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Community-Based Waste Management Model in Villages: Turning Organic Waste into Ecological Enzymes

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Abstract

Waste management is one of the important issues in Indonesia, especially in rural areas because it is related to the quality of the environment, public health, and local economic sustainability. This study aims to explore a community-based waste management model in Baosan Lor Village by converting organic waste into environmentally friendly enzymes as an alternative to organic fertilizers and environmental cleaners. This study uses case studies and a qualitative descriptive approach. Data was gathered through field observations and in-depth interviews with representatives of the Karang Taruna youth organization and Gapoktan Wanita. Additionally, documentation of the procedures used to produce environmentally friendly enzymes was used. The study shows how the women's gapoktan contributes significantly to training on environmentally friendly enzyme manufacturing and garbage sorting activities, with active support from the Youth Organization and guidance from the Tourism and Agriculture Office. This concept has achieved two objectives: raising environmental consciousness and generating revenue through the sale of organic fertilizer. However, it faces problems such as limited resources and uneven community involvement. It is possible to develop this concept into an environment-based educational tour as it can offer a long-term solution to the problem of organic waste at the village level.

Keywords: Baosan Lor Village; Community-Based Waste Management; Community Participation; Ecological Enzymes; Waste Management Model

INTRODUCTION

Waste is one of the biggest environmental problems in Indonesia, especially in rural areas where tourism and agriculture are the main businesses. By 2024, Indonesia will generate over 69.7 tons of garbage each year, with over 35% of that amount not being well managed, according to data from the Ministry of Environment and Forestry (KLHK). The main causes of this state of affairs include a lack of institutional and financial support at the regional level, poor management infrastructure, and minimal community involvement in waste sorting. As a result, a large portion of agricultural and domestic waste is still dumped in open areas without proper treatment. Pollution of the air, water, and land is one of the negative consequences of the mismatch between the growing volume of waste and the management system's limited capacity (Yang & Mu, 2020). Conversely, farmers are forced to use non-subsidized fertilizers at higher prices because subsidized fertilizers are increasingly limited. As a result, crop profit margins have declined and agricultural operating costs have increased (Suryani & Sinuraya, 2024). This phenomenon shows how complex rural management is, especially in

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sustainable agriculture. Therefore, solutions that not only address waste management but also offer alternatives to fertilizer scarcity are needed.

Based on a pre-observation study, the Village-Owned Enterprises (BUMDeS) of Mrayan Village and Baosanlor Village, Ponorogo Regency, run various businesses, such as trading, livestock, agriculture, and services. Agricultural businesses are carried out by utilizing agricultural land in the village to grow various types of crops such as rice, corn, nuts, and vegetables. Both villages run trading businesses operated by BUMDeS Desa Mrayan and Baosanlor, selling agricultural and livestock products to local and regional markets. In carrying out its activities, BUMDes is supported by the local government and related institutions. The local government provides capital assistance and training for newly established BUMDes.

In order to boost the village economy, BUMDeS can also collaborate with enterprises, the government, and related groups. One of the sectors growing at the quickest rate in the Ponorogo Regency is the culinary MSMEs. According to official regional statistics, the number of MSME players increased from around 38,387 in 2021 to 39,650 in 2022. Because the BUMDes level lacks a structured system for production and residential waste management to keep up with this advancement, unmanaged organic and inorganic waste may collect. These two villages face challenges in managing waste sustainably, especially organic waste from households and agricultural activities. Organic waste, if managed properly, can be converted into useful resources, such as ecological enzymes, which have been proven to have potential as alternative organic fertilizers (Muliata & Darmawan, 2021; Muarief, R. et al., 2022). This community-based waste management model is not only an environmental solution, but it is also expected to support local agricultural independence by reducing dependence on expensive and limited chemical fertilizers.

Although a lot of work has been done in some regions to turn organic waste into useful items, there have been few research on community waste management models that are tied to tourism and agriculture (Wen et al., 2021; Suryani & Sinuraya, 2024). Although previous research has mostly focused on centralized systems or urban waste management, local communities are crucial for sustainable management (Kuthiala et al., 2022; Muarief et al., 2022; Samitra, D., 2021; Agustrina, R., 2023). In contrast to other research, this study examines village-level community waste management models while taking socio-tourism, economic (agricultural), and environmental factors into account. In order to create a sustainable waste management system in rural areas, this study also highlights the significance of cross-sectoral cooperation between local governments, community organizations, and village institutions. Thus, this study advances our knowledge of how village communities aid in the creation of ecologically friendly technology that has global applications.

