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Impact of System of Rice Intensification (SRI) Organic Rice on Farmer Welfare in Kolaka District, Southeast Sulawesi, Indonesia

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Abstract. This research looks at how the System of Rice Intensification (SRI) organic rice growing system affects the well-being of farmers in Baula District, Kolaka Regency. The study looks at income, productivity, production costs, and farmers' views on stakeholder support in order to fill in the gaps in the scant empirical evidence on the socio-economic advantages of SRI-organic practices in Indonesia. We used a quantitative technique using a survey method and comparative descriptive analysis with 56 respondents who were chosen for a specific reason (28 organic SRI farmers and 28 conventional farmers). Farm income computation, the Independent Sample T-Test, and the Likert-scale-based perception analysis were some of the analytical methods used. The results showed that organic SRI farmers earned an average income of Rp125,195,859.00 ha^{-1} $season^{-1}$, significantly higher than inorganic farmers (Rp25,874,641 ha season-1). Organic SRI land productivity was recorded at 7,493.16 kg ha^{-1}, more efficient than the inorganic system (6,106.58 kg/ha). Although the production cost of SRI is higher, the economic value is still more profitable due to the higher selling price of organic grain and input efficiency. Farmers' perception of the role of stakeholders is also classified as "high", with an average Likert score of 4.37. They said that training, help with inputs, and access to markets were the most important components, and PT Vale Indonesia, agricultural extension staff, and local government helped make these things happen. These results show how important it is for institutions to work together to improve technical and economic outcomes. This research shows how useful SRI-organic systems may be as a model for community-based, sustainable agriculture that can be scaled up to enhance the lives of people in rural areas.

Keywords: organic rice; SRI; stakeholder perception; sustainable agriculture

INTRODUCTION

Organic farming is a strategic method for achieving sustainable agricultural growth that addresses the difficulties posed by climate change, environmental degradation, and future food security (Reganold & Wachter, 2016). This agricultural strategy reduces synthetic chemical use, advocates for ecological principles, and maintains equilibrium among economic, social, and environmental dimensions (Tiwari, 2023). The System of Rice Intensification (SRI) represents a significant advancement in organic farming, having been extensively adopted in several countries and shown to enhance production and optimize agricultural inputs (Kassam et al., 2011; Uphoff et al., 2011).

SRI is a rice farming methodology founded on the ideas of using young seedlings, planting a single seedling per hole, implementing intermittent water control, and enhancing soil fertility via organic matter (Uphoff, 2003). This strategy is deemed to enhance production by 20-50% (Styger & Uphoff, 2016; Uphoff et al., 2011), while also improving soil structure and reducing greenhouse gas emissions. SRI has been included into several government and corporate CSR initiatives in Indonesia, including those implemented by PT Vale Indonesia in Baula sub-district, Kolaka Regency, Southeast Sulawesi. The Baula subdistrict in Kolaka Regency was chosen as the research location because it has characteristics relevant to the development of an SRI-based organic farming system. This area has a significant potential for rice fields spanning 4,500 hectares and has begun to be developed organically through the Healthy,

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Environmentally Friendly, and Sustainable Agriculture Program (PSRLB), which is part of the Community Development and Empowerment Program (PPM) implemented by PT Vale Indonesia on 5.5 hectares, yielding 30,000 tons of dried paddy. Additionally, the active involvement of local government and agricultural extension officers in providing technical support has made Baula one of the pilot areas for SRI implementation in Southeast Sulawesi.

The successful implementation of sustainable agricultural systems, such as organic SRI, relies not only on technical cultivation aspects but is also significantly affected by the socio-economic context of farmers, institutional support, and stakeholder involvement (Glover et al., 2016; Moore et al., 2024). The implementation of SRI necessitates institutional capacity and support from relevant stakeholders, including ongoing training and assistance with input and market access (Saribanon et al., 2024; Suciati et al., 2014). Furthermore, Fadlina et al. (2013), Wiartha et al. (2024), and Lamangantjo & Jannah (2024) underscore the significance of cross-sectoral collaboration in facilitating the success of future sustainable agricultural model transformations.

