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Post-harvest handling of coffee and making liquid organic fertilizer for environmental sustainability Harjokuncaran Village

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ABSTRACT

Harjokuncaran Village possesses significant potential for Robusta coffee (Coffea canephora) cultivation; however, the quality of the coffee remains suboptimal, and prolonged use of chemical fertilizers has led to soil degradation. To address these challenges, a community service program was implemented focusing on farmer education in post-harvest handling, encompassing harvesting, sorting, drying, and storage, as well as the production of liquid organic fertilizer (LOF). The program aimed to enhance the knowledge and practical skills of local coffee farmers while promoting the adoption of environmentally friendly agricultural practices using LOF derived from livestock waste, rice washing water, coconut water, and rice bran. The program involved surveys, observations, and hands-on workshops attended by 25 coffee farmers. Pre- and post-tests were conducted to evaluate the program's effectiveness and support long-term implementation. During the workshops, participants actively engaged in discussions and practiced both post-harvest techniques and LOF production. Results demonstrated a significant increase in farmers' understanding, with knowledge levels improving from 8–92 percent to 92–100 percent. Additionally, the adoption of proper red cherry picking and improved post-harvest practices led to noticeable enhancements in coffee quality. Farmers' awareness and ability to produce and use LOF also rose sharply from 4 percent to 100 percent. This program effectively strengthened farmers' competencies in sustainable coffee farming and fostered collaboration between the implementation team and local stakeholders to support continued agricultural and environmental development in the village.

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1. INTRODUCTION

Coffee (*Coffea spp.*) is a major agricultural commodity with substantial global economic significance. The growing demand for coffee worldwide has contributed to evolving consumer lifestyles and increased appreciation for coffee quality. In Indonesia, the coffee plantation sector holds a strategic role in the national economy, particularly as a source of employment and income for coffee farmers (Cen & Faisal, 2021). Taxonomically, two primary coffee species that cultivated in Indonesia are *Coffea arabica* (Arabica) and *Coffea canephora* (Robusta). These species differ in their agroecological requirements. Arabica coffee thrives at higher elevations, typically above 800 meters above sea level (MASL), with

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cooler temperatures and evenly distributed rainfall (Marianto et al., 2022), while Robusta coffee is more tolerant of warmer climates and can be cultivated in lowland to mid-elevation areas (Satibi et al., 2019).

Harjokuncaran Village, situated at an elevation below 800 MASL and characterized by a warm climate, presents favorable conditions for Robusta coffee cultivation. These agroecological conditions have led to the predominance of coffee farming as the main livelihood among local residents. According to interviews conducted by the implementation team with the head of the Agricultural Extension Agency (Badan Penyuluhan Pertanian, or BPP), data from the 2021/2022 "Rencana Definitif Kebutuhan Kelompok Tani" (RDKK) indicates that Harjokuncaran Village has approximately 100 hectares of coffee plantation land, producing around 1.5 tons annually across four harvest cycles. The harvest season begins in May and peaks in July, continuing until August. This highlights the considerable potential for Robusta coffee production in the village.

Despite this potential, several challenges hinder optimal productivity. Observations and discussions with local farmers revealed issues such as declining crop quality due to inadequate knowledge and skills in post-harvest handling, as well as soil degradation resulting from the prolonged use of chemical fertilizers. These factors directly impact coffee quality. Post-harvest handling is a critical aspect governed by the Ministry of Agriculture Regulation No. 52/Permentan/OT.140/9/2012, which outlines standard procedures including fruit sorting, depulping, fermentation, washing, drying, bean sorting, packaging, storage, and quality standardization. Kasyfillah & Setiawati (2022) stress that timely and proper post-harvest practices are essential to maintaining coffee quality. This is supported by Haile & Kang (2019), who found that up to 60 percent of coffee's physical and chemical quality is determined during the post-harvest phase. One critical component is selective picking; however, most farmers in the area engage in indiscriminate picking (i.e., mixing ripe and unripe cherries), which contributes to quality degradation. This finding is consistent with research by Yokawati & Wachjar (2019), which indicates that non-selective harvesting can disrupt the metabolic processes of coffee beans and increase susceptibility to pests and diseases, ultimately diminishing the final product quality.