Therefore, this research will explore in greater depth how the community-based waste management model in Baosan Lor Village can be integrated into agriculture and

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tourism programs. This research focuses on the role of Gapoktan Wanita, also called Gabungan Kelompok Tani Wanita (Women's Farmers Group Association), a women's farmer organization at the village level that oversees agricultural operations, waste management, and training in the creation of eco-friendly enzymes. Karang Taruna, another organization that empowers young people through environmental and social initiatives, also helps convert organic waste into enzymes. In addition, in an effort to develop a more sustainable waste management model that meets regional needs, this study considers aspects of inter-agency cooperation such as the departments of tourism, agriculture, and forestry. The author says that this study will be very helpful in building more environmentally friendly and sustainable tourist settlements. This study can also be included in a collection of data on community-based waste management strategies that combine tourism and agriculture. The results can be used as guidelines for other villages experiencing similar problems.

Conceptually, the study is grounded in community-based management (CBM), which provides the basis for understanding local participation in waste management.

All levels of society, from families to neighborhoods, work together to create solutions tailored to their needs and conditions based on the idea of community-based management (CBM), which argues that communities must be actively involved in local waste management because they are the ones who are affected by policies and are the main actors in designing, implementing, and overseeing waste management systems in their neighborhoods.

According to Schubeler et al. (1996), community-based techniques boost commitment by encouraging a sense of ownership and responsibility for the environment. This kind of waste management is frequently more successful when locals actively participate in daily operations and decision-making processes (Agustrina, R. 2023). Community involvement gradually raises environmental consciousness and promotes more sustainable behavior.

Karang Taruna and Gapoktan Wanita, also known as women's farmer groups, were originally gamelan-based cultural organizations. However, both are now companies focused on agribusiness and agriculture. These two organizations are currently participating in the Baosan Lor Village waste management program and supporting community-based forest management strategies. This capacity building program can turn environmental challenges into profitable outcomes by providing villages with the skills and resources necessary to convert household and agricultural waste into environmentally friendly enzymes. This technique can be useful in sustainable waste management. The partnership between Karang Taruna and Gapoktan Wanita demonstrates their commitment to assisting in waste management. This commitment is reinforced by their collaboration with other institutions, such as the Office of Tourism and Agriculture.

The success of waste management programs depends on the involvement of local

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communities in community-based waste management (CWBM). Local organizations and residents must be actively involved in these programs. Community involvement, according to Sekito et al. (2013), improves the overall effectiveness of waste management systems, especially in rural areas. In addition, their research shows that socialization and environmental education are very important to raise public awareness of sustainable practices and encourage more people to use more responsible waste management methods.

The Women Farmers Group (Gapoktan Wanita) of Baosan Lor Village held various training sessions to increase their participation. The production of environmentally friendly enzymes from organic waste and waste management methods were two of the main topics. Agricultural extension officers are still investigating whether environmentally friendly enzymes can help agriculture, especially in areas where chemical fertilizers are scarce or unavailable. This program aims to raise public awareness of environmental damage and teach the community how to manage local waste.

The most crucial approach is the best-worst waste management method (CBWM), which places an emphasis on ownership. Because they actively participate in garbage management, communities typically feel more accountable (Setiadi, 2015). Local citizens' participation is crucial to the success of CBWM because they assist in developing systems that meet their needs and circumstances, claim Schubeler et al. (1996). This procedure is evident in Baosan Lor Village, where neighborhood organizations like Karang Taruna and Gapoktan Wanita take part in waste management, encouraging a sense of collective accountability.

According to Agustina R. (2023), effective involvement and cooperation from all stakeholders is crucial for the success of community-based waste management (CWBM). Cooperation between government agencies, local communities, and external stakeholders is necessary for the success of CWBM. Effective cooperation is needed to develop efficient waste management system technology and operations. To improve the quality of Baosan Lor, the local government, the Agriculture Office, the Tourism Office, the Women's Farmer Group (Gapoktan Wanita), and the Youth Organization (Karang Taruna) must work together. The Tourism Office supports community-based tourism through waste management programs, while the Agriculture Office recommends the use of environmentally friendly enzymes as a substitute for traditional fertilizers. The goal of this effort is to reduce our dependence on limited and expensive chemical fertilizers. The tourism, land management, and forestry sectors must work together to succeed. By implementing this collaborative approach, all parties can work together to achieve common goals. This encourages the establishment of a more effective and sustainable waste management system.

