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UTILIZATION OF TRICHO-COMPOST AND LOCAL MICROORGANISMS TO SUPPORT ORGANIC FARMING FOR THE ORA ET LABORA FARMER GROUP IN KUPANG CITY

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***Abstract**. The "Ora et Labora" Farmer Group in Naioni Village, Kupang City, has developed horticultural and livestock farming on a three-hectare area cultivating long beans, tomatoes, and chilli peppers using a drip irrigation system. Despite these advancements, farmers remain dependent on chemical fertilizers and pesticides, which over time damage soil structure, reduce fertility, and disrupt the balance of soil microorganisms. To address this issue, an organic farming system was introduced as an environmentally friendly alternative using tricho-compost based on Trichoderma spp. and Local Microorganisms (MOL). Tricho-compost improves nutrient availability and suppresses soil-borne pathogens, while MOL acts as a natural starter for organic matter fermentation and a potential biocontrol agent. This Community Service Program (PKM) aimed to enhance farmers' understanding and skills in producing and applying tricho-compost and MOL. The results demonstrated improved knowledge, technical ability, and motivation among farmers to independently implement organic farming, thereby promoting sustainable and environmentally friendly cultivation systems.*

***Keywords:** farmer empowerment, local microorganisms, organic farming, organic fertilizer, tricho-compost.*

Abstrak. Kelompok Tani "Ora et Labora" di Kelurahan Naioni, Kota Kupang, telah berkembang dalam bidang hortikultura dan peternakan dengan lahan seluas tiga hektar yang ditanami kacang panjang, tomat, dan cabai menggunakan sistem irigasi tetes. Meskipun telah maju, petani masih bergantung pada pupuk dan pestisida kimia yang dalam jangka panjang merusak struktur tanah, menurunkan kesuburan, serta mengganggu keseimbangan mikroba tanah. Untuk mengatasi hal tersebut, diperkenalkan sistem pertanian organik sebagai alternatif ramah lingkungan melalui pemanfaatan triko-kompos berbasis *Trichoderma* spp., dan mikroorganisme lokal (MOL). Triko-kompos berfungsi meningkatkan ketersediaan hara dan menekan patogen tular tanah, sedangkan MOL menjadi starter alami fermentasi bahan organik sekaligus pengendali hayati penyakit tanaman. Kegiatan Pengabdian kepada Masyarakat (PKM) ini bertujuan meningkatkan pemahaman dan keterampilan petani dalam pembuatan serta penerapan triko-kompos dan MOL. Hasil kegiatan menunjukkan peningkatan pengetahuan, keterampilan, dan motivasi petani untuk menerapkan pertanian organik secara mandiri menuju sistem budidaya yang berkelanjutan dan ramah lingkungan.

Kata Kunci: mikroorganisme lokal, pemberdayaan petani, pertanian organik, pupuk organik, triko-kompos.

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INTRODUCTION

The "Ora et Labora" Farmer Group is in Naioni Village, Kupang City, and comprises 22 active members. This group has established a strong social capital base and has made considerable advances in horticultural cultivation, as evidenced by the adoption of a drip irrigation system for commodities including long beans (*Vigna unguiculata* subsp. *sesquipedalis*), tomatoes (*Solanum lycopersicum*), and chili peppers (*Capsicum annuum*) across three hectares of land. Despite this progress, the group continues to face significant challenges in accessing updated knowledge and technology, particularly regarding practices that support long-term agricultural sustainability. Higher education institutions play a strategic role in

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bridging this gap by enhancing the institutional capacity and human resource development of farmer groups through Community Service Programs (PKM), in alignment with the tridarma mandate of Indonesian universities.

