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Development of Cocoa Superior Products through Upstream–Downstream Training in Bodag Village, Kare District, Madiun

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A B S T R A C T

Bodag Village in Kare District, Madiun Regency, has an agroecological environment that strongly supports cocoa cultivation, with approximately 40 hectares of farmland managed by the Murah Sandang Farmer Group and strengthened by downstream initiatives through the Bodag Chocolate House. However, this potential has not yet translated into optimal productivity, as farmers face several constraints, including limited availability of organic fertilisers, rising production costs due to higher chemical fertilizer prices, and insufficient understanding of sustainable cultivation practices and the utilization of organic waste. To address these challenges, this community service program implemented a participatory training program on the production and application of Liquid Organic Fertiliser (POC) using locally available materials, as a more environmentally friendly and economical alternative. The training included socialization, hands-on POC production, technology application in demonstration plots, and evaluation of program effectiveness. The results showed a significant improvement in participants' knowledge, indicated by an increase in the number of participants in the "understand" and "highly understand" categories and the disappearance of the "do not understand" category. Participants' enthusiasm also increased in each training session, and the farmer group successfully produced high-quality liquid and solid organic fertilizers. The program's outcomes demonstrate that the training effectively enhanced farmers' technical capacity, improved their understanding of sustainable cultivation through organic fertiliser production, and strengthened the sustainability of cocoa farming as Bodag Village's leading commodity.

Contribution to Sustainable Development Goals (SDGs):
SDG 2 (Zero Hunger)
SDG 4 (Quality Education)
SDG 12 (Responsible Consumption and Production)
SDG 15 (Life on Land)

1. INTRODUCTION

1.1. Research Background

Bodag Village, located in the Kare Subdistrict of Madiun Regency, is situated on the slopes of Mount Wilis, offering an ideal agroecosystem for cocoa cultivation. This potential has been utilised for generations, with approximately 40 hectares of cocoa plantations managed by the local community (1), particularly those organised under the Murah Sandang Farmers Group (2). Demographically, the villagers are actively engaged in agriculture and have demonstrated upstream–downstream initiatives by establishing the *Bodag Chocolate House*, managed by the Village-Owned Enterprise (BUMDes). This initiative not only processes cocoa beans into derivative products but also serves as an agro-tourism destination (3). These conditions make cocoa the village's leading commodity, playing a strategic role in

supporting the local economy and regional development of Madiun Regency. Despite its great potential, the *Murah Sandang Farmers Group* still faces significant challenges during cultivation, which directly affect the quality and quantity of the final product. The main issue in Bodag Village, Kare District, is the limited production of organic fertilizer, which directly affects the low availability of environmentally friendly agricultural inputs. This limitation is caused by the lack of technical knowledge, inadequate processing facilities, and the suboptimal use of organic waste from livestock and crop residues (4)(5). These conditions hinder efforts to improve soil fertility and crop productivity, including cacao, one of the village's leading commodities (6). The rising price of chemical fertilizers, which has become unaffordable, often leads farmers to apply fertilizers suboptimally. Meanwhile, farmers' knowledge and skills (human resources) regarding sustainable cultivation practices and the utilization of organic waste remain limited. This dependence on external inputs hinders the farmers' economic independence and creates long-term negative impacts on soil fertility and environmental sustainability.

To address low productivity and high production costs, appropriate technology interventions that leverage local resources are required. Therefore, this community service activity introduces a solution in the form of *Training on the Production of Liquid Organic Fertilizer (LOF)*. LOF is recommended for its ability to improve soil health, reduce reliance on inorganic chemical fertilisers, and utilise local agricultural and livestock waste as valuable raw materials (7)(8). The training aims to enhance the technical skills (human resource management) of members of the *Murah Sandang Farmers Group*, enabling them to produce agricultural inputs independently. Consequently, this activity not only supports the improvement of higher-quality cocoa production but also strengthens farm management toward more efficient and sustainable cocoa cultivation as the flagship product of Bodag Village (9)

The main problems faced by the *Murah Sandang Farmers Group* in Bodag Village encompass three crucial aspects, primarily related to cultivation and human resource factors. The **Production (Cultivation) aspect** is characterized by low cocoa productivity caused by factors such as pest and disease attacks (notably *Vascular Streak Dieback* or VSD), limited understanding of good agricultural practices (such as suboptimal fertilization), and high production costs resulting from rising chemical fertilizer prices (10)(11). The **Management (Human Resources) aspect** involves farmers' limited knowledge and skills in managing plantations efficiently—particularly in utilizing organic waste as a value-added production input—and their lack of skills in producing agricultural inputs independently. Finally, the **Marketing aspect** faces challenges related to fluctuating cocoa bean prices and low bean quality (due to insufficient fermentation), both of which are largely influenced by poor upstream harvest quality, thereby reducing the product's overall market competitiveness.