Eco-friendly enzymes can be made from organic waste by managing community waste. This represents a significant step towards sustainability. As shown by a study by

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Varshini and Gayathri (2023), eco-friendly enzymes made from organic waste aid in organic fertilizer production and pest control. The process of converting organic waste into eco-friendly enzymes has yielded economic and environmental benefits for the community. Farmers can shift to more sustainable agricultural practices and reduce their reliance on chemical fertilizers, which are often lacking. Another study showed that the fermentation of organic waste such as straw and animal manure can produce eco-friendly enzymes. Eco-friendly enzymes used as organic fertilizer in Baosan Lor Village improved soil quality and crop yields, helping farmers overcome fertilizer shortages and reduce harvesting costs. Therefore, this natural fertilizer solution can be used for routine cleaning purposes (Wen et al., 2021). Agricultural production and environmental sustainability can be improved by utilizing local resources.

METHODOLOGY

The technique used in qualitative case studies is descriptive analysis. Qualitative case studies were chosen because the researchers wanted to understand the community-based waste management process in one location, namely Baosan Lor Village (Yin, 2018). This technique was chosen because it allows researchers to thoroughly understand the institutional context, the roles of actors, and the social processes involved in the implementation of the community-based waste management concept in Baosan Lor Village. This strategy aims to improve understanding of the steps and results related to the implementation of the community-based waste management program in Baosan Lor Village. An additional objective of this study is to gain an understanding of how local organizations, particularly Women Farmers Groups or Youth Organizations, manage organic waste and convert it into enzymes that are beneficial to the environment. Taking into account the necessary social dynamics, the level of community involvement, and the importance of cross-sectoral cooperation, this study aims to explain the role of mentoring in developing sustainable waste management solutions.

For this study, individuals responsible for waste management issues in Baosan Lor Village were also interviewed. These included the head and members of the Women's Farmers Group, representatives from the LMDH and Perhutani, members of the Youth Organization, extension officers from the Agriculture Office, and employees from the Tourism Office. One of the objectives of these interviews was to understand the motivations, responsibilities, and challenges faced by each partner in waste management and ecological enzyme production. It is hoped that the information obtained from these interviews will provide an overview of the community's waste management approaches and the factors influencing their success or failure. Consistent with Yin (2018), this approach allows researchers to observe firsthand how community approaches are used in waste management.

Through participant observation, the waste management process was also directly observed. The primary objectives of this observation were the separation of

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organic and non-organic waste and the production of environmentally friendly enzymes. Furthermore, findings included interactions between stakeholders involved in training and outreach activities conducted by the Department of Agriculture and the Department of Tourism. As a result, research is underway to develop a more environmentally friendly waste management system.

The final data collection, namely documentation, was carried out by collecting secondary data from Gapoktan Wanita activity reports, archives from the Agriculture and Tourism Office, as well as related regulations and documents. The data obtained from observations and interviews was supplemented with data from these written sources. In addition, this data provides context for institutional support and policies for community- based waste management.

Furthermore, referring to Yin (2018), the data obtained was analyzed using thematic analysis techniques combined with descriptive analysis (Hollweck, 2015). The stages of analysis in this case include, first, data reduction, where data obtained from interviews, observations, and questionnaires will be reduced to identify the main themes relevant to the grouped data will be presented in descriptive and visual forms, such as tables and diagrams, to make it easier for readers to understand the waste management process. Conclusions are drawn by considering the themes that emerge consistently and based on the theoretical framework described in the literature review.

RESULTS AND DISCUSSION

The Role of the Community in Waste Management

Local communities, especially the Women's Farmers Group (Gapoktan Wanita) and the Youth Organization (Karang Taruna), play a crucial role in waste management in Baosan Lor Village. They are actively involved in the Community-Based Waste Management Program ( ), promoting waste separation at the household level and socializing the benefits of eco-enzymes as an alternative fertilizer. We have identified several actors involved in waste management efforts in Table 1 below.