On the other hand, coffee farmers in Harjokuncaran Village still use chemical fertilizers for a long period of time in maintaining coffee fruits, causing damage to the soil. Although chemical fertilizers can increase productivity, continuous use has a negative impact on the environment and affects the quality of the harvest. According to research by Ammurabi et al. (2020), the continuous use of high doses of chemical fertilizers can cause soil structure damage, water and air pollution. This is due to the soil becoming nutritionally imbalanced and increasingly acidic, ultimately leading to reduced crop yields and agricultural efficiency (Rusli & Wardiana, 2015). If left unaddressed, this condition may threaten the future production of high-quality coffee. To mitigate this issue, the implementation team introduced liquid organic fertilizer (LOF) as a potential solution. Sitanggang et al. (2022) define LOF as a naturally produced liquid fertilizer obtained through fermentation, resulting in a solution derived from the decomposition of livestock waste, plant materials, and household waste. Educating farmers on LOF production serves as both an environmental conservation effort for Harjokuncaran Village and a means to enhance coffee plant quality during the seedling stage. This initiative aligns with the findings of Gau et al. (2022), which indicate that LOF benefits both coffee cultivation and the environment by preserving nutrient content and promoting the growth of beneficial microorganisms. LOF is not only an alternative to chemical fertilizers in coffee cultivation, but also helps to process waste into something useful. The benefits of liquid organic fertilizer (LOF) are as follows: it provides nutrients to plants slowly, so that nutrient absorption is more effective (Anggraeni et al., 2024).

These problems require solutions and sustainability to improve the welfare of farmers and preserve the environment. Therefore, this community service program can be an effort to empower coffee farmers in Harjokuncaran Village by providing socialization and hands-on practice. The focus of

the community service program is to increase knowledge and skills in post-harvest handling and the production of liquid organic fertilizer as an alternative to chemical fertilizers to improve crop quality and environmental sustainability in Harjokuncaran Village. The objective of this program is to provide a positive impact in line with Sustainable Development Goals (SDGs) and to benefit coffee farmers and the local village government. The implementation team hopes that this community service program will provide a solution for farmers in Harjokuncaran Village to improve coffee quality.

2. METHODS

Activity Method

This community service program was implemented in Harjokuncaran Village, Sumbermanjing Wetan, targeting 25 coffee farmers from 5 farmer groups in Harjokuncaran Village over a period of 5 months, from July to November 2024. The series of activities was systematically designed using 4 methods.

First survey

This method was used to assess the challenges faced by coffee farmers in Harjokuncaran Village. The survey was also necessary to communicate with the farmers and the Agricultural Extension Agency (BPP) of Sumbermanjing Wetan Sub-district. Through interviews and discussions, it was found that farmers were facing challenges related to the decline in harvest quality due to a lack of understanding and skills in post-harvest handling. Additionally, soil degradation is caused by coffee farmers in Harjokuncaran Village still using chemical fertilizers. This survey method also involves direct observation to assess the current conditions, resulting in reduced coffee quality and some degraded soil. The survey results serve as the basis for designing a work program tailored to farmers' needs.

Socialization and education

Socialization was conducted to enhance farmers' understanding of proper post-harvest handling and the introduction and benefits of organic fertilizers for environmental sustainability in Harjokuncaran Village. The activities included a pre-test to measure initial understanding levels, presentation of materials, interactive discussions to explore farmers' deeper curiosity about post-harvest handling and organic fertilizers, and forms of interaction between farmers and presenters. A post-test is conducted to evaluate improvements in farmers' understanding. The results of the pre-test and post-test are used to evaluate the success of the workshop.

Field practice

To ensure the application of knowledge, farmers are invited to participate in hands-on practice of proper post-harvest processes and the production of liquid organic fertilizer (LOF). The stages of post-harvest practice include: (1) Harvesting; (2) Sorting; (3) Drying; and (4) Storage. Meanwhile, the stages of LOF production practice include: (1) Preparation of tools and materials; (2) Introduction of materials; (3) LOF production; and (4) Explanation of the concentration, which is 1:1 (LOF and water) when watering. This practical session will be conducted with direct guidance from the instructor to the farmers to demonstrate the process and explain the tools and materials used during the practice.

Monitoring and evaluation

Monitoring and evaluation are conducted to measure the effectiveness of the program and changes in farmers' knowledge and skills in post-harvest handling and organic fertilizer (LOF) production. Success indicators include: (1) Changes in coffee quality before and after the workshop on post-harvest handling and LOF production; (2) improved farmer understanding through pre-tests and post-tests; (3) Farmers' ability to independently apply post-harvest handling practices and liquid organic fertilizer (LOF) production; (4) Collaboration between the implementation team and farmers for program sustainability and post-harvest module development; and (5) Monitoring through the implementation team's observations of coffee farmers to assess changes in post-harvest handling practices and the sustainable application of LOF fertilizer.