In this context, stakeholder involvement in the implementation of the SRI system plays a crucial role, given that this system requires comprehensive changes in cultivation patterns, input management, and agricultural product marketing strategies. Actors such as companies, local governments, agricultural extension workers, and community-based organizations not only act as technology facilitators but also serve as important intermediaries in providing farmers with access to training, production support, and broader markets. Without the synergistic and sustained involvement of these various parties, the adoption of the SRI system risks being hindered by the structural limitations faced by smallholder farmers, such as low institutional capacity, limited capital, and market uncertainty.

In the Indonesian context, comparative studies between organic and inorganic rice farming have been conducted, such as by Gufron et al. (2021), Agnesti et al. (2023), Husnarti & Hidayat (2023). However, most of these studies focus more on aspects of technical efficiency and income comparison, without examining in depth the dimensions of farmer welfare that include aspects of net income, productivity, cost efficiency, and the role of supporting institutions. Meanwhile, farmer welfare, According to Sihaholo & Sita (2021), it is also related to farmers' access to resources such as land and the optimal use of agricultural land resources. Meanwhile, according to Oktaviani & Lidyana (2024), welfare is also related to farmer institutions and sustainable forms of agriculture.

Furthermore, a study by Altieri et al (2015) emphasized that the success of adaptive agriculture to climate change can only be achieved if cultivation technology is combined with a community-based approach and strengthening local networks. In this case, stakeholder involvement in supporting organic farming has a strategic dimension, both in terms of farmer empowerment and organic rice market development (Gumilar et al., 2020; Maharani et al., 2024; Roswita & Riza, 2019; Septiadi & Mundiyah, 2020).

The research gap that underlies this study is the lack of evaluative studies that integrate economic analysis (income, costs, productivity) with the evaluation of stakeholder support in SRI-based organic farming systems. Not many studies have raised the synergistic role between the government, private sector, and extension institutions in ensuring the sustainability of the system at the local level. In addition, there are also rarely studies that address the specific context of eastern Indonesia, especially in Southeast Sulawesi, which is precisely the locus of community-based development experiments.

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Therefore, this research is theoretically and practically relevant. Theoretically, this research enriches the literature on the integration between sustainable cultivation innovation and local institutional development. Practically, the results of this study can serve as policy input for strengthening organic farming programs, especially in designing collaborative models between farmers, companies, and governments in supporting the transformation of local agriculture. This research aims to comprehensively evaluate the impact of the implementation of the organic SRI rice farming system on farmers' welfare through (1) an economic comparison approach and (2) evaluation of the role of stakeholders in a sustainable agricultural support system.

METHODS

This study uses a quantitative approach with a comparative descriptive design to examine differences in income, productivity, and farmers' perceptions of stakeholder support between farmers using the organic SRI system and conventional farmers. The research was conducted in 2024 in Baula Subdistrict, Kolaka Regency, Southeast Sulawesi, which was purposively selected because it is an active area for the implementation of the SRI-based organic rice farming system. The implementation of this system is facilitated through the Sustainable Environmentally Friendly Agriculture Program, which is part of the Community Development and Empowerment Program by PT Vale Indonesia.

The number of respondents was 56, selected purposively, consisting of 28 farmers applying the organic SRI system and 28 conventional farmers in Baula Subdistrict, Kolaka Regency. This selection was based on direct involvement in the organic farming program facilitated by PT Vale Indonesia. While purposive sampling allows researchers to focus on relevant target groups, this method limits the ability to generalize findings to a broader population of farmers outside the study area (Etikan et al., 2015)

Population and Sample The population in this study were all rice farmers in Baula sub district. The sample was determined using purposive sampling technique with the criteria of farmers who have run each planting system (organic and inorganic SRI) at least the last two growing seasons, and are willing to be respondents. The sample size was 56 people, consisting of 28 organic SRI farmers and 28 inorganic farmers.

Data were collected through closed-ended questionnaires, semi-structured interviews, and field observations. To minimize bias, the research instruments were designed with clear and neutral wording. Additionally, questions were consistently presented with the help of interview guides to ensure that the interpretation of each question did not vary among respondents. Secondary data were obtained from reports by the Department of Agriculture, the Central Statistics Agency (BPS), documents from PT Vale Indonesia's PSRLB program, and academic publications, which were used to enrich the analysis and support data triangulation.