Table 1. Role of Actors in Waste Management in Baosan Lor Village

Key Actors	Role	Description
Women's Farmers Group	Pioneer and coordinator of environmentally friendly enzyme activities	Socialization of waste sorting, training in the production of environmentally friendly enzymes
Youth Organization	Environmental and youth advocates in waste management	Waste collection, sorting, and environmental hygiene counseling
Tourism	Support for ecotourism	Collaboration in promoting environmentally friendly enzymes as environmentally friendly products
Agricultural services	Technical guidance and training in the production of environmentally friendly enzymes	Training in the production of environmentally friendly enzymes and sustainable agricultural technology

Based on Table 1 above, the Women's Farmers Group plays a key role as the main driver in initiating and implementing an effective and sustainable waste

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management model. This group not only does things to encourage change, but also provides a forum where community members can help and learn from each other. In addition, the Youth Organization has had a significant influence on waste management in Baosan Lor Village, especially in terms of encouraging young members. This shows that Karang Taruna, as a youth group and environmental institution, influences sustainable waste management models. The Tourism and Agriculture Office then acted as an external supporter by offering technical assistance and training to the people of Baosan Lor Village.

The Process of Transforming Organic Waste into Eco Enzymes

The process of transforming organic waste into environmentally friendly enzymes in Baosan Lor Village has shown positive and relevant results as an alternative in agriculture and the daily activities of villagers. This series of processes involves three main stages: sorting and collecting organic waste, fermentation, and utilizing environmentally friendly enzymes ( ) (see Figure 1). Each stage is carried out with the active participation of the community, especially by members of the Women's Gapoktan and Karang Taruna, who act as the main drivers in educating and coordinating the entire process.

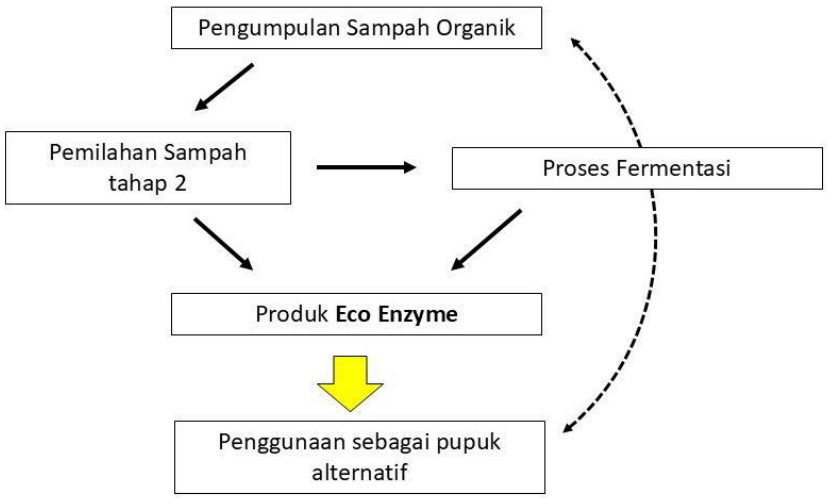

Figure 1. Flowchart of the Ecological Enzyme Production Process
(Source: Data analyzed by the researcher, 2024)

Referring to Figure 1 above, in the initial stage, the residents of Baosan Lor Village separate organic and non-organic waste at the household level. This waste separation involves education provided by Gapoktan Wanita and Karang Taruna to residents about the importance of waste separation as the first step in effective processing. The participation of each household is very important because the process of making eco- enzymes is highly dependent on the quality of organic waste such as vegetable scraps, straw, and livestock manure. In addition, the second stage, namely the fermentation stage, which is the core of the eco-enzyme production process, involves mixing the collected organic materials with brown sugar and water in a closed container. The correct ratio of ingredients usually 1:3:10 is very important to achieve the best results. This consists of one part brown sugar, three parts organic waste, and ten parts water. For three months, this mixture is left in anaerobic conditions, where natural microorganisms ferment and break it down.

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The fermentation process needs constant attention and care in order to maintain the mixture's homogeneity and yield high-quality goods. Members of the Women Farmers Group (Gapoktan) in Baosan Lor Village had the opportunity to talk about the important microbiology that occurs during the fermentation process and the methods used to ensure that the process runs smoothly. The use of enzymes from the environment is the final step. The ecologically beneficial enzymes created during the fermentation process are used in a variety of ways by the residents of Baosan Lor Village. Since there are no subsidized chemical fertilizers, this substance is particularly beneficial for agriculture when used as organic fertilizer. Eco-friendly enzymes can be utilized in both home gardens and agricultural land since they include bioactive compounds that can enhance soil quality and hasten plant growth. An overview of the analysis of the benefits of environmentally friendly enzymes is provided in Table 2.

