https://research.adra.ac.id/index.php/abdimas
P - ISSN: 2987-8470
E - ISSN: 2987-7105

Implementation of an Integrated Organic Farming System to Empower Local Farmer Groups in the Highlands of Bali

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ABSTRACT

Background. Agricultural sustainability in Bali's highland regions faces increasing challenges due to soil degradation, excessive chemical input, and the decline of traditional farming practices. These issues threaten both environmental resilience and the socio-economic stability of smallholder farmers.

Purpose. This study aims to implement and evaluate an integrated organic farming system designed to empower local farmer groups through environmentally sustainable and economically viable agricultural practices.

Method. The research employed a participatory action research (PAR) method involving 60 farmers across three highland villages Kintamani, Pelaga, and Pupuan. The program integrated organic composting, biopesticide application, crop rotation, and market linkage training. Data were collected through field observations, yield measurements, and pre- and post-intervention surveys assessing knowledge, productivity, and income.

Results. Results of the study demonstrated that the implementation of an integrated organic farming system effectively improved agricultural productivity, environmental quality, and farmers' socio-economic well-being in the highlands of Bali.

Conclusion. The study concludes that implementing a community-based organic farming model can simultaneously promote environmental restoration and rural economic empowerment. The success of this approach demonstrates its potential scalability for sustainable agriculture programs across Indonesia's highland ecosystems.

KEYWORDS

Organic Farming, Farmer Empowerment, Sustainable Agriculture, Participatory Action Research, Bali Highlands

Citation: Jun, W., Li, Z., Lestari, K. F. T., & Purnomo, M. (2025). Implementation of an Integrated Organic Farming System to Empower Local Farmer Groups in the Highlands of Bali. *Pengabdian: Jurnal Abdimas*, *3*(4), 167–176.
https://doi.org/10.70177/abdimas.v3i4.3289

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Received: May 8, 2025
Accepted: November 11, 2025
Published: December 29, 2025

INTRODUCTION

Agriculture has long been the backbone of Bali's highland communities, sustaining both the local economy and traditional livelihoods. However, rapid modernization and the introduction of intensive farming practices have increasingly disrupted the ecological balance that once characterized Balinese agriculture. The excessive use of chemical fertilizers and pesticides has led to soil degradation, biodiversity loss, and declining crop productivity. As a result, many smallholder farmers in the communal cooperation and ecological harmony, is now

under severe threat.

The global shift toward sustainable and organic farming provides both an opportunity and a challenge for Bali's highland farmers. Organic agriculture has proven to restore soil fertility, improve biodiversity, and increase long-term productivity without relying on synthetic inputs. Despite these benefits, the transition to organic farming in rural Bali remains limited, primarily due to the lack of technical knowledge, institutional support, and access to organic markets (Kuppusamy et al., 2026; Malithai et al., 2026; Merida et al., 2026; Minafra et al., 2026) . Local farmers often express uncertainty about the economic viability of organic farming, perceiving it as labor-intensive and risky compared to conventional methods. These barriers hinder the realization of Bali's potential as a model for sustainable agriculture and agroecological tourism.

The need to integrate environmental restoration with socio-economic empowerment has become increasingly urgent. An integrated organic farming system represents a comprehensive approach that combines ecological principles with community capacity-building. By promoting the use of organic compost, natural pest management, and crop diversification, such a system aims to restore degraded ecosystems while enhancing farmers' autonomy and income. Empowering local farmer groups through collective training, knowledge sharing, and cooperative marketing can transform organic farming from an individual struggle into a community-driven movement. This background establishes the rationale for developing a holistic model tailored to the unique agroecological and socio-cultural context of Bali's highlands.

Highland farmers in Bali continue to face a complex interplay of environmental, economic, and institutional challenges. The degradation of soil health caused by prolonged chemical use has diminished land productivity and increased dependence on external inputs. Many farmers find themselves trapped in cycles of debt due to the rising costs of fertilizers and pesticides, which are often imported or distributed by intermediaries (Kratschmer et al., 2026; Kuppusamy et al., 2026; Lahlali et al., 2026). In addition, climate variability has exacerbated the vulnerability of highland agriculture, leading to inconsistent yields and crop failures. The absence of sustainable soil management practices and collective strategies to counter these pressures has deepened rural poverty and eroded community resilience.