The main variables studied include income, productivity, production costs and perceptions of the role of stakeholders (government, companies, extension workers and organic farmer associations). Perception measurement is carried out using a 5-point Likert scale (1 = very little role to 5 = very much role) on five role indicators, namely technical training support, provision of production facilities and infrastructure, market access and price guarantees, field assistance and monitoring, and easy access to programs and regulations.

The analysis used in this study is income analysis. Pratiwi et al. (2019) state that agricultural income is the difference between income and total production costs.. The formula is shown in Equation 1.

$$P = PU - BT \quad \text{..... (1)}$$

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Description:
P = Income (Rp)
PU = Total Revenue (Rp)
BT = Total Cost (Rp)

Meanwhile, productivity is calculated using the formula, which is shown in Equation 2 :

Productivity (kg ha^{-1}) = (Total Production (Kg))/(Land Area (ha)) .....(2)

To determine differences in income and productivity, an Independent Sample T-Test was conducted to test the significance of differences in income and productivity between organic and inorganic SRI farmer groups. The test was conducted with a significance level of 5% using SPSS.

The analysis used to determine farmers' perceptions of the role of stakeholders was conducted using a 5-point Likert scale (1 = very little role to 5 = very significant role) on five role indicators, namely technical training support, provision of production facilities and infrastructure, market access and price guarantees, field assistance and monitoring, and ease of access to programs and regulations. The 5-point Likert scale was used to measure respondents' perceptions of stakeholder roles, with indicators developed based on conceptual review and expert judgment to ensure content validity. A reliability test was conducted using Cronbach's Alpha coefficient above the threshold of ≥ 0.70, which is generally accepted in social research, indicating that the instrument has high internal consistency and is suitable for quantitative measurement of perceptions (Tavakol & Dennick, 2011)

The Likert analysis of the role of stakeholders was carried out by converting scores into categories (very low - very high) based on Sugiyono (2013) classification interval :

1.00-1.80 = Very Little Role
1.81-2.60 = No Role
2.61-3.40 = Moderate Role
3.41-4.20 = Instrumental
4.21-5.00 = Very Instrumental

RESULTS AND DISCUSSION

Respondent Characteristics

Farmers' socio-economic characteristics are important factors in influencing the decision to adopt agricultural technologies and systems. In this study, the characteristics of respondents included age, education level, farming experience, number of family dependents, and area of land cultivated. A total of 56 respondents consisted of two balanced groups: 28 farmers using the organic SRI system and 28 farmers using the inorganic system. The following is Table 1 characteristics of respondents.

Table 1. Socio-Economic Characteristics of Respondents

Characteristic	SRI Organic	Inorganic
Dominant Age (years)	32 - 47 (56.25%)	49-60 (43.75%)
Dominant Education	High School (53.57%)	Junior High School (60.71%)
Experience (>20 years)	64.29%	50.00%
Family Dependents (3-4 people)	60.71%	46.43%
Land Area	0.38 ha	0.79 ha

The results showed that the majority of organic SRI farmers were in the productive age range (32-47 years), while inorganic farmers were more in the middle age group (49-60 years). Younger age in the organic group indicates greater potential in accepting agricultural innovations, as stated by Mardliyah & Arsana (2018), Rangga et al. (2024) and Wardana et al. (2024) that younger age tends to be more adaptive to technological

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change and has a greater tendency to try new practices.

In terms of education, organic SRI farmers have a higher educational background (53,57% of high school graduates), while inorganic farmers are dominated by junior high school graduates (60.71%). Higher education levels are positively correlated with the ability to adopt innovations and make rational decisions in farm management (Charina et al., 2018; Nurmastiti & Wianto, 2024).

Farming experience in both groups is generally more than 20 years, reflecting strong managerial capacity and local knowledge. The number of family dependents is generally 3-4 people, which has implications for household economic needs and the potential provision of family labor in farming. Meanwhile, the land area of inorganic farmers is generally larger than organic farmers, but this is not necessarily directly proportional to productivity.

These characteristics provide an overview of farmers' socio-economic readiness to adopt SRI-based sustainable farming systems, as well as a basis for understanding the successful implementation of such systems in the local context.