3. RESULTS DAN DISCUSSION

Target Identification

Harjokuncaran Village is located in Sumbermanjing Wetan Subdistrict, Malang Regency, East Java, approximately 51 km from the Muhammadiyah University of Malang campus, or about 1 hour and 27 minutes by car. The coffee farming human resources in the village are organized into five farmer groups. Most coffee farmers have an educational background limited to junior high school (SMP) and senior high school (SMA), which presents a challenge in improving their understanding of post-harvest coffee handling and the application of liquid organic fertilizer (LOF). Based on the initial survey results, the primary issue faced by coffee farmers in Harjokuncaran Village is the decline in coffee quality, largely due to the practice of indiscriminate harvesting (red-green picking) (Figure 1), which results in inconsistent quality of the dried coffee beans (Figure 2).

Figure 1. (a) Improper picking (green-red); (b) Uneven drying; (c) Damaged soil
Figure 2. Discussion on program planning

Socialization

Before presenting the material, a pre-test was conducted as a benchmark to assess the initial understanding of the 25 farmers regarding the material to be presented. The pre-test lasted for 15 minutes, after which the resource person presented the material on two topics, as follows: (1) Post-harvest handling; and (2) Introduction to Liquid Organic Fertilizer (LOF) to the participants. The pre-test and presentation of the material are shown in Figure 4. The results of the pre-test for both materials can be seen in Table 1.

Figure 3. (a) Pre-test implementation; (b) Post-harvest workshop and LOF

Figure 4. (a) Question and answer session; (b) Post-test implementation

Table 1. Pre-test and post-test results on coffee post-harvesting

Questions	Score							
	Pre-Test				Post-Test			
	Yes	%	No	%	Yes	%	No	%
Harvesting coffee using the red/cherry picking method?	5	20	20	80		100	0	0
Sorting after harvesting?	4	16	21	82	25	100	0	0
Proper drying process?	2	8	23	92	24	96	1	4
Does proper post-harvesting affect coffee quality?	8	32	17	68	25	100	0	0
Does proper storage affect harvest quality?	7	28	18	72	25	100	0	0

Table 2. Pre-test and post-test results on Liquid Organic Fertilizer (LOF)

Questions	Score							
	Pre-Test				Post-Test			
	Yes	%	No	%	Yes	%	No	%
Are you using liquid organic fertilizer?	0	0	25	100	25	100	0	0
What are the benefits of liquid organic fertilizer for plants?	1	4	24	96	25	100	0	0
What is the impact of chemical fertilizers on the environment?	15	60	10	40	25	100	0	0
Can you make liquid organic fertilizer from waste yourself?	4	16	21	84	25	100	0	0
Can the use of organic fertilizer reduce production costs?	2	8	23	93	25	100	0	0

The first material presented ranged from: (1) Introduction and understanding of general criteria for coffee harvesting; (2) Methods of coffee harvesting; (3) Coffee sorting; (4) Optimal coffee drying; (5) Storage; and (6) Use of fertilizer during seedling cultivation. The second topic included: (1) introduction and understanding of liquid organic fertilizer (LOF), (2) the benefits of liquid organic fertilizer (LOF) for plants and the environment, and (3) the production of LOF. This in-depth material is important information for coffee farmers, serving as a major motivation for them to improve the quality of their harvests and care for the environment. The presentation of this material lasted for 2 hours, followed by a discussion and a question-and-answer session. During this session, farmers were enthusiastic and actively asked questions about post-harvest handling and the production of liquid organic fertilizer (LOF) (Figure 5). After that, a post-test was conducted to assess the increase in farmers' knowledge after participating in the socialization and discussion activities. The post-test results are shown in Figure 6, and the analysis of the post-test results for both materials is presented in Table 2.

Practice

Post-harvest handling

The stages of post-harvest handling begin with the preparation of the tools and materials to be used. The first stage of post-harvest handling is the picking of coffee cherries. During this stage, farmers are taught to pick coffee cherries that are fully ripe, i.e., red in color. The next stage is sorting, where farmers are taught how to separate coffee beans based on their physical appearance. Next is drying, which is the stage of drying the coffee beans by placing them on a mat. The final stage in post-harvest handling is storage, which determines the final quality of the coffee beans. This storage practice teaches farmers to leave space between coffee sacks. The bags used must be clean and dry. In post-harvest handling practices, farmers actively participate, and the results can be seen in Figure 5. The changes made by farmers before and after the Workshop can be seen in Table 3.