A critical issue confronting this and many similar smallholder farmer groups is the continued reliance on synthetic chemical fertilizers and pesticides. While these inputs offer short-term productivity benefits, their prolonged use generates multiple adverse consequences. Chemically intensive agriculture progressively degrades soil physical structure, reduces soil organic matter content, impairs water-holding capacity, and disrupts the biological activity of soil microorganisms (Hossain et al., 2022). Continuous application of nitrogen-based chemical fertilizers has been documented to alter the diversity and composition of rhizosphere microbial communities, diminishing populations of beneficial bacteria essential for nutrient cycling and pathogen suppression (Ren et al., 2020). These cumulative effects ultimately compromise the productive capacity and long-term resilience of agricultural land, placing smallholder farmers in an increasingly precarious cycle of chemical dependency and declining yields.

Organic farming represents a holistic and scientifically grounded alternative to address these challenges. It is defined as an agricultural management system that maintains ecosystem equilibrium, promotes biodiversity, sustains soil fertility, and ensures food security without depleting natural resources (Khadda, 2021). The core principles of organic farming include maintaining soil health, producing high-quality food, and minimizing environmental harm by avoiding the use of synthetic chemical inputs that endanger human health and contaminate ecosystems (Hossain et al., 2022). The transition from conventional to organic farming, however, is not without barriers. Knowledge gaps, perceived complexity, limited access to affordable inputs, and economic uncertainty are among the primary obstacles that smallholder farmers face. A systematic review by Sapbamrer and Thammachai (2021) identified training, extension contact, access to information, farmer networks, and the perceived economic and environmental benefits of organic practices as the most consistent drivers of organic farming adoption. This finding underscores the pivotal role that structured extension and training programs play in enabling behavioural change among farming communities. Corroborating this view, a randomized experimental study conducted in Indonesia demonstrated that even short, intensive, hands-on organic farming training significantly improved farmer adoption of organic inputs, knowledge scores, and perceptions of organic practices (Grimm & Luck, 2020), providing direct empirical support for the type of intervention implemented in this program.

Among the most promising components of organic farming technology is the use of compost enriched with *Trichoderma* spp., widely known as "tricho-compost." *Trichoderma* spp. is naturally occurring saprophytic fungi renowned for their potent antagonism against soil-borne plant pathogens. When integrated into compost, these fungi not only accelerate organic matter decomposition but also significantly enhance the biological suppression of pathogens such as *Pythium* spp., *Sclerotium* spp., *Phytophthora* spp., and *Rhizoctonia* spp. (Nahar et al., 2012; Ren et al., 2020; Coelho et al., 2021). The biocontrol efficacy of Trichoderma is attributable to three complementary mechanisms: (1) mycoparasitism, whereby Trichoderma hyphae directly penetrate and enzymatically degrade pathogen cell walls through the secretion of hydrolytic enzymes including chitinases and β-1,3-glucanases; (2) antibiosis, through the production of secondary metabolites such as gliotoxin, viridian, and peptaibols that inhibit pathogen growth and sporulation; and (3) induction of systemic resistance (ISR) in host plants, which primes the plant's innate immune system against a broad spectrum of foliar and root pathogens (Singh et al., 2021; Baazeem et al., 2021). These multifunctional properties make Trichoderma a particularly valuable biological input for integrated organic soil health management, simultaneously improving nutrient availability and providing durable plant protection.

Complementing tricho-compost in the organic system is the use of Local Microorganisms (MOL), biologically active preparations produced by fermenting locally available organic materials such as rice wash water, overripe fruits, vegetable scraps, or coconut water. MOL preparations contain a diverse consortium of beneficial microorganisms, including bacteria of the genera Bacillus and Pseudomonas, which function as decomposers and biocontrol agents, as

well as lactic acid bacteria (e.g., *Lactobacillus* spp.), yeasts (e.g., *Saccharomyces* spp.), and nitrogen-fixing bacteria (e.g., *Azotobacter* spp.) (Mohanty et al., 2021). This microbial diversity collectively contributes to organic matter breakdown, phosphate solubilization, production of plant-growth-promoting hormones (e.g., auxins, gibberellins, cytokinins), and suppression of fungal pathogens (Baazeem et al., 2021; Shahwar et al., 2023). As a result, MOL can function dually as a liquid organic fertilizer and as a biopesticide, making it a highly versatile, cost-effective, and environmentally compatible input for resource-limited smallholder farmers. The local availability and minimal cost of MOL substrates—such as coconut water, palm sugar, and overripe fruits—further strengthen its suitability for independent adoption by low-income farming communities in developing regions.

