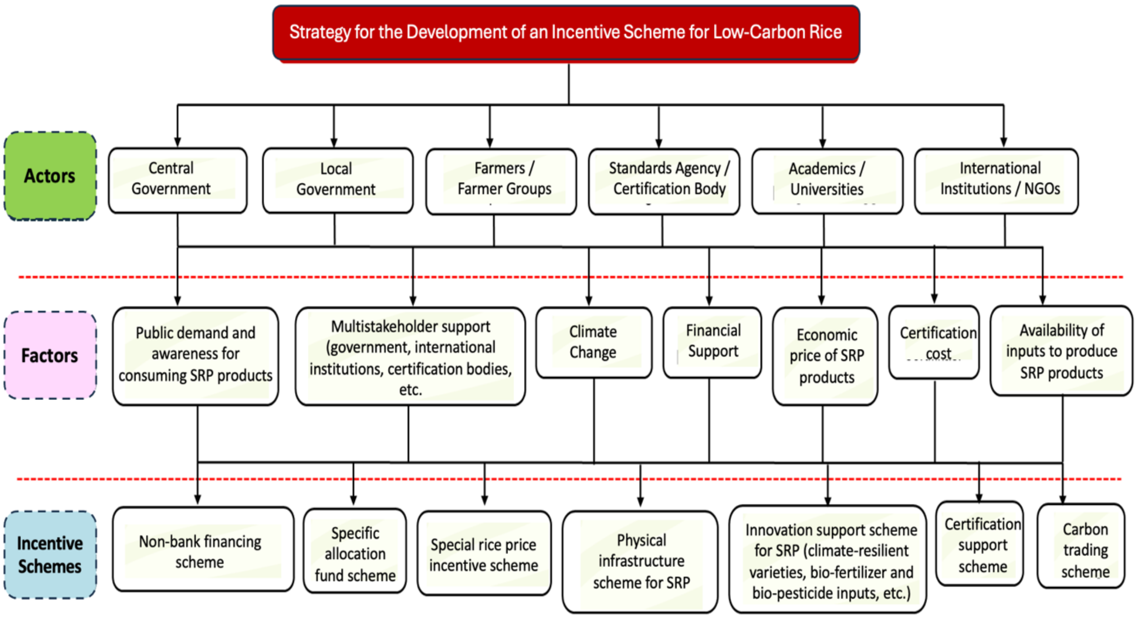

Figure 6. Analytical Hierarchy Process (AHP) Hierarchy Tree

3. **Evaluation of criteria by expert respondents through FGDs.** Respondents assessed the criteria by comparing the relative importance of one criterion to another in a pairwise manner. The comparison scale ranged from 1 to 9 (Saaty, 1993), as presented in Table 6.

Table 6. Levels of Element Importance Using Pairwise Comparisons

Value	Description	Explanation
1	Both elements are equally important	The two elements have equal influence on the objective
3	One element is slightly more important than the other	Experience and judgment slightly favor one element over the other
5	One element is more important than the other	Experience and judgment strongly favor one element over the other
7	One element is clearly and absolutely more important than the other	One element is strongly supported and appears dominant in practice
9	One element is extremely and absolutely more important than the other	Evidence supporting one element over the other has the highest possible degree of affirmation
2,4,6,8	Intermediate values between two adjacent judgments	Values are assigned when a compromise is needed between two choices
Invers	If activity i is assigned a value when compared to activity j, then activity j has the reciprocal (inverse) value when compared to activity i	

Source: Saaty, 1993

4. Analysis of priority strategies was conducted based on the comparative values among criteria provided by expert respondents. Theoretically, the analytical stages and formulas used are as follows:

   a. The values provided by experts were aggregated using the following geometric mean equation:

$$GM = \sqrt[n]{(X1)(X2)\ldots\ldots(Xn)}$$

Dimana : GM = *Geometric Mean* (rata-rata geometri)
X1 = score from expert 1
X2 = score from expert 2
Xn = score from expert *n*

b. A pairwise comparison matrix for actor criteria and factor criteria was then constructed.
Each criterion weight derived from respondent assessments was entered into the pairwise comparison matrix. This matrix served as the basis for the calculation process. Subsequently, criterion weights were calculated by normalizing the pairwise comparison matrix and computing the average of the summed values in each row of the matrix. The resulting weights for each criterion were then multiplied by the pairwise comparison matrix to obtain priority values. Pairwise comparison calculations were performed at the levels of actor criteria, factor criteria, and strategic alternatives.

CHAPTER 4
IDENTIFICATION OF CHARACTERISTICS, POLICIES, AND THE DEVELOPMENT OF SPECIALTY RICE IN INDONESIA

CHAPTER 4
IDENTIFICATION OF CHARACTERISTICS, POLICIES, AND THE DEVELOPMENT OF SPECIALTY RICE IN INDONESIA

4.1 Concept of Price Differentiation in Rice

The consumer decision-making process for purchasing a product is influenced by several factors (Engel et al., 1995). This purchasing decision process is determined by three main elements: information input, information processing, and factors that shape the decision-making process. Information input and information processing represent the influence of marketing stimuli carried out by marketers with the objective of enabling consumers to develop a clear and accurate understanding of the products being marketed. These stimuli can influence the consumer decision-making process depending on how information is processed and on consumers' perceptions of the product. One factor that influences the decision to purchase a product is its uniqueness.

According to Engel et al. (1994), the uniqueness of a product can easily attract the attention of consumers or customers. The uniqueness of a product can be observed through the attributes it possesses, including rice products. Rice product attributes are characteristics of rice that function as evaluative criteria during the decision-making process, and these attributes depend on the type of rice product and its intended use. Rice product attributes consist of three types: features, functions, and benefits. Feature attributes may include taste, size, shape, and other product characteristics such as flavor, color, and price; components or parts; raw materials; manufacturing processes; services; appearance; pricing structure; composition; trademarks or brand names; and other related aspects. Functional attributes may include serving as a source of carbohydrates and protein, being low in calories for individuals with diabetes, or containing specific nutrients. Benefit attributes may include utility, sensory pleasure, and non-material benefits such as health, convenience, and comfort.

Referring to the fact that rice attributes classified as features include size, shape, taste, and color, Hermanto and Saptana (2017) argue that changes in these forms influence rice prices. According to Hermanto and Saptana (2017), rice undergoes changes in form throughout the production, processing, and post-harvest stages. These changes in form subsequently affect price variations. Considering that paddy produced by farmers must undergo several transformations before reaching its final form consumed by end consumers, and that each stage of transformation requires processing costs and generates value added, the formulation of paddy/rice pricing policies must take into account the price levels corresponding to each form of paddy/rice. One of the key considerations in determining paddy/rice prices is the cost of processing and value creation at each stage of transformation. Taking into account the magnitude of opportunity costs associated with the production and processing of paddy/rice as well as value-added creation, price-based incentives play an important role in ensuring availability.

As commonly recognized in trade, various types of rice exist, each with different prices: (a) aromatic rice, whose cooked rice has a fragrant aroma, such as Pandan Wangi, Cianjur rice, Jasmine rice, and Hom Mali rice; (b) rice with different textures, such as non-sticky (dry/fluffy) rice (e.g., Siam Unus rice and Barek Solok rice) and soft/sticky rice (e.g., Rojolele rice, Cianjur rice, Japonica rice, and glutinous rice); (c) functional rice, such as parboiled rice, which is commonly consumed by individuals with Diabetes Mellitus (DM); (d) colored rice, such as red rice and black rice; (e) organic rice, which is cultivated using organic farming systems without the use of inorganic inputs; and (f) general rice, which is commonly traded in markets and whose price is determined by its quality. Therefore, given that SRP differs from medium and premium rice, price incentives through the designation of SRP as a specialty rice are expected to encourage the availability of SRP rice in the market.

4.2 Specialty Rice Policy

Based on Presidential Regulation Number 66 of 2021, the National Food Agency is mandated to formulate standards for the safety and quality of fresh food, including rice. This policy is stipulated in Regulation of the National Food Agency of the Republic of Indonesia Number 2 of 2023 concerning Rice Quality and Labeling Requirements. Regulation of the National Food Agency of the Republic of Indonesia Number 2 of 2023 also regulates specialty rice, as stipulated in Article 2, in which rice is classified based on:

a. Classification; and
b. Quality grade.

Article 3 states that the rice classification referred to in Article 2 consists of: (a) general rice; and (b) specialty rice. As referred to in paragraph (1), specialty rice includes:

a. Glutinous rice;
b. Red rice;;
c. Black rice;
d. Local variety rice;
e. Fortified rice;
f. Organic rice;
g. Rice with geographical indication;
h. Rice with health claims; and
i. Certain types of rice that cannot be produced domestically.

Along with the dynamic changes in the rice farming and rice sector, as well as the rapid advancement of science and technology, the National Food Agency, in collaboration with the Ministry of Agriculture, is currently initiating policy development to create opportunities for the addition of new classifications of specialty rice. This initiative aims to promote innovation, improve rice quality, and enhance consumer protection through the recognition of rice produced using specific techniques. This additional category is referred to as "specialty rice produced using specific techniques in line with developments in science and technology."

Within this context, low-carbon sustainable rice cultivated under the Sustainable Rice Platform (SRP) standard has the potential to be recognized as part of specialty rice, particularly under the category of "specialty rice produced using specific techniques in line with developments in science and technology." On the other hand, low-carbon sustainable rice represents broader and more complex attributes than rice produced solely through organic farming practices. Low-carbon sustainable rice produced under the SRP standard incorporates a set of requirements that not only promote environmentally friendly practices but also address farmer and labor safety, as well as their overall welfare.

Referring to Santosa (2025), sustainable rice farming is defined as "*a farming system that enhances farmers' welfare (economic dimension), safeguards food security (social dimension), and preserves biodiversity as well as the quality of water, soil, and air* *(environmental dimension), supported by productive and competitive institutions (governance)"*.

The main objectives of sustainable agriculture are as follows:

1. To conserve soil, water, natural resources, and ecosystems so that they remain productive and balanced in the long term;
2. To reduce greenhouse gas (GHG) emissions and strengthen the resilience of production systems to the impacts of extreme climate events;,
3. To improve income, welfare, and equity for farmers and communities in a fair and inclusive manner; and,
4. To reduce dependence on external inputs (fertilizers, pesticides, and fossil fuels) by optimizing local resources, and to produce safe, healthy, and nutritious food.

The indicators include: (1) precision inputs (water, fertilizers, pesticides, and varieties); (2) high productivity and yield stability; (3) soil, water, and air quality as well as biodiversity; and (4) a low carbon and water footprint. Examples of such practices include the subak agricultural system and mina padi (integrated rice–fish farming)

Meanwhile, according to Santosa (2025), organic agriculture is defined as "*a rice production system that relies on ecological processes, biodiversity, and natural cycles without the use of synthetic inputs such as chemical fertilizers, synthetic pesticides, or genetically modified organisms (GMOs). This system emphasizes the use of organic fertilizers, biologically based integrated pest management, and sustainable soil and water management. The main objective of organic agriculture is to produce rice that is healthy and safe for consumers, while maintaining soil fertility, conserving the environment, and supporting farmers' long-term welfare*."

Organic agriculture is characterized by the following indicators: (1) the absence of chemical fertilizers and synthetic pesticides; (2) no use of GMOs; (3) reliance on organic inputs (compost, manure, and biofertilizers); (4) an orientation toward ecosystem and consumer health; and (5) certification. Meanwhile, its main challenges include productivity (which is generally lower due to the absence of synthetic fertilizers) and limited market access.

Meanwhile, low-carbon cultivation refers to farming practices that minimize greenhouse gas (GHG) emissions, particularly CO_2 (fuel-related emissions), CH_4 (methane from flooding and organic matter decomposition), and N_2O (nitrous oxide from nitrogen fertilizers). The primary objective is to reduce emissions that contribute to global warming. The main approaches include: (1) reducing continuous flooding through Alternate Wetting and Drying (AWD); (2) precision fertilization (e.g., slow-release fertilizers, urease inhibitors, and balanced nutrient application); (3) the use of low-emission rice varieties (drought-tolerant varieties, deep-rooted varieties, high-yielding varieties, and varieties with low emission potential); (4) biochar application; and (5) composting.

Referring to the various definitions discussed above, the Sustainable Rice Platform (SRP) is characterized not only by its emphasis on sustainable cultivation practices, but also by its attention to a broad range of dimensions, including environmental, economic, social, technological, institutional, and policy aspects. These criteria confer distinct characteristics to SRP, shaping inherent product attributes that differentiate it from medium and premium rice commonly available in the market, thereby justifying its classification as a specialty rice.

In various inter-ministerial discussion forums involving the National Food Agency, the Ministry of Agriculture, the Ministry of National Development Planning (Bappenas), and other relevant stakeholders, it has been agreed that the recognition of low-carbon sustainable rice (produced using the SRP approach) as specialty rice requires formal verification. Such verification may take the form of: (i) certification; (ii) an official information document explaining the cultivation system, issued by the minister responsible for agricultural affairs; or (iii) other supporting evidence that ensures the implementation of the cultivation system and the quality of the rice produced (Bapanas, 2025). Therefore, moving forward, a dedicated certification scheme for low-carbon sustainable rice produced under the SRP approach is required as a means of providing quality assurance to consumers. At the global level, certification bodies for SRP products already exist; however, obtaining such certification entails relatively high costs. Nevertheless, producers of SRP-compliant rice may apply the SRP label to their products, provided that they meet the requirements of the SRP assurance scheme and undergo verification by an authorized third party through the use of the SRP-verified label.

Verification of SRP products is fundamentally important through the implementation of a certification scheme. Although there is currently no domestic SRP certification body in Indonesia and global SRP certification remains costly, opportunities to obtain such certification still exist. Based on discussions with stakeholders, it was identified that, in order to be recognized as specialty rice, low-carbon sustainable rice produced under the SRP approach may be proposed for integration into SNI (Indonesian National Standard) 8969:2021 on Good Agricultural Practices for food crops or other relevant SNI standards. Through the SNI development process, agreements may also be reached regarding the designation of domestic certification bodies or assurance institutions.

In relation to the importance of certification, from a supply-side perspective, incentives are required for farmers cultivating SRP-compliant rice to ensure its availability in the market. Price incentives for SRP rice, enabling it to be positioned as specialty rice, are essential to motivate SRP farmers to transition their business models from conventional practices to SRP-based production. The SRP business model requires relatively high initial investment during the early stages of cultivation, although it becomes more efficient in the long term. From the demand-side perspective, potential demand for SRP rice has also been increasing. In March 2022, GIZ and YouGov conducted a survey funded by the develoPPP program, implemented by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH in collaboration with private sector partners through the Mainstreaming Sustainable Rice project. The survey revealed that white rice is a staple food in nearly every household, with 97% of respondents consuming it daily across regions. In addition, although overall consumption of red rice is lower, it is more prevalent among older consumers and upper-income households, particularly in the Greater Jakarta (Jabodetabek) area, where 25% of respondents reported purchasing it regularly. The study also generated important findings regarding consumers' willingness to pay for SRP rice.