Figure 5. (a) Red harvesting; (b) Coffee fruit sorting figure; (c) Coffee fruit drying

Table 3. Pre- and post-workshop results

Pre	Post
 **Harvesting (red-green)**	 **Red Picker**
 **Uneven Drying**	 **Even Drying**

Figure 5 and Table 3 show the results of important stages after the implementation of post-harvest handling of coffee, starting from picking to the drying process. Figure 5a shows the activity of picking red coffee cherries, which are fully ripe coffee cherries that are ready to be harvested. These red cherries are selected because of their better bean quality for the next process. Figure 5b shows the sorting process, as follows: separating good coffee beans from those that are less suitable, based on size, color, and other physical conditions. Next, Figure 5c shows the process of drying coffee beans to reduce their moisture content before storage or further processing.

Table 3 shows significant changes in farmers' practices before and after the workshop. Before the workshop, farmers still picked unripe (green) and ripe (red) fruits together, and the drying process was uneven. This could affect the final quality of the coffee produced. However, after the training, there was an improvement in post-harvest handling practices, marked by picking only red fruits and a more even drying process. These changes show that the education and guidance provided through the workshop were very effective in improving the quality of farmers' coffee harvests.

Practice of making LOF organic fertilizer

During this stage of organic fertilizer production, the implementation team prepares the tools and materials. After preparation, the farmers attentively listen to explanations regarding the function of each tool and material used. Fermentation is conducted using a drum that serves as a container for mixing the waste. This fermentation drum also functions to eliminate odors, reduce temperature, kill harmful bacteria and pathogens, and enhance the quality and availability of nutrients. The livestock

waste utilized contains nutrients that are beneficial for plant growth, such as chicken manure, which is rich in nitrogen; cow manure, which contains phosphorus; goat manure, which is high in potassium; along with rice water, coconut water, and rice bran, which serve as nutrients for bacterial development. Based on this composition, the resulting liquid organic fertilizer contains essential macronutrients, such as nitrogen (N), phosphorus (P), and potassium (K).

Figure 6. Explanation of materials and practice of LOF production

Table 4. Results before and after the community service program

Indicator	Before	Service Activity	After
Coffee quality	Reduction in coffee quality due to improper picking (red-green)	Conducting socialization and training in post-harvest handling	Improvement in coffee quality after the implementation of proper post-harvest handling (Table 5)
Improved understanding among farmers of post-harvest handling and organic fertilizers	Lack of understanding of post-harvest handling among coffee farmers in Harjokuncaran Village	Conduct socialization and training on post-harvest handling and introduction to liquid organic fertilizer (LOF)	Significant improvement in farmers' understanding from pre-test to post-test results (Tables 1-4)
Ability to apply post-harvest handling and organic fertilizer production (LOF)	Lack of skills in post-harvest handling, resulting in a reduction in coffee quality	Conduct hands-on practice to help farmers improve their skills in post-harvest handling and liquid organic fertilizer (LOF) production	Improvement in skills and active participation in the practice (Figure 9)
Partnerships	None	Conduct socialization, practice, evaluation, and monitoring activities to build cooperation	Formation of cooperation between the implementation team and farmers for the desired program (Figure 14)
Monitoring dan Evaluation	None	Explain the monitoring and evaluation system for handling practices	Implementation of an effective monitoring system to assess changes in practices and LOF implementation

The process then continues to the stage of liquid organic fertilizer production. The stages are as follows: (1) Prepare a 200-liter drum for mixing, stirring, and fermentation; (2) Put cow, chicken, and goat manure into the drum; (3) Add 200-250 liters of tajin water (4-5 times the weight of the waste); (4) Add 1–2 liters of coconut water; (5) Then add 5–10 kg of rice bran; (6) Next, mix all ingredients thoroughly; (7) Seal the container tightly and let it sit for 7–14 days to complete the fermentation process; (8) Check the aroma and condition of the fertilizer; (9) The fertilizer is ready for use.

During the LOF production process, farmers are involved in measuring the use of materials and controlling the fermentation process (Figure 5). After the LOF is ready, farmers participate in making liquid organic fertilizer independently, with materials and tools prepared by the implementation team. After farmers independently produce LOF, they are encouraged to apply it to coffee plants at a 1:1 concentration (LOF and water) during irrigation. At this stage, the presenter reiterates the benefits of LOF for plant growth and soil health, which influence crop quality.

