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Utilization of Banana Stem Waste as Liquid Organic Fertilizer Based on Local Microorganisms (MOL) for Plants Around People's Homes

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ABSTRACT

The excessive use of chemical fertilizers in household and agricultural practices has contributed to declining soil quality and environmental degradation. Meanwhile, banana corm waste, which is abundantly available in rural areas, has not been optimally utilized despite its potential as a source of Local Microorganisms (LMOs) for producing liquid organic fertilizer (LOF). This community service program aimed to improve community knowledge and skills in utilizing banana corm waste to produce environmentally friendly liquid organic fertilizer based on Local Microorganisms (LMOs). The program was conducted in Sonorejo Village, Jakenan District, Pati Regency, involving 25 community members. A participatory approach was employed through four stages: preparation, implementation, mentoring and monitoring, and evaluation. The implementation included field observations, pre-test, educational sessions, demonstrations, hands-on practice, continuous assistance during the fermentation process, and post-test evaluation. Program effectiveness was measured using the N-Gain Score, while participant engagement was evaluated through direct observation. The results showed a significant improvement in participants' knowledge and skills, indicated by an average N-Gain score of 0.768 (76.81%), which falls into the high category. Participants successfully mastered the production process of liquid organic fertilizer and demonstrated the ability to apply it independently to household plants. Furthermore, the program increased community awareness of organic waste utilization and reduced dependence on chemical fertilizers. Therefore, this community empowerment model is considered effective and has the potential to be replicated in other rural communities with similar agricultural waste resources to support sustainable agriculture and environmental conservation.

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1. INTRODUCTION

Sustainable agriculture is a key agenda in community development because it is closely linked to food security, environmental sustainability, and improving community welfare [1]. One effort that can be made is optimizing the use of local organic waste into useful products, thereby reducing dependence on synthetic chemicals and supporting a more environmentally friendly agricultural system [2]. Therefore, community empowerment through the utilization of local resources is an important strategy to increase community independence in managing the environment and meeting the needs of sustainable crop cultivation.

The use of synthetic chemical fertilizers in agriculture remains a dominant practice, both on a farm scale and in household crop cultivation [3]. While the continued use of inorganic fertilizers can increase crop productivity in the short term, in the long term, it can degrade the physical, chemical, and biological quality of the soil. This leads to reduced soil fertility, decreased microbial activity, and increased risk of environmental pollution due to chemical residues accumulating in the soil and water.

On the other hand, Indonesia has abundant organic waste potential from both the household and agricultural sectors [2]. Various types of organic waste, such as vegetable and fruit scraps and crop residues, are largely underutilized, resulting in them becoming waste that has the potential to pollute the environment. However, this organic waste contains various nutrients and organic compounds that can be recycled into organic fertilizer, providing added value to the community. Utilizing organic waste is also a form of implementing a circular economy, reducing waste volume while increasing agricultural productivity.

One of the agricultural wastes that has great potential is banana stumps [4]. After harvest, banana stumps are generally left to rot or simply thrown away because they are considered to have no economic value [5]. In fact, banana stumps contain various nutrients, organic compounds, and local microorganisms (MOL) which play an important role in the decomposition process of organic matter and increase the availability of nutrients for plants [6]. The content of microorganisms such as *Bacillus sp.*, *Azotobacter*, *Azospirillum*, cellulolytic microbes, and several other microorganisms makes banana stumps potentially used as raw materials for MOL-based liquid organic fertilizer [7].

However, this potential has not been optimally utilized by the community, particularly in Sonorejo Village, Jakenan District, Pati Regency. Based on initial observations, banana stem waste is still largely discarded after harvest and has not been processed into useful products. This situation is influenced by the community's limited knowledge about the contents of banana stems, techniques for making liquid organic fertilizer, and the benefits of using local microorganisms as an environmentally friendly fertilizer alternative. As a result, the community continues to rely on chemical fertilizers to maintain plants around their homes.

In addition to limited knowledge, the lack of training and mentoring is also a factor preventing communities from independently processing banana stem waste. However, the process of making MOL-based liquid organic fertilizer is relatively simple, uses readily available materials, is low-cost, and can be implemented on a household scale. This situation demonstrates the need for community empowerment programs that not only provide education but also build practical skills through ongoing mentoring.