The survey showed that consumers in the Surabaya region were more willing to pay a price premium for sustainable rice, with 29% expressing willingness to accept a 10% price increase, compared to a national average of 17%. Overall, purchasers of sustainable rice tend to be millennials and older consumers with higher levels of education and upper economic status, who frequently consume white rice, particularly in cities outside Java, and prefer local markets and wholesalers. These findings are reinforced by a study by Widyastutik et al. (2022), conducted in collaboration with the Ministry of Agriculture and funded by the International Fund for Agricultural Development (IFAD), which indicates higher interest and willingness to pay among millennials and women for sustainable products, including social impact bonds and green bonds. Environmental considerations were found to dominate preferences for bond instruments issued to finance environmentally oriented initiatives.

These findings indicate a growing consumer interest in sustainable rice. The main considerations in selecting this product are quality, price, and rice type. Based on insights from the survey, consumers who are willing to pay a premium for sustainable rice are most likely to be between 25–34 years old or aged 55 and above, and come from upper-income households with high levels of education. Consumers aged over 55, in particular, place primary importance on quality, health aspects, and taste when choosing sustainable food, indicating that these factors strongly influence their purchasing decisions. Health considerations represent the main appeal of sustainable rice, with consumers emphasizing the importance of farming practices that minimize the use of chemical inputs (45%) as well as contributions to improving farmer welfare (43%) in shaping their purchasing choices.

CHAPTER 5
EXPLORATION OF OPPORTUNITIES AND CHALLENGES FOR LOW-CARBON SUSTAINABLE RICE AS A GOVERNMENT-REGULATED SPECIALTY RICE

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5.1 Characteristics of Survey Respondents

The next objective of this study is to explore the opportunities and challenges of positioning low-carbon sustainable rice as a specialty rice regulated by government policy. To address this objective, a survey was conducted among farmers located in areas covered by the Sustainable Rice Platform (SRP) intervention program, namely Boyolali Regency and Klaten Regency. The number of respondents in each area consisted of 30 farmers who had implemented SRP practices in their rice cultivation activities.

Prior to addressing this objective, the characteristics of farmer respondents in both study areas are first presented. Figure 7 illustrates the characteristics of respondents by age, showing that the majority of farmers in both regions fall within the 45–54 age group, accounting for 33.33% of respondents in Boyolali Regency and 36.67% in Klaten Regency. The subsequent age groups are those aged 55–64 and 65–74 years. This indicates that farmers involved in the SRP program are generally no longer young, which poses challenges for program implementation and consistency. Field findings reveal that it is relatively difficult to identify farmers who continue to implement SRP practices, as some farmers have reverted to conventional farming methods. This tendency is associated with the characteristics of older farmers, who often find it difficult to adopt new cultivation techniques and tend to place greater trust in conventional farming practices passed down through generations.

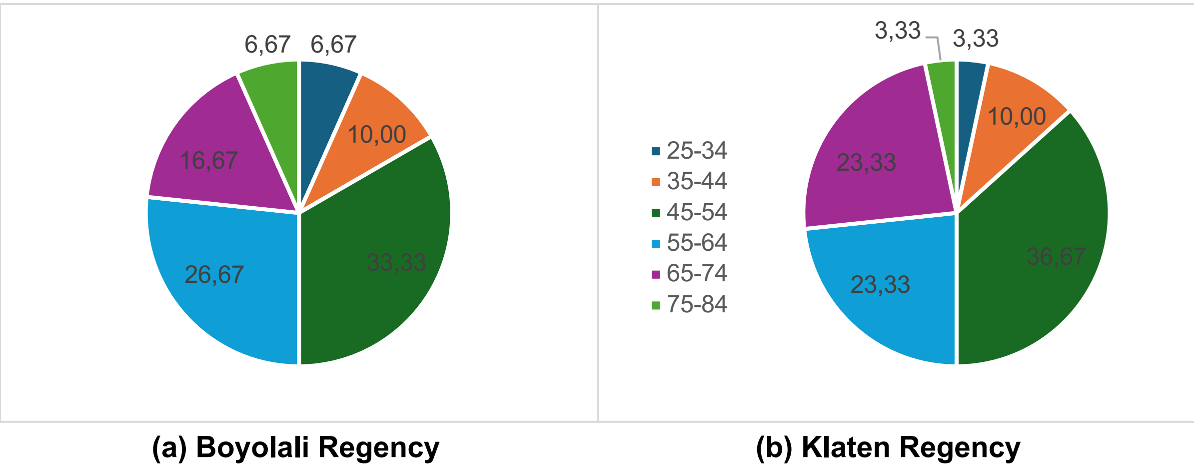
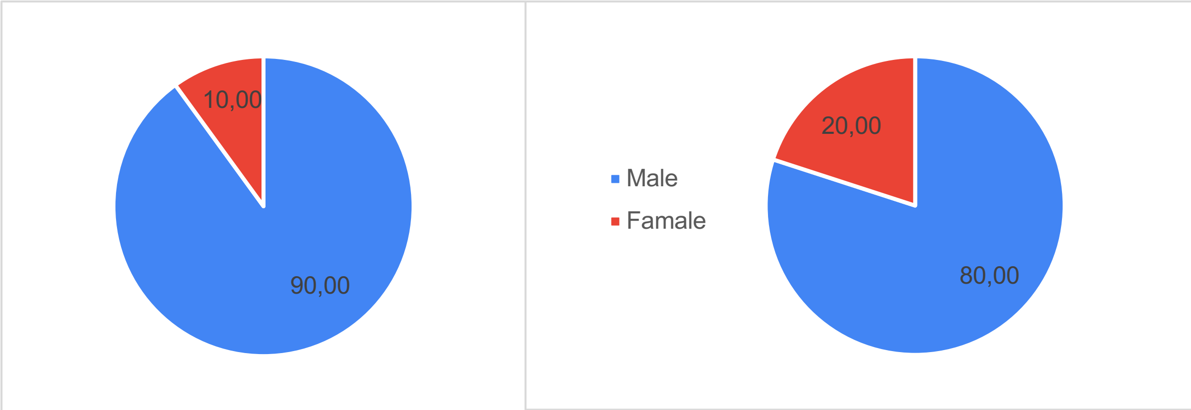


Figure 7. Respondent Characteristics by Age (%)

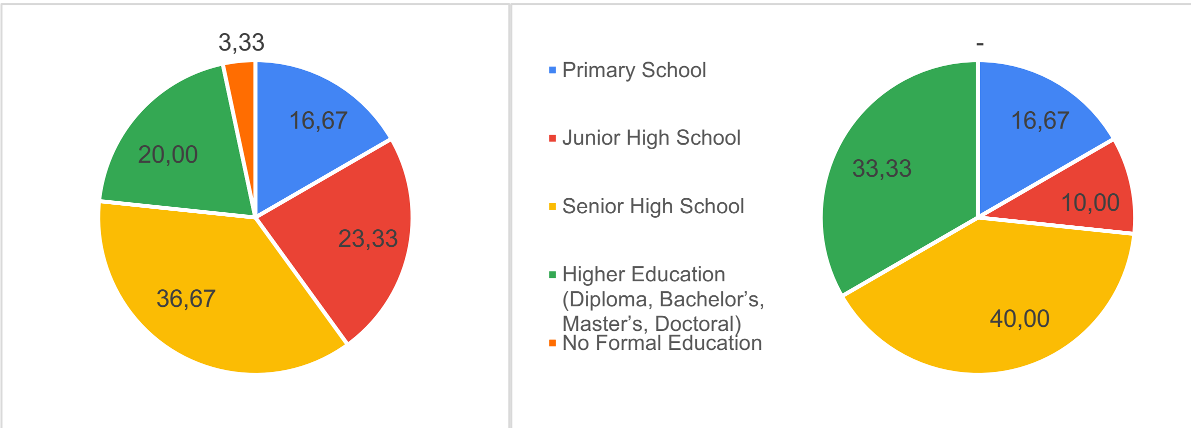
Furthermore, the characteristics of farmer respondents are differentiated by gender. In both Boyolali Regency and Klaten Regency, male farmers dominate the respondent group, accounting for 90% and 80%, respectively. In Klaten Regency, some female respondents also hold positions as heads of farmer groups. This finding indicates that women have equal opportunities to lead farmer groups adopting the SRP approach, in line with the principles of gender mainstreaming.



(a) Boyolali Regency **(b) Klaten Regency**

Figure 8. Respondent Characteristics by Gender (%)

The next characteristic of farmer respondents is differentiated based on their highest level of education, as presented in Figure 9. In both Boyolali Regency and Klaten Regency, the majority of respondents have completed senior high school or an equivalent level, accounting for 36.67% and 40%, respectively. It is also evident that a substantial proportion of farmer respondents have attained tertiary education, comprising 20% in Boyolali Regency and 33.33% in Klaten Regency.



(a) Boyolali Regency **(b) Klaten Regency**

Figure 9. Respondent Characteristics by Education Level (%)

Farmer respondents are members of farmer groups (poktan) and hold various roles, such as chairperson, secretary, treasurer, or regular member. The majority of survey respondents who belong to farmer groups serve as regular members, accounting for 66.67% in Boyolali Regency and 43.33% in Klaten Regency. A considerable proportion of respondents also hold leadership positions as chairpersons of farmer groups, representing 23.33% in Boyolali Regency and 36.67% in Klaten Regency. In detail, the distribution of respondents based on their positions within farmer groups is presented in Figure 10.

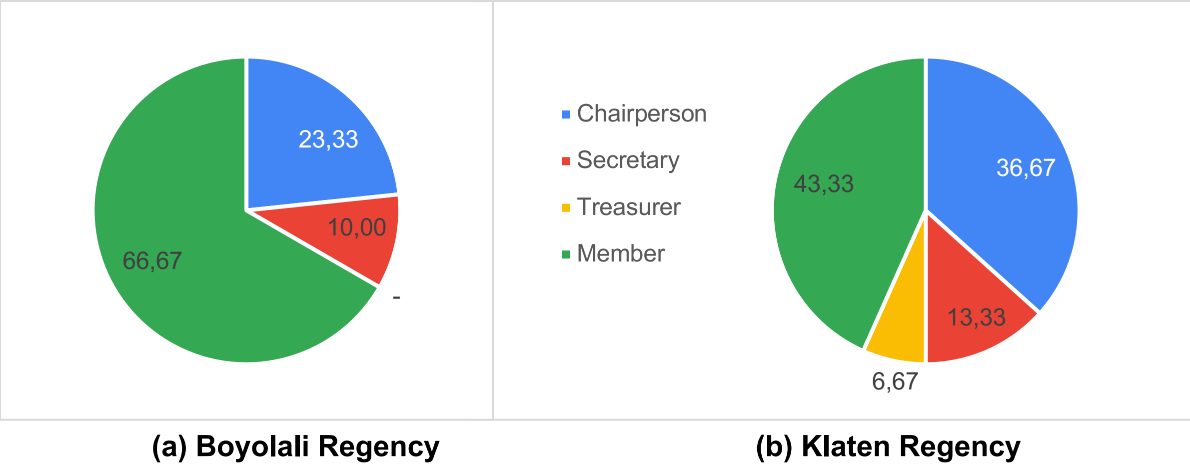


Figure 10. Respondent Characteristics by Position in Farmer Groups (%)

As explained in the previous section, in Klaten Regency, female respondents also hold crucial positions within farmer groups (poktan), serving as chairpersons (3.33% or one person) and secretaries (3.33% or one person). This indicates that women are equally capable of assuming leadership roles alongside men in leading farmer groups. In contrast, in Boyolali Regency, the role of women within farmer groups has not yet been evident at the leadership level and remains limited to membership roles only.

Table 7. Cross-Tabulation of Respondent Characteristics by Gender and Position in Farmer Groups (%)

Regency	Chairperson	Secretary	Treasurer	Member	Total
1. Boyolali Regency	23.33	10.00	-	66.67	100
a. Male	23.33	10.00	-	56.67	100
b. Famale	-	-	-	10.00	100
2. Klaten Regency	36.67	13.33	6.67	43.33	100
a. Male	33.33	10.00	6.67	30.00	100
b. Famale	3.33	3.33	-	13.33	100

Figure 11 illustrates the next characteristic, namely the role of farmer groups (poktan) for farmers. In both Boyolali Regency (36.84%) and Klaten Regency (34.33%), the majority of respondents stated that their involvement in poktan primarily serves as a forum for collective learning. A considerable proportion of respondents also indicated that the role of poktan remains largely focused on facilitating access to agricultural inputs, particularly seed and fertilizer assistance. This is because farmers are required to be members of a farmers' group in order to be eligible for seed and fertilizer subsidies or assistance programs.

