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Increasing Farmer Group Capacity through Balanced Fertilization Education in Jaten District

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Abstract

The continuous use of inorganic fertilizers without proper balance in rice cultivation can degrade soil quality, increase production costs, and reduce the sustainability of agricultural systems. Therefore, education for farmer groups is needed to improve their understanding of balanced fertilization through the combination of organic and inorganic fertilizers. This community service activity aimed to improve farmers' knowledge, attitudes, and interest in implementing a balanced fertilization system by using organic fertilizers, such as manure and leaf litter, as partial substitutes for inorganic fertilizers. The activity was carried out using an extension method, with a leaf litter fertilizer producer and an agricultural extension officer serving as resource persons. The evaluation was conducted through pre-test and post-test surveys, observation of farmers, and perception questionnaires involving 25 participants. The results showed an increase in farmers' understanding of balanced fertilization concepts by 44%, an increase in knowledge of the benefits of organic fertilizers by 40%, and an increase in interest in implementing the system by 36%. In addition, most farmers showed positive attitudes toward reducing inorganic fertilizer use and utilizing organic fertilizers as more environmentally friendly and economical alternatives. This activity contributed to improving participants' capacity as agents of change in implementing sustainable rice cultivation. Therefore, balanced fertilization education is an important step in supporting more efficient, environmentally friendly, and sustainable agricultural systems.

Keywords*: organic, paddy, sustainable agriculture*

1. INTRODUCTION

Rice (*Oryza sativa* L.) is a strategic food commodity that plays a vital role in maintaining national food security, as over 95% of the Indonesian population relies on rice as their primary carbohydrate source. Efforts to increase rice production over the past few decades have been heavily supported by the intensive use of inorganic fertilizers. However, continuous and imbalanced application of inorganic fertilizers has led to various issues, including soil fertility degradation, low soil organic matter (SOM) content, and decreased fertilization efficiency (Liu et al., 2024; Das et al., 2017). SOM content in intensive lowland rice fields in Indonesia is generally reported to be below 2%, whereas the ideal level to support optimal productivity ranges between 3–5% (Miyarnis et al., 2026). This condition adversely affects soil quality and potentially reduces long-term rice productivity. One strategy to improve rice cultivation systems is the implementation of balanced fertilization by combining organic and inorganic fertilizers. Organic fertilizers, such as manure and leaf litter, play a crucial role in improving the physical, chemical, and biological properties of the soil, while enhancing the nutrient-use efficiency of inorganic fertilizers (Liu et al., 2024). Research indicates that integrated nutrient management (INM) combining organic and inorganic sources can increase SOM content by up to 30% and improve rice yields by 10–20% compared to the use of inorganic fertilizers alone (Sumantra et al., 2021). Furthermore, organic amendments enhance the activity of soil microorganisms involved in nutrient cycling and soil fertility.

Jaten District, Karanganyar Regency, is an area with high potential for rice production, characterized by technically irrigated paddy fields that support intensive year-round cultivation. Based on field observations and discussions with agricultural extension officers, most farmers still rely on inorganic fertilizers as their primary nutrient source. Inorganic fertilizer application by farmers exceeds 300 kg/ha per planting season, while organic fertilizer use remains relatively low at less than 2 tons/ha. Additionally, agricultural waste

such as leaf litter and livestock manure—which have high potential as organic fertilizer—has not been optimally utilized. Initial identification reveals that 80% of farmers have not implemented balanced fertilization systems and remain dependent on synthetic inputs. Furthermore, farmers' knowledge regarding the benefits and application techniques of organic fertilizers is limited. This situation highlights a gap between available resources and the adoption of sustainable cultivation technologies. Previous studies show that education and assistance programs can improve farmers' knowledge and skills in implementing balanced fertilization technologies, increasing fertilizer use efficiency by up to 25% (Harti et al., 2025). Community service initiatives have demonstrated that education on organic fertilizer use effectively increases awareness and technology adoption. Moreover, integrating organic fertilizers into rice cultivation systems has been proven to improve production cost efficiency and increase farmers' income (Salam et al., 2017).

Based on the aforementioned context, the problems faced by farmer groups in the target area are formulated as follows: (1) high dependence on inorganic fertilizers, (2) low utilization of locally available organic resources, and (3) limited knowledge regarding balanced fertilization systems. Therefore, this community service project aims to enhance farmers' knowledge and understanding of balanced fertilization, encourage the utilization of organic fertilizers (such as manure and leaf litter), and reduce dependence on inorganic inputs. This activity is expected to support the transition toward sustainable rice cultivation, improve soil fertility, and foster long-term productivity and farmer welfare.

