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The role of farmer groups and agricultural extension services in enhancing rice productivity and farm income

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ABSTRACT

Background: The rising national demand for rice has drawn attention as farmers face low rice productivity and inadequate farm income. Farmer groups and agricultural extension agents are predicted to tackle these problems; however, their specific contributions remain unclear. Therefore, this study aims to examine the roles of farmer organizations and extension agents in improving rice productivity and farm income in Indonesia. **Methods**: This study employed 2024 cross-sectional data covering all provinces of Indonesia, gathered from the Central Bureau of Statistics (BPS) and the Ministry of Agriculture. Further, the data for rice productivity are specific, while the available farm income data represent overall agricultural income due to data limitations. Our study analyzed the data employing two separate multiple linear regression approaches, incorporating composite indices for farmer groups and extension agents, as well as priority province status as control variables to assess the influence of these actors on rice productivity and farm income. **Findings:** The study finds that neither farmer organizations nor extension agents hava a significant effect on rice productivity. However, farmer organizations display an adverse effect on farm income at the 10% significance level, while extension agents have a positive but statistically insignificant effect. Additionally, the priority province variable shows statistical significance at the 1% level for rice productivity but not for farm income**. Conclusion**: The findings conclude that strengthening farmer organizations and extension services in Indonesia remains a major concern for improving rice productivity and farm income. Despite these insights, using aggregate farm income data remains a limitation that can not fully reflect the specific economic dimension of rice-based farming. **Novelty/Originality of this article:** Prior research focused on data from a specific region, whereas this article employs national data to provide a broader analysis of farmer organizations and extension agents.

KEYWORDS: agricultural extension; farm income; farmer organizations; Indonesia; rice productivity.

1. Introduction

Since 2010, the population in Indonesia has grown by 3.25 million of people annually (Badan Pusat Statistik, 2020). By 2045, the country is predicted to reach the position of the world's fifth most populous country, thus raising concerns about food security (Bodirsky et al., 2015; Becker & Fanzo, 2023; Rawat, 2019). The rapid increase in population will result in a greater demand for staple foods, especially rice, which plays a crucial role in both Indonesia's food culture and its agricultural sector. As a result, rice production systems are increasingly pressured to raise rice productivity and guarantee adequate supplies to fulfill the rising food needs of Indonesia's growing population (Arifin et al., 2021; Sulaeman, 2023). Further, efforts to enhance the efficiency and productivity of rice farming have become more urgent. However, the implementation of these improvements is far from

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straightforward, as a number of long-standing structural constraints continue to limit progress within the domestic agricultural sector.

In Indonesia, the challenges of rice production are substantial and hinder the potential for increased productivity. Rice farmers, for example, face difficulties such as limited access to high-quality seeds and fertilizers (Santoso et al., 2023; Ekaria & Muhammad, 2025; Qadir et al., 2024; Fitri & Nainggolan, 2022). Soil degradation and weather extremes also worsen the problem (Ansari et al., 2021; Khumairoh et al., 2018; Kamakaula & Fenetiruma, 2025; Hirakawa et al., 2024). Further, the adverse effects of climate change on the farming conditions predispose rice to lower yields so that national food security will be threatened (Ansari et al., 2021; Rondhi et al., 2019). Soil degradation and weather extremes also worsen the problem (Ansari et al., 2021; Khumairoh et al., 2018; Kamakaula & Fenetiruma, 2025; Hirakawa et al., 2024; Santoso et al., 2023). Additionally, the negative effects of climate change on the farming conditions predispose rice to lower yields so that national food security will be threatened (Ansari et al., 2021; Rondhi et al., 2019).

Apart from serving as a staple food, rice supports the livelihoods of millions of people and remains the backbone of rural economies (Sutardi et al., 2023). Fluctuations in rice productivity and farm income can have broad social and economic impacts, particularly for farmers who are vulnerable to risks such as land conversion and climate variability. Nevertheless the initiatives have been implemented; Indonesia continues to struggle to realize rice self-sufficiency. This struggle for self-sufficiency is mainly caused by the permanent loss of paddy fields and long-standing structural issues within the farming sector (Sutardi et al., 2023).

Rapid population growth and climate change in developing countries result in food insecurity (Lin et al., 2022; Food and Agriculture Organization of the United Nations (FAO), 2022; Sundram, 2023; Raj et al., 2022). Further, some major producing countries, such as Vietnam, India, and Thailand, implement institutional reforms, a robust extension system, and active farmer organizations so that they can sustain agricultural productivity amid these challenges (Truong, 2022; Saengchai et al., 2020; Venkatesan et al., 2023). The effectiveness of international experience offers valuable insights into strengthening Indonesia's agricultural resilience through institutional empowerment, so that accelerating progress toward national food security and rural development goals can be realized. The main lesson from these countries shows that strong local organizations are key to successfully delivering policy to farmers and stabilizing food supply. For Indonesia, this means that the most practical way forward is to strengthen the farmer groups and extension services.

