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Sustainable Vegetable Farming: Organic Fertilizer Strategies for Rural Development in Mekarmanik Village Using Participatory Action Research Approach

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ABSTRACT

The high price of fertilizer is a major challenge in increasing the productivity of farmers in Mekarmanik Village. However, Mekarmanik Village has one of the profitable potentials, which is vegetable waste that can be processed into organic fertilizer as an alternative to the high cost of chemical fertilizers. Based on these problems, an integrated strategy is needed that includes appropriate technology, training based on community participation, and the utilization of agricultural waste into organic fertilizer. This strategy is expected to answer the environmental and economic challenges faced by the people of Mekarmanik Village, as well as encourage more sustainable and independent agriculture. The research, conducted with 30 vegetable farmers from December to January, identified key findings: (1) 80% of farmers reported a positive perception of organic fertilizer usage, (2) 65% of the farmers experienced a 15-20% increase in vegetable yields after using organic fertilizers, and (3) 50% of farmers indicated a reduction in fertilizer costs by up to 30%. The analytical method used in this research is descriptive qualitative with a survey approach through field interviews. The study found that while intercropping with coffee land has been beneficial, the lack of literacy regarding waste management poses a significant challenge. This has the potential to become a threat to Mekarmanik Village due to vegetable waste that can pollute the environment. Thus, improving waste management sustainability offers an opportunity to increase agricultural productivity, leading to better environmental outcomes and a more balanced economy.

INTRODUCTION

Mekarmanik Village, located in Cimenyan Sub-district, Bandung Regency, is an agricultural area with most of the population working as farmers (Assefa Tofu & Wolka, 2023; Khumalo et al., 2024). The village's agricultural system is traditional and relies heavily on the use of chemical fertilizers . This dependence not only increases production costs but also negatively affects soil quality, crop yields, and long-term environmental sustainability. In fact, this village has great potential in the form of post-harvest agricultural waste that has not been optimally utilized as raw material for organic fertilizer.

This condition causes two main problems. First, the accumulation of unmanaged agricultural waste can pollute the environment and reduce soil fertility. Second, farmers experience economic pressure due to the high cost of using chemical fertilizers. Research by (Wijayanto et al., 2019) shows

that training in making organic fertilizer from local waste can increase farmers' knowledge and skills in managing waste productively. (Hida & Rachmina, 2023) shows that training in making organic fertilizer from local waste can increase farmers' knowledge and skills in managing waste productively.

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However, most of the existing studies are still limited to technical aspects or conducted in other areas outside West Java (Gosnell et al., 2019; Heider et al., 2023). There are not many studies that specifically discuss the strategy of developing organic fertilizer based on agricultural waste in mountainous areas such as Mekarmanik, especially through a village community empowerment approach. (Tropika, 2024) emphasizes the importance of agricultural waste-based fertilizer alternatives in the context of national food security. Meanwhile, (Virianita et al., 2019) from a Scopus indexed journal shows that farmers' perceptions of government support in implementing sustainable agricultural systems, including the use of organic fertilizers, are still relatively low.

In addition, approaches that involve the community directly and transfer knowledge to farmers as the main actors have not been much of a focus in the development of local organic fertilizers. Beding & Lewaherilla, (2020) emphasizes the importance of local resource-based bioindustry innovation as a sustainable solution, but its application in mountainous agricultural areas has not been widely discussed in previous studies.

Based on these problems, an integrated strategy is needed that includes appropriate technology, training based on community participation, and utilization of agricultural waste into organic fertilizer. This strategy is expected to address the environmental and economic challenges faced by the people of Mekarmanik Village, as well as encourage more sustainable and self-reliant agriculture.

RESEARCH METHODS

Method and Type of Research

This research uses a descriptive quantitative approach with the Participatory Action Research (PAR) method or participatory research (Daly, 2007; Longhofer et al., 2012). This approach was chosen because it involves the community actively in the change process, from planning to evaluation. This type of research is applied because it aims to provide real solutions in managing agricultural waste into organic fertilizer in a sustainable manner at the village level.

Data and Data Sources

The data used consisted of primary and secondary data (Hammersley, 2003; McMahon & McGannon, 2024). Primary data was obtained through observations, interviews, and questionnaires to farmers and village parties (Fenton & Baxter, 2016; Murphy & Dingwall, 2017). Secondary data came from official village documents, agricultural reports, as well as scientific literature and related institutions such as FAO and World Bank that discuss sustainable agriculture and waste management.

Population and Sample

The population of this study was all active farmers in Mekarmanik Village (Clair, 2003; Kawamura, 2020). The sample was selected purposively, based on certain criteria: actively farming for at least two seasons, producing farm waste, and willing to participate in training. A sample of 30 farmers was used, which was considered representative of the field conditions.

Data Analysis Methods

Quantitative data were analyzed using descriptive statistics such as averages and percentages.

Operational Variables

This study has three main variables as proxies of literacy. First, waste utilization is measured by the type and volume of waste processed (Fife, 2020). Second, farmers' knowledge of organic fertilizer is measured from the results of interviews and farmers' knowledge of the fertilizers used. Third, attitude towards sustainable agriculture is measured through discussion sessions with relevant parties.

RESULTS AND DISCUSSION

Appropriate Technology for Efficiency and Independence of Farmers in Mekarmanik Village

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Mekarmanik Village is faced with classic challenges in the agricultural sector, namely high dependence on chemical fertilizers, low input use efficiency, and limited access to agricultural technology relevant to local conditions. In response to this, appropriate technology is applied in the form of processing post-harvest waste into organic fertilizer, using simple equipment such as composter barrels and EM4 fermentation techniques. This technology is adaptive, utilizes local materials that are easily available, and does not require high energy or costs, so it can be adopted by farmers independently

This application is in line with the findings of (Khan et al., 2021) which emphasize the importance of community-based appropriate technology in realizing sustainable agricultural systems, especially in rural areas that are vulnerable to external pressures. These technologies not only improve farming efficiency, but also strengthen farmers' self-reliance through local resource management.

