Community Education and Service Journal
https://scholar.ummetro.ac.id/index.php/cesj/index
Vol. 1, No. 2 (2025), 30-40
e-ISSN 3090-5796 p-ISSN 3090-5613

WORKSHOP ON THE CULTIVATION OF *PIPER RETROFRACTUM* VAHL AND HORTICULTURAL CROPS

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Article Info

Article history:

Received October 10,2025
Revised November 12,2025
Accepted November 26,2025

Keywords:

community empowerment
food security
Javanese long pepper
organic cultivation
Piper retrofractum

ABSTRACT

Environmental issues, food security, and healthy lifestyles are urgent challenges that require practical and educational responses. This community service program aimed to enhance public knowledge and skills in organic cultivation of *Piper retrofractum* Vahl (Javanese long pepper), and vegetables, while promoting the productive use of home gardens. The implementation was carried out through participatory methods in several stages: site survey and needs assessment, socialization, theoretical training, field practice, technical assistance, and evaluation with reflection. The program involved lecturers and students of the Biology Education Study Program at Universitas Muhammadiyah Metro as facilitators, as well as partner communities such as women farmer groups, waste bank communities, schools, and the general public. The results showed a significant increase in participants' understanding of organic cultivation principles, indicated by a 70% improvement in knowledge scores.The survival rate of *Piper retrofractum* and vegetables exceeded 80%, reflecting the suitability of cultivation techniques with local conditions. The program's impact included improved ecological awareness, growing interest among participants to develop small-scale organic-based businesses, and the formation of household food self-sufficiency patterns that are healthier and more sustainable. Overall, this program proved effective in empowering local communities through organic agriculture that is environmentally friendly and economically valuable.

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INTRODUCTION

Environmental degradation, manifested through declining soil quality, water and air pollution, and biodiversity loss, has become a critical global concern. Conventional agricultural practices, characterized by excessive reliance on chemical fertilizers and pesticides, are significant contributors to these environmental challenges. Numerous studies indicate that the residues from these agricultural chemicals not only degrade soil structure and fertility but also contaminate water resources and impact long-term human health (Singh et al., 2024; Raj et al., 2024; Tahat et al., 2020). These alarming trends underline the urgent need for agricultural transformation towards sustainable and eco-friendly practices.

In the quest for sustainable food production, organic agriculture emerges as a robust alternative. By emphasizing natural inputs, biological soil fertility management, and ecological pest control, organic farming is not only environmentally sustainable but also addresses food security at the community level (Chandel et al., 2024; Raj et al., 2024; Fernández et al., 2022).

Research consistently demonstrates that organic practices contribute positively to soil health, enhance biodiversity, and lead to safer food production devoid of chemical residues (Taki et al., 2022; Geense et al., 2015; Asha et al., 2023).

Organic farming systems increase soil fertility and promote biodiversity through practices like crop rotation, composting, and the use of organic manures, thereby mitigating the reliance on synthetic fertilizers (Singh et al., 2024; Raj et al., 2024). Such practices are instrumental in improving household food self-reliance by optimizing local resources, such as the productive use of home gardens to grow organic produce like vegetables and fruits (Taki et al., 2022; Vaish et al., 2020).

Among the crops that exemplify the economic and health potentials of organic agriculture is *Piper retrofractum* Vahl, or Javanese long pepper. This indigenous Indonesian spice has been traditionally utilized in herbal medicine, thus playing a crucial role in both dietary and medicinal contexts. The bioactive compounds found in Javanese long pepper open avenues for its application in phytotherapy and functional foods, helping meet both domestic and export demands Vaish et al., 2020; (Sindhu et al., 2020) . Enhancing the cultivation of this crop within organic systems could yield significant income for agriculture-based communities, promoting overall local economic development.

Despite the demonstrated benefits of organic agriculture, particularly in the cultivation of Piper retrofractum, implementing these practices at the community level faces notable challenges. A significant gap exists between the scientific knowledge available about organic techniques and the local communities' capacity to utilize this knowledge practically (Chandel et al., 2024; Raj et al., 2024; Reddy et al., 2023). While extensive research has been conducted on the agronomic characteristics and market potential of organic crops, the necessary frameworks for hands-on training and community engagement remain sparse (Wiggins & Nandwani, 2020; Sharma, 2024).