Promoting sustainable agricultural development in Indonesia are related to broad policy objectives such as reducing poverty, protecting the environment, and empowering rural communities (Food and Agriculture Organization of the United Nations (FAO), 2022; Ruspayandi et al., 2022). Achieving the goals calls for close collaboration among government, private enterprises, non-governmental organizations, and local communities. In this context, intermediary actors—particularly farmer groups and agricultural extension agents—are essential in linking national policies to practical changes at the grassroots level. For this reason, strengthening the two institutional actors has become a central element in strategies aimed at improving agricultural performance and rural livelihoods. Because of differences in organizational capacity, leadership quality, and resource accessibility, the effectiveness of the two institutional arrangements often varies widely. Therefore, a clear assessment of the operational strength of farmer groups and extension services is crucial to understanding their actual contribution to Indonesia's agricultural success.

In spite of their crucial roles in enhancing rice productivity and farm income, extension agents and farmer groups continue to receive uneven institutional support across Indonesia. Since 2015, the government has conducted several initiative programs, including UPSUS PAJALE, to supply high quality seeds, fertilizers, machinery, and technical support to farmer in the priority provinces (Purnamasari et al., 2023; Zulfitriyana et al., 2020). In 2025, the government sustains its efforts to expand modern farming technologies across priority provinces (BBPP Ketindan, 2025). As a result, the provinces generally receive stronger

institutional attention and support, whereas non-priority regions have more limited access to such resources. This systemic allocation disparity directly translates into inconsistent capacity and operational strength among institutions outside these focused programs. Consequently, understanding the actual performance of farmer groups and extension agents in regions lacking priority support is vital for formulating equitable national agricultural policies.

Institutional arrangements in Indonesia—such as farmer groups and agricultural extension agents—are intended to enhance farmers' capacities and support better farm outcomes (Cholisoh & Gayatri, 2023; Nuryanti & Swastika, 2011; Sulaiman et al., 2011). Further, farmer groups have the role in sharing knowledge and technologies, as well as facilitating access to agricultural resources and markets (Anantanyu, 2011; Barokah et al., 2023; Nuryanti & Swastika, 2016; Indrayani et al., 2025; Rahmadanih et al., 2018). Extension agents also help the government implement best practices and innovative agriculture for rice farmers. Yet, the real success of these two institutions is fully determined by the quality of the support from government, including training and effective policy execution (Aziz & Wardani, 2025; Jamil et al., 2023; Salahuddin et al., 2025; Utama & Sukiyono, 2025). This highlights that the contribution of these institutions is often inconsistent when measured across different local communities. Addressing this variability requires an empirical examination of the internal dynamics—such as organizational capacity—to measure their true impact on farm outcomes.

The Indonesian government has implemented various programs to boost rice productivity. The program effectiveness can be achieved through the meaningful participation of farmer groups and agricultural extension agents (Anderson & Feder, 2004; Rivera & Rasheed, 2009; Ma et al., 2023). Empirical studies from some countries also provide evidence that farmers who actively participate with extension agents and farmer organizations are more likely to adopt technologies so that they can achieve higher agricultural productivity and earn greater farm income (Ahmed & Mesfin, 2017; Anang et al., 2020; Aremu & Reynolds, 2024; Aremu et al., 2025; Danso-Abbeam et al., 2018; Wossen et al., 2017; Ragasa & Mazunda, 2018; Demont, 2022; Lin, et al., 2022; Bachke, 2019; Seneerattanaprayul & Gan, 2021). Furthermore, research conducted in some regions of Indonesia such as Aceh (Agussabti et al., 2022), Bengkulu (Utama & Sukiyono, 2025), Bali (Sedana et al., 2021), Central Java (Sudrajat, 2020), East Java (Hakim et al., 2021), South Sulawesi (Jamil et al., 2023; Rahmadanih et al., 2018; Salam et al., 2024), and West Java (Anwarudin & Dayat, 2019) confirms the same findings on rice productivity and income improvements due to their involvement with extension services and farmer organizations, particularly farmer groups. Despite this strong agreement on positive impact, the most current studies overlook the internal factors that enable or restrict the operational success of farmer groups and agricultural extension agents. Identifying which specific role of the two organizational structures actually drive improved productivity and income requires a focused investigation into the dynamics of both institutions.