Table 2. Analysis of the Benefits of Ecological Enzymes

Benefits	Description
Economic	Reducing agricultural operating costs by replacing chemical fertilizers with more affordable environmentally friendly enzymes
Environmental	Reduces greenhouse gas emissions from naturally decomposing organic waste
Social	Increasing community participation and awareness in waste management

(Source: Data analyzed by researchers, 2024)

Economically speaking, employing environmentally friendly enzymes can reduce the need for costly chemical fertilizers, lowering farm operating expenses and increasing farmers' profit margins. In terms of the environment, employing environmentally friendly enzymes can reduce the amount of organic waste that is disposed of in landfills and the greenhouse gas emissions caused by uncontrolled waste breakdown processes. Waste management is also a valuable resource for goods from a social standpoint; community- based projects can help people appreciate the importance of sustainable waste management and foster a cooperative mindset. The following graph shows the level of awareness among the people living in Baosan Lor Village.

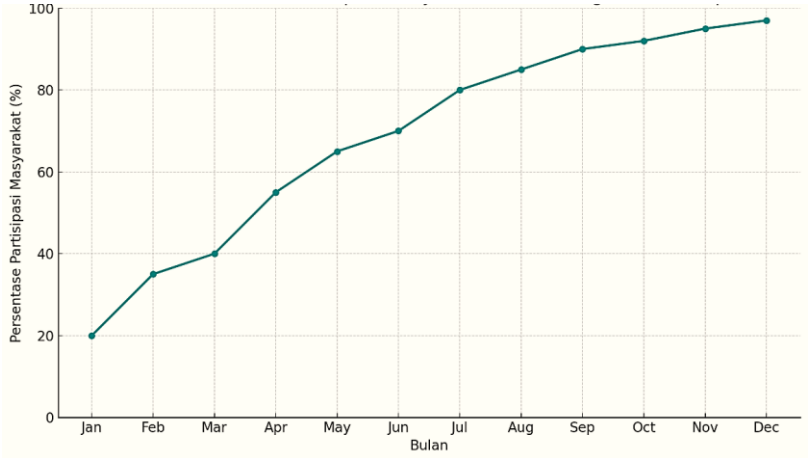

Figure 2. Graph of Community Participation in Waste Management
(Source: Data processed by the researcher, 2024)

Figure 2 above shows a monthly increase in community participation. This is

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particularly evident after training and socialization conducted by Gapoktan Wanita and Karang Taruna. This upward trend indicates the success of community efforts in encouraging citizen involvement, both in waste sorting and in the production of environmentally friendly enzymes, which has a positive impact on environmental awareness and the sustainability of waste management programs. Based on the data processing, it is known that the existing waste management model of producing environmentally friendly enzymes is an alternative to subsidized fertilizers, which are difficult to find due to limited availability and yield, so farmers use non-subsidized fertilizers at relatively higher prices. This results in higher operational costs and can reduce profits from existing crops, so in this case, the production of environmentally friendly enzymes using household waste is carried out. The existing waste management model is illustrated in Figure 3.