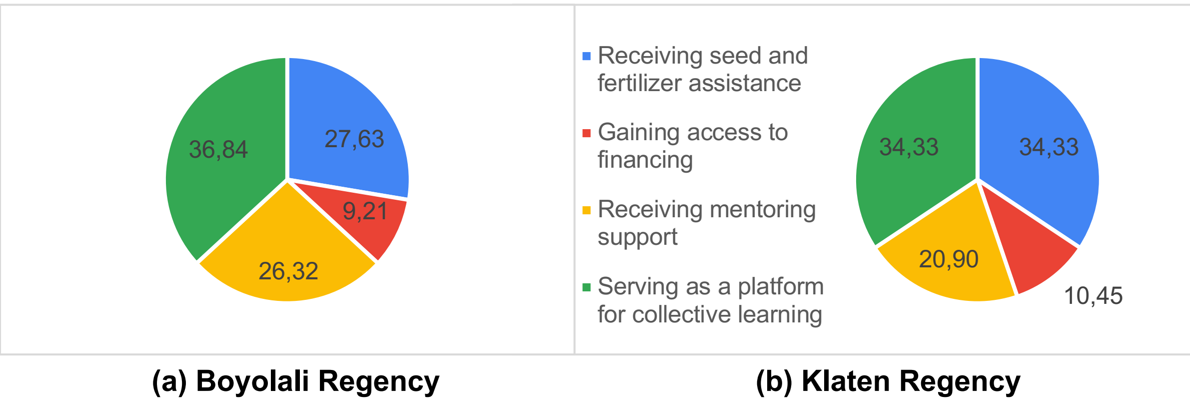


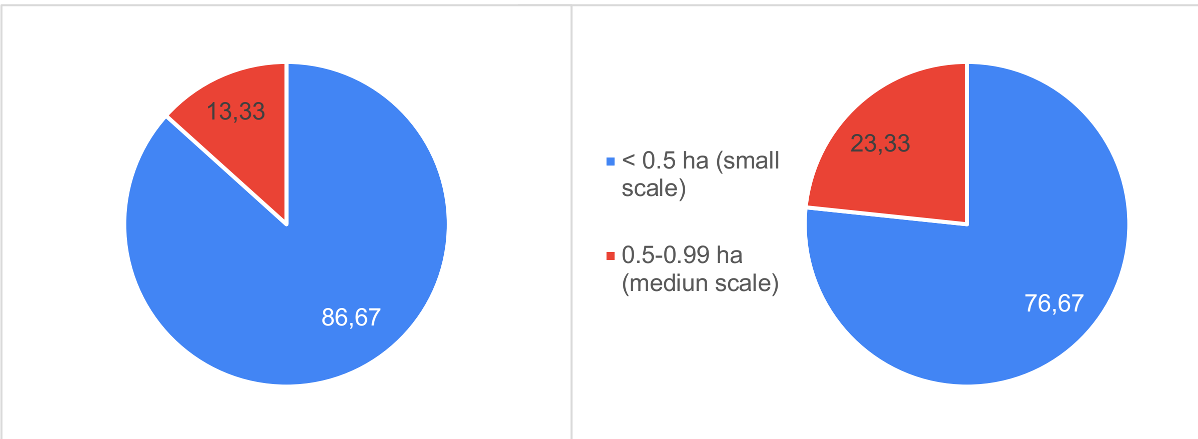
Figure 11. Respondent Characteristics by Farmer Group Roles (%)

The next characteristic relates to the ownership of organic certification. As shown in Figure 12, only farmers in Boyolali Regency have obtained organic certification, and this accounts for just one respondent (3.33%). In this regard, farmers need to be encouraged to obtain organic certification, even though the SRP implementation concept still allows the use of chemical inputs (fertilizers, pesticides, and herbicides). Although a dedicated SRP certification will be essential in the future to formally recognize the distinctiveness of SRP compared to organic rice, which already has an established SNI standard, the current possession of organic certification can already serve as an added value for SRP products.

(a) Boyolali Regency **(b) Klaten Regency**

Figure 12. Respondent Characteristics Based on Organic Certification Ownership (%)

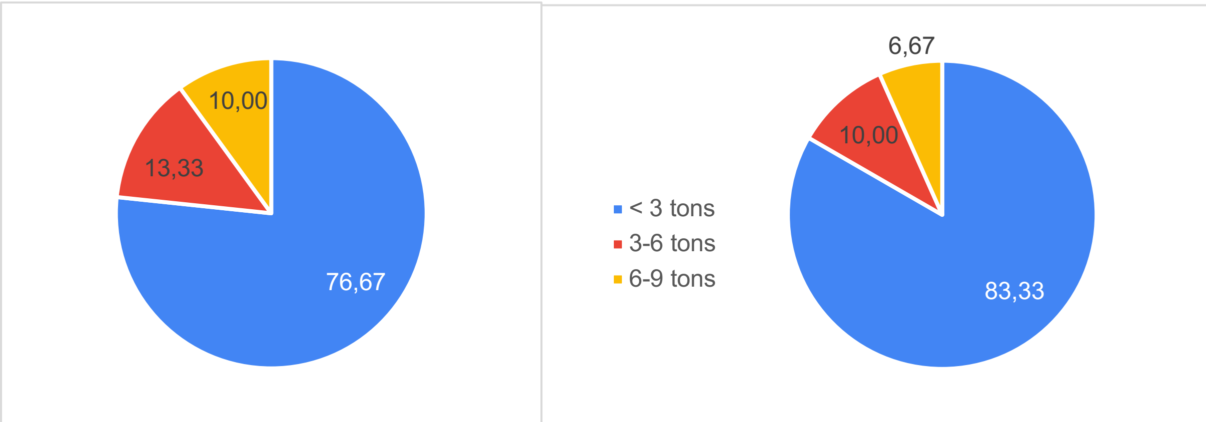
Landholding size is an important indicator in describing the characteristics of rice farmers, as it is directly related to production levels, scale of operation, and farmers' access to agricultural inputs and technology. Based on the survey results, respondents fall into only two categories according to cultivated land size: small-scale farmers (<0.5 ha) and medium-scale farmers (0.5–0.99 ha). The majority of respondents in both Boyolali Regency (86.67%) and Klaten Regency (76.67%) are small-scale farmers cultivating less than 0.5 hectares of land.



(a) Boyolali Regency **(b) Klaten Regency**

Figure 13. Respondent Characteristics Based on Land Area (%)

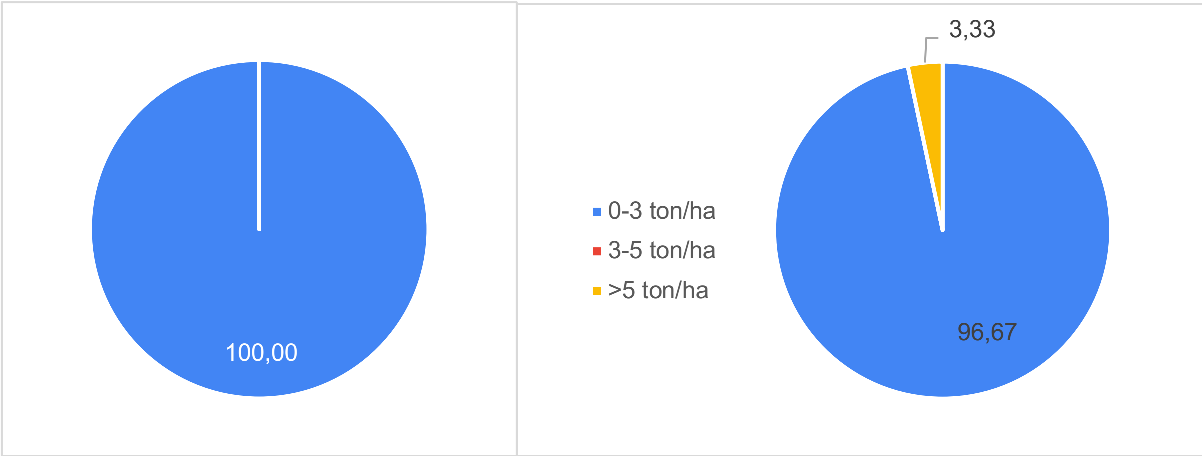
As an implication of cultivated land size, it directly affects the volume of rice production obtained. As shown in Figure 14, the amount of SRP rice production cultivated by respondent farmers varies considerably and is predominantly less than 3 tons in both Boyolali Regency (76.67%) and Klaten Regency (83.33%). However, a number of respondents were found to achieve relatively high production levels, ranging from 6 to 9 tons, namely 10% in Boyolali Regency and 6.67% in Klaten Regency. Farmers with larger landholdings tend to produce higher output compared to those with smaller plots. This is due to greater planting capacity, more optimal use of production inputs, and better opportunities to adopt more efficient cultivation technologies on relatively larger areas. In contrast, small-scale farmers with limited land size are more likely to experience suboptimal resource utilization, which constrains their production capacity.



(a) Boyolali Regency **(b) Klaten Regency**

Figure 14. Respondent Characteristics Based on Production Volume (%)

The relationship between land size and production volume clearly indicates that the larger the land area controlled by farmers, the greater the amount of rice produced, primarily due to higher planting capacity. However, land size is not always directly proportional to productivity, as productivity is influenced not only by land area but also by other factors such as cultivation management, seed quality, fertilization, irrigation, and pest control. In other words, farmers with smaller landholdings who apply intensive cultivation technologies can achieve higher productivity than farmers with larger land areas but suboptimal management. Based on the survey, respondent farmers implementing SRP still exhibit relatively low productivity levels, ranging from 0–3 tons/ha in both Boyolali Regency (100%) and Klaten Regency (96.67%). This finding emphasizes that land size determines the total volume of production, whereas productivity reflects the efficiency and quality of SRP farm management, which remains suboptimal. Low productivity among farmers adopting SRP or organic cultivation is commonly observed during the initial stages of adoption. One best practice example of organic rice cultivation in East Java, namely Poktan Rame Gawe II in Ngablak Hamlet, Prijekngablak Village, Karanggeneng Sub-district, Lamongan Regency, shows that at the early stage of adopting organic practices, productivity was around 5 tons per hectare, and after four years of continuous implementation, productivity increased to 7.2 tons per hectare.



(a) Boyolali Regency **(b) Klaten Regency**

Figure 15. Respondent Characteristics Based on Productivity (%)

The number of laborers employed in rice cultivation greatly determines the resulting production and productivity. Based on survey results in both Boyolali and Klaten Regencies, the majority of labor used comes from outside the family. When examined in more detail, family labor is predominantly male in both regencies. This is because fieldwork in rice cultivation, such as land preparation, planting, and maintenance, generally requires significant physical effort, which is more often performed by male family members. In contrast, non-family labor is predominantly female, especially in post-harvest activities such as harvesting, threshing, drying, and other post-harvest tasks, which require precision and can be carried out in groups. This pattern reflects a gender-based division of roles in rice farming, where men are more dominant in core field labor, while women play a crucial role as supplementary labor, particularly in the final stages of production. Furthermore, laborers with disabilities are not yet involved in SRP rice cultivation and post-harvest processes, as fieldwork demands physically intensive activities.

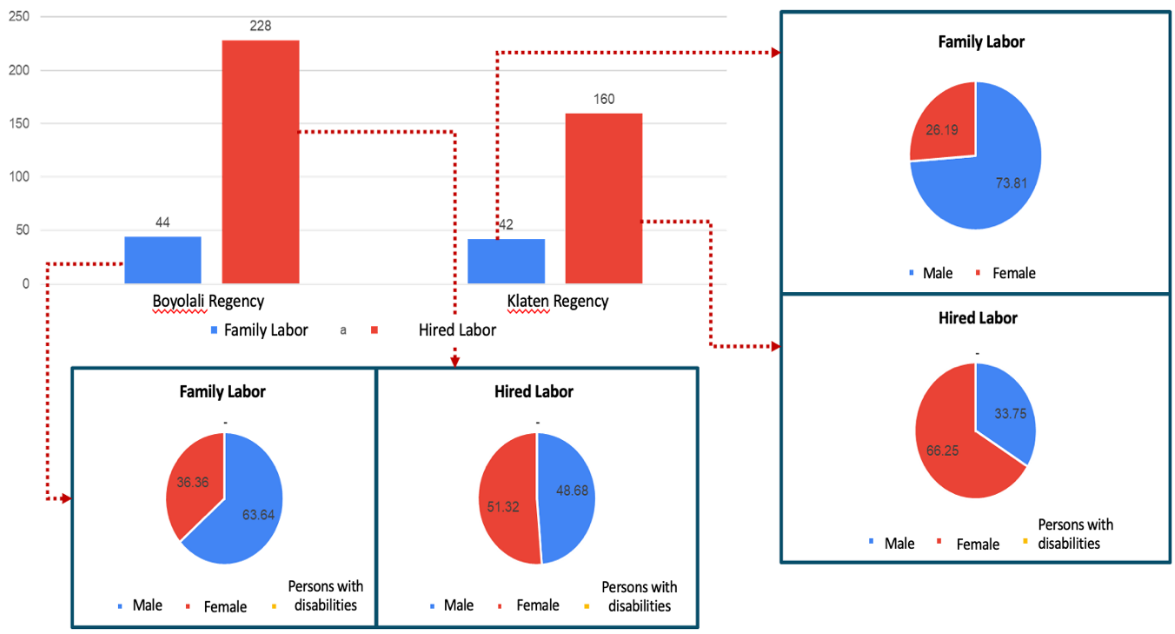
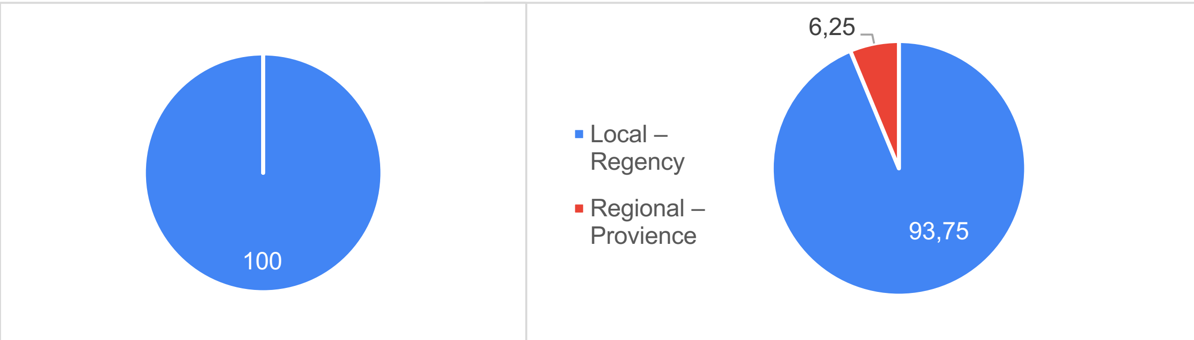


Figure 16. Respondent Characteristics Based on Labor Utilization (%)

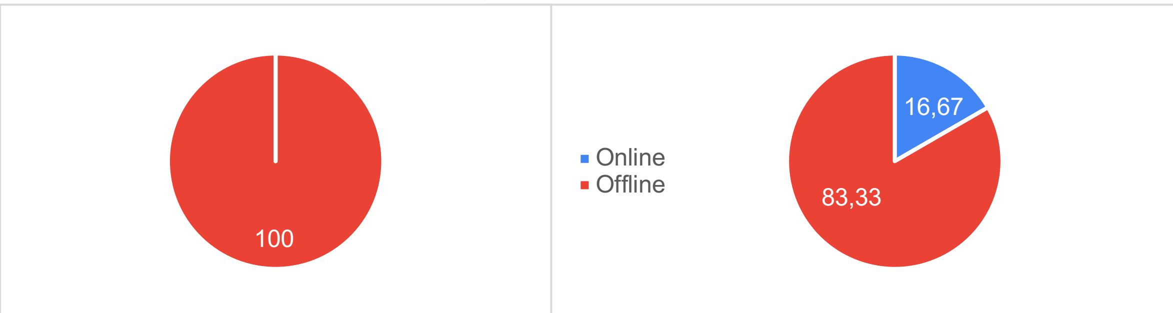
The marketing area for rice generally covers local, regional, and even national levels, depending on the scale of production and farmers' access to markets. Farmers with small-scale production usually sell their harvests locally, such as in traditional markets or through middlemen, primarily to meet the needs of nearby consumers. In contrast, farmers with larger production volumes tend to reach regional markets or collaborate with rice mills and major traders who distribute rice to other cities. Survey results indicate that in Boyolali Regency, all farmer respondents still market the SRP rice they produce within the local area (within the same regency) (17a). Meanwhile, farmer respondents in Klaten Regency market SRP rice not only locally within the regency (93.75%) but also regionally within the same province (6.25%). The marketing area for SRP rice is influenced not only by production volume but also by distribution networks, post-harvest facilities, and market absorption capacity at various regional levels. These factors explain why the marketing area remains limited for SRP rice produced in the two surveyed regions.