Additionally, local communities often struggle with producing organic fertilizers and managing growing media without resorting to synthetic inputs, indicating that successful organic practices require not only technological availability but also educational initiatives tailored to local contexts Naskar et al., 2024; Wang et al., 2021; Asha et al., 2023). Sustainable engagement processes, continuous mentoring, and education are essential for empowering communities to adopt and maintain organic agricultural practices effectively.

In response to these challenges, the Biology Education Study Program at Universitas Muhammadiyah Metro is committed to bridging the research-service gap. By integrating scientific knowledge with field-based practice, the program aims to adopt a participatory approach to educate communities on organic farming principles (Taki et al., 2022; Vaish et al., 2020; Scortichini, 2022). This initiative focuses on practical skill development in cultivating organic crops, particularly Piper retrofractum, while building ecological awareness regarding environmentally friendly methodologies.

The expected outcomes of this community service program include enhanced community capacity to manage organic home gardens, strengthened ecological awareness, and the establishment of sustainable household food patterns. Additionally, the program intends to support the development of small-scale organic enterprises, ultimately fostering local food security and economic self-sufficiency (Sindhu et al., 2020; Naskar et al., 2024; Fernández et al., 2022).

IMPLEMENTATION METHOD

This community service program employed a participatory and applied approach, emphasizing the active involvement of community partners at every stage of implementation (Hartati et al., 2024; Nirmala et al., 2007). The methods applied included socialization activities, theoretical training, field-based practice, technical assistance, as well as evaluation and reflective assessment.

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https://scholar.ummetro.ac.id/index.php/cesj/index
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e-ISSN 3090-5796 p-ISSN 3090-5613

Figure 1. *Community Service Implementation Flow*

Based on Figure 1, the community service program was implemented through six sequential and complementary stages, beginning with preparation Stage, the community service program began with a site survey and a needs assessment to determine the focus of the activities. The academic team coordinated with community partners, including women farmer groups and waste bank communities, to ensure alignment between program objectives and local conditions (Nirmala et al., 2007; Trisno et al., 2024). Socialization Stage, the socialization stage was conducted by disseminating information on the benefits of organic crop cultivation and the importance of utilizing home gardens to support household food self-sufficiency (Hartati et al., 2024; Andriyani et al., 2023). Theoretical Training, the training was delivered in the form of workshops covering the basic principles of organic farming, techniques for producing organic fertilizers, and the preparation of eco-enzymes as environmentally friendly agricultural inputs (Andriyani et al., 2023; Trisno et al., 2024). Field Practice, field practice activities were carried out through hands-on demonstrations, including the preparation of planting media, the planting of Piper retrofractum seedlings and organic vegetables, fertilization procedures, and crop maintenance techniques (Wang et al., 2022; Trisno et al., 2024). Technical Assistance, participants received intensive technical assistance through regular field visits and online communication to monitor the progress and success of the organic cultivation practices (Hartati et al., 2024; Andriyani et al., 2023). Evaluation and Reflection, the program concluded with an evaluation and reflection phase, focusing on the assessment of program outcomes as well as the measurement of improvements in participants' knowledge and practical skills (Takahashi et al., 2017; Nirmala et al., 2007). Tools and Materials, the tools used in this program included hoes, polybags, planting pots, sprayers, weighing scales, and buckets for biofertilizer production. The materials consisted of Javanese long pepper seedlings, vegetable and fruit seedlings, compost, liquid organic fertilizer, and eco-enzymes produced during the training activities.

RESULTS AND DISCUSSION

The outcomes of this community service program should be interpreted not merely as descriptive achievements, but as evidence of a structured intervention responding to Indonesia's agricultural sustainability challenges. In line with community service reporting standards, results are most meaningful when they are analytically linked to program objectives and interpreted in relation to relevant theories and empirical findings. Accordingly, the organic farming program can be positioned as a strategic response to structural constraints in Indonesian agriculture particularly in plantation and smallholder-based systems where conventional input-intensive practices have contributed to declining soil health, reduced biodiversity, and weakened environmental resilience (Singh et al., 2024; Raj et al., 2024; Tahat et al., 2020). The program's

impacts are best understood through two complementary dimensions: ecological transition (reducing dependence on synthetic inputs while restoring agroecosystem functions) and community empowerment (strengthening farmers' knowledge, skills, and agency so changes persist beyond the project period).