Despite the well-documented benefits of tricho-compost and MOL, knowledge and practical skills related to these technologies remain limited among Indonesian smallholder farmers. Most farmers in communities such as the "Ora et Labora" group have not been exposed to these practices, and many remain unaware of the cumulative environmental and health risks associated with continuous chemical input use, including soil fertility decline, groundwater contamination, and chronic health effects from agrochemical residue exposure (Hossain et al., 2022). Research by Muneret et al. (2018) confirmed that organic farming constitutes an effective strategy for reducing reliance on synthetic pesticides without increasing pest or disease infestation severity. Translating this scientific knowledge into accessible, practical farmer training is therefore a critical priority for agricultural extension services and higher education institutions alike.

Based on this needs assessment, this PKM program was designed around three main activities: (1) extension counseling on the negative impacts of chemical fertilizers and pesticides and an introduction to the principles of organic farming; (2) practical training in tricho-compost production and application for soil fertility improvement and pathogen suppression; and (3) practical training in MOL production and utilization as a liquid biofertilizer and biocontrol agent. The overarching objectives of the program were to strengthen farmer capacity, reduce dependence on external chemical inputs, improve soil biological health, and ultimately facilitate the transition toward a more sustainable and ecologically sound farming system.

METHODS

This Community Service Program (PKM) was implemented using a participatory andragogy approach, a learning methodology tailored to adult learners that emphasizes the relevance of training content to participants lived experiences, active engagement in the learning process, and experiential knowledge construction (Putri & Sunarti, 2023). This approach was selected to ensure effective and enduring knowledge and technology transfer that would not only increase conceptual understanding but also catalyze practical behaviour change and skills development among members of the "Ora et Labora" Farmer Group. Program implementation was structured into two main phases: an extension and knowledge transfer phase, followed by a practical training phase, supplemented by ongoing monitoring and evaluation.

Extension and Knowledge Transfer.

The extension phase aimed to build awareness and conceptual understanding among participants. It was delivered through interactive lectures combined with participatory discussion sessions, enabling participants to ask questions, share field experiences, and relate content directly to their specific farming challenges. Topics included: (1) the negative impacts of continuous chemical fertilizer and pesticide use on soil health and the surrounding environment, and an introduction to the principles and benefits of organic farming; (2) the fundamentals of tricho-compost production, including the biological role of *Trichoderma* spp. as decomposer and biocontrol agent, and application techniques; and (3) the principles and methods of MOL production and utilization as a liquid organic fertilizer and biological plant protection tool.

Practical Training

To transform theoretical content into applicable skills, hands-on field training was conducted at the farmer group's own site. Participants, guided by the PKM implementation team from the Faculty of Agriculture, Universitas Nusa Cendana (Faperta Undana), collaboratively engaged in: (1) the preparation and production of tricho-compost using locally available organic materials including fallen leaves, crop residues, rice husk charcoal, animal manure, rice bran, and soil, inoculated with Trichoderma inoculant at the appropriate stage of decomposition; and (2) the fermentation-based production of MOL from locally obtainable materials such as coconut water, palm sugar, and overripe fruits. Participants were guided through each step of both production processes and received instruction on appropriate dosage rates and field application methods for each product.

Monitoring and Evaluation

Monitoring and evaluation were conducted to assess program effectiveness and identify implementation barriers. Monitoring was carried out through direct site visits to observe participant skill development and document technical challenges encountered during technology adoption. Evaluation employed structured questionnaires administered before and after the training activities to measure changes in knowledge, attitudes, and practical skills. These results formed the basis for providing corrective feedback and planning follow-up activities designed to ensure the long-term sustainability of program outcomes.