(a) Boyolali Regency **(b) Klaten Regency**

Figure 17. Respondent Characteristics Based on Marketing Area (%)

When linked to marketing channels, which also influence the marketing area, survey results show that all farmer respondents in Boyolali Regency still rely on offline marketing channels (Figure 18a). In contrast, in Klaten Regency, 16.67% of respondents have utilized online marketing channels, thereby expanding their marketing area (Figure 18b). The use of modern channels such as digital platforms, marketplaces, and social media allows farmers to reach regional and even national markets. Effective marketing channels not only broaden market reach but also increase product visibility, shorten distribution chains, and create opportunities for more competitive pricing. This indicates that the more diverse and modern the marketing channels used, the wider the marketing area that can be achieved.



(a) Boyolali Regency **(b) Klaten Regency**

Figure 18. Respondent Characteristics Based on Marketing Channels (%)

5.2 Access to Financing for Sustainable Rice Farming

The capital requirements in the sustainable rice farming sector are relatively high, especially during the initial transition from conventional practices. Based on interview results in both Boyolali and Klaten Regencies, financing for SRP farming is still largely self-funded, accounting for 90.9%. Other types of financing accessed by SRP farmers in Klaten Regency include bank loans, primarily from BRI, at 6.1%, and non-bank loans at 3.0%. Meanwhile, in Boyolali Regency, other sources of financing include bank loans, also from BRI, at 6.1%, and joint capital arrangements at 3.0%, typically between landowners and farm laborers.

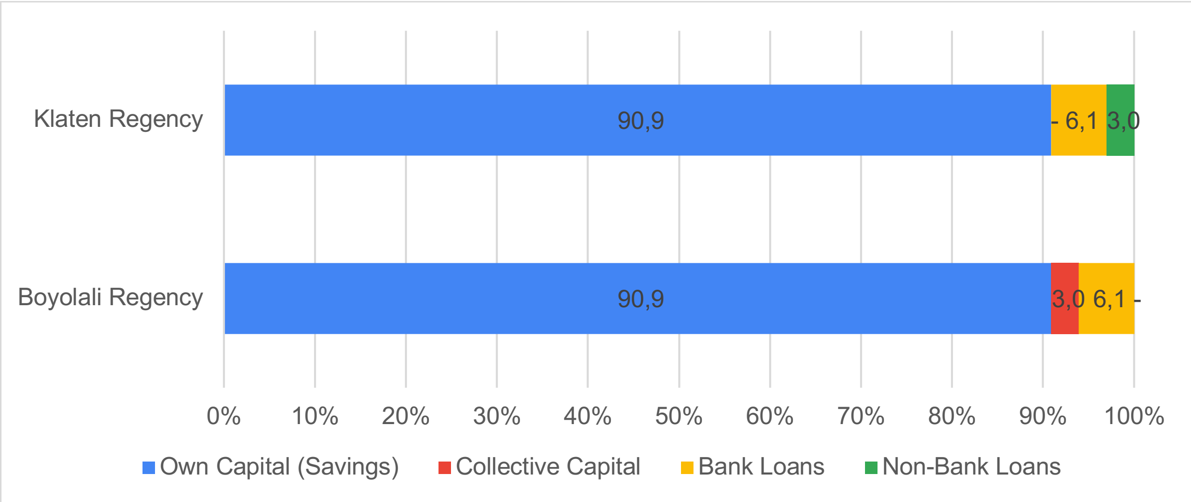


Figure 19. Initial Capital for the Implementation of Sustainable Rice Farming (%)

Given the limited sources of financing from financial institutions, further analysis was conducted to determine whether farmers had ever accessed financing from such institutions. Based on the questionnaire results, 16.67% of farmers in Klaten Regency had accessed financing from financial institutions, both banks and non-banks, while the remaining 83.33% had never accessed bank financing. In contrast, in Boyolali Regency, a higher percentage of farmers, 30.43%, had accessed financing from financial institutions, whereas 69.57% had not. This situation is related to the lack of collateral and concerns over the inability to repay loan installments.

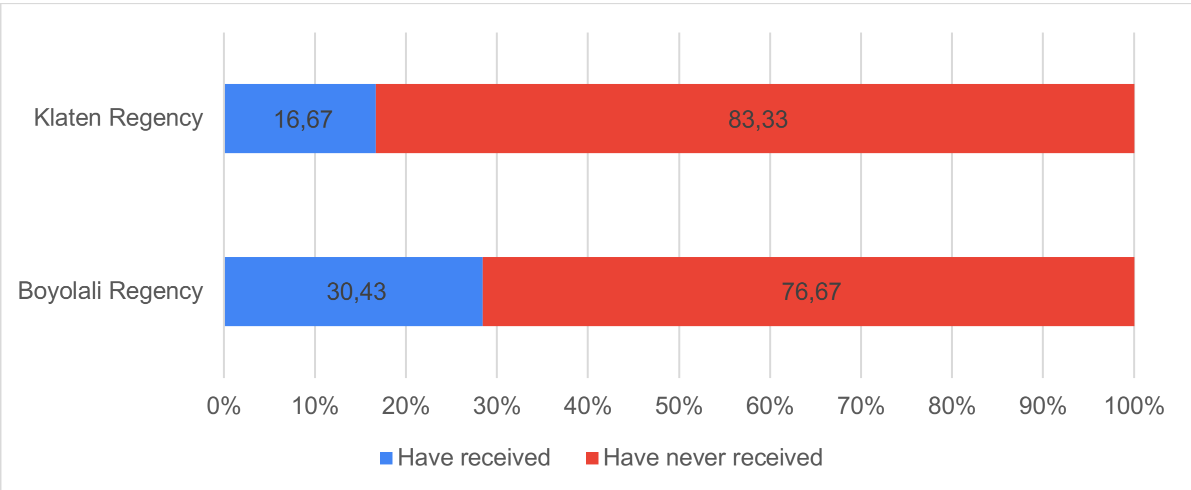


Figure 20. Accessing Financing from Bank/Non-Bank Institutions (%)

Based on interview results, among farmers in Klaten Regency who had accessed bank or non-bank financing, 13.33% reported experiencing difficulties in obtaining funds, while 86.67% did not encounter any difficulties. This indicates that, generally, farmers find it relatively easy to access financing from banks or non-bank institutions. Meanwhile, in Boyolali Regency, 6.67% of farmers who had accessed bank or non-bank financing experienced difficulties. Notably, the proportion of SRP farmers who have accessed financing remains relatively small compared to those who have not.

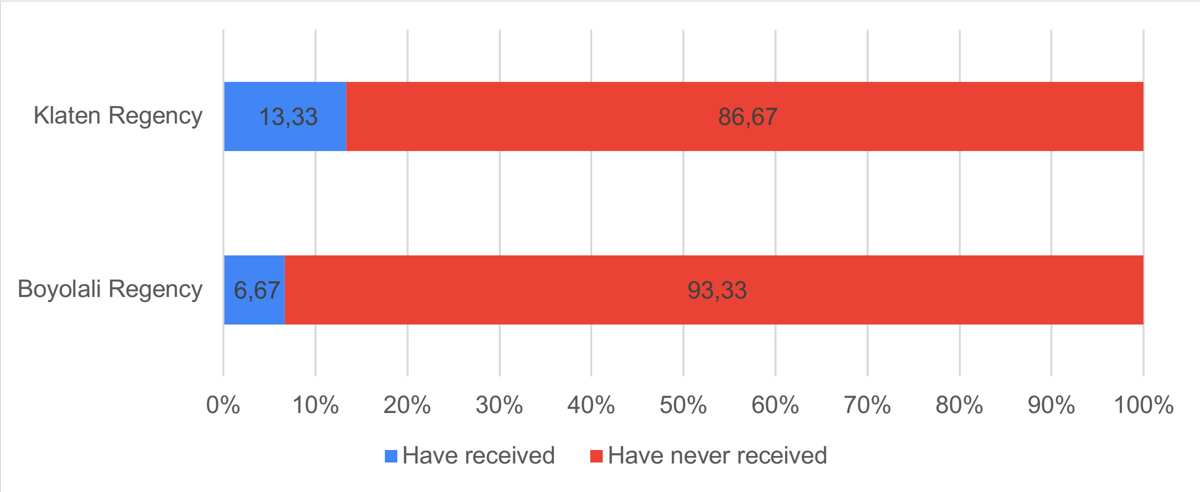


Figure 21. Difficulty in Accessing Financing from Bank/Non-Bank Institutions (%)

Next, the main problems or challenges faced by farmers who have accessed financing in Klaten Regency are primarily related to the availability of collateral and the lengthy loan application and bureaucratic processes. Collateral becomes a challenge because most farmers do not own their land, instead renting or using "maro" land. In addition, the lengthy credit application procedures cause farmers to lose valuable working time. The second major problem is the high interest rates and short repayment periods. Most farmers access the KUR (People's Business Credit) program with an interest rate of 6%, which farmers perceive as relatively high. This perception is linked to the relatively low returns from their farming activities. Monthly KUR installments are also considered burdensome for SRP farmers. This situation is particularly relevant to SRP cultivation, where the harvest requires approximately 4–5 months to mature, especially during the early transition period from conventional to SRP practices, which demands a relatively longer time.

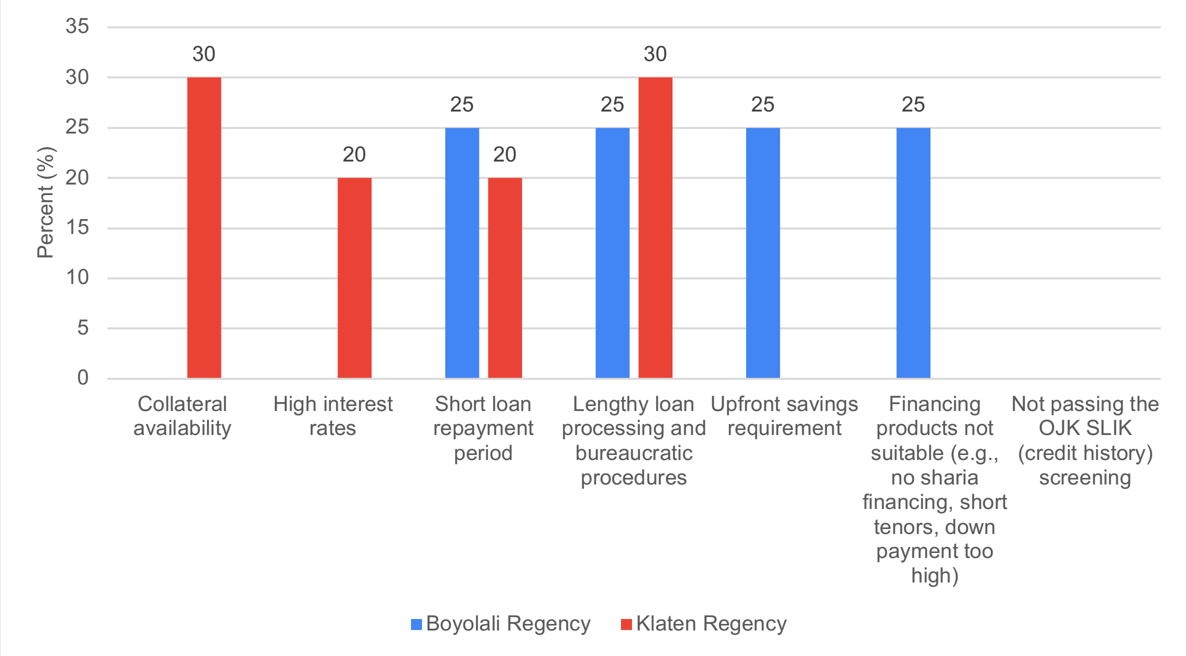


Figure 22. Problems/Challenges Faced by Respondents Who Have Received Financing (%)

Meanwhile, in Boyolali Regency, the challenges were evenly distributed (25% each). These challenges include short loan repayment periods, lengthy loan application and bureaucratic processes, requirements for upfront savings, and financing products that do not meet farmers' needs (for example, the absence of Sharia-compliant financing, short loan terms, and excessively high down payments).