Agriculture remains a central pillar of Indonesia's economic framework, contributing substantially to GDP, rural employment, and food security. Yet, this strategic role is accompanied by persistent challenges, including productivity disparities across regions and farmer categories, climate-driven production volatility, and sustainability concerns linked to soil degradation and ecosystem simplification. These constraints are particularly apparent in commodity-oriented and plantation-dominated landscapes, where short-term yield gains from intensive chemical inputs often mask long-term ecological and economic costs (Singh et al., 2024; Raj et al., 2024; Tahat et al., 2020). Soil organic matter depletion, declining soil biota, and reduced functional diversity in farm landscapes can increase vulnerability to drought and pest outbreaks while simultaneously heightening dependence on fluctuating input prices. For rural communities, these pressures have a direct consequence because agriculture is not only an economic sector but also a socio-economic stabilizer that sustains livelihoods, buffers households against food insecurity, and supports local economies through labor absorption and value-chain activity (Chandel et al., 2024). In smallholder-dominated areas, where farming decisions are shaped by limited resources and risk aversion, sustainability interventions must therefore go beyond technical instruction and address the social and institutional conditions that enable adoption.

Within this broader context, the program's participatory and practice-oriented design becomes a critical mechanism for change. By engaging community partners such as women farmer groups and waste bank communities the intervention is embedded in local social structures that influence household decision-making and community resource management. This approach is consistent with the view that sustainability transitions are strengthened when agronomic improvements are linked to social organization and local institutions, thereby increasing ownership and contextual relevance (Dalmiyatun et al., 2018; Alfitri et al., 2021). Such embeddedness is particularly important in the plantation subsector, where smallholders often operate within broader commodity networks that contribute to local development and export revenues (Fernández et al., 2022; Taki et al., 2022), yet remain vulnerable when production systems rely heavily on external chemical inputs and become environmentally fragile and financially exposed.

A critical barrier addressed by the program is the entrenched use of synthetic fertilizers and pesticides. Although these inputs can enhance yields in the short term, they frequently generate negative externalities, including soil structure deterioration, disrupted nutrient cycling, biodiversity loss, and risks of water and environmental contamination (Geense et al., 2015; Asha et al., 2023). In many smallholder contexts, ecological degradation translates into economic risk: increasing production costs, dependency on volatile input markets, and diminishing returns as soil fertility declines. The program's focus on organic fertilizers and eco-enzymes should therefore be interpreted not merely as introducing alternative inputs, but as an attempt to restore ecological processes at the farm and household-garden scale—enhancing soil biological activity, improving nutrient availability, and reducing chemical dependence. This orientation aligns with broader sustainability objectives and supports resilience-building under climate uncertainty.

The selection of Javanese long pepper (Piper retrofractum Vahl) as a focal crop further strengthens the contextual fit of the intervention. As an indigenous spice and medicinal plant, it has economic and cultural value and can tolerate less fertile soils, making it suitable for marginal agricultural areas such as Pamekasan Regency (Vaish et al., 2020). Its relevance to traditional medicine and local market potential can also motivate community uptake as a livelihood-oriented crop (Sindhu et al., 2020; Reddy et al., 2023). At the same time, the crop's underdeveloped cultivation highlights a broader gap: limited integration between scientific knowledge and field-based models emphasizing sustainability and empowerment (Wiggins & Nandwani, 2020; Sharma, 2024). Continued farmer reliance on synthetic inputs reflects habits, market pressures, and constrained access to practical training (Naskar et al., 2024). Embedding Piper retrofractum

into organic home-garden demonstrations and participatory learning thus provides a tangible entry point for transition that can scale through household replication and community diffusion.