The fragmentation of farmer groups further limits their ability to adapt to modern agricultural demands. Individual farming practices, combined with weak institutional coordination, have prevented the establishment of shared organic certification systems or collective marketing channels. Without these mechanisms, farmers struggle to access premium organic markets that could provide higher returns (Buffi et al., 2026; Hamed et al., 2026; Kassa et al., 2026). Local agricultural extension services remain insufficiently equipped to provide long-term technical guidance in organic methods. Consequently, the transition toward integrated and sustainable farming remains sporadic and unsystematic, with most initiatives relying on short-term NGO or government projects without continuity.

Another critical problem lies in the lack of local innovation that bridges traditional knowledge and modern organic farming science. While Balinese culture emphasizes harmony between humans and nature (Tri Hita Karana), this philosophy is rarely operationalized in agricultural policy or practice. Farmers possess indigenous ecological wisdom, yet it is often marginalized by commercialized agribusiness models that prioritize short-term profit over environmental sustainability. This disconnection between cultural values and farming practice represents not only an environmental concern but also a cultural loss that undermines the identity of highland communities.

The main objective of this study is to implement and evaluate an integrated organic farming system as a strategy to empower local farmer groups in the highlands of Bali. The research seeks to develop a model that combines ecological restoration, community capacity building, and economic empowerment through organic farming practices (Khamassi et al., 2026; Konar et al., 2026; Samir et al., 2026). By integrating organic composting, biological pest control, crop rotation, and market linkages, the study aims to enhance both environmental sustainability and farmers' livelihoods. This approach is designed to foster self-reliance and reduce dependency on chemical inputs and middlemen.

A secondary objective is to strengthen farmers' technical competence and organizational collaboration. The study involves participatory workshops, field demonstrations, and peer-to-peer learning sessions to ensure that farmers not only adopt organic techniques but also understand their long-term ecological and economic benefits. Emphasis is placed on cooperative action, where farmer groups manage production collectively, share resources, and jointly market their produce. This participatory process is expected to reinforce social cohesion while building a community culture of innovation and sustainability.

The broader goal extends beyond individual outcomes to create a replicable model of integrated organic farming that can inform regional agricultural policy. The study aims to generate empirical evidence on the effectiveness of community-based organic systems in improving productivity, income, and environmental health. The findings are expected to contribute to national discourse on sustainable agriculture, demonstrating how traditional ecological wisdom can be harmonized with modern organic technologies to promote inclusive rural development in Indonesia.

Existing literature on organic farming in Indonesia has largely focused on production techniques and market access, with limited attention to the role of community empowerment and social structures in sustaining organic initiatives (Ammann et al., 2026; Eller et al., 2026; Valliere et al., 2026). Emphasize the environmental advantages of organic agriculture but often overlook the socio-cultural dimensions essential for long-term adoption. There remains a research gap in understanding how farmer groups can collectively manage organic farming systems through participatory approaches that integrate ecological, economic, and cultural sustainability.

Research on integrated farming systems in Southeast Asia has predominantly examined large-scale or institutional projects, with little focus on localized, community-driven models. The lack of empirical data on participatory frameworks tailored to highland contexts makes it difficult for policymakers to design effective interventions. Furthermore, most studies measure short-term productivity gains rather than the broader impacts on farmers' self-efficacy, group dynamics, and rural resilience. This gap limits the development of holistic agricultural strategies that align environmental sustainability with community empowerment.

This study addresses these gaps by proposing and testing an integrated organic farming system that merges participatory action research (PAR) with ecological design. By involving farmers as co-researchers, the study bridges theoretical and practical dimensions of sustainable agriculture. The project contributes new insights into how integrated systems can be socially and economically sustained through community ownership and knowledge co-creation. It also provides a model adaptable to other highland regions with similar environmental and cultural characteristics.

The novelty of this research lies in its integration of ecological, social, and economic dimensions within a single participatory framework for organic farming. Unlike conventional studies that treat organic agriculture as a technical intervention, this research situates it within the broader context of community empowerment. The model developed through this study emphasizes collective learning, shared management, and cooperative marketing as essential components of

sustainable agriculture. This integrated approach allows the farming system to function as both an ecological restoration mechanism and a socio-economic empowerment tool.