Various previous studies have shown that liquid organic fertilizer from banana stems can improve the growth of various plant species. The use of liquid organic fertilizer from banana stems has been reported to increase plant height, leaf number, and productivity of horticultural crops such as chilies, tomatoes, and shallots [8], [9], [10]. These results indicate that banana stems have great potential as an effective and environmentally friendly source of organic fertilizer when processed through a fermentation process based on local microorganisms.

However, most previous research has focused on agronomic aspects, namely testing the effectiveness of liquid organic fertilizer on plant growth [11]. Research integrating the use of banana stem waste with a community empowerment approach through education, training, hands-on practice, mentoring, and evaluation of community knowledge is still relatively limited. Therefore, knowledge transfer and behavioral change in organic waste management require greater attention.

Based on these conditions, this community empowerment activity aims to improve the knowledge and skills of the people of Sonorejo Village, Jakenan District, Pati Regency, in utilizing banana stem waste into liquid organic fertilizer based on local microorganisms (MOL). The program is implemented through stages of education, training, demonstrations, direct practice, mentoring, and monitoring so that the community is expected to be able to produce liquid organic fertilizer independently, reduce the use of chemical fertilizers, utilize organic waste optimally, and open up business opportunities based on local resources that support sustainable agriculture.

2. METHOD

This community service activity was carried out in Sonorejo Village, Jakenan District, Pati Regency, in April 2025, involving 25 community members, the majority of whom were housewives and residents who had an interest in cultivating plants around their homes. The approach used was Participatory Action Learning (PAL), which emphasized active community involvement in the entire series of activities through counseling, training, direct practice, and mentoring. This approach was chosen so that participants not only gained theoretical knowledge, but were also able to master the skills in processing banana stem waste into liquid organic fertilizer (POC) based on Local Microorganisms (MOL) independently [12].

The activity began with field observations and surveys to identify environmental conditions, potential banana stem waste, the level of organic waste utilization, and community needs related to organic fertilizer use [13]. The observations served as the basis for developing training materials and mentoring strategies to ensure that the activities were tailored to local conditions and needs. Coordination with the village government and community leaders was then conducted to determine the time, location, and implementation mechanism for the activities.

The community service program is implemented through four main stages as follows:

a. Preparation Stage

The preparation stage includes field observation, problem identification, coordination with the village government, preparation of training materials, provision of tools and materials, and preparation of evaluation instruments in the form of pre-test and post-test questions. In addition, at this stage, preparation

of materials for making liquid organic fertilizer is carried out, consisting of banana stems, brown sugar, rice washing water, clean water, and fermentation containers.

b. Implementation Stage

The implementation stage began with a pre-test to determine the participants' initial level of knowledge regarding organic waste, liquid organic fertilizer, and local microorganisms (MOL) [18] . Furthermore, counseling was provided regarding the impact of excessive use of chemical fertilizers, the benefits of liquid organic fertilizer, the nutritional content of banana stems, and the working principles of local microorganisms in the fermentation process.

Following the presentation, the activity continued with a demonstration of making MOL-based liquid organic fertilizer using banana stems. The community service team demonstrated each step, from preparing the ingredients, chopping the banana stems, mixing the ingredients, the fermentation process, and storing the liquid organic fertilizer. Participants then practiced in groups under direct guidance from the community service team, providing hands-on experience.

c. Mentoring and Monitoring Stage

Mentoring was provided throughout the liquid organic fertilizer fermentation process. [19] . The community service team monitored the success of the fermentation process, provided consultations if participants encountered any problems, and assisted the community in applying the liquid organic fertilizer to plants around their homes. This stage aimed to ensure the community was able to apply the training results independently and sustainably.

d. Evaluation Stage

Evaluation of the activity was carried out using quantitative and qualitative approaches. Quantitative evaluation was carried out by administering a pre-test before the activity and a post-test after the entire training series was completed to measure the increase in participants' knowledge. [20] .