1.2. Literature Review

1.2.1. Technology and Definition of Liquid Organic Fertilizer (LOF)

Liquid Organic Fertiliser (LOF) is a type of fertiliser derived from the biological decomposition of organic materials (such as plant residues, animal manure, or industrial waste) through a biological engineering process, producing a solution rich in essential nutrients (Hadisuwito, 2012). Technologically, the main process in producing LOF is fermentation—either aerobic or anaerobic—with the aid of specific microbial inoculants, such as *Effective Microorganisms (EM4)* or *Local Microorganisms (MOL)*. This fermentation process is crucial because it breaks down complex organic compounds into simpler forms that are more readily absorbed by plants (Susetya, 2004).

1.2.2. Advantages and Disadvantages of Liquid Organic Fertilizer (LOF)

Liquid Organic Fertiliser (LOF) has significant advantages over chemical fertilisers, particularly its ability to holistically improve soil physical, chemical, and biological properties, enhance cation exchange capacity (CEC), and stimulate the activity of beneficial microorganisms (12). LOF leaves no harmful residues, making it environmentally friendly. However, LOF also has several weaknesses. Although it contains a complete range of nutrients, their levels tend to be lower and more variable depending on the raw materials used, compared to the higher nutrient concentrations found in inorganic fertilizers (13) Other limitations include the need for larger application volumes, the relatively long fermentation process required for production (Mulyono, 2018), and the necessity of strict quality control in large-scale manufacturing

1.2.3. Main Raw Materials and Additives

The quality of Liquid Organic Fertiliser (LOF) is highly dependent on the raw materials used, which should ideally be sourced from local resources. The primary raw materials are generally divided into nitrogen (N) sources rich in protein (such as livestock manure or fish waste) and potassium (K) and phosphorus (P) sources commonly found in fruit waste (such as banana peels or cocoa pod husks) or rice-washing water. Meanwhile, additives play a crucial role as biological activators. The most important of these are decomposer microorganisms (such as EM4 or MOL) and carbon energy sources for the microbes, including molasses, granulated sugar, or coconut water (Hadisuwito, 2012). Utilizing agricultural waste from cocoa itself as a raw material can increase the potassium content, which is essential for improving cocoa bean quality

1.2.4. Efficient Procedure for Producing Liquid Organic Fertilizer (LOF)

The standard procedure for producing Liquid Organic Fertilizer (LOF) involves four main steps: **Preparation of Materials, Mixing, Fermentation, and Filtration/Dilution.** During the preparation stage, raw materials must be chopped or ground to accelerate decomposition. The mixing stage includes combining the raw materials, water, microbial starter, and molasses in a closed (anaerobic) or ventilated (aerobic) container. Next is the fermentation stage, during which biological decomposition

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occurs and can last 7-30 days. . The key to success lies in maintaining proper anaerobic conditions and monitoring the optimal pH. Once fermentation is complete, the LOF is filtered to remove solid residues and must be diluted to the recommended ratio (e.g., 1:10 or 1:20) before application.

1.2.5. Benefits of Liquid Organic Fertilizer (LOF) in the Cocoa Plant Ecosystem

Specifically, within the cocoa-farming ecosystem, Liquid Organic Fertiliser (LOF) plays a dual role. In addition to providing essential nutrients, LOF enhances soil microbial activity, which is vital for disease prevention and nutrient absorption. The natural phytohormone content in LOF (such as auxins, gibberellins, and cytokinins) has also been proven to stimulate vegetative growth, flowering, and fruiting in cocoa plants (GDM Organik, 2025). The use of LOF can serve as a management strategy to reduce the impact of soil-borne pathogens and increase plant resilience to environmental stress issues that are crucial in cocoa cultivation across Indonesia (Irianto, 2014).

1.2.6. Recommendations and Program Sustainability

The application of Liquid Organic Fertilizer (LOF) on cocoa plants (*Theobroma cacao L.*) is recommended to strengthen the generative phase, reduce fruit drop, and improve bean quality. Effective application methods include a combination of soil drenching (around the root zone) to enhance soil condition and foliar spraying (on young leaves) for rapid nutrient absorption, particularly before the flowering phase (Lazada, 2025). To ensure the sustainability of this community service program, efforts should focus on establishing independent LOF production units managed by farmer groups. This approach ensures that the introduced technology is not merely adopted but also developed into a sustainable innovation integrated within the local cocoa farm management system.

1.3. Research Objective

The main objective of the Liquid Organic Fertiliser (LOF) production training activity is to address the partner's production-related problems. The goal in this regard is to enhance knowledge of Liquid Organic Fertiliser (LOF) production to improve soil fertility and increase cocoa plant productivity.

2. METHODS

The approach used in this program was the **Participatory Sustainable Cycle Model**, which consists of five main stages designed to ensure effective knowledge transfer and technology adoption by the partner community.