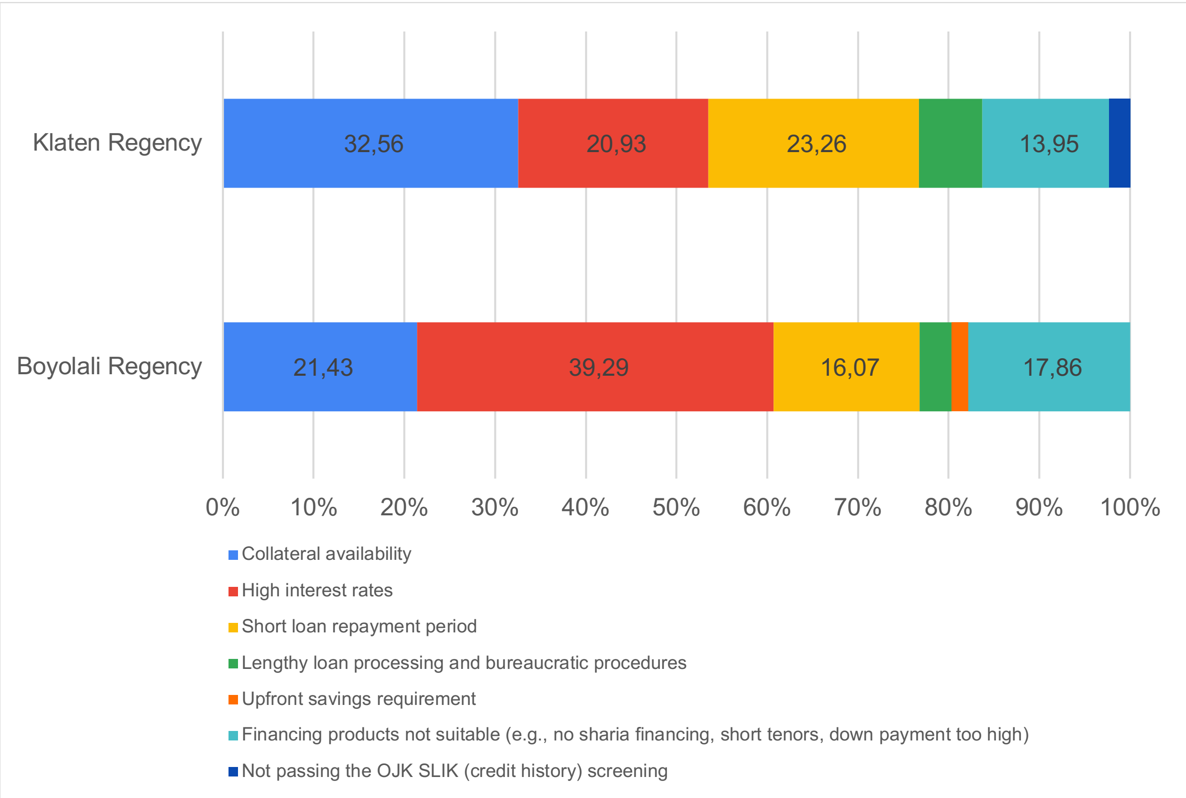


Figure 23. Problems/Challenges Faced by Respondents Who Have Never Accessed Financing

The high percentage of farmers who have not accessed financing from either banks or non-bank institutions warrants an examination of the underlying problems and challenges. Based on interview results, the challenges faced by farmers in Klaten and Boyolali Regencies differ slightly. For farmers in Klaten Regency who have never accessed financing, the main challenges, in order of prevalence, are the availability of collateral (32.56%), short loan repayment periods (23.26%), high interest rates (20.93%), and financing products that do not meet their needs (for example, the absence of Sharia-compliant financing, short loan terms, and excessively high down payments).

5.3 The Impact of Incentives on the Performance of Sustainable Rice Farming Enterprises

In relation to sustainable farming practices, incentives are necessary to encourage more farmers to adopt them. Therefore, perceptions regarding the impact of incentives on the performance of sustainable rice farming enterprises were explored. Respondents ranked the priority of six types of government incentives or programs. Based on the interviews, the priorities of incentives or government programs needed for the adoption of sustainable farming are as follows: The highest priority is access to soft loans (53.33%), which is related to the need for fertilizers that differ from those previously used and the relatively high cost of certification, both of which require financial support. The next priority is certification cost incentives (45%), as high certification costs lead farmers to seek facilitation during initial certification, which is usually more expensive than re-certification. Support for biological production inputs (such as fertilizers, seeds, and others), as well as training and guidance, is the next priority at 38.33%. This is because the seeds and fertilizers used differ from those typically planted, requiring initial facilitation, and the different cultivation methods necessitate training and guidance to achieve optimal results. Following this, the next priority is obtaining a premium selling price (33.33%), and finally, market access (31.67%). Given that these cultivation practices differ from conventional methods, producing higher-quality and healthier products, farmers expect to receive a premium price for their grain or rice. Similarly, with increased productivity, a wider market is required, making facilitation of market access highly necessary.

Table 8. Priority Scale of Incentives/Government Programs Required for the Implementation of Sustainable Agriculture

Priority Scale	Premium Selling Price	Certification Cost Incentives	Access to Soft Loans	Market Access	Training and Mentoring	Support for Biological Agricultural Inputs (fertilizer, seeds, etc)
1	33.33	1.67	1.67	13.33	11.67	38.33
2	11.67	3.33	5.00	13.33	38.33	28.33
3	18.33	5.00	6.67	30.00	26.67	13.33
4	20.00	13.33	10.00	31.67	13.33	11.67
5	15.00	45.00	23.33	8.33	5.00	3.33
6	1.67	31.67	53.33	3.33	5.00	5.00

Next, respondents assessed the impact of government incentives on the performance of sustainable farming enterprises using a scale of 1–5 (much worse – much better). Based on interviews with SRP farmers in Boyolali Regency, there are eight impacts with scores above 3.5, indicating improvements resulting from the adoption of sustainable farming practices. The highest impact is observed in productivity and technology adoption, which improved the most, with a score of 3.97. Next, production capacity also increased, with a score of 3.90. The subsequent rankings are as follows: employment of workers with disabilities, profit/earnings, employment of female labor, income, overall employment, implementation of environmentally friendly sustainable practices, assets, and green investment.

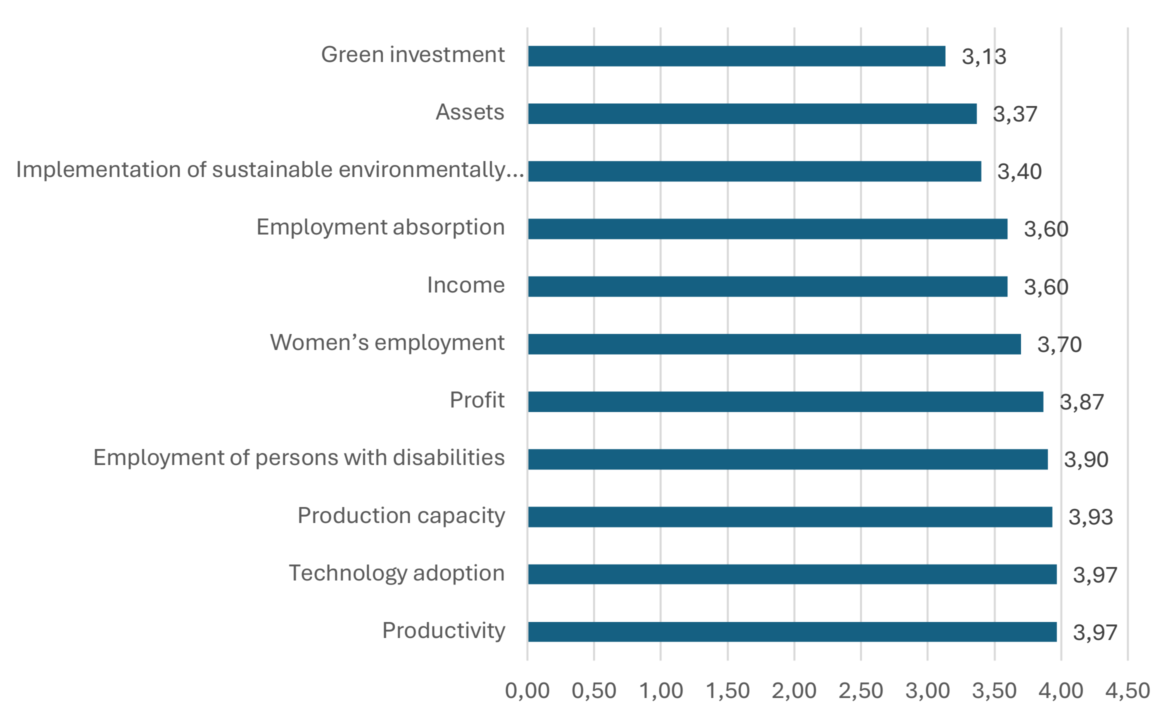


Figure 24. Rata Average Perception of the Impact of Government Incentives on the Performance of Sustainable Farming Businesses, Boyolali Regency

Based on the difference test regarding perceptions of the impact of government incentives on the performance of sustainable farming enterprises in Boyolali Regency, all impacts were found to be significant, as indicated by t-values exceeding the p-values. This suggests that the implementation of sustainable farming practices has a significant effect on production capacity, productivity, profit/earnings, income, technology adoption, the application of environmentally friendly sustainable practices, green investment, assets, employment of female labor, overall employment, and employment of workers with disabilities.

Table 9. Difference Test of Perceptions on the Impact of Government Incentives on the Performance of Sustainable Agricultural Enterprises, Boyolali Regency

Impact of Incentives	T-Value	P-value	Conclusion
Production Capacity	8.7642	0.000000	**There is an improvement** in the performance of sustainable agricultural enterprises in terms of production capacity.
Productivity	8.6099	0.000000	**There is an improvement** in the performance of sustainable agricultural enterprises in terms of productivity.
Profit	6.1166	0.000001	**There is an improvement** in the performance of sustainable agricultural enterprises in terms of profit.

Impact of Incentives	T-Value	P-value	Conclusion
Income	4.8711	0.000018	**There is an improvement** in the performance of sustainable agricultural enterprises in terms of income.
Technology Adaption	6.9221	0.000000	**There is an improvement** in the performance of sustainable agricultural enterprises in terms of technology adoption.
Implementation of Sustainable Environmentally Friendly Practices	3.8898	0.000270	**There is an improvement** in the performance of sustainable agricultural enterprises in terms of the implementation of sustainable environmentally friendly practices.
Green Investment	2.1122	0.021699	**There is an improvement** in the performance of sustainable agricultural enterprises in terms of green investment.
Assets	4.0975	0.000153	**There is an improvement** in the performance of sustainable agricultural enterprises in terms of assets.
Female Labor Absorption	5.8872	0.000001	**There is an improvement** in the performance of sustainable agricultural enterprises in terms of female labor absorption.
Labor Absorption	4.8711	0.000018	**There is an improvement** in the performance of sustainable agricultural enterprises in terms of labor absorption.
Absorption of Workers with Disabilities	6.4960	0.000000	**There is an improvement** in the performance of sustainable agricultural enterprises in terms of absorption of workers with disabilities.

The perception of the impact of government incentives on the performance of sustainable farming enterprises in Klaten Regency is not substantially different from that in Boyolali Regency. Production capacity received the highest score (4.13), followed by productivity and technology adoption. The implementation of sustainable farming practices increases soil nutrient content, thereby enhancing production capacity and productivity (3.93). Additionally, changes in cultivation patterns also contribute to an increase in technology adoption (3.93). The subsequent impacts, in order, are profit/earnings, employment of female labor, employment of workers with disabilities, overall employment, income, assets, the application of environmentally friendly sustainable practices, and green investment. Green investment received the lowest impact score in both regencies, which is related to the continued allowance of chemical fertilizer use in SRP implementation and the absence of specific SRP certification.

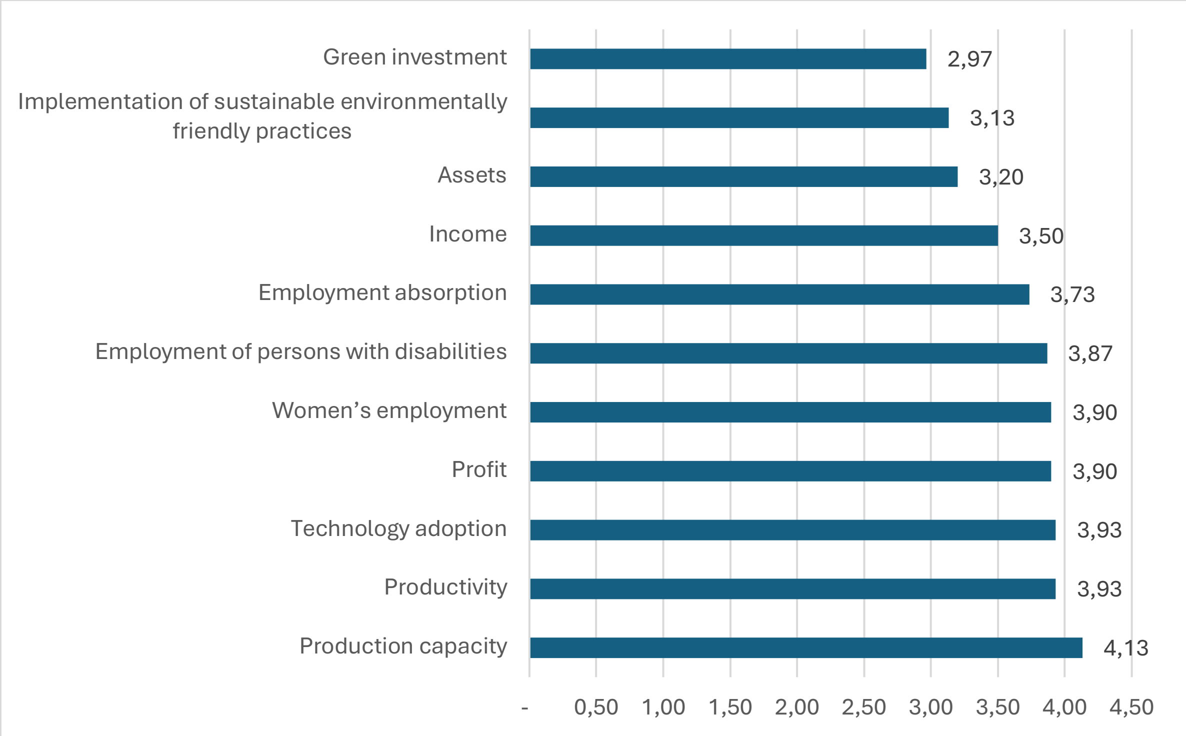


Figure 25. Average Perception of the Impact of Government Incentives on the Performance of Sustainable Farming Businesses, Klaten Regency

To determine whether government incentives have a significant impact on the performance of sustainable farming enterprises, a difference test was conducted. Based on the results regarding perceptions of the impact of government incentives on sustainable farming performance in Klaten Regency, two impacts were found to be insignificant: the application of environmentally friendly sustainable practices and green investment. This is related to the continued allowance of chemical fertilizer use and the absence of specific SRP certification. The remaining nine impacts were found to be significant, namely production capacity, productivity, profit/earnings, income, technology adoption, assets, employment of female labor, overall employment, and employment of workers with disabilities.

Table 10. Difference Test of Perceptions on the Impact of Government Incentives on the Performance of Sustainable Agricultural Enterprises, Klaten Regency

Dampak Insentif	Nilai t	p-value	Kesimpulan
Production Capacity	17.9540	0.000000	**There is an improvement** in the performance of sustainable agricultural enterprises in terms of production capacity.
Productivity	14.0000	0.000000	**There is an improvement** in the performance of sustainable agricultural enterprises in terms of productivity.
Profit	10.2557	0.000000	**There is an improvement** in the performance of sustainable agricultural enterprises in terms of profit.
Income	4.3489	0.000077	**There is an improvement** in the performance of sustainable agricultural enterprises in terms of income.