To date, investigations from Indonesia have indicated that well-functioning farmer groups and extension agents impact the adoption of technology, effective management, and strong resilience to climate change among farmers (Agussabti et al., 2022; Sugihono et al., 2025; Jamil et al., 2023). Further, when the cooperation between extension agents and farmer groups has shown successful, traditional rice farming can then be a more productive and sustainable system (Rikardus, 2025; Rosdiana et al., 2023; Utama & Sukiyono, 2025; Sutardi et al., 2023). Nonetheless, these potential benefits are still unevenly spread because of differences in resource allocation, quality of training, and extension coverage within farmer groups and extension services. Although the regional studies confirm positive impacts, the current literature fails to provide comprehensive insight into the role of these institutions at the national level. This lacuna can be filled by conducting an initial investigation using national secondary data.

Assessing the effectiveness and influence of extension agents and farmer groups requires comprehensive studies. The majority of existing research in Indonesia remains scarce at the national level, because most existing research focuses on specific regions

(Rahmadanih et al., 2018; Salam et al., 2024) and rarely investigates differences between priority and non-priority provinces. Internationally, only two research conducted by Ragasa & Mazunda (2018) and Wossen et al. (2017) has quantitatively analyzed the correlation between the quantity of extension agents and farmer groups and agricultural results. The limited availability of nationwide evidence hinders the ability to develop programs that specifically and effectively improve rice productivity and farmers' incomes. This situation creates a strong demand for national quantitative data that can capture the institutional landscape and clearly assess the impact of the government's priority status. Beyond investigating more regions, our study also improves to measure the impact of these organizations at a national level. Therefore, the current study fills this critical gap by presenting the first national-level quantitative assessment of the role played by these two institutional actors.

The need for a focused investigation into these institutions is further intensified by the rapid technological changes currently reshaping the agricultural landscape. The agricultural sector, particularly rice commodities in Indonesia, has recently entered a period of accelerated modernization, as indicated by the introduction of digital technologies, precision agriculture, and climate-smart farming practices (Isnurdiansyah et al., 2025; Sutardi et al., 2023; Pamungkas et al., 2024; Wandayantolis et al., 2024; Widanti et al., 2024). Such modernization brings on huge opportunities to increase and sustain rice productivity and farm income. At the same time, ongoing technological progress is motivating farmers to rely more on data-oriented and environmentally responsible practices, further strengthening the transformation taking place within the rice farming system.

This study applies the Diffusion of Innovations Theory by Rogers (2003) to develop a framework that highlights the vital role of institutional actors, particularly extension agents and farmer groups, in supporting the adoption of agricultural programs and innovations (Anderson & Feder, 2007; Bachke, 2019). Additionally, this study aims to provide comprehensive empirical evidence about their impact on rice productivity and farm income in Indonesia by examining the number of extension agents and farmer groups, along with the provincial priority status. This quantitative approach also offers the first national-level assessment of the institutional actors' influence on farm performance, directly filling a key gap in the extant literature. Based on the Diffusion of Innovations Theory, our study postulates that a greater number of extension agents and farmer groups will lead to higher rice productivity and farm income. Further hypotheses state that the government's priority province status serves as a significant catalyst in amplifying these impacts. Ultimately, the findings will inform policy decisions on effective institutional support and resource equity for Indonesia's rice sector.

Our theoretical framework suggests that these two institutional actors enhance farm performance—specifically rice productivity and income—by breaking down knowledge barriers and fostering collective efforts. We further argue that extension agents are key to driving innovation adoption, while farmer groups provide the social capital necessary for better resource access. Unlike prior investigations focusing on specific regions, our study leverages national-level data to verify these mechanisms through a quantitative lens.

2. Methods

A quantitative method is applied to examine the factors influencing rice productivity and farm income in Indonesia. The two indicators function as the dependent variables whereas the independent variables are chosen according to their relevance to the study objectives and the availability of cross-sectional data from official sources. The rice productivity data is obtained from the Central Bureau of Statistics (BPS) for February 2024, expressed as the average rice production per hectare in each province of Indonesia. Additionally, data regarding farm income for the same period are from BPS and reflect on the average net monthly income of self-employed individuals within the Indonesian agriculture, forestry, hunting, and fisheries sectors. The data are employed because of the unavailability of farm income from rice commodities. The use of official, nationally

representative data sources ensures high reliability and broad external validity for the findings of this study.

The number of farmer groups and extension agents in each province in 2024 is one of the three independent variables used in this study. Although the data are nonspecific to the rice commodities, they are still relevant when rice is the dominant crop cultivated across Indonesia (Arie et al., 2024). Further, one of the remaining independent variables is a binary indicator representing provinces designated as priority areas for the rice development program by the Ministry of Agriculture. Combining this binary policy status with continuous institutional data allows us to simultaneously assess both organizational capacity and strategic resource allocation. Specifically, the incorporation of priority province status serves as a control to mitigate potential omitted variable bias, accounting for non-random government policy targeting that might otherwise confound the estimated effects.