RESULTS AND DISCUSSION

Extension Stage and Knowledge Transfer

The extension activities were conducted using an active participatory communication method, allowing all farmer group members to ask questions, engage in real-time discussion, and share their views as materials were presented by the team from Faperta Undana. Topics covered during the extension included: (1) the negative impacts of continuous chemical fertilizer use in agriculture; (2) balanced fertilization for chili, eggplant, and long bean cultivation; (3) the risks of excessive chemical pesticide application; (4) the principles and concept of organic farming; (5) tricho-compost production techniques; and (6) MOL production techniques. Extension and training activities conducted under this PKM program for the "Ora et Labora" Farmer Group in Naioni Village, Kupang, East Nusa Tenggara, were received with high enthusiasm and positive engagement by all participants (Figure 1).

Questionnaire-based evaluation results confirmed that the program was effective in delivering content clearly and systematically, producing tangible improvements in farmer knowledge, motivation, and openness to improving cultivation practices. More than 90% of participants rated the materials on Trichoderma, MOL, and tricho-compost as clearly presented. Prior to the program, many participants reported using exclusively chemical fertilizers and pesticides without fully understanding their long-term consequences; through the extension, they began to recognize the importance of ecological balance in agricultural systems. In terms of perceived utility, the majority rated the content as highly beneficial or beneficial. Several participants identified specific, longstanding problems, including premature chili flower and fruit drop, leaf yellowing, and slow, unhealthy vegetable growth, and expressed that MOL and tricho-compost could offer natural remedies to these problems without continued chemical dependence.

Before the program, most participants had never heard of Trichoderma, MOL, or tricho-compost; only a few had encountered the terms but had never applied them. This confirms that the program delivered new, directly relevant knowledge that addressed genuine knowledge gaps. Participants were attracted to the program in part because the content was presented in accessible, practical language and was directly linked to problems they encountered daily in the field. The training methods used; lecture, live demonstration, and interactive group discussion (Figure 2), were rated as highly appropriate by nearly all participants.



Figure 1. *Members of the Ora et Labora Farmer Group participating in the extension activity*

These outcomes are consistent with comparable community service initiatives. Andriani et al. (2023a) similarly reported high participant enthusiasm and measurable knowledge gains in a Trichoderma composting technology extension program for a women's farmer group in Bali, attributing success to interactive delivery methods linked directly to observable field problems faced by participants. Grimm & Luck (2020), in a randomized experiment on organic farming training in Indonesia, further established that structured, contextually relevant training produces statistically significant increases in organic farming knowledge scores, adoption of organic inputs, and positive perceptions of organic practices. Sapbamrer and Thammachai (2021) likewise identified training and extension contact as among the most robust predictors of organic farming adoption across a systematic review of global studies, underscoring that the participatory, skill-focused approach employed in this program reflects evidence-based best practice.



Figure 2. *Extension activity conducted by the community service team*

Skill Enhancement in Tricho-Compost Production

Before the training, most participants had no prior familiarity with *Trichoderma* or with technical aspects such as microbial fermentation and biological decomposition processes in composting. Although several participants had experience with conventional composting, tricho-compost production using *Trichoderma* inoculant represented an entirely new domain of knowledge. Through clearly structured instructional content and interactive training

methods, participants successfully acquired the fundamental concepts, benefits, and application techniques associated with *Trichoderma* spp. in a systematic and accessible manner.

The training also raised participant awareness of the specific negative consequences of overreliance on chemical inputs, including: (a) degradation of soil physical structure and long-term fertility decline; (b) groundwater and surrounding ecosystem contamination; and (c) health risks such as skin irritation, respiratory disorders, and chronic poisoning from residual agrochemical accumulation. This awareness functioned as a critical behavioral trigger reinforcing farmers' motivation to transition toward more environmentally responsible practices, a dynamic identified as central to sustainable agriculture adoption in the literature (Grimm & Luck, 2020).