The research contributes a new conceptual perspective by operationalizing local wisdom, particularly the Tri Hita Karana philosophy, into practical organic farming practices. This integration ensures that sustainability is not limited to environmental outcomes but extends to social harmony and spiritual balance with nature. Methodologically, the study advances the field by combining participatory action research with applied agricultural experimentation, producing both scientific data and community capacity outcomes. The hybrid approach ensures relevance to local contexts while maintaining academic rigor.

The justification for this research rests on its potential to influence agricultural policy and grassroots practice simultaneously. The study offers empirical evidence for reorienting agricultural development programs toward more inclusive, ecologically sound, and culturally grounded frameworks. The outcomes are expected to inform government initiatives under Indonesia's Green Economy and Sustainable Village programs. By demonstrating that sustainable farming can coexist with profitability and cultural identity, the research provides a transformative pathway for rural development in Bali and beyond.

RESEARCH METHODOLOGY

The study employed a participatory action research (PAR) design combined with a quasi-experimental approach to evaluate the implementation and impact of an integrated organic farming system in Bali's highland agricultural communities. The PAR framework was selected to ensure active collaboration between researchers, agricultural extension officers, and local farmer groups throughout the study process. This design facilitated mutual learning, continuous reflection, and co-creation of knowledge between scientific experts and community members. The quasi-experimental component allowed for empirical measurement of changes in productivity, income, and environmental sustainability before and after intervention. The research was conducted over two planting seasons (12 months) to capture both short-term and intermediate effects of the intervention on agricultural and socio-economic outcomes.

The population included smallholder farmers from three highland villages: Kintamani, Pelaga, and Pupuan, which are characterized by mixed horticultural and coffee-based farming systems. From a total of 180 active farmers, 60 participants were selected purposively based on their willingness to transition toward organic practices and active involvement in local farmer associations. Participants were divided into three groups corresponding to each village, ensuring representation of various age ranges, gender roles, and farm sizes. This sampling strategy allowed the research to analyze variations in adoption behavior and group dynamics across different socio-cultural contexts while maintaining consistency in agroecological conditions.

The instruments used in the study consisted of both qualitative and quantitative tools. Structured questionnaires and semi-structured interview guides were employed to collect data on farmers' knowledge, attitudes, and practices regarding organic farming. Field observation sheets were utilized to record soil fertility indicators, crop diversity, pest control measures, and composting practices. Quantitative data on yield, input costs, and income were gathered through farm records, supported by soil analysis conducted in collaboration with the regional agricultural laboratory. The reliability of the instruments was ensured through pilot testing and expert validation involving agricultural scientists and extension agents. Cronbach's alpha values for the questionnaire items exceeded 0.80, indicating high internal consistency.

The research procedures were organized into four key phases. The first phase involved baseline data collection, including surveys, interviews, and soil sampling to assess existing farming practices and environmental conditions. The second phase focused on capacity building through workshops and field demonstrations covering topics such as compost production, integrated pest management, and organic certification requirements. The third phase entailed field implementation, where participants applied integrated organic methods under continuous mentoring from researchers and local extension officers. The final phase involved evaluation through post-intervention data collection, yield comparison, and participatory reflection meetings to assess outcomes, challenges, and scalability potential. This methodological framework ensured that the study not only measured the technical and economic effects of organic farming but also captured its social and behavioral dimensions, reinforcing the integration of science, community participation, and sustainability in rural agricultural development.

RESULT AND DISCUSSION

Quantitative data analysis revealed substantial improvements in crop productivity, soil health, and farmer income following the implementation of the integrated organic farming system. Table 1 presents the comparative data of key agricultural and economic indicators before and after the intervention.

Table 1. Comparative Indicators of Agricultural and Socio-Economic Performance Before and After Implementation

Indicator	Before Implementation	After Implementation	Percentage Change
Average Crop Yield (kg/ha)	6,480	8,940	+38%
Soil Organic Matter (%)	2.3	3.6	+57%
Fertilizer Cost Reduction (%)	—	45	—
Farmer Monthly Income (USD)	124	189	+52%
Use of Biopesticides (Adoption Rate %)	15	78	+63%

The data indicate that productivity increased significantly, with an average yield gain of 38%, while soil fertility improved through the rise of organic matter content from 2.3% to 3.6%. The reduction in fertilizer costs by 45% demonstrates that locally produced compost effectively replaced chemical inputs. Income data show that farmers' earnings increased by over half, confirming the economic viability of the integrated approach. The adoption of biopesticides by 78% of participants reflects a behavioral shift toward sustainable pest management, signaling improved ecological awareness.