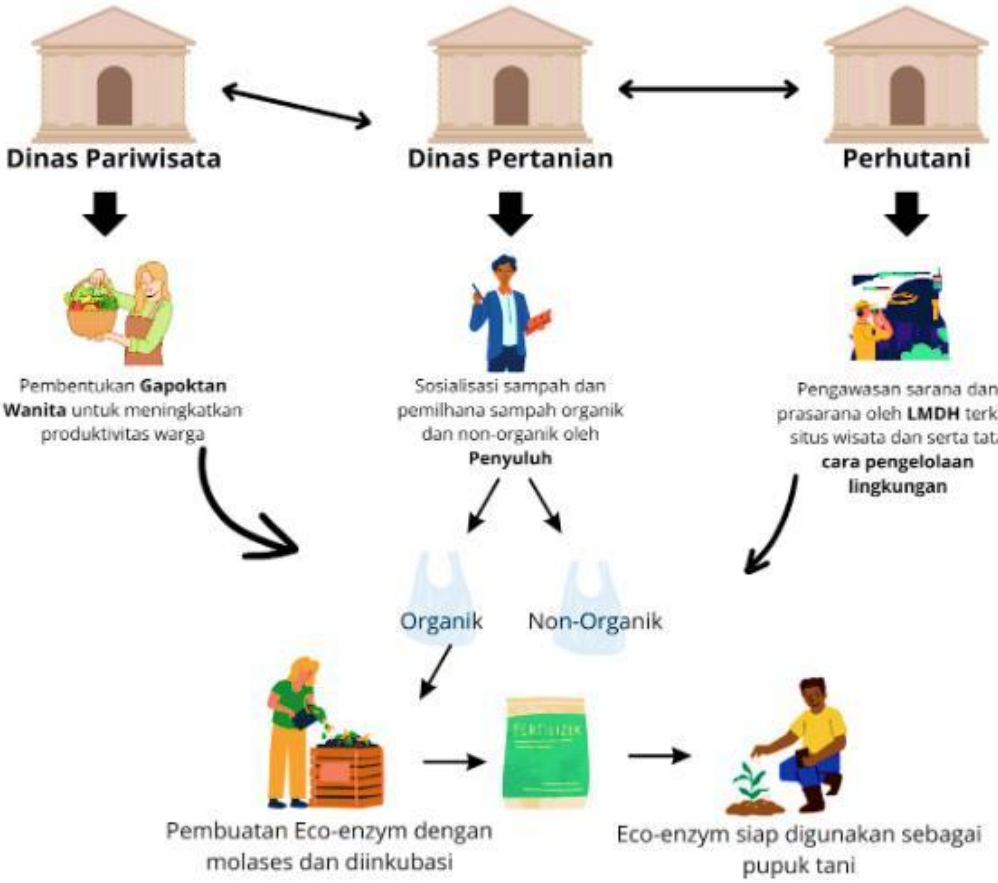

Figure 3. Community-Based Village Waste Management Model: Converting Organic Waste into Ecological Enzymes
(Source: Data analyzed by the researcher, 2024)

The model above shows the waste management process in Baosan Lor Village, as it is known that the Tourism Office has taken an interest in Baosan Lor Village and initiated the formation of the Women's Gapoktan Group. The Women's Gapoktan was initially a karawitan group and was later formed to increase the productivity of the Baosan Lor Village community. The Women's Gapoktan has received a lot of socialization and training, such as processing agricultural products into coffee powder, ginger powder, and batik making training. In addition, the Agriculture Office sent

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extension workers to conduct socialization and training so that the Women's Gapoktan could improve their skills. As for waste management, the extension officers can provide examples and socialization related to waste management, assisted by local youth organizations, where the waste produced by the Women's Gapoktan ( ) is then separated into organic and non- organic waste to facilitate waste management into eco enzymes.

The eco-enzymes demonstrated are derived from livestock manure, household organic waste, straw, and others. Perhutani also plays an important role and pays close attention to the development of the Baosan Lor Village community, where Perhutani leases their land to farmers, in addition to the existence of the Village Forest Community Institution (LMDH) which directly supervises existing tourist attractions, because it is known that Baosan Lor Village has high tourism potential and efforts are being made to optimize this potential. In this context, preparing for a tourist village must prioritize waste management readiness, where the LMDH can oversee visitors to ensure environmental cleanliness. Through cooperation between officials and the community, organic and inorganic waste can be separated and collected for further processing. Organic waste can be processed into ecological enzymes and used as alternative agricultural fertilizer when subsidized fertilizer is unavailable, while inorganic waste can be processed into new products based on the principle of added value.

DISCUSSION

The Role of Local Communities in Waste Management

This study found that local communities, particularly the Gapoktan Wanita (Women's Farmers Group) and Karang Taruna (Youth Group), are creative spaces where people can collaborate and gather to produce ecological enzymes and learn about the environment. These findings align with those of Halim et al. (2023), who emphasized that training and coaching groups for women farmers in Manggarai to improve their technical skills and independence can enhance local capacity to process agricultural waste into useful products. Therefore, every community member must actively participate in the waste management process for a sustainable community-based waste management system. A study showed that most Gapoktan members in Baosan Lor Village are young, working women. Many studies have shown that women's groups play a crucial role in maintaining group cohesion and fostering community-wide initiatives (Wang et al., 2017).