In terms of practical skill development, participants became capable of independently preparing all required raw materials for tricho-compost production—including fallen leaves, agricultural by-products, rice husk charcoal, animal manure, rice bran, and soil—and of executing the production protocol step by step (Figure 3). They gained clear understanding of the role of EM4 (effective microorganisms) as a decomposition activator, learning how to dissolve it in water with palm sugar before application to the composting pile. Critically, participants understood the optimal timing for Trichoderma inoculation: specifically, during the late stage of decomposition after compost temperature has decreased to ambient levels, to prevent thermal inactivation of Trichoderma propagules. Participants also developed appreciation for the importance of regular compost turning, moisture management, and aeration to ensure uniform decomposition and compost quality (Nemet et al., 2021). All participating farmers expressed willingness to use tricho-compost in their cultivation systems and received guidance on recommended dosage: approximately 0.5–1 kg of tricho-compost per planting hole at transplanting, with a follow-up application of 0.5 kg per plant at 30–60 days post-planting depending on crop growth duration.



Figure 3. *Series of practical activities for making trichome-compost*

These outcomes are consistent with findings from comparable community service programs. Andriani et al. (2025) reported that tricho-compost training in Subak Taman, Bali increased farmer knowledge of liquid organic fertilizer production from 40% to 80%; field-level adoption of tricho-compost in organic rice systems subsequently produced dry grain yield increases of 4.4%–17.4% relative to conventionally managed plots, demonstrating that knowledge gains translate meaningfully into agronomic performance improvements when technology transfer is effectively executed. Andriani et al. (2023a) further documented that trichocompost technology implemented in a women's farmer group in Bali resulted in in-field

fungal pathogen suppression rates of up to 98.53%, affirming the practical efficacy of the technology when applied correctly. In a related floriculture context, Andriani et al. (2023b) found that trichocompost training and application for a chrysanthemum farmer group reduced white rust disease incidence by 56.4%, decreased yield losses by 23.4%, and increased farmer income by 28.2%. Taken together, these comparative studies strengthen confidence in the transferability and effectiveness of the tricho-compost training approach employed in the present program and support the expectation that field-level adoption will yield measurable agronomic and economic benefits for the "Ora et Labora" group.

Skill Enhancement in MOL Production and Application

MOL production training successfully empowered participants to utilize locally available materials, specifically coconut water and overripe fruits such as bananas and papayas that were no longer fit for consumption, as fermentation substrates for biofertilizer production (Figure 4). Participants gained a clear understanding of the core fermentation process underlying MOL production, including the characteristic observable indicators of a successful fermentation: a brownish color change and the development of a fresh, acidic aroma, which together signal that the MOL preparation is ready for use after 7–14 days of anaerobic fermentation. Application of MOL as liquid organic fertilizer was particularly well received for use on horticultural crops including chili and leafy vegetables.

The dilution protocol for MOL application as liquid fertilizer, one part fermented MOL to 10–20 parts water, was clearly conveyed and demonstrated, enabling participants to apply it with confidence. Participants received explicit guidance that MOL functions dually as a liquid organic fertilizer and as a biologically active pesticide, consistent with its characterization in the literature as a multifunctional input for sustainable agriculture (Shahwar et al., 2023). The simplicity and low cost of the production process were highlighted as key factors influencing participant confidence: upon seeing that the required materials were limited to coconut water, palm sugar, and locally available overripe fruits, participants expressed certainty that the technology could be adopted independently without significant financial investment.

The questionnaire results revealed a strongly positive participant response, with 100% of participants expressing their intention to use both MOL and tricho-compost in their farming systems. This finding indicates that the training and mentoring activities successfully increased participants' confidence in adopting these environmentally friendly agricultural technologies. Farmers specifically identified the expectation that MOL would help address chronic problems such as premature chilli flower and fruit drop associated with pest damage while improving overall plant health. In addition, participants recognized that producing bioinputs from agricultural by-products and locally available organic waste would substantially reduce dependence on purchased chemical fertilizers and pesticides, thereby lowering production costs and improving farm profitability. These findings demonstrate the participants' strong commitment to implementing sustainable agricultural practices based on locally available resources.