Technology Adaption	11.3658	0.000000	**There is an improvement** in the performance of sustainable agricultural enterprises in terms of technology adoption.
Implementation of Sustainable Environmentally Friendly Practices	1.6820	0.051650	**There is no improvement** in the performance of sustainable agricultural enterprises in terms of the implementation of sustainable environmentally friendly practices.
Green Investment	-0.4412	0.331181	**There is no improvement** in the performance of sustainable agricultural enterprises in terms of green investment
Assets	2.2622	0.015676	**There is an improvement** in the performance of sustainable agricultural enterprises in terms of assets.
Female Labor Absorption	16.1555	0.000000	**There is an improvement** in the performance of sustainable agricultural enterprises in terms of female labor absorption.
Labor Absorption	8.9303	0.000000	**There is an improvement** in the performance of sustainable agricultural enterprises in terms of labor absorption.
Absorption of Workers with Disabilities	10.9333	0.000000	**There is an improvement** in the performance of sustainable agricultural enterprises in terms of absorption of workers with disabilities.

5.4 Opportunities and Challenges for Low-Carbon Sustainable Rice as a Specialty Rice

Low-carbon sustainable rice has significant potential to be developed as a specialty rice due to global trends increasingly emphasizing environmental issues, sustainability, and healthy food consumption. Market demand for premium products, both domestically and internationally, provides opportunities for farmers to obtain added value through product differentiation, environmentally friendly certification, and government policy support aligned with emission reduction commitments. However, the development of low-carbon rice also faces several challenges that need to be mitigated. Essentially, the opportunity to develop low-carbon sustainable rice as a specialty rice is substantial, but its success heavily depends on synergy among farmers, the government, the private sector, and consumers. In detail, the internal and external factors influencing the development of low-carbon sustainable rice in Boyolali and Klaten Regencies are presented in the following sub-sections.

5.4.1 Internal and External Factors in the Development of Low-Carbon Sustainable Rice, Boyolali Regency

The internal factors in the development of low-carbon sustainable rice as a specialty rice are distinguished from external factors. Based on the perceptions of farmer respondents regarding internal factors in Boyolali Regency, (1) more efficient costs and (2) health benefits of the produced rice were perceived as the main strengths by 73.33% of respondents. Meanwhile, farmers perceived that (1) support from farmer groups, (2) the availability of standard operating procedures (SOPs) for sustainable rice farming, and (3) seed independence still represent weaknesses. Therefore, these factors, which are considered weaknesses, need to be addressed by relevant stakeholders to ensure that the development of low-carbon sustainable rice can achieve optimal results.

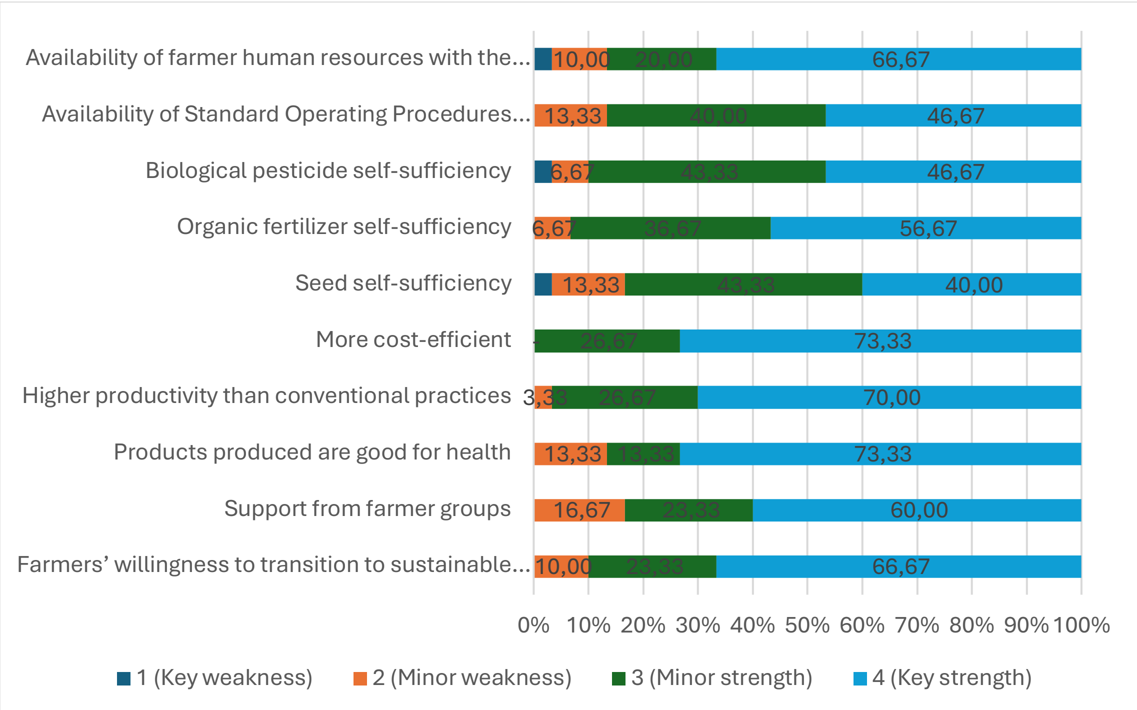


Figure 26. Perceived Assessment of Internal Factors (Strengths and Weaknesses) in the Development of Low-Carbon Sustainable Rice, Boyolali Regency

Furthermore, based on the Internal Factor Evaluation (IFE), these internal factors can be distinguished as strengths and weaknesses in the development of low-carbon sustainable rice. Based on the calculation of weight × rating, the average value obtained was 0.349. If a factor's weight × rating is above the average, it is considered a strength, whereas a value below the average is considered a weakness.

Table 11 shows that (1) more efficient costs, (2) higher productivity compared to conventional methods, and (3) health benefits of the produced rice are the main strengths in the development of low-carbon sustainable rice in Boyolali Regency. The implementation of environmentally friendly practices, such as water-saving, balanced fertilization, and integrated pest management, reduces excessive use of chemical inputs, thereby making production costs more efficient. On the other hand, improvements in soil fertility and the balance of the paddy field ecosystem increase productivity compared to conventional methods, as crops grow healthier and harvests are more stable in the long term. Chung and Theng (2025) stated that rice farmers implementing SRP by reducing the amount and timing of pesticide and herbicide applications achieved higher yields. Furthermore, minimizing chemical use results in rice that is safer for consumption and has added value as a healthy food product. Thus, low-carbon rice not only benefits farmers economically but also meets the demands of modern markets, which increasingly prioritize health and environmental sustainability.

However, the development of low-carbon sustainable rice still faces weaknesses, according to farmers' perceptions. Seed independence, the availability of standard operating procedures (SOPs) for sustainable rice farming, independence in biological pesticides, and support from farmer groups are perceived as weaknesses in Boyolali Regency. Low seed independence makes farmers highly dependent on external supplies, which may not always meet local needs, posing risks to costs and production continuity. The absence of clear and standardized SOPs can also hinder the adoption of SRP practices, as farmers lack uniform technical guidelines. Similarly, weak independence in biological pesticides indicates limitations in reducing reliance on chemical pesticides, even though biological pesticides are crucial for reducing emissions while maintaining ecosystem health. Moreover, insufficient support from farmer groups is perceived to weaken farmers' collective capacity to share knowledge, access technology, and advocate for common interests, resulting in a slower and uneven transformation toward a low-carbon rice system.

Table 11. Strengths and Weaknesses of Low-Carbon Sustainable Rice Development, Boyolali Regency

Internal Factors	Weight	Rating	Weight x Rating
Strengths			
More cost-efficient production	0,107	3,733	0,400
Higher productivity compared to conventional farming	0,105	3,667	0,386
Products are healthier for consumers	0,103	3,600	0,372
Farmers' willingness to shift to sustainable rice farming	0,102	3,567	0,365
Self-sufficiency in organic fertilizer	0,100	3,500	0,351
Availability of farmer human resources with the capacity to implement sustainable rice cultivation practices (environmental, economic, social, technological, as well as institutional and policy dimensions)	0,100	3,500	0,351

Internal Factors	Weight	Rating	Weight x Rating
Weaknesses			
Support from farmer groups	0,098	3,433	0,338
Self-sufficiency in biological pesticides	0,096	3,333	0,319
Availability of standard operating procedures (SOP) for sustainable rice farming	0,096	3,333	0,319
Seed self-sufficiency	0,092	3,200	0,294
Total	**1,000**		**3,494**
Average			**0,349**

Next, Figure 27 presents respondents' perceptions of external factors in the development of low-carbon sustainable rice in Boyolali Regency. It can be seen that the factor most frequently perceived as a key opportunity for the development of low-carbon sustainable rice is a higher price compared to conventional rice (83.33%). Meanwhile, (1) climate change and (2) stakeholders' still low perception of the empowerment, health, and safety of SRP farmers were both perceived by 80% of respondents as major threats to the development of low-carbon sustainable rice in Boyolali Regency.

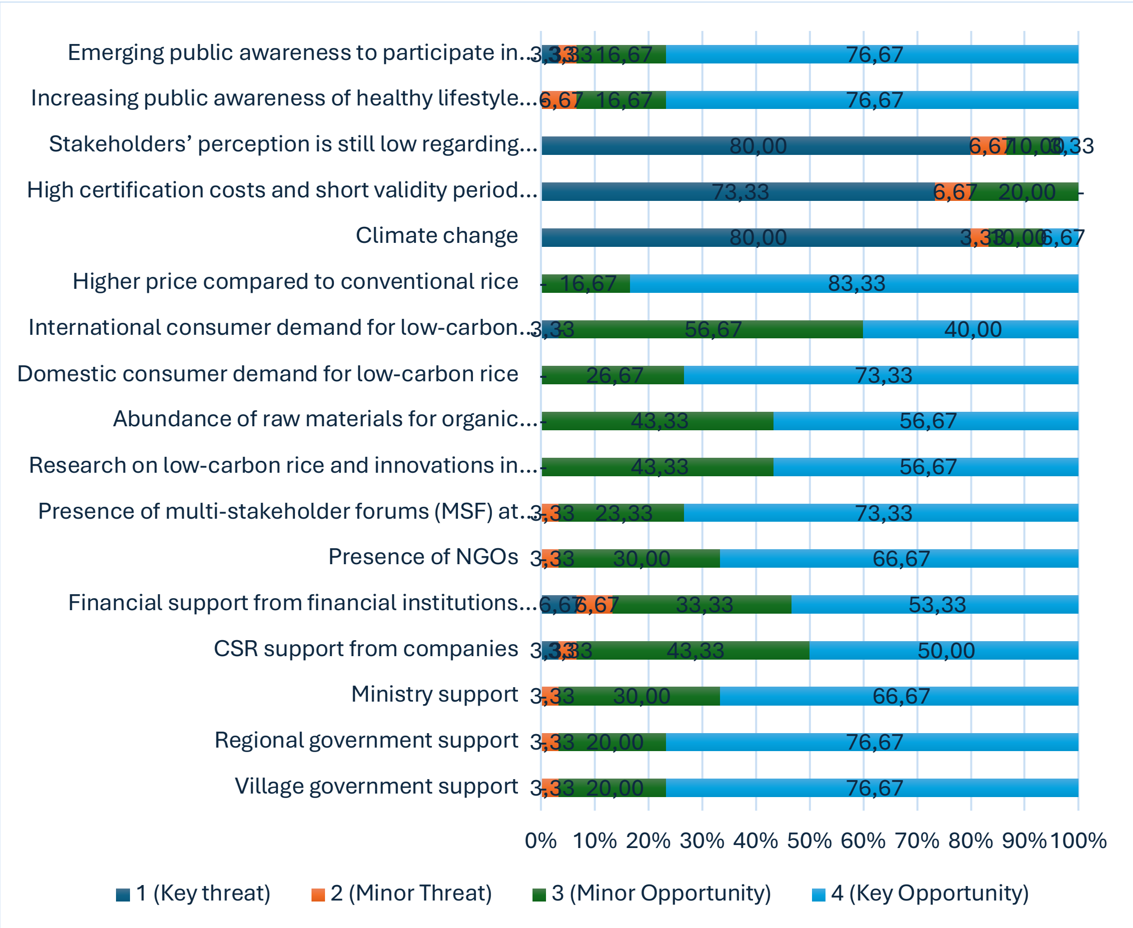


Figure 27. Respondents' Perceptions of External Factors (Opportunities and Challenges) in the Development of Low-Carbon Sustainable Rice, Boyolali Regency

Furthermore, based on the External Factor Evaluation (EFE) presented in Table 12, the perceived opportunities and challenges in the development of low-carbon sustainable rice in Boyolali Regency are shown. With an average weight × rating value of 0.203, the factors with weight × rating values above the average, and the highest among them, are perceived as key opportunities for developing low-carbon sustainable rice in Boyolali Regency. These factors include (1) higher prices compared to conventional rice, (2) support from village governments, (3) support from regional governments, and (4) domestic consumer demand for low-carbon rice. Higher selling prices reflect added value due to product quality and sustainability. If the government can establish policies designating low-carbon rice as a specialty rice, this can provide economic incentives for farmers to adopt environmentally friendly practices. Village government support plays a crucial role in facilitating technology adoption, providing information, and strengthening farmers’ institutions at the local level, while regional government support can expand reach through policies, budgets, and strategic programs that support marketing and access to wider markets. On the other hand, domestic consumers’ awareness and demand for healthy and environmentally friendly food create a more stable market and promote long-term sustainability. The synergy between economic incentives, institutional support, and a growing market makes these factors key opportunities for accelerating the development of low-carbon sustainable rice. In detail, the opportunities for developing low-carbon sustainable rice in Boyolali Regency can be seen in Table 12.

Table 12. Opportunities and Challenges in the Development of Low-Carbon Sustainable Rice, Boyolali Regency

External Factors	Weight	Rating	Weight x Rating
Opportunities			
Higher price compared to conventional rice	0,070	3,833	0,268
Support from village governments	0,068	3,733	0,254
Support from local governments	0,068	3,733	0,254
Domestic consumer demand for low-carbon rice	0,068	3,733	0,254
Presence of a Multi-Stakeholder Forum (MSF) at the regional level	0,067	3,700	0,250
Increasing public awareness of healthy lifestyles	0,067	3,700	0,250
Growing public awareness of environmental protection	0,067	3,667	0,245
Support from ministries	0,066	3,633	0,241
Presence of NGOs	0,066	3,633	0,241
Research on low-carbon rice and innovations in cultivation and technology from universities and research institutions	0,065	3,567	0,232
Abundant raw materials for organic fertilizers and biological pesticides	0,065	3,567	0,232
Corporate CSR support	0,062	3,400	0,211
Challenges			
Financing support from financial institutions (bank and non-bank)	0,061	3,333	0,203
International consumer demand for low-carbon rice	0,061	3,333	0,203
High certification costs and short validity period (if SRP certification is applied)	0,027	1,467	0,039
Climate change	0,026	1,433	0,037
Low stakeholder perception regarding the empowerment, health, and safety of SRP farmers	0,025	1,367	0,034
Total	**1,000**		**3,447**
Average			**0,203**

Next, the challenges perceived by farmer respondents in Boyolali Regency are related to (1) stakeholders' still low perception of the empowerment, health, and safety of SRP farmers, (2) climate change, and (3) high certification costs with short validity periods (if SRP certification is implemented). Low stakeholder recognition of farmers' empowerment, health, and safety in SRP implementation can create obstacles, as farmers do not yet receive full acknowledgment, protection, or adequate support, even though sustainable production heavily depends on their safety and well-being. Climate change is also a major challenge due to weather uncertainty, climate anomalies, and increasing frequency of disasters such as floods or droughts, which directly affect planting cycles and productivity. Thus, even if low-carbon practices are applied, the risk of crop failure remains high. Furthermore, if SRP is later designated as a specialty rice requiring certification, the high certification costs with short validity periods may impose an additional burden on small-scale farmers, who generally have limited capital. While certification is important to ensure standards and provide access to premium markets, without a financial support scheme, certification could become a barrier to SRP adoption.