Table 1. Description of variables, their definitions, units, and data sources

Variable	Definition	Unit	Sources
Rice productivity	Average rice yield per province, February 2024	tons/hectare	Central Bureau of Statistics (Badan Pusat Statistik, 2025)
Farm income	Average net monthly income of self-employed individuals in agriculture, forestry, hunting, and fisheries sectors, February 2024	IDR/month	Central Bureau of Statistics (Badan Pusat Statistik, 2024)
Number of farmer group in agriculture sector	Total number of farmer groups per province, December 2024	Group(s)	Agricultural Data Center and Information System, Ministry of Agriculture (Pusat Data dan Sistem Informasi Pertanian, 2024a)
Number of extension agents in agriculture sector	Total number of extension agents per province December, 2024	Person	Agricultural Data Center and Information System, Ministry of Agriculture (Pusat Data dan Sistem Informasi Pertanian, 2024a)
Farmer group index	Composite index of agricultural and forestry farmer groups per province, annual 2024 (fishery group data unavailable)	Index	Agricultural Data Center and Information System, Ministry of Agriculture (Pusat Data dan Sistem Informasi Pertanian, 2024a; SIMP2SDM, 2024)
Extension agents index	Composite index of agricultural and forestry extension agents per province, annual 2024 (fishery extension agent data unavailable)	Index	Agricultural Data Center and Information System, Ministry of Agriculture (Pusat Data dan Sistem Informasi Pertanian, 2024a; SIMP2SDM, 2024)
Priority provinces	Dummy variable: 1 if designated as a priority province for rice development program, 0 otherwise	Dummy (1/0)	Agricultural Data Center and Information System, Ministry of Agriculture (Pusat Data dan Sistem Informasi Pertanian, 2024b)

To analyze farm income thoroughly, composite indices were created as independent variables following the approach outlined by the OECD (2008). Further, these indices were

constructed by normalizing the raw data to a common scale and then applying equal weights to the components before aggregation. These indices represent the combined number of farmer groups and, separately, extension agents from both the agricultural and forestry sectors, using annual data from the Ministry of Agriculture and the Ministry of Forestry. Data on farmer groups and extension agents in the fishery sector were excluded due to unavailability. Detailed information on all variables is presented in table 1. This methodological decision can improve the farm income model's robustness by mitigating the measurement error inherent in general income data. All variables in table 1 were analyzed using two separate multiple linear regression models. The two main regression models are specified as follows:

$$P = \beta_0 + \beta_1 NFG + \beta_2 NEA + \beta_3 D + \varepsilon \quad \text{(Eq. 1)}$$

$$I = \beta_0 + \beta_1 IFG + \beta_2 IEA + \beta_3 D + \varepsilon \quad \text{(Eq. 2)}$$

The information shows that P represents rice productivity, I represents farm income, NFG refers to the number of farmer groups, NEA indicates the number of extension agents, IFG denotes the index of farmer groups, and IEA represents the index of extension agents. These variables are used to describe key aspects of agricultural performance and institutional support in the farming sector. They also provide an analytical basis for examining the relationships between productivity, farmer organization, and the role of agricultural extension services.

In this study, independent and dependent variables, as well as a further analytical framework, are grounded in the body of literature that examines the institutional and policy determinants of agricultural productivity and farm income. The previous literatures underline that farmer groups and agricultural extension agents can contribute to enhancing the spread of new technologies, strengthening the skills of farmers, and fostering the rapid adoption of innovations so that greater productivity and better agricultural performance (Anderson & Feder, 2007; Rivera & Rasheed, 2009; Davis et al., 2014; Ma et al., 2023; Wossen et al., 2017; Nuryanti & Swastika, 2011). Further, by applying the composite index method from OECD (2008), this study can consolidate different aspects of institutional support into a straightforward score. This approach also helps to clearly demonstrate the strength and effectiveness of the support systems in each province so that the results provide a more accurate picture than when only one factor is considered (Irz et al., 2001). Additionally, reducing measurement error, improving explanatory power and providing meaningful comparisons across regions are beneficial for the composite indices (Greco et al., 2019). Ultimately, using a dummy variable for priority provinces can increase the robustness of the analysis, so that the effects of targeted government policies can be more clearly identified, as recommended in agricultural policy studies (Timmer, 2010; Fan et al., 2008).