These outcomes are consistent with findings from analogous programs. Rukmini and Andriani (2022) reported that a MOL production training program conducted for a women's farmer group in Sanur Kauh Village, Denpasar produced an estimated 70% participant comprehension of the production process, reduced production costs by approximately 25%, decreased organic household waste by approximately 80%, and increased crop production by approximately 25% following adoption. This parallel program demonstrates that community-level MOL training can yield concurrent benefits across economic, environmental, and agronomic dimensions. Similarly, Yudiawati et al. (2023) reported significant improvements in knowledge and practical skills in a farmer community in Bungo Regency following MOL extension and training activities, with participants expressing intent to continue producing MOL independently after program completion. Tsani et al. (2023) observed comparable outcomes in a forest farmer group, where MOL training enabled participants to produce and apply locally derived organic fertilizer, effectively reducing their reliance on purchased chemical inputs. Collectively, these comparative studies confirm that MOL production training, when delivered

through practical demonstration using familiar and accessible local materials, consistently generates high levels of participant engagement, confidence, and adoption intent, regardless of the geographic or agricultural context in which it is applied.



Figure 4. *Production of Local Microorganisms (MOL) from household waste materials*

Integration of Program Success Factors and Sustainability

The overall success of this program is attributable to the coherence and strategic integration between its conceptual and practical components. The combination of andragogy-based extension with hands-on practical training proved effective in simultaneously shifting farmer mindsets and strengthening technical competencies, a finding consistent with Putri and Sunarti (2023), who emphasize that adult learners engage most productively when training content is directly relevant to their lived experiences and when participatory, problem-based methods are employed. The conceptual understanding of chemical input risks served as a critical psychological trigger for behavior change, what educators term a transformative learning moment, while the practical training in tricho-compost and MOL production provided concrete, immediately actionable, and economically accessible solutions (Grimm & Luck, 2020).

The ease of raw material procurement and the minimal cost of production were identified as pivotal factors for the long-term sustainability of technology adoption. By utilizing agricultural and household waste streams as fermentation substrates and composting inputs, the program operationalized principles of the circular economy while simultaneously lowering input costs, an outcome aligned with the sustainability values underpinning organic farming (Khadda, 2021). *Trichoderma* spp. and the diverse microbial consortia present in MOL act as biological agents that simultaneously improve soil fertility and suppress pathogens, directly supporting Muneret et al.'s (2018) evidence that organic farming systems can promote natural pest control without increasing infestation risk. Furthermore, Sapbamrer and Thammachai's (2021) systematic review positions the perceived economic benefit of organic inputs as a primary adoption driver, a factor clearly demonstrated here in participants' expressed expectation of cost reduction through local input production.

To support sustained post-program adoption, a WhatsApp communication group was established as a remote mentoring and technical problem-solving platform, enabling ongoing dialogue between the PKM team and farmer group members. This type of sustained institutional linkage has been recognized as essential for maintaining farmer motivation and resolving dynamic field challenges that inevitably arise after formal training activities end. Student participation in the program additionally enriched its implementation by providing supplementary human resources and enabling academic recognition of community engagement activities through academic competency certificates (SKPI), thereby integrating all three pillars

of the university's tridarma mandate, education, research, and community service, in a synergistic and mutually reinforcing manner.

CONCLUSION

This PKM successfully enhanced the awareness, practical skills, and motivation of the "Ora et Labora" Farmer Group toward organic farming adoption. Participants demonstrated clear commitment to applying tricho-compost and MOL, expressing confidence that these inputs would improve plant health, reduce pest-related yield losses, and decrease dependence on purchased chemical inputs. The outcomes are consistent with comparable community service programs across Indonesia, confirming that participatory, hands-on training effectively increases farmer knowledge, competency, and adoption intention. Trichoderma-based compost and locally fermented microorganism preparations proved practical, affordable, and replicable, aligned with both sustainable agriculture principles and the resource realities of smallholder farmers in eastern Indonesia. Several participants requested follow-up mentoring visits and illustrated technical guides for independent troubleshooting. Future programs should prioritize developing such extension materials and incorporate field-trial monitoring protocols to quantitatively document the agronomic and economic impacts of adoption across multiple growing seasons.

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