Discussion

Post-harvest handling socialization activities and LOF creation

The analysis of the post-harvest socialization activity results from the pre-test revealed that 80 percent of farmers did not engage in red picking, 82 percent did not perform sorting, 92 percent were unaware of the correct drying process, 68 percent did not know that post-harvest handling affects coffee quality, and 72 percent did not implement proper storage. The results of the organic fertilizer pre-test showed that 100 percent of farmers did not use liquid organic fertilizer, 96 percent did not know its benefits for plants, 60 percent were unaware of the negative impacts of prolonged chemical fertilizer use, 84 percent did not know how to produce liquid organic fertilizer from waste, and 93 percent did not realize that using LOF could reduce production costs. These findings indicate that the limited knowledge of post-harvest handling among coffee farmers in Harjokuncaran Village is a major contributing factor to the low quality of coffee (Figures 1a and 1b) and the deterioration of soil due to continued use of chemical fertilizers. According to Abbas and Suhaeti (2016), improved productivity and market value are determined by effective post-harvest practices. This is further supported by Kusumiyati et al. (2021), who state that post-harvest processes can significantly enhance quality. The socialization method applied in this community service initiative aimed to educate farmers on post-harvest handling and introduce the use of liquid organic fertilizer (LOF). As stated by Nasution (2015), socialization is a learning process that necessitates participation to foster awareness and knowledge. Prior to the socialization, the implementation team conducted a pre-test to assess the farmers' knowledge regarding post-harvest handling and organic fertilizers. This pre-test served to measure the farmers' understanding before the delivery of educational materials.

The community service activity proceeded with a presentation of the material by the speaker, followed by an interactive question-and-answer session. During this session, farmers actively engaged by asking questions related to post-harvest handling and organic fertilizer production. This method proved effective in enhancing farmers' soft skills by encouraging the exchange of opinions, experiences, and information with the presenter. According to previous research, the question-and-answer method facilitates direct, two-way communication, making it an effective approach to delivering material (Malawi & Dayu, 2019). This approach enables farmers to gain a broader and more practical understanding of post-harvest processes and liquid organic fertilizer (LOF).

Following the presentation, the implementation team distributed a post-test to assess the farmers' comprehension of the material. Unlike the pre-test, which evaluates prior knowledge, the

post-test serves as an evaluative tool to determine whether the material has been clearly understood. The results showed a 100 percent increase in the farmers' understanding of the importance of proper post-harvest handling and the use of LOF in improving harvest quality. According to Magdalena et al. (2021), pre-tests and post-tests are designed to gauge the level of understanding achieved through educational interventions. Thus, these tools serve as key indicators of the effectiveness of community service programs in enhancing the knowledge of coffee farmers.

It can be concluded that the improved comprehension among farmers indicates the success of the community service initiative in effectively increasing awareness and knowledge through socialization activities, as demonstrated in Tables 1–4. These findings align with the study by Budiarto et al. (2023), which showed that socialization activities employing pre- and post-test techniques significantly improve knowledge. In this study, the improvement in farmers' understanding reached 71.2 percent from an initial baseline of 0 percent.

Post-harvest handling practices and the production of Liquid Organic Fertilizer (LOF)

The practical method aims to train and enhance farmers' ability to apply the knowledge acquired through socialization activities. This hands-on practice is conducted directly on the farmers' land, allowing them to experience the processes firsthand, which in turn helps to strengthen their skill development (Chasanah & Supriani, 2016). The practical activities are divided into two categories: post-harvest handling of coffee and the production of liquid organic fertilizer (LOF). In the post-harvest handling practices, tools and materials are prepared for the stages of picking, sorting, drying, and storage, fundamental processes that coffee farmers must master to produce high-quality coffee. According to Kuswoyo and Mutaqin (2023), post-harvest handling is a critical determinant of coffee yield quality.

Before post-harvest handling, harvesting is a crucial stage in improving coffee quality. The quality of harvested coffee cherries is assessed by their ripeness, indicated by their red color. Field observations show that farmers have begun implementing red harvesting, indicating an improvement in their skills. This supports the conclusion that proper post-harvest handling enhances coffee quality, as demonstrated in Table 5. According to Maleachi (2024), coffee cherries harvested at full ripeness have optimal sugar and acid levels, contributing to a better taste and aroma.