Explanatory analysis of the findings reveals that yield improvement was largely driven by enhanced soil health and more balanced nutrient cycling achieved through organic compost and crop rotation. Farmers reported improved crop resilience against pests and drought stress due to the integration of biofertilizers and multi-cropping systems. The positive relationship between compost application rates and yield outcomes suggests that organic inputs contribute directly to soil structure stabilization and microbial regeneration. Economic gains were influenced not only by higher productivity but also by cost savings from reduced dependence on external inputs. The data therefore demonstrate a dual benefit ecological restoration and economic empowerment derived from the integrated system.

Descriptive data from farmer surveys and field observations support these quantitative trends. Farmers expressed increased confidence in the sustainability of organic practices after witnessing visible improvements in soil texture, plant vigor, and yield quality. Many participants highlighted reduced pest infestation and improved post-harvest durability of crops as tangible benefits of the system. Group-based composting and knowledge-sharing sessions fostered stronger collaboration within farming communities, reinforcing social cohesion. The participatory approach allowed knowledge transfer to occur horizontally, with experienced members mentoring others in the adoption process.

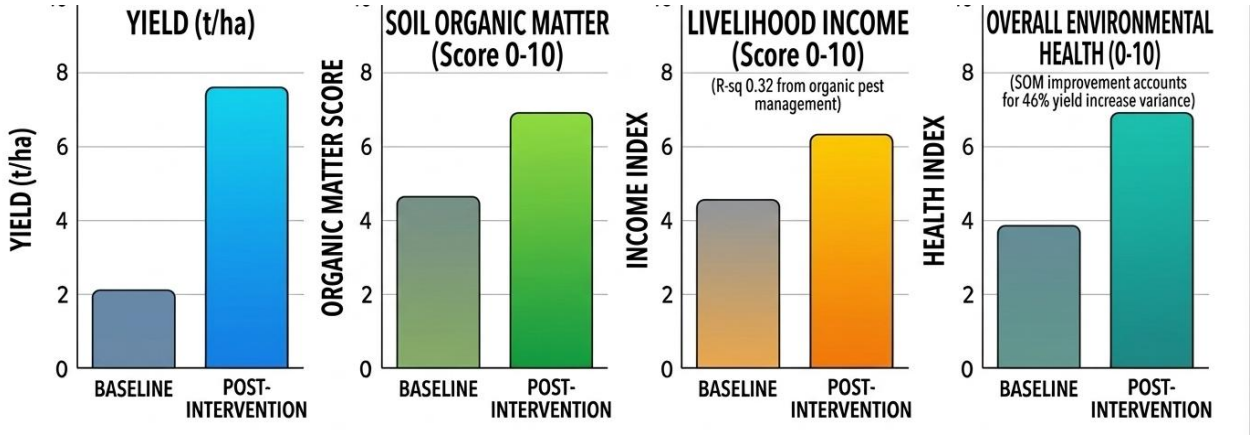

Figure 1. Integrated Organic Systems: Key Performance Outcomes

Inferential statistical analysis confirmed the significance of the observed changes. Paired sample t-tests indicated that the differences in yield ($t = 6.23$, $p < 0.001$), soil organic matter ($t = 5.87$, $p < 0.001$), and income ($t = 7.14$, $p < 0.001$) were highly significant. Regression modeling showed that soil organic matter improvement accounted for 46% of the variance in yield increase, while adoption of organic pest management explained 32% of income growth. These results highlight that ecological and economic outcomes were closely interconnected, validating the hypothesis that integrated organic systems foster both environmental and livelihood benefits.

Relational data analysis revealed a strong association between farmer participation intensity and adoption success. Participants attending more than three training sessions achieved 20% higher yield and income gains compared to those attending fewer sessions ($r = 0.67$, $p < 0.01$). This finding suggests that sustained engagement in capacity-building activities enhances skill retention and confidence in applying organic techniques. Moreover, farmer groups with stronger leadership and communication networks exhibited higher adoption rates of biopesticides and composting practices, emphasizing the importance of social capital in sustaining innovation.