Our study applied Stata Software to perform statistical analyses. In the analyses, diagnostic tests for multicollinearity, heteroskedasticity, and residual normality were undertaken to ensure the reliability and validity of the regression results for both models (Asteriou & Hall, 2021; Gujarati & Porter, 2009). When our study detected heteroskedasticity, robust standard errors were utilized in both models. Further, the linear model was chosen as it is more parsimonious and easier to interpret than alternative specifications. Because the models satisfy all classical linear regression assumptions, the OLS estimates are confirmed as Best Linear Unbiased Estimators (BLUE). This BLUE ensures that the findings remain robust against potential endogeneity issues**.** The detailed model equations and the diagnostic test results are presented in the next section.

3. Results and Discussion

3.1 Evaluation of classical assumptions for regression models

Before identifying the results from the two regression analyses, it is crucial to determine whether the preliminary checks have been accomplished. For both rice productivity and farm income models, this study has also committed diagnostic tests, incorporating the checks for multicollinearity, heteroskedasticity, and normality of the residuals. The parameters are unbiased after the remaining conditions are satisfied and the OLS is efficient and consistent (Asteriou & Hall, 2021; Gujarati & Porter, 2009). Furthermore, the application of cross-section or secondary data, as highlighted in the econometric literature, indicates considerable diagnostic checks (Youssef, 2022). Therefore, successfully passing these diagnostics ensures that the Ordinary Least Squares (OLS) results presented later are reliable for inference.

The Variance Inflation Factor (VIF) is a value to evaluate the multicollinearity so that the potential high correlations among the independent variables can be identified. A VIF value below 10 indicates that multicollinearity is not a major issue, meaning the variables can be included in the regression model (Asteriou & Hall, 2021). In table 2, all independent variables have VIF values well below this threshold in both the rice productivity and farm income models, reinforcing that multicollinearity is not a problem in this analysis.

Table 2. Variance Inflation Factor (VIF) values for independent variables

Independent variable	Rice productivity model	Farm income model
Number of farmer group in agriculture sector	5.27	
Number of extension agents in agriculture sector	5.27	
Farmer group index		7.12
Extension agents index		6.75
Priority provinces	1.22	1.27

Heteroskedasticity is the variance of the error terms that is not constant across observations, so that the efficiency and reliability of the regression model estimates are affected (Asteriou & Hall, 2021). To detect heteroskedasticity, the Breusch–Pagan/Cook–Weisberg test was conducted for both the rice productivity and farm income models. Both models in table 3 produced p-values greater than 0.05, indicating that heteroskedasticity is not present and that the assumption of homoskedasticity is satisfied. This confirmation validates that the standard errors derived from the OLS estimation are efficient and the statistical significance of the coefficients is trustworthy.

Table 3. Results of the Breusch–Pagan/Cook–Weisberg test for heteroskedasticity

Model	Chi-square	p-value
Rice productivity	3.62	2.83
Farm income	0.057	0.092

The normality of regression residuals was checked using the Shapiro–Wilk test, which is recommended for evaluating whether residuals follow a normal distribution. Meeting the normality assumption of residuals is essential for accurate statistical inference and the validity of confidence intervals, particularly in research with moderate sample sizes (Gujarati & Porter, 2009). If this assumption is not met, the reliability of hypothesis testing may be compromised. Both models (table 4) have p-values above 0.05 so that the normality assumption is fulfilled. Hence, the calculated t-statistics and F-statistics are valid for hypothesis testing across both the rice productivity and farm income models.

Table 4. Result of the Shapiro–Wilk test for the normality of residuals

Model	Z statistic	p-value
Rice productivity	0.474	0.317
Farm income	0.196	0.422

This research follows the principles of econometric best practices for studies using cross-sectional and secondary data to verify whether the classical regression assumptions are met. Further, problems, such as multicollinearity, heteroskedasticity, and the normality of residuals, should be avoided since they can bring on invalid results and inappropriate policy recommendations. The outcome of diagnostic tests in Tables 2, 3, and 4 show that VIF values are acceptable, while the Breusch–Pagan/Cook–Weisberg and Shapiro–Wilk tests confirm the robustness of the statistical analysis. In conclusion, the successful fulfillment of all classical assumptions allows this study to proceed confidently with the results of the OLS regression models.