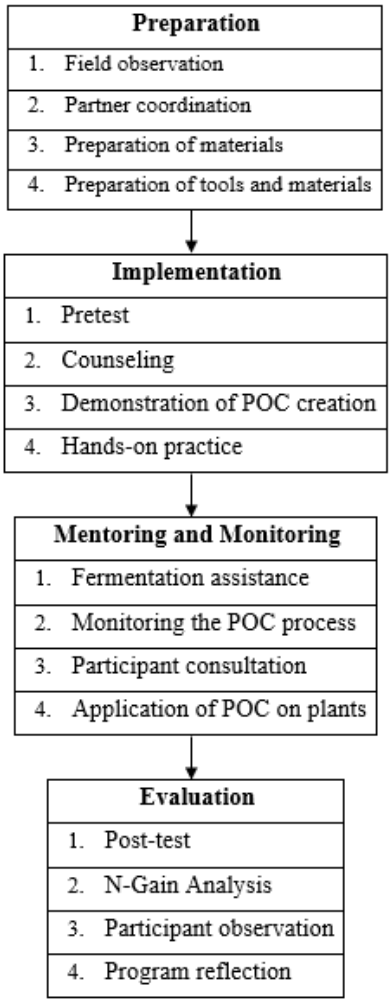

Figure 1. Research Flow

The level of program effectiveness is analyzed using the N-Gain Score with the formula:

$$\text{N-Gain} = \frac{\text{Posttest Score} - \text{Pretest Score}}{\text{Posttest Score} - \text{Pretest Score}}$$

The N-Gain value was then categorized into three levels of effectiveness, namely high ($g > 0.70$), medium ($0.30 \leq g \leq 0.70$), and low ($g < 0.30$) [21] . Meanwhile, qualitative evaluation was carried out through observations during the activity by observing the level of participation, the activeness of participants in discussions, the practical ability to make liquid organic fertilizer, and the enthusiasm of the community during the program.

Pre-test and post-test data were analyzed descriptively using average scores, percentages, and N-Gain calculations to determine participants' knowledge gains after participating in the program. Observation data were analyzed descriptively to support the evaluation of the success of the community empowerment program.

Then, based on the background, method, and flow of the method above, the results and discussion are too brief. Make it more complex according to the flow of the method above.

3. RESULTS AND DISCUSSION

3.1. Implementation of Activities

Community empowerment activities with the title " *Utilization of Banana Stem Waste as Liquid Organic Fertilizer Based on Local Microorganisms (MOL) for Plants Around the Community's Home* " were held on Sunday, April 19, 2025, at the home of one of the residents of RT.04 / RW.01 Sonorejo Village, Jakenan District, Pati Regency, with a total of 25 participants. The activity began at 09.00 WIB, which began with the participant attendance process, then continued with the opening ceremony. The next series of activities included carrying out a *pre-test*, distributing fertilizer-making guides, and demonstrating the making of liquid fertilizer from banana stems. After the demonstration, one of the participants carried out direct practice of making fertilizer, which was then followed by a question-and-answer session. Furthermore, the activity continued with the completion of *a post-test* as a form of evaluation of participant understanding, and ended with closing and documentation.

Throughout the activity, the women demonstrated active participation. This was evident in their enthusiasm, asking questions, and demonstrating a keen curiosity about the liquid organic fertilizer production process.

3.1.1 Preparation Stage

The preparation phase began with field observations and coordination with village officials to identify community conditions and the potential for available banana stem waste. The observations revealed that nearly all households had banana plants, but after harvest, the banana stems were simply left to rot or discarded as waste. In addition to the observations, the community's needs for organic fertilizer were identified.

The discussion results showed that most people still use chemical fertilizers for their yard plants and are unaware that banana stems can be used as a source of local microorganisms (MOL). Based on these conditions, the community service team developed training materials, a liquid organic fertilizer production module, pre- and post-test instruments, and prepared all the tools and materials to be used during the activity. The preparation phase is crucial because it provides an overview of the community's initial conditions so that the material provided can be tailored to the participants' needs. This approach also increases participants' readiness to participate in the entire series of activities.

3.1.2 Implementation Stage

The implementation phase began at 9:00 a.m. WIB with participant registration and the opening of the activity. Prior to the presentation, all participants were asked to take a pre-test to determine their initial level of knowledge regarding liquid organic fertilizer and local microorganisms. Next, the community service team provided information on the impact of excessive use of chemical fertilizers on the environment, the benefits of liquid organic fertilizer, the nutritional content of banana stems, and the fermentation process using local microorganisms (MOL). The presentation of the material was carried out using presentation media, leaflets, and samples of liquid organic fertilizer products so that participants could more easily understand the material provided.