2. METHOD

This community service program was conducted in Jaten District, Karanganyar Regency, in June 2025. The program employed a participatory agricultural extension method aimed at enhancing the knowledge and understanding of farmer groups regarding the application of balanced fertilization through the integration of organic and inorganic inputs in rice cultivation. The activity involved experts from leaf litter fertilizer producers and agricultural extension officers with specialized competence in balanced fertilization technologies.

The target audience consisted of 25 active members of local rice farmer groups. The program was implemented in three distinct phases: preparation, implementation, and evaluation. Preparation, included coordination with farmer groups and extension agents, identification of fertilizer-related field constraints, and the development of instructional materials. Implementation, conducted as an extension workshop covering the ecological impacts of excessive inorganic fertilizer use on soil fertility; the benefits of organic amendments in improving soil physico-chemical and biological properties; production and application techniques for manure-based and leaf litter fertilizers; and the practical implementation of balanced fertilization. This phase included interactive discussion sessions to allow farmers to share field experiences and technical challenges. Evaluation, designed to measure the achievement of program objectives using structured questionnaires and direct observation. A questionnaire was utilized to assess farmers' knowledge, attitudes, and intentions toward organic fertilizer adoption and balanced fertilization. The instrument employed a 5-point Likert scale covering four key indicators: (1) understanding of organic fertilizer benefits, (2) technical proficiency in integrated organic-inorganic fertilization, (3) attitudes toward reducing synthetic fertilizer dependence, (4) intention to adopt organic amendments in future cultivation cycles. A pre-test and post-test design was implemented to quantify changes resulting from the intervention.

Beyond quantitative metrics, a descriptive qualitative evaluation was conducted through direct observation and interviews. This identified shifts in farmer behavior and the technology adoption rate. Indicators of attitudinal change included increased interest in

organic inputs and active participation in technical dialogues. Socio-cultural shifts were monitored through the lens of heightened awareness regarding soil conservation and environmentally friendly agricultural practices. From an economic perspective, the program evaluated the potential for fertilizer use efficiency and production cost reduction by substituting a portion of inorganic fertilizers with locally available organic resources. Success criteria were established based on: (1) significant improvement in post-intervention knowledge scores, (2) positive shifts in attitudes toward organic fertilization, (3) the stated commitment of farmers to implement balanced fertilization in the upcoming planting season.

3. RESULT AND DISCUSSION

The community service project was implemented through an extension method involving 25 farmers who served as participants and agents of knowledge dissemination to their peers. This activity aimed to enhance the understanding of balanced fertilization—integrating organic and inorganic fertilizers—within rice cultivation systems. To measure the achievement of these objectives, pre- and post-extension surveys were conducted using structured questionnaires. The indicators measured included the level of knowledge, understanding of organic fertilizer benefits, attitudes toward organic fertilizer application, and the intention to implement balanced fertilization systems.

Figure 1. Balanced fertilization extension activities. (Left) Implementation of the extension session. (Right) Soil pH testing in farmers' paddy fields (indicating acidic conditions with pH < 7).

Evaluation was conducted using pre- and post-test questionnaires to measure changes in participants' knowledge levels and intentions toward adopting balanced fertilization. The measurement results, based on the questionnaire data, are presented in Table 1.

Table 1. Evaluation results of knowledge and adoption interest in balanced fertilization

No.	Indicator	Pre-Test (%)	Post-Test (%)	Increase (%)
1	Understanding the concept of balanced fertilization	44	88	44
2	Knowledge of organic fertilizer benefits	52	92	40
3	Knowledge of organic fertilizer types (manure and leaf litter)	48	88	40

No.	Indicator	Pre-Test (%)	Post-Test (%)	Increase (%)
4	Willingness to reduce inorganic fertilizer use	40	84	44
5	Intention to implement in rice cultivation	56	92	36
	Average	48	89	41

Based on Table 1, a significant increase was observed across all measured indicators. The level of understanding regarding the balanced fertilization concept rose by 44%, increasing from 44% pre-intervention to 88% post-intervention. Knowledge of organic fertilizer benefits increased by 40%, while the intention to implement balanced fertilization systems grew by 36%. These results demonstrate that the extension activities were effective in enhancing the knowledge capacity and awareness of participants. Furthermore, qualitative evaluation through discussions revealed that 21 participants (84%) acknowledged that organic fertilizer application could reduce dependence on synthetic inputs and enhance agricultural sustainability. Additionally, 22 participants (88%) stated that the program provided valuable new insights for farmers.