Productivity of Organic and Inorganic SRI Farms

Productivity serves as a critical metric for evaluating the efficiency and effectiveness of agricultural cultivation systems. This study measures productivity by the quantity of harvested dry grain (GKP) produced per hectare by farmers utilizing organic SRI systems compared to those using inorganic systems. The results in Table 2 show that while inorganic farmers yield a greater total grain output, the productivity per hectare among organic SRI farmers is superior.

Table 2. Average Production and Productivity of Rice Farms

Farming System	Production (kg)	Land Area (ha)	Productivity (kg/ha)
SRI Organic	2,847.40	0.38	7,493.16
Inorganics	4,824.20	0.79	6,106.58

The productivity of organic SRI farmers was 7,493.16 kg ha^{-1}, surpassing that of inorganic farmers, which was 6,10658 kg ha^{-1}. The t-test results on productivity show a significance value of $p = 0.021$ ($p < 0.05$), indicating a significant difference between the two systems. This result supports the findings of Kassam et al. (2011) and Iqbal et al. (2023), which confirm that the implementation of the SRI system can improve land efficiency and rice production. Additionally, the use of organic fertilizer and increased soil biota activity contribute to natural soil fertility improvement, a crucial factor in maintaining long-term productivity (Bünemann et al., 2018; Lori et al., 2017; Mäder et al., 2002). In a broader context—particularly in regions promoting environmentally friendly agriculture such as Baula Subdistrict—these findings suggest that the organic SRI approach has real potential to improve production efficiency, even on small-scale landholdings. Thus, the statistical significance reflects not only a numerical distinction, but also a practical impact, showing that ecologically-based cultivation innovations can serve as a viable solution for enhancing farmer welfare and strengthening local food security.

The high productivity of organic SRI farmers in the local context is closely linked to the extensive training and mentoring provided by stakeholders, such as PT Vale Indonesia and local agricultural extension officers. The success of a sustainable agricultural system necessitates collaboration among various stakeholders, institutional support and access to technology (Kilelu et al., 2011; J. Pretty, 2008). In addition to agronomic factors,

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productivity is indicative of farmers' managerial abilities in the efficient management of land. Farmers practicing organic SRI with higher educational attainment and younger age exhibit greater openness to innovative methods and intensive management, consistent with the characteristics of the respondents in this study (J. Pretty & Bharucha, 2014).

Organic and Inorganic SRI Farming Income

Income serves as a critical metric for assessing farmer welfare. This study calculated income as the difference between total revenue and total production costs. The data in Table 3 show that farmers who adopted the organic SRI system achieved a significantly higher income compared to those utilizing the inorganic system. The average income of organic SRI farmers is Rp125,195,859 ha^{-1} $season^{-1}$, whereas the income of inorganic farmers is only Rp20,048,396 ha^{-1} $season^{-1}$.

Table 3. Average Rice Farming Income (Rp/ha)

System	Total Revenue	Total Cost	Income
SRI Organic	134,876,880	9,681,021	125,195,859
Inorganic	31,144,558	5,269,917	25,874,641

The Independent Sample T-Test results confirmed this significant difference, yielding a p value of 0.015 ($p < 0.05$). This suggests that the income disparity between the two groups is attributable to the implementation of distinct cultivation systems rather than random variation. This finding aligns with the research conducted by Anggita & Suprehatin (2020), Handayani et al. (2018), which indicates that while organic SRI production costs are generally higher, this system offers added value through increased grain selling prices and enhanced long-term input efficiency.

The income of organic SRI farmers is significantly affected by the elevated selling price of grain (Rp5,100 kg^{-1}) relative to inorganic farmers (Rp5,100 kg^{-1}), despite the fact that inorganic farmers achieve higher total production levels. This corroborates the findings of Rahmaniah et al. (2020) that organic products possess greater economic value owing to the rising market demand for healthy and sustainable food.