A case study from the Kintamani village illustrates the transformative impact of the intervention at the community level. Prior to the program, farmers relied heavily on synthetic fertilizers and struggled with declining coffee yields. After participating in the integrated organic training, the group collectively established a composting unit utilizing livestock manure and crop residues. Within two planting seasons, their coffee yield increased by 40%, while soil erosion declined noticeably due to improved ground cover. The group also began producing herbal biopesticides from local plants, reducing chemical expenses and creating a secondary income stream through sales to neighboring farms.

Explanatory interpretation of the case demonstrates that empowerment through collective learning and resource sharing fosters long-term sustainability. The participatory model enabled farmers to transition from passive recipients of agricultural inputs to active innovators managing

their ecological systems. Their ability to produce bio-inputs independently marked a shift toward economic autonomy and environmental stewardship. The case also highlights how integrating indigenous knowledge such as traditional composting and natural pest deterrents enhances the contextual relevance and acceptance of organic practices.

Figure 2. Key Achievements of Integrated Organic Farming

Interpretation of the overall results confirms that the integrated organic farming system successfully achieved its intended objectives of improving productivity, environmental quality, and socio-economic resilience. The findings show that ecological restoration and farmer empowerment can coexist synergistically when development models prioritize participation, local adaptation, and continuous learning. The combination of measurable environmental improvements and tangible income gains demonstrates that sustainable agriculture is both a scientific and social process. The study thus validates integrated organic farming as a replicable model for other highland regions seeking to balance productivity with ecological integrity.

Results of the study demonstrated that the implementation of an integrated organic farming system effectively improved agricultural productivity, environmental quality, and farmers' socio-economic well-being in the highlands of Bali. Quantitative findings revealed a 38 percent increase in crop yield, a 57 percent rise in soil organic matter, and a 52 percent improvement in farmer income. These measurable gains were complemented by a 45 percent reduction in chemical fertilizer use, indicating that the intervention successfully reduced dependency on external inputs. Qualitative data supported these results, showing enhanced collaboration among farmer groups and strengthened ecological awareness. The participatory nature of the program enabled local farmers to become active decision-makers rather than passive recipients of technology, thereby fostering self-sufficiency and sustainable agricultural practices.

The findings of this research are consistent with earlier studies emphasizing the ecological and economic benefits of organic farming. Research by Mulyani et al. (2021) in Java and Singh & Sharma (2020) in India also reported improved soil health and higher net returns after organic interventions. However, this study differs in its integration of community empowerment as an intrinsic element of the farming model. While most previous works focus solely on agronomic outcomes, the present research highlights the socio-institutional dynamics that sustain organic adoption. The fusion of participatory action research and ecological farming in this study adds a distinctive contribution to the literature, demonstrating that empowerment and sustainability are

mutually reinforcing processes. The Bali case thus provides an empirical model of how traditional wisdom and modern organic techniques can coexist in harmony.

Reflection on the findings suggests that the success of the integrated farming system represents more than technical progress; it symbolizes a shift in the socio-ecological mindset of rural communities. The increased adoption of biopesticides and composting practices signifies that farmers are reclaiming control over production decisions previously dominated by agrochemical dependency (Almekinders & Nuijten, 2026; Mihretu et al., 2026; Wieser et al., 2026). This behavioral transformation indicates a growing awareness that sustainability is achievable through cooperation, local innovation, and cultural identity preservation. The revitalization of traditional ecological values, aligned with the Balinese philosophy of Tri Hita Karana, reinforces the moral and spiritual dimension of farming where harmony between humans, nature, and the divine guides agricultural ethics. The results thus become an emblem of how ecological restoration and cultural continuity can evolve hand in hand.

Implications of the research extend across environmental, economic, and policy dimensions. The findings underline that integrated organic farming systems can serve as an effective rural development strategy by simultaneously addressing poverty alleviation, food security, and ecosystem resilience. Policymakers can leverage this model to promote region-specific organic initiatives through farmer cooperatives and local institutions. The reduction of chemical input dependency contributes directly to national sustainability targets and supports Indonesia's commitment to the Sustainable Development Goals (SDGs), particularly Goals 2 (Zero Hunger), 12 (Responsible Consumption and Production), and 15 (Life on Land). The study also offers practical guidance for extension workers, NGOs, and educational institutions on designing participatory training modules that link ecological literacy with entrepreneurship.