3.2 Analysis of factors affecting rice productivity

Diverse local conditions and the presence of farmer groups and extension agents can contribute to variations in rice productivity. These statements is confirmed by some research from various provinces, revealing that collaboration between farmer organizations, extension agents, and farmers has helped increase rice productivity through some governmental program (Rahmadanih et al., 2018; Salam et al., 2024; Sedana et al., 2021; Sudrajat, 2020; Anwarudin & Dayat, 2019). According to the Diffusion of Innovations theory, the success of innovation, such as agricultural programs, rests on how actively institutions and intermediaries—acting as change agents—engage with the community and provide the necessary support (Rogers, 2003). In addition, provinces identified as area priorities often experience higher rice productivity because they receive greater attention and more resources than non-priority areas. Therefore, this study assesses the role of farmer organizations, extension workers, and the status of priority provinces in explaining the differences in rice productivity throughout Indonesia. Moreover, Figure 1 visualizes the productivity levels across 38 provinces, categorized by their priority status to provide an understanding of these provincial differences. As illustrated in figure 1, there is a distinct performance gap between the two categories. The priority provinces (blue) show higher rice productivity than the non-priority provinces (orange). Although these differences in height are visible in the chart, it is necessary to confirm, through regression analysis, whether this prioritization status truly significantly impacts productivity, as shown in table 5.

The regression analysis results indicate that the productivity of rice in Indonesia is influenced simultaneously by the number of farmer groups, the number of extension agents, and the prioritization of a province within the government development program (Prob > F = 0.000). Additionally, the model's R-squared value of 0.59 implies that 60 percent of the variation in rice productivity can be explained by the three factors when analyzed together. These findings illustrate the need to comprehend the differences in rice productivity by province and the roles of institutions like farmer associations and extension agents, as well as the effect of state policy, as shown by the increased focus of the agriculture development program on a particular province.

The individual effects of each variable, as reported in table 5, reveal that neither the number of farmer groups (coefficient = 0.000117, p-value = 0.323) nor extension agents (coefficient = 0.000495, p-value= 0.622) is significantly associated with rice productivity in Indonesia. Conversely, the priority status of a province emerges as a very important factor (coefficient = 9.21, p-value < 0.001), because provinces with priority status are expected to receive greater resource allocation from government programs, leading to much higher rice productivity compared to non-priority provinces. This highlights that, even though farmer groups and extension agents are present, their impact on rice productivity may be less

significant than the much stronger effect of government policy and resource allocation in priority provinces.

Table 5. Regression outcome for factors influencing rice productivity

Variables	Coefficient	Std. Error	t-value	p-value
Number of farmer groups	0.000117	0.0001167	1.00	0.323
Number of extension agents	0.0004947	0.0009954	0.50	0.622
Priority province status	9.20972	2.067112	4.46	0.0001
Constant (Intercept)	38.32375	1.411504	27.15	0.0001

Overall, these outcomes suggest that improving rice productivity at the national level requires more than just the number of institutional actors, such as farmer groups and extension agents. According to Rogers' diffusion of innovations theory (2003), active change agents and a reinforcing setting, in this case strong government policy and resource distribution, are necessary conditions for the successful adoption of a government program. This theory has been supported by empirical studies in several areas of Indonesia. For instance, government support and resource distribution in rice productivity-enhancing programs facilitated through farmer organizations and extension agents (Sedana et al., 2021; Agussabti et al., 2022; Rahmadanih et al., 2018) constitute a case in point of strategic resource distribution.