The subsequent stages, like sorting, drying, and storage, are equally vital in maintaining the final quality of the coffee beans. Errors during these stages can lead to defects such as uneven sorting or drying, which may significantly lower coffee quality (Mistretta et al., 2018). Findings from post-harvest practice sessions support previous research by Payong et al. (2021), which concluded that education and hands-on training can broaden farmers' knowledge and encourage them to improve the quality of their coffee production in the future.

This practical activity of producing liquid organic fertilizer (LOF) is conducted as an effort by coffee farmers to promote environmental sustainability in Harjokuncaran Village, particularly in preserving soil structure during the seedling phase. LOF offers several advantages: (1) It is easy to produce; (2) It contains a complete array of nutrients; (3) It enhances both the quality and quantity of crop yields; (4) It helps reduce environmental pollution; and (5) It sustainably improves soil quality (Sitanggang et al., 2022). The raw materials for LOF are based on livestock waste, which contains essential nutrients such as nitrogen (N), phosphorus (P), and potassium (K). This waste typically includes animal manure, which must not be applied directly to plants as it may be toxic and lead to plant death (Isnaniah et al., 2023).

To make it suitable for agricultural use, additional components such as rice washing water, rice bran, and coconut water are introduced to serve as bacterial nutrients and facilitate the fermentation

process. The use of livestock waste for LOF not only addresses waste management issues but also reduces production costs in coffee seedling cultivation. Rice washing water, in particular, has been shown to act as a beneficial supplement for plant seedlings (Zistalia et al., 2018) and has the potential to increase total chlorophyll content and plant height (Wijiyanti et al., 2019). It contains valuable elements such as carbohydrates, nitrogen, phosphorus, potassium, magnesium, sulfur, iron, and Vitamin B1 (Hairuddin et al., 2018).

Coconut water also contributes essential nutrients including vitamin C, sodium, thiamine, phosphorus, calcium, and riboflavin, which are beneficial for plant growth (Sari et al., 2021). Meanwhile, rice bran is rich in protein, fat, carbohydrates, and fiber. However, like livestock waste, it requires supplementation with organic materials containing NPK to function effectively as a single-source nutrient input for plants (Hamawi et al., 2024). Therefore, the LOF formulation used in this community service project is a synergistic blend of materials that supply macronutrients (N, P, and K) essential for coffee plants while also supporting soil structure. Furthermore, the hands-on LOF production process serves as a valuable learning experience that enhances the practical skills of farmers, as they are actively involved in independently producing the fertilizer.

4. CONCLUSION AND RECOMMENDATIONS

This community service program aims to implement appropriate post-harvest techniques and introduce liquid organic fertilizer (LOF) into coffee cultivation. The program was carried out in two main stages: implementation and evaluation. During the implementation stage, the program successfully enhanced farmers' knowledge and skills. Prior to the intervention, farmers' understanding of post-harvest techniques ranged from 8 percent to 92 percent; afterward, their knowledge increased to between 92 percent and 100 percent. Additionally, the shift in farmers' understanding and use of LOF rose from 4 percent to 100 percent, indicating that they not only comprehended the concepts but were also able to apply them effectively in their farming practices. The application of LOF made from livestock waste and other organic materials holds significant potential for large-scale use. It offers a sustainable solution for managing organic waste while promoting environmentally friendly agricultural practices. The evaluation component of this program is designed to ensure that farmers continue to implement proper post-harvest techniques and use organic fertilizers, enabling a more accurate assessment of their impact on crop yields. To ensure the long-term sustainability of these efforts, collaboration with local agricultural and environmental institutions must be strengthened. Such partnerships are expected to significantly enhance coffee quality and support the economic resilience of farming communities. In this way, the program not only delivers immediate benefits but also contributes to the long-term development of sustainable and productive agriculture.

It is necessary to build a support network focused on sustainable agriculture, which will create a platform for farmers to share experiences, challenges, and solutions related to the use of LOF and post-harvest handling techniques. Sustainability monitoring and evaluation should be conducted to assess the long-term impact of LOF use and post-harvest handling practices by regularly measuring coffee quality. Collaboration with research institutions can be pursued for further studies on the effectiveness of LOF, with results serving as the basis for best practice recommendations. Environmental awareness campaigns should also be implemented to enhance understanding of the importance of using organic fertilizers. Finally, developing a business model that allows farmers to sell their products directly to consumers can increase income and reduce dependence on intermediaries. With these steps, it is hoped that this program can continue to provide sustainable positive impacts for the farming community and the environment.

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