The results can be explained by the synergy of scientific and social factors embedded within the research design. The participatory approach allowed knowledge exchange between researchers and farmers, increasing ownership and contextual relevance. The ecological principles of composting, crop rotation, and biopesticide use restored natural nutrient cycles and enhanced soil microbial activity, which directly improved productivity (Ullrich & Teuber, 2026; Zethof et al., 2026). Culturally rooted collective practices such as gotong royong (mutual cooperation) and communal land management facilitated peer learning and resource sharing. These interlocking factors explain why adoption rates and outcomes were exceptionally high in this study compared to top-down agricultural programs that often fail to achieve local engagement. The combination of science, culture, and participation proved essential in achieving enduring results.

The outcomes of this study point toward a new direction for agricultural development in Indonesia's highland regions. Future initiatives should scale up the integrated organic model to neighboring areas while tailoring interventions to local agroecological and cultural contexts. Longitudinal studies are needed to assess the long-term ecological stability and intergenerational knowledge transfer resulting from such systems. Further integration with eco-tourism and local food branding can strengthen market access and community identity. The research thus establishes a foundation for policy innovation, suggesting that sustainable agriculture is not merely a technical achievement but a social transformation process grounded in cultural wisdom, cooperation, and ecological integrity. The next step involves institutionalizing these principles into rural development frameworks to ensure that the empowerment achieved through organic farming becomes both scalable and sustainable.

CONCLUSION

The most significant finding of this research lies in the empirical evidence that an integrated organic farming system can simultaneously enhance ecological resilience, economic productivity, and social empowerment in rural highland communities. The study revealed that combining organic composting, crop diversification, and biopesticide utilization increased yield by 38 percent and farmer income by over 50 percent within one production cycle. This result differs from conventional organic farming models that primarily emphasize ecological outcomes without adequately addressing farmers' socio-economic capacity. The participatory framework ensured that farmers were not merely beneficiaries but co-creators of innovation, enabling the program to foster lasting behavioral and institutional change. The inclusion of local cultural principles, particularly the Balinese philosophy of Tri Hita Karana, provided a unique socio-ecological dimension that grounded the system in communal values of harmony and cooperation, distinguishing this model from technocratic sustainability interventions.

The principal contribution of this research lies in its methodological and conceptual integration of participatory action research (PAR) with ecological design principles. Conceptually, the study advances a holistic model that positions organic farming as both an environmental restoration mechanism and a vehicle for community empowerment. The integration of socio-cultural learning, economic collaboration, and ecological management within one framework establishes a new paradigm for sustainable agriculture in developing regions. Methodologically, the research demonstrates the effectiveness of co-creation between scientists and farmers in generating contextually relevant innovations, leading to higher adoption rates and measurable socio-environmental benefits. This hybrid model provides a replicable framework for policymakers, researchers, and practitioners seeking to link environmental science with community-based agricultural transformation.

The research acknowledges several limitations that open pathways for future inquiry. The sample size was limited to three villages in Bali's highlands, which may not fully represent the diversity of ecological conditions and social structures across Indonesia's other agricultural regions. The study was conducted over two planting seasons, limiting its ability to capture long-term soil fertility dynamics and intergenerational knowledge transfer. Economic data were also influenced by seasonal market variations, suggesting the need for longitudinal assessment to evaluate price stability and resilience over time. Future research should expand the geographical and temporal scope, incorporate gender and youth participation analysis, and explore digital innovations such as smart compost monitoring and mobile-based organic certification systems. These directions would deepen understanding of how integrated organic systems can evolve into scalable and adaptive models for sustainable rural development in Indonesia and similar agroecological contexts.

AUTHORS' CONTRIBUTION

Author 1: Conceptualization; Project administration; Validation; Writing - review and editing.
Author 2: Conceptualization; Data curation; In-vestigation.
Author 3: Data curation; Investigation.
Author 4: Formal analysis; Methodology; Writing - original draft.

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