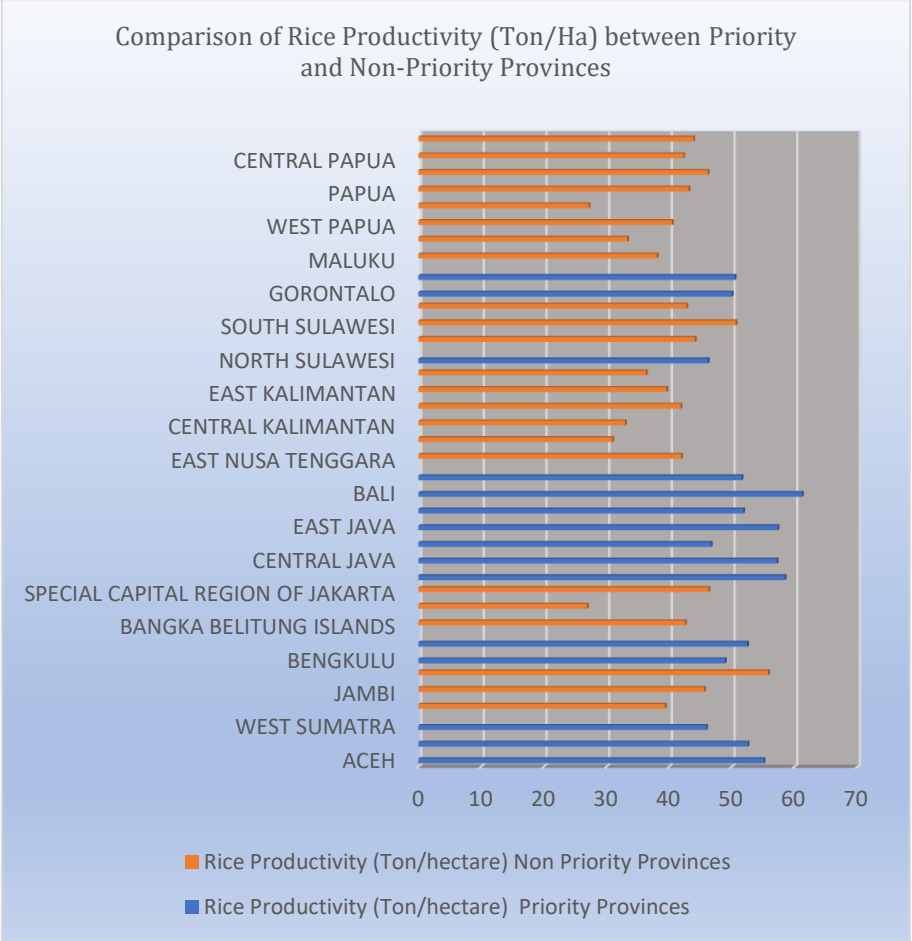

Fig.1. Comparison of rice productivity (Ton/Ha) between priority and non-priority Provinces

Institutional factors are a key determinant of agricultural productivity across different regions, as demonstrated by numerous previous investigations. For instance, the farmer organizations and effective agricultural extension services in Vietnam and the Philippines help farmers adopt technology so that their agricultural productivity can be increased (Inutan et al., 2025; Pham et al., 2021). Furthermore, strong collaborative networks and innovation brokers can translate agricultural innovations into practical applications, and thus amplifying the benefits of public investment in agriculture (Laksono et al., 2024; Sudarwati & Nasu, 2024; Yanfika et al., 2024).

The literature underlines that a holistic policy approach should integrate institutional capacity building with targeted government interventions. Evidences in some regions of Indonesia show that when farmers receive steady support — including training, resource provision, and easier access to credit — their agricultural productivity tends to rise (Gitosaputo & Irawan, 2024; Pramukty et al., 2024; Riyadi, 2019). These findings reinforce the significance of aligning national policies with local institutional dynamics to achieve optimal outcomes in rice productivity.

3.3 Analysis of factors affecting farm income

The influence of the farmer group index, the extension agent index, and provincial priority status on farm income in Indonesia was examined through the regression analysis. Each index was constructed from the totals of farmer groups and extension agents in each province's agriculture and forestry sectors, hence giving an objective view on institutional support. Together, the variables form a statistically significant model ($F = 3.64$; $p = 0.0247$), although the explanatory power is still low ($R^2 = 0.28$). Moreover, the findings suggest that, given the institutional support and regional prioritization, other unexamined variables continue to affect farm income disparity.

Regarding the individual effects presented in table 6, the farmer group index has a negative and statistically significant effect on farm income (coefficient = -525.29; p-value = 0.090). Such a result could suggest that the number of farmer groups in existence has increased, but their quality and effectiveness have not improved. This negative association is that the administrative and bureaucratic burdens of group membership may currently outweigh the financial advantages, especially when the groups focus on subsidy distribution rather than collective marketing or price negotiation. Furthermore, the proliferation of farmer groups in Indonesia is often driven by the requirement to receive government subsidies (*bantuan hibah*) rather than collective economic action, so that the groups lack value-added services. Research, however, shows a different trend, whereby members of more effective organizations, like cooperatives, attain farm incomes that are higher than the average due to enhanced training, the availability of subsidized farm inputs, access to financing, assistance with adoption of farm technologies, secured access to markets, and assistance with marketing (Ahmed & Mesfin, 2017; Seneerattanaprayul & Gan, 2021; Verhofstadt & Maertens, 2015).

The index of extension agents in Table 6 does not significantly influence farm income (coefficient = 197.43; $p = 0.459$) so that an increase in the number of extension agents does not necessarily lead to higher earnings for farmers. This lack of significance probably indicates that extension services are still focused on technical cultivation methods rather than economic aspects such as addressing market integration or post-harvest efficiency. Concur with this view, arguing that the effectiveness of extension services rests on their quality. Furthermore, Ragasa & Mazunda (2018) state that meaningful impact requires improvements in both the number and effectiveness of extension agents. Similarly, provincial priority status has an insignificant partial effect on farm income (coefficient = –100.13; $p = 0.602$), indicating that potential gains from better allocation of governmental program resources may not increase farmer earnings. This insignificant result shows that government priority status in Indonesia probably concentrates more on production targets (quantity) than on farmer profit (quality). As a result, even in priority areas, farmers still struggle with high costs and unstable market prices that the current programs do not yet

address. Ultimately, these findings emphasize that the priority status fails to improve farm income; the policy is designed to increase harvest tons to meet national food needs, but it often ignores the high costs farmers have to pay out of their own pockets.