The findings indicate that the extension methodology was effective in improving participants' knowledge and attitudes toward organic fertilizers and balanced nutrient management. This improvement occurred because participants received direct information from practitioners and extension officers with field experience, making the material more applicable and contextual. The extension method facilitated two-way communication, which enhanced the efficiency of knowledge transfer. Such knowledge gain is critical, as organic amendments are proven to improve the physico-chemical and biological properties of soil. According to Guo et al. (2025), the combination of organic and inorganic fertilizers can enhance nutrient use efficiency (NUE) by 20–30% and significantly increase rice yields. Other studies suggest that organic fertilizers increase soil organic matter (SOM) content and the activity of microorganisms essential for soil fertility (Liu et al., 2024). Regarding attitudinal shifts, the increased interest among participants in reducing inorganic fertilizer use signifies a positive behavioral change. This aligns with Becerra-Encinales et al. (2024), who stated that agricultural extension is a primary driver in the adoption of sustainable farming technologies. This program also provided socio-economic added value; in the short term, participants gained increased intellectual capacity, while in the long term, the adoption of balanced fertilization has the potential to reduce production costs by utilizing local resources such as livestock manure and leaf litter. Moreover, organic fertilizer use supports long-term land productivity.

The implementation difficulty of this activity was categorized as low, as the extension methods were straightforward and required no specialized equipment. However, the primary challenge remains the sustainability of field implementation. There is significant potential for scaling this initiative, particularly through demonstration plots (demplots), continuous farmer assistance, and training in independent organic fertilizer production. This is supported by Emerick and Dar (2020), who argued that the success of agricultural technology adoption increases significantly when accompanied by field demonstrations and ongoing mentoring. Overall, this community service project successfully achieved its objectives in enhancing the knowledge, awareness, and readiness of participants to implement balanced fertilization as an effort to improve sustainable rice cultivation systems.

In addition to knowledge improvement, farmers' socioeconomic conditions also influence the adoption of balanced fertilization technology. Most farmers in the study area operate on small landholdings and have limited financial capacity, making them cautious about adopting new practices that may involve additional labor, time, or initial costs. Limited access to capital, insufficient availability of organic fertilizer materials in ready-to-use form,

and uncertainty about short-term economic returns can become barriers to technology adoption. Furthermore, farmers' educational background and reliance on conventional fertilization habits may reduce their confidence in shifting toward integrated nutrient management. Therefore, beyond extension activities, continuous assistance, demonstration plots, and institutional support are essential to strengthen farmers' motivation and reduce the socioeconomic constraints that hinder sustainable technology adoption.

4. CONCLUSION

The community service initiative, conducted through an extension program on balanced fertilization—integrating organic and inorganic inputs—successfully enhanced farmers' knowledge, understanding, and attitudes toward more sustainable rice cultivation systems. Survey results demonstrated a 44% increase in farmers' understanding of the balanced fertilization concept, a 40% increase in knowledge regarding organic fertilizer benefits, and a 36% increase in the intention to implement these systems. These findings indicate that the extension activities were effective in strengthening the capacity of farmers to serve as agents of knowledge dissemination within their communities. The strength of this program lies in the delivery of applicable content by practitioners and field extension officers, providing farmers with contextual insights relevant to local agricultural conditions. However, the program faced certain limitations, specifically the absence of direct field-based practical sessions and the lack of long-term mentoring to ensure the sustained implementation of the technology. Therefore, this initiative has significant potential for further development through demonstration plots (demplots), technical training for independent organic fertilizer production, and ongoing assistance for farmer groups. Such measures are expected to generate a broader impact on increasing agricultural productivity, improving production cost efficiency, and fostering the long-term sustainability of rice cultivation systems. Local governments and agricultural institutions should support balanced fertilization practices by providing regular training, continuous assistance, and demonstration plots for farmers. Support such as incentives for organic fertilizer production and easier access to inputs can also encourage adoption. With consistent mentoring and institutional support, the implementation of balanced fertilization can be more sustainable and widely adopted by farmers.

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