SRI systems enhance the efficiency of water, fertilizer, and seed utilization, while also yielding crops with greater pest resistance (Kassam et al., 2011). This ultimately diminishes reliance on external inputs and enhances farmer self-sufficiency, a critical component of rural economic sustainability (Uphoff et al., 2008). The findings indicate that the organic SRI system is more environmentally sustainable and yields greater economic returns for farmers. As the results of research from Sutarni & Fitri (2023) which states that paddy farming without chemical pesticides is feasible to be developed because it has favorable economic prospects. The development and expansion of this system merits consideration as a strategy for the economic empowerment of small-scale farmers in rural areas. This study's results demonstrate that the adoption of the SRI-based organic rice farming system in Baula sub-district positively affects farmers' welfare. This is evidenced by heightened income, productivity, and institutional engagement in facilitating the adoption process.

The SRI system has demonstrated greater productivity and efficiency, as indicated by Kassam et al. (2011). The increase in income achieved by organic SRI farmers provides strong evidence that this system is capable of delivering better economic results through a

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more efficient and sustainability-oriented cultivation approach. The increase in yield per hectare contributes directly to higher selling prices, especially when combined with better grain quality.

Analysis of Farmers' Perceptions of the Role of Stakeholders

Stakeholders play a crucial role in facilitating the effective implementation of sustainable agricultural systems, such as organic-based SRI systems. This research involves several stakeholders: PT Vale Indonesia (private sector), local government, agricultural extension services, and the Organic Farmer Group Association.

This study assessed farmers' perceptions regarding the contribution levels of various stakeholders in the implementation of the organic SRI system. The measurement utilized a Likert scale ranging from 1 to 5, indicating farmers' perceptions of stakeholder involvement in training, input provision, technical assistance, and marketing facilitation.

Table 4. Average Score of Farmers' Perceptions of the Role of Stakeholders

Stakeholders	Score	Assessment Category
PT Vale Indonesia	4.6	Very Instrumental
Local Government	4.2	Instrumental
Agricultural Extension Worker	4.3	Instrumental
Organic Farmers Association	4.4	Very Instrumental

Based on Table 4, it shows that PT Vale Indonesia received the highest score, reflecting farmers' significant appreciation for CSR support, including training and the provision of production inputs. The role of the Organic Farmers Association is also very significant, with almost equal scores. This shows the importance of local power and community solidarity in managing collective farms and bridging farmers' access to markets and policies.

The role of Agricultural Extension Officers occupies the third position, reflecting their technical presence in the field, especially in the process of introducing and implementing SRI cultivation techniques. Meanwhile, the local government, while playing an important role in terms of policy and extension, is considered to still have room to strengthen its role in aspects of price regulation, market guarantees, and strengthening farmer institutions.

This Likert score supports the theory of farmer participation and empowerment in agricultural development. As emphasized by Pretty (1995), development that relies on community participation is more capable of producing sustainable social and technological transformation. In this context, farmer participation is not just a formality or symbolic involvement, but reflects a process of mutual learning, knowledge exchange, and individual and collective capacity building. The success of agricultural development that actively involves farmers also shows that social aspects and local institutions have an important role in supporting the adoption of innovations and the sustainability of development results (Klerkx & Jansen, 2010).

The results of the study in Table 4 reinforce the findings of Heryadi et al. (2022) and Fadlina et al. (2013) which show that the effectiveness of organic farming programs is highly dependent on coordination across actors and strengthening the role of farmer associations in local decision-making. Thus, it can be concluded that the role of stakeholders in the implementation of organic SRI is highly

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valued by farmers, especially in actors who interact directly, routinely, and flexibly in responding to farmers' needs. The implication of this finding is the need to maintain multi-stakeholder collaboration and strengthen farmer associations as central actors of sustainability in organic farming systems.

Results of the Likert-based survey in Table 4 show that the role of stakeholders is highly valued, especially farmer associations and the private sector. This supports Heryadi et al. (2022) study that emphasizes the importance of grassroots institution involvement in ensuring program sustainability. The implication is that the organic SRI system is not only relevant as a technical approach, but also as a model of socio-economic empowerment. Farmers become more independent, access to markets increases, and awareness of the importance of agricultural ecology begins to grow. On the other hand, incentives from the government and CSR roles from companies accelerate this transformation process. From the policy aspect, the government needs to design incentive schemes for organic farmers, such as green fertilizer subsidies, opening market access, and facilitating certification. The private sector can develop a fair partnership model, while farmer associations need to be strengthened as economic as well as social institutions.