5.4.2 Internal and External Factors in the Development of Low-Carbon Sustainable Rice, Klaten Regency

Next, regarding the development of low-carbon sustainable rice in Klaten Regency, the main strengths perceived by respondents are (1) more efficient costs (76.67%) and (2) independence in organic fertilizer production (76.67%). Cost efficiency arises because low-carbon cultivation practices encourage a reduction in the use of expensive external inputs, such as chemical fertilizers and synthetic pesticides, while optimizing the use of local resources through water-saving techniques and sustainable land management. This not only reduces production costs but also increases farmers' profit margins. In addition, independence in organic fertilizer production is a strategic factor because farmers are able to produce and utilize fertilizers from local materials, such as livestock manure or agricultural waste, which not only reduces expenditures but also naturally improves soil fertility. Given Klaten Regency's potential for organic fertilizer development, it is highly likely that production costs can ultimately be further optimized.

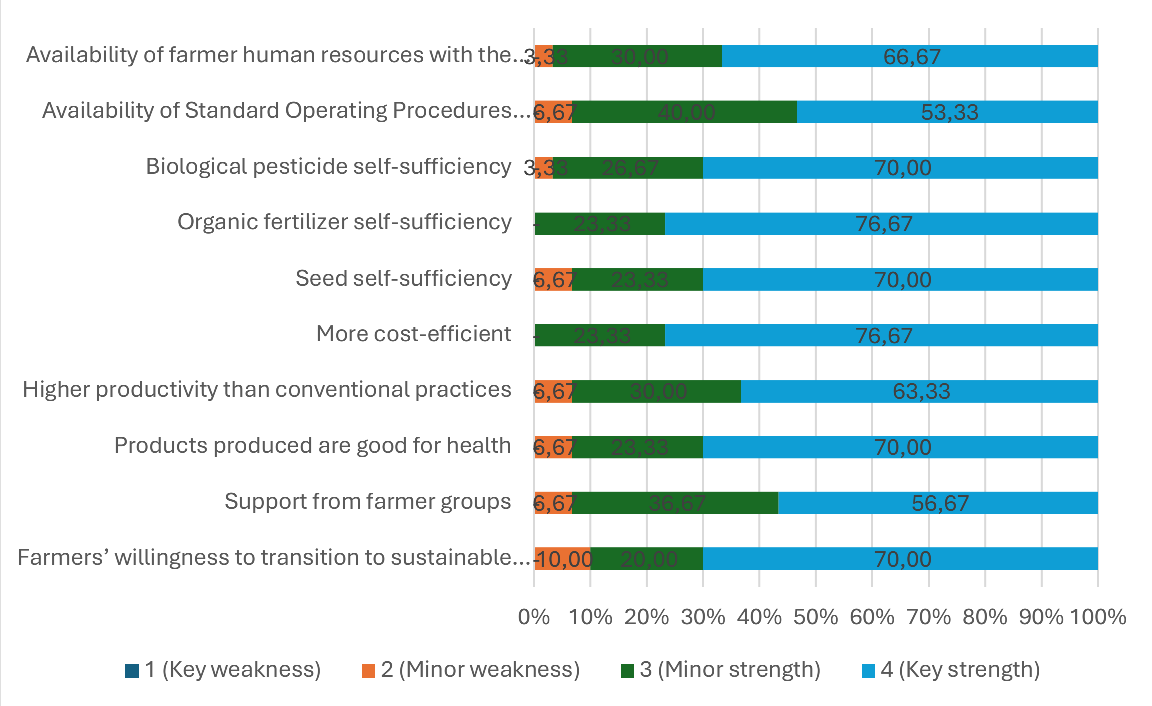


Figure 28. Respondents' Perceptions of Internal Factors (Strengths and Weaknesses) in the Development of Low-Carbon Sustainable Rice, Klaten Regency

Next, Table 13 presents the strengths and weaknesses based on internal factors as perceived by farmer respondents in Klaten Regency. With an average weight × rating value of 0.363, the main strengths are related to (1) more efficient costs, (2) independence in organic fertilizer production, and (3) independence in biological pesticide production. As previously explained, the resources available in Klaten Regency for producing organic fertilizers and biological pesticides can promote cost efficiency in agricultural production. The perception of cost efficiency as a strength in developing low-carbon sustainable rice in Klaten is also shared by farmer respondents in Boyolali Regency. This indicates that the implementation of SRP can reduce costs through savings in water use, fertilizers, and pesticides.

The weaknesses in the development of low-carbon sustainable rice perceived by farmers in Klaten are reflected in weight × rating values below the average, and are related to (1) the availability of standard operating procedures (SOPs) for sustainable rice farming, (2) support from farmer groups, (3) higher productivity compared to conventional methods, and (4) farmers' willingness to transition to sustainable rice farming. The limited availability of SOPs means that farmers do not yet have uniform and standardized technical guidelines to consistently implement low-carbon practices. Similarly, support from farmer groups (poktan) is considered suboptimal, even though they play a strategic role in strengthening institutions, enhancing capacity, and facilitating the adoption of new technologies among farmers. Although, in theory, sustainable rice productivity can exceed that of conventional rice, in practice farmers remain skeptical due to limited knowledge, experience, and actual harvest results that have not fully met expectations. Furthermore, farmers' willingness to switch to a sustainable system remains low, primarily due to concerns about harvest risks, additional capital requirements, and markets that are not yet fully accessible.

Compared to the weaknesses perceived by farmer respondents in Boyolali Regency, support from farmer groups and the availability of SOPs also emerge as issues that need to be addressed. Ideally, farmer groups should not only serve as a channel for obtaining assistance or incentives but also facilitate the adoption of sustainable rice farming methods in accordance with SOPs. Therefore, developing SOPs that are easily understood by farmers is essential, and continuous monitoring is needed to ensure that these SOPs are consistently applied in sustainable rice cultivation.

Table 13. Strengths and Weaknesses of Low-Carbon Sustainable Rice Development, Klaten Regency

Internal Factors	Weight	Rating	Weight x Rating
Strengths			
More cost-efficient production	0,104	3,767	0,392
Self-sufficiency in organic fertilizer	0,104	3,767	0,392
Self-sufficiency in biological pesticides	0,101	3,667	0,371
Products are healthier for consumers	0,100	3,633	0,364
Seed self-sufficiency	0,100	3,633	0,364
Availability of farmer human resources with the capacity to implement sustainable rice cultivation practices (environmental, economic, social, technological, as well as institutional and policy dimensions)	0,100	3,633	0,364
Weaknesses			
Farmers' willingness to shift to sustainable rice farming	0,099	3,600	0,358
Higher productivity compared to conventional farming	0,098	3,567	0,351
Support from farmer groups	0,097	3,500	0,338
Availability of standard operating procedures (SOP) for sustainable rice farming	0,096	3,467	0,332
Total	**1,000**		**3,626**
Average			**0,363**

Figure 29 illustrates the external factors influencing the development of low-carbon sustainable rice. Farmer respondents in Klaten Regency perceived that (1) the abundance of raw materials for organic fertilizers and biological pesticides (93.33%) and (2) the growing public awareness of environmental protection (90%) are the main opportunities for developing low-carbon sustainable rice. The availability of local raw materials, such as agricultural waste, livestock manure, and other biological inputs, provides an important foundation to promote input independence, reduce reliance on chemical fertilizers and pesticides, and lower production costs. Meanwhile, increased public awareness of environmental issues creates social support and expands the market for low-carbon rice, as consumers tend to value environmentally friendly products.

However, farmers also perceived major threats. About 73.33% of respondents identified high certification costs with short validity periods as a threat, while 70% perceived climate change as a significant challenge. High certification costs can burden small-scale farmers if SRP certification is implemented without subsidies or incentives. Climate change poses serious risks directly affecting production stability, including floods, droughts, and pest outbreaks that are more difficult to predict. Thus, although there are significant opportunities in terms of local resources and public support, the successful development of low-carbon rice still requires policy and institutional interventions to address financing constraints for certification and the threats posed by climate change.

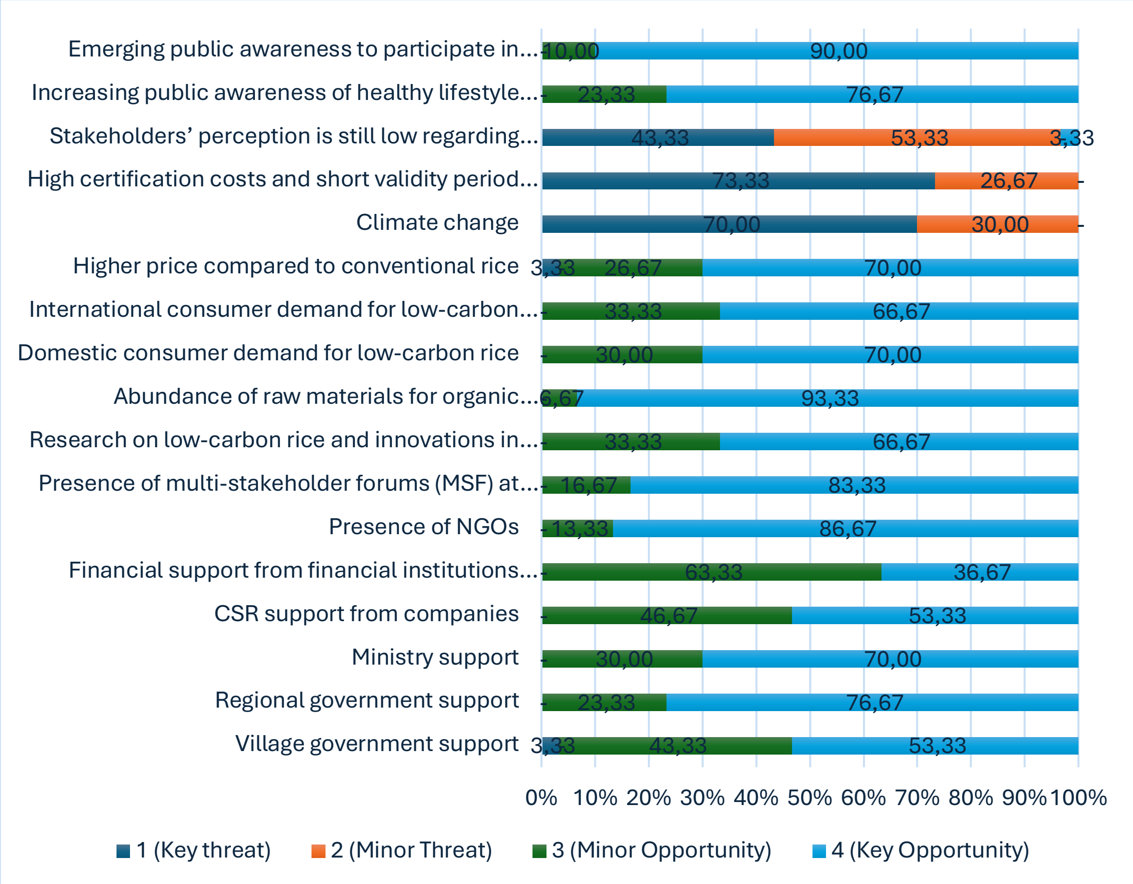


Figure 29. Respondents' Perceptions of External Factors (Opportunities and Challenges) in the Development of Low-Carbon Sustainable Rice, Klaten Regency

The opportunities for developing low-carbon sustainable rice in Klaten Regency are identified based on weight × rating values above the average. According to Table 5.8, these opportunities are related to (1) the abundance of raw materials for organic fertilizers and biological pesticides, (2) the growing public awareness of environmental protection, (3) the presence of NGOs, and (4) the existence of multi-stakeholder forums (MSFs) at the regional level. As previously explained, the advantage of implementing SRP lies in reducing the use of production inputs by utilizing organic fertilizers and biological pesticides, whose raw materials are abundant in Klaten Regency. The presence of NGOs that directly support SRP implementation and the existence of MSFs at the regional level, which keep all stakeholders informed about SRP developments, also constitute key opportunities for the development of low-carbon sustainable rice in Klaten Regency.

Table 14. Opportunities and Challenges in the Development of Low-Carbon Sustainable Rice, Klaten Regency

External Factors	Weight	Rating	Weight x Rating
Opportunities			
Abundant raw materials for organic fertilizers and biological pesticides	0.0702	3.9333	0.2763
Growing public awareness to participate in environmental protection	0.0696	3.9000	0.2716
Presence of NGOs	0.0690	3.8667	0.2670
Presence of a Multi-Stakeholder Forum (MSF) at the regional level	0.0685	3.8333	0.2624
Support from local governments	0.0673	3.7667	0.2534
Increasing public awareness of healthy lifestyles	0.0673	3.7667	0.2534
Support from ministries	0.0661	3.7000	0.2445
Domestic consumer demand for low-carbon rice	0.0661	3.7000	0.2445
Research on low-carbon rice and innovations in cultivation and technology from universities and research institutions	0.0655	3.6667	0.2401
International consumer demand for low-carbon rice	0.0655	3.6667	0.2401
Higher prices compared to conventional rice	0.0649	3.6333	0.2357
Corporate CSR support	0.0631	3.5333	0.2229
Support from village governments	0.0619	3.4667	0.2146
Challenges			
Financing support from financial institutions (bank and non-bank)	0.0601	3.3667	0.2024
Low stakeholder perception regarding the empowerment, health, and safety of SRP farmers	0.0292	1.6333	0.0476
Climate change	0.0232	1.3000	0.0302
High certification costs and short validity period (if SRP certification is applied)	0.0226	1.2667	0.0287
Total	**1.0000**		**3.5352**
Average			**0.2080**

Next, the challenges perceived by farmer respondents in Klaten Regency are related to (1) high certification costs with short validity periods (if SRP certification is implemented), (2) climate change, (3) stakeholders' still low perception of the empowerment, health, and safety of SRP farmers, and (4) limited financial support from financial institutions (banks and non-banks). These four challenges identified by farmers in Klaten are also reported by respondents in Boyolali Regency. High certification costs with short validity periods are a major constraint because they can increase the financial burden on small-scale farmers if SRP certification is implemented without subsidies or adequate financing schemes. In addition, climate change introduces production uncertainties due to changes in rainfall patterns, droughts, and unpredictable pest outbreaks, thereby increasing the risks associated with farming activities. Furthermore, the low perception of stakeholders regarding farmers' empowerment, health, and safety indicates that the well-being and protection of farmers have not yet been prioritized in the implementation of sustainable farming systems, even though these aspects are critical for maintaining motivation and ensuring the long-term sustainability of practices in the field. Another challenge is limited financial support from financial institutions, both banks and non-banks, which makes it difficult for farmers to access working capital, invest in environmentally friendly equipment, or cover certification costs. A longstanding issue remains the difficulty for farmers to access financing due to various reasons, including insufficient collateral and lengthy application and bureaucratic procedures. Overall, these challenges emphasize that the development of low-carbon rice not only depends on technical innovation but also requires structural support in the form of policies, inclusive financing, and recognition of farmers as the primary actors in the transformation toward sustainable agriculture.