Table 6. Regression outcome for factors influencing rice productivity

Variables	Coefficient	Std. Error	t-value	p-value
Farmer groups index	-525.2883	298.7405	-1.76	0.090
Extension agents index	197.4276	262.875	0.75	0.459
Priority province status	-100.1349	189.8149	-0.53	0.602
Constant (Intercept)	1,703.789	118.9306	14.33	0.0001

The study's findings reveal that the rise in farm income across all provinces of Indonesia is likely attributed to the quality and quantity of services provided by farmer groups and extension agents. This national evidence is substantiated by local studies in Aceh, East Java, and South Sulawesi, which show that increases in farm income result from involvement in extension activities and farmer groups—but only when farmers are genuinely engaged and the assistance is appropriate. Rogers' Diffusion of Innovations theory provides a useful framework for understanding this phenomenon. The theory describes that adopting innovation such as a governmental program successfully requires not only supportive groups but also clear communication, mutual trust, strong leadership, and cooperative efforts between organizations.

To further strengthen the clarity and substance of this study, it is essential to acknowledge diverse aspects of factors influencing farm income. In addition to institutional assistance and provincial priorities status, the existing international literature notes that access to credit, infrastructure, education level, market integration, input prices, and climate variability lead to differences in farm income, which is one of the leading indicators used to measure farmer welfare (Alene et al., 2008; Barrett et al., 2017; Gebrehiwot & van der Veen, 2015; Minten et al., 2009; Sheahan & Barrett, 2016). Our results in table 6, however, should be interpreted carefully. While Figure 1 shows that priority provinces lead slightly in rice productivity, our regression found no significant impact on farm income. These findings probably occur because farm income in this study includes various crops, whereas the government's priority status is focused specifically on rice. Therefore, the differences in farm income across Indonesia can be comprehensively obtained after considering these various factors. Further, subsequent studies should broaden a wide range of explanatory variables as well as utilize panel data so that causal links and improved policy formulation can be elucidated. The overall discussion and implications fit with the growing consensus that institutional effectiveness — particularly in farmer groups and extension agents — depend not only on quantity but also on quality (Agole et al., 2022; Birner et al., 2009; Davis et al., 2014; Landini, 2020; Lamm et al., 2023; Ouerghemmi et al., 2024; Rivera & Rasheed, 2009). For this reason, successful exsistences of farmer groups and extension services require a strong foundation in capacity building, participatory approaches, and continuous evaluation to ensure their relevance and impact.

4. Conclusions

This study used 2024 cross-sectional data from across Indonesia to explore how farmer groups and extension agents affect rice productivity and farm income. The results indicate that neither the number of farmer groups nor the number of extension agents has a clear impact on rice productivity. Further, the number of farmer groups has a significant negative impact on farm income, while the number of extension agents has a positive but not significant effect. In addition, provinces designated as priority regions to receive governmental programs showed better rice productivity; however, this improvement did not lead to higher farm income. For this reason, it is essential to strengthen the capacity of farmer groups and extension workers and to adapt their approaches to the specific needs of each local area in order to improve rice productivity and farm income.

A strategic and practical approach is needed to maximize the roles of farmer groups and extension agents to improve rice productivity and farmers' incomes in Indonesia. Further, the significant negative impact of the number of farmer groups on farm income, as well as the non-significant contribution of extension agents and farmer groups to rice productivity, suggests that the presence or quantity of these institutions is insufficient to deliver a positive impact. These findings illustrate that the quality of farmer groups or extension agents must be considered before raising their number. Additionally, although priority provinces receive greater support and achieve higher rice yields than non-priority provinces, this difference does not inherently lead to higher farmer income. For this reason, optimizing the capacity of farmer groups and extension agents should focus on context-specific support for government initiatives. Such measures are expected to ensure that corresponding gains are able to match an increase in productivity in farm income. As a specific action, the government should undertake the revitalization of farmer groups by providing business management training. Moreover, the government should reorient extension worker incentives to be linked to farmers' profit rather than crop harvest. Our study faces a drawback due to its reliance on aggregate-level data, which might obscure the specific financial aspects and diverse income realities of individual households. For this reason, our findings may not reflect the micro-level heterogeneity across regions and suggest that future studies should investigate how extension services and farmer group dynamics interact in the field to provide a more comprehensive perspective.

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Data Availability Statement
The data used in this study are publicly available from the Statistics Indonesia (BPS) and the Ministry of Agriculture, and the Ministry of Forestry of the Republic of Indonesia.

Conflicts of Interest
The author declares no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results

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No generative artificial intelligence tools were used in the preparation of this manuscript.

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