After the presentation of the material, the activity continued with a demonstration of making liquid organic fertilizer. The community service team demonstrated the stages of chopping bananas directly from the stems, mixing ingredients, adding brown sugar and rice washing water as an energy source for microorganisms, and the fermentation process in a closed container. Next, participants were divided into several small groups to carry out independent practice accompanied by the community service team. Through this direct practice, participants gained real experience in making liquid organic fertilizer so that they not only understood the concept theoretically but were also able to apply it independently. During the activity, participants showed high enthusiasm.

This was evident from the many questions asked regarding the duration of fermentation, fertilizer dosage, storage techniques, and application methods for various types of yard plants.

Figure 2.
Fertilizer Making Practice

Figure 3.
Group Photo with the Community

Figure 4.
Liquid Organic Fertilizer

3.1. 3 Stages of Mentoring and Monitoring

The mentoring phase begins after the fertilizer-making workshop is complete. The community service team provides guidance on the fermentation process for approximately two weeks, communicating regularly with participants. Monitoring is conducted to ensure the fermentation process is running smoothly. Indicators observed include changes in the liquid's color, the appearance of a characteristic fermentation aroma, the formation of gas bubbles, and the absence of mold, which would indicate fermentation failure.

In addition to monitoring the fermentation process, the team also provided guidance on how to use liquid organic fertilizer on yard plants. Participants were instructed to dilute the fertilizer before applying it to plants so that nutrients could be optimally absorbed without causing damage to the plants. This guidance was an important factor in increasing community confidence because participants had the opportunity to consult if they encountered any problems during the process of making or using liquid organic fertilizer. [23] .

3.1.4 Mentoring and Monitoring Stage

Quantitative evaluation was conducted using pre-test and post-test instruments to determine the increase in participants' knowledge after participating in the activity. [20] . Meanwhile, qualitative evaluation was conducted through observations of participants' activeness during the discussion, their ability to practice making liquid organic fertilizer, and the level of community participation during the entire series of activities. The evaluation results showed that almost all participants were able to follow each stage of the activity well and were able to repeat the process of making liquid organic fertilizer without experiencing significant difficulties.

3.2. Activity Results

Based on the results of the implementation of activities, several achievements were obtained as follows:

First, there was an increase in public knowledge regarding the use of banana stumps as a liquid organic fertilizer based on local microorganisms. Based on the results of the pre-test and post-test analysis, the average N-Gain was 0.768 (76.81%), which is included in the high category. These results indicate that the extension method combined with direct practice was able to effectively increase participants' understanding. Second, participants successfully mastered the skills of making liquid organic fertilizer, starting from material preparation, chopping banana stumps, mixing fermentation ingredients, and the storage process. At the end of the activity, most participants stated that they were able to practice making liquid organic fertilizer independently at home.

Third, the level of community participation during the activity was considered excellent. All participants participated from start to finish, actively engaging in discussions, asking questions, and participating in group practice sessions. The high level of participant enthusiasm demonstrated that the material provided was tailored to the community's needs. Fourth, a liquid organic fertilizer product based on local microorganisms was successfully produced through demonstrations and hands-on practice. The resulting product exhibited good fermentation characteristics, making it suitable for application on garden plants as an alternative to reducing the use of chemical fertilizers.

Overall, this empowerment activity went well and was able to achieve the stated objectives, namely increasing the community's knowledge and skills in utilizing banana stem waste into useful products.

Table 1of Pre-Test and Post-Test Results

No	*Post-Test*	*Pre-Test*	*Post - Pre*	Ideal Score (100 - Pre)	N Gaim Score	N Gaim Score (%)
1	97	95	2	5	0.4	40
2	97	93	4	7	0.571428571	57.14285714
3	93	90	3	10	0.3	30
4	90	87	3	13	0.230769231	23.07692308
5	97	90	7	10	0.7	70