Participation-Based Training as an Empowerment Approach

The innovation adoption process in Mekarmanik Village is carried out through participatory training . Vegetable farmers in Mekarmanik Village are actively involved in the practice of making organic (How et al., 2020; Ofuoku & Ekorhi-Robinson, 2020)fertilizer, group discussions, and evaluating the results of application on their land. This approach not only improves technical skills, but also builds a sense of ownership of the innovations implemented. Direct community involvement contributes to the sustainability of the practices and strengthens the local capacity of Mekarmanik Village.

This approach draws on the principles of participatory agroecology as described by (Altieri et al., 2017) which places producers as agents of change rather than mere recipients of technology. In a village with strong mutual cooperation values like Mekarmanik, this model has proven effective in strengthening solidarity and expanding the impact of innovations.

According to the FAO (Food and Agriculture Organization), agroecology is an approach that incorporates ecological principles into food production systems, with the aim of achieving food security, improving the welfare of smallholder farmers, and maintaining environmental sustainability (Alotaibi et al., 2021; Hien & Bao, 2024). Agroecology not only covers technical aspects such as crop rotation, crop diversity and the use of organic fertilizers, but also touches on socio-economic dimensions such as active involvement of farmers, strengthening community organizations and improving market access. This approach contributes to the achievement of the Sustainable Development Goals (SDGs), particularly Goal 2 (Zero Hunger), Goal 12 (Responsible Consumption and Production), Goal 13 (Addressing Climate Change), and Goal 15 (Protection of Terrestrial Ecosystems).

Utilization of Post-harvest Waste in a Circular Economy

Every season, Mekarmanik Village produces large volumes of agricultural waste such as mustard stalks, corn husks, and other horticultural crop residues (Prazeres et al., 2023; Taranov & Kawabata, 2024). Instead of being burned or dumped, this waste is processed into solid compost and organic liquid fertilizer that is returned to the farmland. This practice has succeeded in reducing pollution, restoring soil fertility, and reducing dependence on external inputs such as pesticides whose prices continue to increase over time. This effort is a concrete implementation of the circular bioeconomy concept, which is a sustainable production system that integrates waste as a key resource. According to (Yulistika, 2023), the circular economy concept emphasizes the reuse of by-products from the production process to create an efficient and sustainable production system. This approach is particularly relevant in organic waste management, such as post- harvest waste, as it is able to transform leftover production products into valuable resources, while reducing environmental impacts and supporting local economic resilience. FAO (2023) emphasizes that such an approach is an important pillar in the transition to resource-efficient and low-carbon agriculture.

Double Effect: An Ecological and Economical Solution

The transformation of agricultural waste into organic fertilizer not only contributes to environmental sustainability, but also has a direct impact on farmers' welfare (Jezeer et al., 2019;

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Miyake et al., 2022). Local data shows that about 70% of farmers experienced a reduction in production costs between 25-35% after switching from chemical fertilizers to homemade organic fertilizers. On the other hand, the experimental fields showed improved soil structure and fertility naturally, without the addition of synthetic inputs (Omodara et al., 2023; Tresson et al., 2020). This strategy is in line with the Sustainable Livelihoods Framework (SLF) approach that underlines the importance of strengthening local assets such as knowledge, social networks, and natural and physical resources. According to (Ginns et al., 2018) a community-based approach that integrates sustainability principles can be an important foundation in strengthening economic resilience in rural areas. This is in line with the findings of (Triwanto, 2023), agroforestry systems have great potential in increasing agricultural productivity and farmers' income, while maintaining ecological sustainability. This approach is considered relevant for strengthening economic resilience in rural areas through the integration of ecological and economic benefits.

Community Independence as a Pillar of Local Development

One of the significant impacts of agricultural transformation in Mekarmanik Village is the emergence of independent and sustainable community initiatives (Singh et al., 2022; Zwane, 2019). Post-training, farmers not only apply the technology individually, but also form working groups that collectively produce, package, and market organic fertilizer (Sanogo et al., 2023; Sattar et al., 2023). This initiative has developed into a productive economic-based community institution that is managed independently. This phenomenon reflects the principle of Community-Based Development (CBD) which emphasizes the importance of community social capacity, collaboration between parties, and the use of local approaches as the foundation of development. As described by (Castro-Arce & Vanclay, 2020), social transformation that emerges from community initiatives can accelerate the achievement of sustainable development goals, especially if it is carried out in a participatory manner and integrated in local institutional networks.

CONCLUSION

Mekarmanik Village shows that successful sustainable agricultural development can be achieved through the use of simple technology that suits local needs, active community involvement, and strengthening community capacity. By processing agricultural waste into organic fertilizer using easy-to-implement methods and local raw materials, farmers are able to reduce dependence on chemical fertilizers, reduce production costs, and improve soil quality naturally. The process of engaging farmers in training and technology application not only improves skills and knowledge, but also strengthens social solidarity and ownership of innovations. This practice also reflects the application of circular economy at the village level, which can provide solutions to environmental as well as economic problems. The experience in Mekarmanik Village proves that a participatory approach rooted in local potential can be a strong foundation for sustainable and self-reliant rural development.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest in the conduct of research and writing of this article. The entire process was conducted independently and was the result of pure scientific research activities, without any influence from financial interests, personal relationships, or institutional affiliations that could affect the analysis, interpretation, or conclusions of this study.

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