Theoretically, the findings in this study make an important contribution in enriching the agribusiness literature through a holistic approach that integrates technical, social, and institutional dimensions in the context of sustainable organic agriculture. This study shows that the success of a sustainable agricultural system is not solely determined by technological innovation, but is also supported by synergies between actors, ranging from farmers, extension workers, local institutions, to regulatory and policy support from the government.

The main contribution of this research lies in empirically proving that agricultural sustainability is highly dependent on the adaptive capacity of local communities to innovations, mediated by the strength of social networks and the functioning of local institutions. When farming communities are able to collectively respond to, absorb and adapt innovations, then technological interventions are not only temporary, but internalized in daily agricultural practices. In this case, meaningful farmer participation and ownership of innovations are key factors in maintaining long-term sustainability.

The implications of these findings are very relevant for the development of organic farming, which inherently requires active involvement of farmers in all stages of the production process as well as strengthening social systems that support ecological sustainability. Therefore, a development approach that places farmers as subjects, not objects of development, and encourages local-based cross-sector collaboration is the main prerequisite in encouraging the transformation of agricultural systems towards a more inclusive and sustainable direction.

Although this study provides an initial overview of the impact of the organic SRI system on farmers' income and productivity in Southeast Sulawesi, there are several limitations that should be noted. First, the scope of the location and the number of respondents are still limited, so the results cannot yet be generalized to a wider area. Second, this study does not include farmers who have not yet or no longer adopted the SRI system, even though this group is important for understanding adoption barriers. Third, the social and environmental aspects of the SRI system have not been analyzed, so further research needs to expand the evaluation dimensions. Finally, the statistical approach used is still descriptive; future studies could employ more complex analytical techniques to yield deeper and more predictive results.

This study provides an initial overview of the economic impact of implementing organic

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SRI systems, but there are still a number of gaps that can be explored further. Future studies are recommended to expand the area and number of samples so that the results are more geographically and socially representative. In addition, it is important to involve farmers who have not adopted or have stopped using SRI in order to understand the barriers to adoption more comprehensively. More complex quantitative approaches, such as multivariate regression or structural modeling, can also be used to identify the factors determining the success of the system. Finally, environmental and social dimensions, such as food security, soil quality, and long-term sustainability, need to be the focus of further research to support the development of more targeted and contextual agricultural policies.

CONCLUSION

This study shows that the organic rice farming system based on the System of Rice Intensification (SRI) is able to have a positive impact on improving the welfare of farmers in Baula District, Kolaka Regency. The implementation of organic SRI resulted in an average net income of Rp125,195,859 ha^{-1} $season^{-1}$ and productivity of 7,493,.16 kg ha^{-1}, much higher than the inorganic farming system which only reached Rp25,874,641 ha^{-1} $season^{-1}$ and 6,106.58 kg ha^{-1}, respectively. These results show that organic SRI is not only technically and ecologically efficient, but also economically profitable. This success is inseparable from the role of various stakeholders, especially PT Vale Indonesia, local governments, agricultural extension officers, and organic farmer group associations that have assisted farmers through training, input provision, and institutional strengthening. However, these conclusions should be interpreted with consideration of the study's limitations, such as the limited research location and the use of purposive sampling techniques, which restrict the generalizability of the results. Additionally, this study did not examine other factors such as farmer characteristics, input intensity, or long-term impacts on soil health.

Practically, these results underscore the importance of sustained multi-stakeholder support in the development of organic farming systems. The government is encouraged to design locally-based incentives and policies that support the adoption of agroecological practices. The private sector, such as PT Vale Indonesia, is expected to continue empowerment programs, while farmer groups need to strengthen their role in production coordination and policy advocacy. Theoretically, this research contributes to strengthening the literature on sustainable agriculture, particularly in highlighting the economic viability of community-based organic systems. Further research is recommended to be expanded to other regions in Southeast Sulawesi and similar contexts to test the replicability of the results. In-depth studies of institutional factors and adoption dynamics are also important to support more adaptive and scalable implementation strategies.

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