No	*Post-Test*	*Pre-Test*	*Post - Pre*	Ideal Score (100 - Pre)	N Gaim Score	N Gaim Score (%)
6	100	90	10	10	1	100
7	93	90	3	10	0.3	30
8	93	90	3	10	0.3	30
9	100	80	20	20	1	100
10	100	95	5	5	1	100
11	100	97	3	3	1	100
12	100	97	3	3	1	100
13	95	90	5	10	0.5	50
14	95	90	5	10	0.5	50
15	100	97	3	3	1	100
16	100	95	5	5	1	100
17	100	95	5	5	1	100
18	97	95	2	5	0.4	40
19	100	90	10	10	1	100
20	100	95	5	5	1	100
21	100	95	5	5	1	100
22	100	95	5	5	1	100
23	100	97	3	3	1	100
24	100	97	3	3	1	100
25	100	93	7	7	1	100
	97.88	**92.72**	**5.16**	**7.28**	**0.768087912**	**76.80879121**

3.3. Discussion

The results of the activity showed that a participatory approach combined with outreach, demonstrations, hands-on practice, and mentoring effectively increased community knowledge and skills. This was demonstrated by the N-Gain score of 76.81%, which is considered high. This value indicates that most participants experienced increased understanding after participating in the entire series of activities [14].

This improvement was not only due to the theoretical delivery of the material, but also because the participants were directly involved in the process of making liquid organic fertilizer. The learning by doing approach allows participants to gain real experience so that the concepts presented are easier to understand and remember. This is in line with various community empowerment studies, which state that practice-based training is more effective than extension services that only involve lectures [15].

In addition to increasing knowledge, this activity also successfully improved the community's skills in processing banana stem waste into useful products. Prior to the activity, most participants considered banana stem waste to be useless agricultural waste. After the training, participants understood that banana stem waste contains local microorganisms that can be used as bioactivators in the production of liquid organic fertilizer. This change in perspective demonstrates that the empowerment activity not only resulted in increased knowledge but also raised community awareness of the importance of organic waste management.

The success of the program was also influenced by the high level of community participation. [26] . During the activity, participants actively discussed, asked questions, and were involved in every stage of the practice. Active participation is one indicator of the success of the empowerment program because it shows that the community is not only the object of the activity, but also plays a role as a subject involved in the learning process. [25] . The mentoring provided after the training further strengthened the success of the program because it provided participants with the opportunity to consult when facing obstacles during the fermentation process or the application of liquid organic fertilizer. [27] .

However, the evaluation results also showed variations in knowledge gain among participants. Some participants achieved N-Gain scores in the low to moderate categories. This condition is likely influenced by differences in education level, previous experience with organic fertilizers, and the participants' ability to understand the material in a relatively short time. Age and intensity of participant involvement during the practice are also thought to influence the learning outcomes obtained. [28] .

Overall, this community service activity successfully achieved its stated objectives, namely increasing community knowledge, skills, and awareness in utilizing banana stem waste into liquid organic fertilizer based on local microorganisms. In addition to providing benefits in reducing organic waste and chemical fertilizer use, this program also has the potential to support family food security through the use of organic fertilizer on yard plants

and open up opportunities for developing businesses based on local resources. Therefore, the implemented empowerment model is worthy of replication in other villages with similar agricultural waste potential.

4. CONCLUSION

A community empowerment program utilizing banana stump waste as a liquid organic fertilizer (POC) based on Local Microorganisms (MOL) in Sonorejo Village, Jakenan District, Pati Regency, has been successfully implemented through preparation, outreach, and training, hands-on practice, mentoring, and evaluation. This program has successfully increased the community's knowledge and skills in processing banana stump waste into a valuable and environmentally friendly liquid organic fertilizer.

The success of the program was demonstrated by the pre-test and post-test evaluation results, which obtained an average N-Gain of 0.768 (76.81%) in the high category, thus indicating that the extension method combined with demonstrations, direct practice, and mentoring was effective in increasing participant understanding. In addition, the community was able to independently practice the process of making liquid organic fertilizer, starting from preparing the ingredients, the fermentation process, and its application to plants around the house.

This program has also had a positive impact on increasing public awareness of the importance of utilizing organic waste as an alternative to reducing the use of chemical fertilizers. By utilizing readily available local resources, communities not only obtain a more economical and environmentally friendly solution but also have the opportunity to develop businesses based on liquid organic fertilizer. Therefore, this community empowerment model is worthy of being implemented and replicated in other areas with similar agricultural waste potential to support sustainable agriculture, environmental management, and improve community well-being.

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