Organic agriculture is widely recognized as a pathway to strengthen sustainability by improving soil health, maintaining ecological balance, and reducing chemical input reliance (Wang et al., 2021; Scortichini, 2022). However, successful implementation depends on learning processes and institutional support. Programs that simply "deliver technology" frequently underperform because farmers require contextual adaptation, repeated practice, and ongoing feedback to reduce perceived risk and build competence. For this reason, organic transition should be treated as a capacity-building process rather than a one-time technical package (Sugiharjo et al., 2025; Wahana et al., 2023). In this program, the integration of socialization, theoretical workshops, field practice, and continuous technical assistance reflects a participatory learning framework that strengthens understanding while building practical confidence. Through demonstration and mentoring, participants can translate abstract concepts soil health, nutrient cycling, ecological pest management into observable and repeatable practices.

The role of the university is also central in making this transition credible and actionable. Higher education institutions can bridge research-based innovation and community implementation by translating evidence-based practices into farmer-friendly models and sustaining iterative learning through mentoring and evaluation (Sudrajat, 2020). In this case, Universitas Muhammadiyah Metro's initiative can be interpreted as an applied extension mechanism that increases community capacity while supporting national priorities such as reducing synthetic fertilizer reliance and strengthening organic food systems (Minardi et al., 2023). The university's involvement enhances legitimacy, supports troubleshooting, and reinforces monitoring, while collaboration with women's groups and waste bank communities strengthens the social infrastructure needed for long-term maintenance.

Empirically, initial outcomes indicate meaningful improvements in community capacity. Knowledge assessments showing approximately a 70% increase in participants' understanding of organic agriculture principles (Wiyono et al., 2024) should be interpreted as strengthened cognitive readiness participants become more capable of evaluating farming decisions and understanding the rationale behind organic inputs. Such knowledge gains are often prerequisites for sustained behavioral change, especially when misconceptions about organic farming must be overcome. Practical feasibility is supported by the establishment of home-garden demonstration plots, where crop survival rates exceeding 80% suggest that participants were not only informed but also able to apply core practices such as planting media preparation, planting, fertilization, and maintenance under local conditions (Putri et al., 2023). This outcome is significant because it indicates ecological compatibility and operational manageability at the household scale. Beyond technical performance, the reported evolution in attitudes toward sustainable agriculture reflected in increased interest in small-scale organic enterprises such as seedling production and marketing signals movement from subsistence orientation toward more entrepreneurial and sustainability-driven models (Kifli et al., 2021). This shift is particularly important for scaling, as long-term adoption is more likely when farmers perceive organic practices as economically and socially valuable, not only environmentally beneficial.

The program's participatory approach combining socialization, workshops, field demonstrations, and ongoing technical support also represents a strategic departure from short-term interventions that tend to produce limited durable impacts (Rozaki et al., 2023). Experiential learning increases ownership and retention, while repeated mentoring supports process-based skills such as composting and fermentation that require practice and feedback. The inclusion of women farmer groups strengthens continuity at the household level, while waste bank communities connect cultivation to circular economy practices by supporting composting inputs and reinforcing environmentally responsible resource use. Together, these partnerships broaden the intervention ecosystem and increase the likelihood that practices will persist and spread.

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Vol. 1, No. 2 (2025), 30-40
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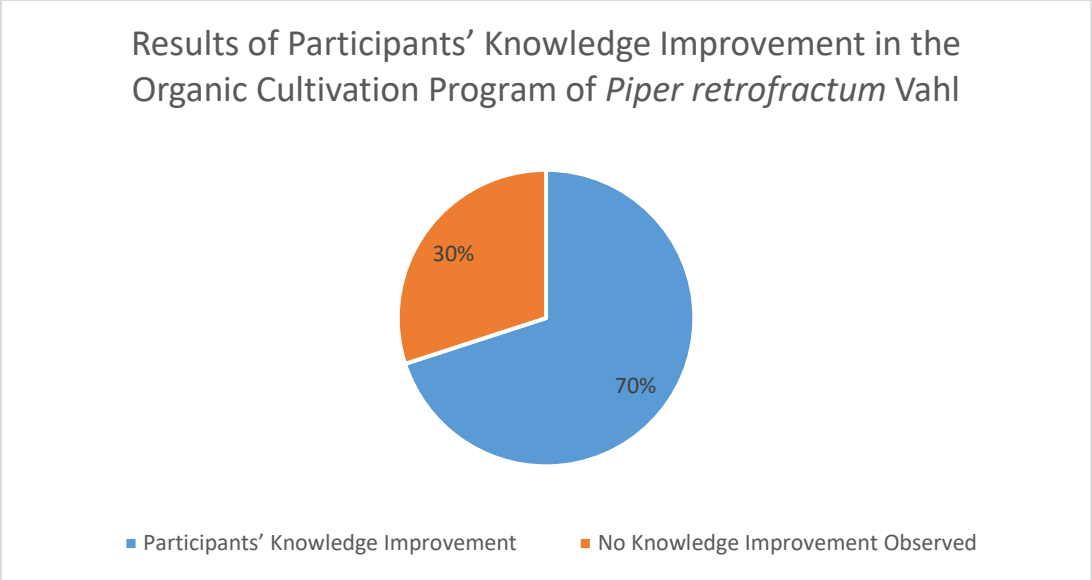