Furthermore, there is evidence of youth active involvement in gotong royong (mutual cooperation), indicating that they are crucial agents of change for the success of this model. Adnan's (2022) findings indicate that youth participation in environmental programs positively impacts the creation of sustainable practices in the community. Furthermore, the active involvement of youth in gotong royong demonstrates that the younger generation is a crucial agent of change for the success of this model. The synergy between women and youth reflects the principle of community empowerment, meaning that all generations are involved in maintaining environmental sustainability.

Government Support and Multi-Stakeholder Collaboration

In turn, the District Agriculture Office, which is responsible for promoting eco-friendly tourism, and the Tourism Office, which provides technical training on eco-friendly enzyme production, have helped optimize the work of the Women's Farmers

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Group (Gapoktan) and the Youth Organization (Karang Taruna). In addition, local farmers receive assistance from extension workers from the Agriculture Office in adopting environmentally friendly agricultural technologies.

These results support research on multistakeholder collaboration, which shows that the role played by local governments and institutions in providing technical support significantly influences the success of community-based programs (Qomariyah & Hamid, 2023). This study also shows that the success of community-based collaboration is strongly influenced by the clarity of the institutional structure and the legal legitimacy that supports it. In the case of Baosan Lor, active participation by the local government not only improved the technical capabilities of the community, but also provided formal legitimacy for the waste management practices that the community had developed. This method illustrates a model of collaboration between the government, the community, and village institutions.

Implementation of Sustainable Waste Management Practices

Every household in Baosan Lor Village separates organic and non-organic waste. The Women's Farmers Group and Youth Organization ensure that organic waste such as vegetable scraps, straw, and livestock manure are collected as raw materials for environmentally friendly enzyme- . This separation not only reduces the volume of waste that needs to be further processed, but also ensures the sustainability of raw materials. This approach is in line with the theory of sustainable waste management according to Sekito et al. (2013), where waste reduction and separation at the source can help reduce final processing costs.

Separating waste at the source improves the effectiveness of composting systems in agriculture-based villages. The implementation of sustainable practices in Baosan Lor demonstrates a bottom-up environmental awareness, which is a key characteristic of community-based waste management.

The use of ecological enzymes as an environmental and economic solution

Eco-friendly enzymes are a cheaper and more environmentally friendly organic fertilizer, and can be used as a regular cleaner. This supports the suggestion found in the literature that organic waste from agricultural areas should be processed into products that can be used for various purposes. By using eco-friendly enzymes as a substitute for organic fertilizer, rural farmers can reduce their dependence on more expensive and sometimes difficult-to-access chemical fertilizers. Environmentally friendly enzymes have the potential to lower adverse environmental effects while lowering agricultural production costs, per research by Kuthiala et al. (2022).

In addition, research conducted by Halim et al. in 2023 shows that women's organizations can convert domestic waste into enzymes, which can generate additional income. This has ecological and economic benefits for rural areas.

Social implementation and the potential of environmentally-based villages

Figure 2 illustrates how this tactic raises public awareness of the importance of environmental protection, especially among youth. These results are in line with research demonstrating that sustainable environmental education can improve pro-environmental behavior in communities (Sekito et al., 2013; Varshini & Gayathri, 2023). Baosan Lor Village may become an educational tourist destination if the sustainable waste management strategy is implemented. Our model affects the environmental economy as ,

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as well as the rural economy. Environmentally conscious educational travel is attractive and can increase local income, claims Setiadi (2015).

These results also lend credence to the notion put forth by Qomariyah & Hamid (2023) that social, economic, and environmental factors must be integrated for sustainable rural development. Thus, in addition to local customs, Tetai can serve as a replication model for other villages with comparable features.

CONCLUSION

One of the value-added products produced by the community-based waste management of Baosan Lor Village is environmentally friendly enzymes. Despite a lack of resources and involvement, the Youth Organization and Women's Farmers Group collaborated with the Tourism and Agriculture Office to achieve this goal. The effectiveness of the waste management program depends on community involvement and participation, as stated in the report. As a result, this project has benefited both the environment and the community.

The results of this study greatly influence the efforts of Indonesian society to develop a more effective waste management system. The results of this study show the importance of community involvement in the implementation of waste management regulations. Second, the results show that community-based strategies can be successful and sustainable with the help of regional groups and the government. Ultimately, this research shows that enzymes and other waste management solutions not only reduce the amount of waste generated, but also reduce the impact of waste management on the environment.

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