CHAPTER 6
RECOMMENDATIONS AND STRATEGIES TO PROMOTE LOW-CARBON SUSTAINABLE RICE AS A SPECIALTY RICE

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In order to promote the development of low-carbon sustainable rice as a special rice category, it is necessary to formulate appropriate strategic priorities to achieve optimal results. There are six actors involved in the development of low-carbon sustainable rice, namely:

1. Central Government (Ministry of National Development Planning / National Development Planning Agency, the Ministry of Agriculture, the Ministry of Finance—particularly through the initiation of special People's Business Credit/KUR for sustainable rice, BPDLH, the Ministry of Environment and Forestry, and the Ministry of Trade);
2. Local Governments**;**
3. Farmers / Farmer Groups (Poktan) / Farmer Group Associations (Gapoktan)**;**
4. Standards Bodies / Certification Institutions**;**
5. Academics / Higher Education Institutions**;**
6. International Institutions / NGOs**.**

Furthermore, seven (7) factors that support the development of low-carbon sustainable rice were identified, namely:

1. Public demand and awareness for the consumption of SRP products;
2. Multi-stakeholder support (central and local governments, standards bodies/certification institutions, NGOs, and higher education institutions);
3. Climate change;
4. Financial support;
5. Economically viable pricing of SRP products;
6. Availability of inputs required to produce SRP products;
7. Certification costs.

Based on the actors and factors above, strategic recommendations in the form of incentive schemes were formulated to support the development of low-carbon sustainable rice, including:

1. Banking and non-banking financing schemes;
2. Special Allocation Fund schemes;
3. Special rice price incentive schemes;
4. SRP physical infrastructure schemes (light traps, planting equipment, drones, pest trap houses, and others);
5. SRP innovation support schemes (climate-resilient varieties, biofertilizers, biopesticide inputs, and others);
6. Certification assistance schemes;
7. Carbon trading schemes.

The detailed results of the Analytical Hierarchy Process (AHP) analysis are presented in Figure 30.

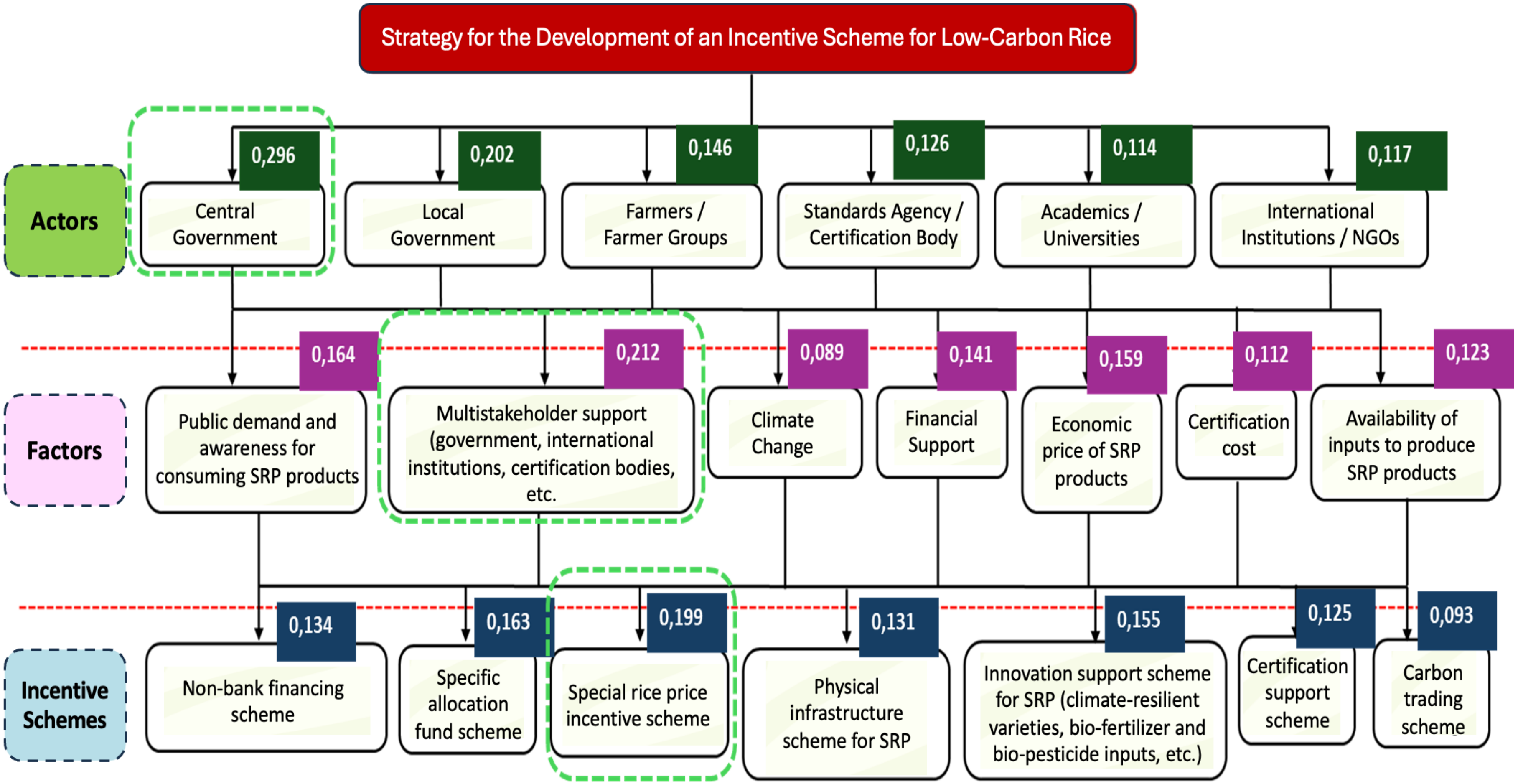

Figure 30. Strategy for Developing an Incentive Scheme for Low-Carbon Sustainable Rice
Source: Primary Data from FGDs in Boyolali, Klaten, and Jakarta (2025)

The AHP questionnaire was completed by key expert respondents, including representatives of farmers, local governments, and the central government who are involved in the development of low-carbon sustainable rice. The results of the analysis indicate that the central government is the primary actor playing a crucial role in the development of SRP incentive schemes. This finding suggests that the role and support of the central government are considered the most strategic, as it holds the authority to formulate national policies and regulations, as well as to allocate budgets that can influence the direction and sustainability of low-carbon agriculture implementation across regions. In addition, the central government serves as the main driving force in the development of national standards, the provision of incentives, and the facilitation of cross-sector partnerships required to strengthen the sustainable agriculture ecosystem. The dominance of this priority also reflects the view that the success of low-carbon sustainable rice development is highly dependent on macro-level policy support and effective inter-institutional coordination from the central to the local level.

Furthermore, based on the AHP analysis results, local governments rank as the second-priority actors in the development of low-carbon sustainable rice and are perceived to play an important role as a bridge between national policies and their implementation at the regional level. Local governments play a strategic role in translating central policies into programs that are aligned with local conditions, including the provision of technical support, farmer assistance, and facilitation of access to environmentally friendly technologies and sustainable rice markets. Moreover, local governments have the capacity to build inter-agency synergies, strengthen farmer institutions, and promote collaboration with the private sector and financial institutions. Through these coordinative and facilitative roles, local governments become the frontline actors in ensuring the sustainability of low-carbon agricultural practices within their regions, while also bridging farmers’ needs with policies and resources available at the central level. This approach has been implemented by the local governments of Klaten and Boyolali Regencies, in collaboration with NGOs, through their strong support for the establishment of a multi-stakeholder forum (MSF) as a platform for discussing SRP needs and implementation. With support from local governments, development capital for sustainable agriculture is derived not only from assistance and incentives provided by the central government, but also from support from NGOs. Furthermore, the existence of local-level regulations that demonstrate alignment with and support for farmers adopting SRP represents a form of institutional backing that encourages the long-term sustainability of SRP.

At the factor level, multi-stakeholder support emerges as the top priority in the development of low-carbon sustainable rice, as the successful implementation of this program is highly dependent on collaboration among various parties with different roles and interests along the agricultural value chain. The involvement of central and local governments, standards bodies/certification institutions, higher education institutions, and NGOs is essential to create a supportive ecosystem from upstream to downstream. Governments play a role in formulating regulations and providing incentives, while universities and research institutions contribute low-emission technological innovations. Synergy among these stakeholders enables knowledge transfer, resource efficiency, and the sustainability of implementation.

Furthermore, public demand and awareness regarding the consumption of SRP products also serve as a major driving factor encouraging farmers to produce SRP rice. In production activities, producers must pay close attention to market conditions and consumer preferences. This is because the growing consumer interest in healthy, safe, and environmentally friendly products creates promising market opportunities. Such awareness arises alongside changes in lifestyle and increasing public concern about the environmental impacts of agricultural activities, thereby giving SRP rice added value compared to conventional rice. Continuously increasing demand encourages farmers to adapt to higher production standards, adopt environmentally friendly practices, and maintain product quality in line with consumer preferences. In addition to providing economic incentives, the rising trend in SRP rice consumption also strengthens farmers' motivation to shift toward low-carbon agricultural systems due to the assurance of market access and the potential for higher selling prices.

The incentive scheme prioritized for the development of low-carbon sustainable rice based on the AHP analysis is the "special rice price incentive scheme." This incentive scheme directly provides economic motivation for farmers to shift to and remain in sustainable agricultural systems. By offering a higher selling price compared to conventional rice, farmers receive compensation for the additional efforts required to implement environmentally friendly practices, such as emission reduction, the use of organic fertilizers, and resource efficiency, including the empowerment of women and persons with disabilities. This price incentive also reflects the added value of sustainability aspects, both in terms of product quality and food safety, as well as positive environmental impacts. Farmers need to be provided with special incentives in the implementation of low-carbon sustainable rice, as this scheme not only aims to improve farmers' welfare but also encourages the development of a more equitable and transparent sustainable rice supply chain, in which consumers are willing to pay a premium for products that contribute to climate change mitigation. These findings are consistent with a survey conducted by GIZ and YouGov (2022), funded by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH.

GIZ and YouGov conducted a survey in March 2022 with funding from the develoPPP program, implemented by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH on behalf of the German Federal Ministry for Economic Cooperation and Development (BMZ), in collaboration with private companies through the Mainstreaming Sustainable Rice project. This study aimed to expand the global production and demand for sustainable rice and targeted respondents who regularly consume rice and are responsible for household food purchases in India, Indonesia, Pakistan, Thailand, and Vietnam. The survey results indicate a growing consumer interest in sustainable rice, with the main reasons for choosing such products being quality, price, and rice type. Older consumers, particularly those aged over 55 years, prioritize quality, health, and taste when selecting sustainable food products, highlighting the importance of these factors in the decision-making process.

Health emerged as the primary attribute associated with sustainable rice, with characteristics such as minimal use of chemical inputs (45%) and improvements in farmers' welfare (43%) influencing purchasing decisions. The survey also found that consumers in the Surabaya region were more willing to pay a premium for sustainable rice, with 29% expressing interest in a 10% price increase, compared to the national average of 17%. Sustainable rice consumers are generally millennials and older adults with higher education levels and upper-income backgrounds, who frequently consume white rice. Based on the survey, consumers willing to pay a premium for sustainable rice are most likely to be aged 25–34 years or 55 years and above, come from upper-income households, and have higher levels of education. Quality, health, and taste are the main factors influencing consumer purchasing decisions (Sustainable Rice Platform, 2022). The incentive scheme in the form of a premium selling price is also consistent with the findings presented by Wiyono (2025). Furthermore, Wiyono (2025) states that other incentive schemes may take the form of tax reductions; access to concessional credit specifically for bio-based and organic agriculture; support for bio-based production inputs (such as local biofertilizers and botanical pesticides); and continuous technical assistance and training. In this study, the SRP innovation support scheme (including climate-resilient varieties, biofertilizer inputs, biopesticides, and others) ranked third with a value of 0.155, while banking and non-banking financing schemes ranked fourth with a coefficient value of 0.134.

The incentive scheme ranked second is related to the "Special Allocation Fund (DAK) incentive scheme," which functions as a fiscal policy instrument to strengthen government support for sustainable agriculture programs. Through the DAK, the central government can allocate dedicated funding to local governments to support various strategic activities, such as the provision of environmentally friendly infrastructure and facilities, farmer training, research, and the facilitation of sustainable rice certification, which remains a major challenge based on farmers' perceptions. This scheme not only helps reduce cost burdens at the farmer level but also ensures program continuity from the central to the local level.

Ranked third, the incentive scheme is directed toward Sustainable Rice Platform (SRP) innovation support through increased investment in Research and Development (R&D) activities to produce superior low-carbon rice varieties, as well as support for the provision of bio-based production inputs such as biofertilizers, seeds, and biopesticides. This scheme aims to reduce farmers' dependence on external chemical inputs while addressing the limited farmer self-reliance in seed provision and production inputs. With the availability of production inputs that are aligned with SRP principles, cultivation efficiency can be improved, production risks can be reduced, and the sustainability of rice farming systems can be strengthened, thereby ensuring the adequate availability of inputs required to produce low-carbon sustainable rice in accordance with SRP standards.

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