Figure 2. Distribution of Participants' Knowledge Improvement in the Organic Farming Program

Based on figure 2 presents the distribution of participants' knowledge gains following participation in the organic farming program. Beyond reporting score differences, the figure elucidates how learning improvements are distributed across the participant cohort—indicating whether program effects were broadly experienced or concentrated within specific levels of improvement. This distributional pattern provides insight into the effectiveness of the training and mentoring components by highlighting dominant improvement categories, the degree of variability among participants, and subgroups that may require additional reinforcement or targeted follow-up support.

The implementation of the community service program at Universitas Muhammadiyah Metro demonstrated significant progress in enhancing community capacity. Several key outcomes were achieved. First, knowledge improvement: participants' knowledge scores increased by approximately 70%, reflecting the effectiveness of participatory delivery methods in facilitating learning and understanding (Anindita et al., 2022; Isnijar et al., 2023). Second, the establishment of demonstration plots: home garden areas were utilized as demonstration plots for the cultivation of Javanese long pepper and other organic vegetables, providing tangible evidence of the practical application of the technologies introduced during the program (Haring et al., 2023; Anindita et al., 2022). Third, increased active participation: community engagement, particularly among women farmer groups (KWT), increased during field practice activities and continued through post-training crop maintenance, indicating the program's potential for sustainability (Haring et al., 2023; Cahyaningsih et al., 2022).

These achievements underscore the positive impact of practice-based educational approaches in empowering communities and enhancing their adaptive capacity. Moreover, the program created opportunities for participants to explore small-scale organic agriculture–based enterprises, such as seedling production and the marketing of harvested products, thereby extending the benefits beyond knowledge acquisition to economic empowerment (Haring et al., 2023; Anindita et al., 2022).

From a broader perspective, the findings suggest that national agricultural development strategies should extend beyond a narrow focus on production increases. Instead, such strategies should prioritize: (1) productivity gains, measured as output per unit of labor and land; (2) value addition through processing and downstream development; (3) food system stability, particularly resilience to climate and market shocks; and (4) improvements in farmers' welfare. This framework aligns with the broader argument that agriculture remains a leading sector within Indonesia's economic structure, particularly when agricultural development encompasses food

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Vol. 1, No. 2 (2025), 30-40
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crops, plantations, fisheries, and livestock as integrated components of a resilient and sustainable food system (Haring et al., 2023; Anindita et al., 2022).

Figure 3. Field Activity Documentation of the Organic Farming Community Service Program.

CONCLUSIONS AND SUGGESTIONS

The community service activities successfully achieved their objectives by improving community understanding of organic cultivation principles, enhancing practical skills in cultivating Piper retrofractum Vahl (Javanese long pepper), vegetables, and fruits, and promoting the productive use of home garden areas. The results indicate a 70% increase in participants' knowledge, the establishment of demonstration plots, successful production of organic fertilizers and eco-enzymes, and plant survival rates exceeding 80%. These findings confirm the effectiveness of a participatory, practice-based approach in strengthening community capacity, supporting food self-reliance, and promoting environmentally sustainable agriculture.

To ensure sustainability, future community service programs should emphasize long-term mentoring, strengthen local organic farmer groups, and incorporate value-added processing and marketing strategies to enhance the economic impact of organic agriculture and reinforce local food security.

ACKNOWLEDGMENTS

The authors would like to express their sincere gratitude to LazisMu for serving as a partner and providing financial and technical support, which enabled the successful implementation of this community service program.

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