2.1. Socialization

The objective is to increase understanding of the benefits of Liquid Organic Fertilizer (LOF) production technology. **Evaluation:** Conducted by measuring improvements in pre-test scores (knowledge) and assessing participant attendance and enthusiasm levels.

2.2. Training

A hands-on activity involving demonstrations of LOF production and calculation of production costs. **Evaluation** Conducted by assessing improvements in post-test scores (skills) and the quality of LOF products that have undergone optimal fermentation.*Technology Application*

Implementation of LOF on the partner's cocoa demonstration plot, including determining appropriate fertilizer dosage and application timing. **Indicator:** Independent application of LOF on the demonstration plot.

2.3. Evaluation (Indicators)

Measurement of program impact, including increased knowledge (pre–post test), improved cost efficiency (management), and observed improvements in cocoa quality and productivity (production). **Data collected:** Quantitative data (increased LOF production volume}.

3. RESULT AND DISCUSSION

3.1. Improvement in the Farmers Group Members' Competency Level

The results of the activity show that participants' understanding improved significantly before and after the training. Detailed data on the changes in the partners' competency levels are presented in Figure 1.

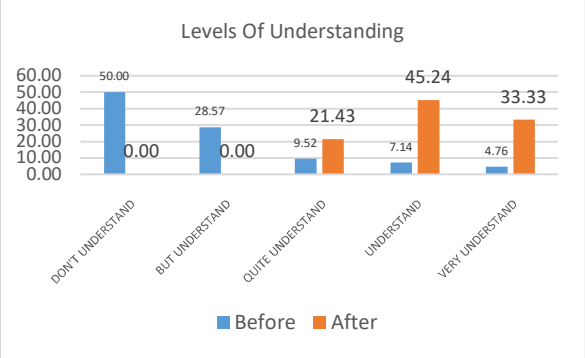

Fig 1. Improvement in the Level of Technological Understanding Before and After the Training

Figure 1 shows that after the activity, there was a significant increase across all categories of positive understanding. Participants in the *understand* category rose to 45.24%, while those in the *very understand* category increased to 33.33%. Meanwhile, the *don't understand* category dropped drastically to 0%, indicating that no participants completely failed to understand the material after the training was conducted. Furthermore, regarding enthusiasm in implementing the training, the results of the activity are shown in Figure 2.

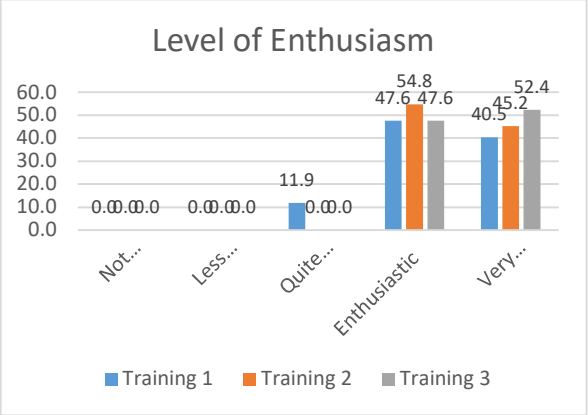

Fig. 2. Level of enthusiasm during training

Figure 2 shows that participants' enthusiasm increased at each stage of the training. In the first session, the majority of participants were categorised as enthusiastic (47.6%) or very enthusiastic (40.5%), with 11.9% as quite enthusiastic and none as low-enthusiasm. In the second training session, the proportion of enthusiastic participants increased to 54.8%, and in the third session, the very enthusiastic category rose to 52.4%. These findings indicate that as the program progressed, participants' motivation and engagement continued to grow, reflecting its success in fostering learning interest and motivation.

The results of implementing the training in one period produced solid fertilizer and liquid fertilizer, the amount of fertilizer production before and after the training is presented in Figure 3

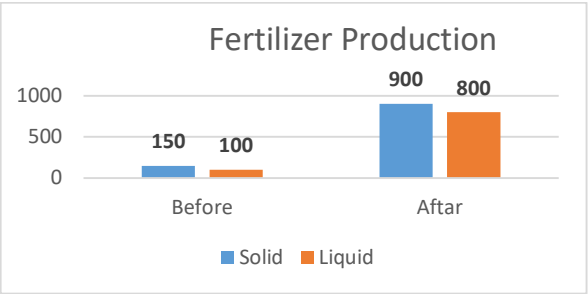

Fig... 3. Productivity of fertilizer production

The figure above shows a significant increase in fertiliser production following the activity. Before the program, solid fertiliser production reached only 150 units, and liquid fertiliser production reached only 100 units. However, following the training and mentoring, solid fertiliser production rose dramatically to 1,000 units, and liquid fertiliser production to 800 units. The key finding from this data is that the community service activity substantially enhanced the capacity for organic fertiliser production, both in solid and liquid forms.

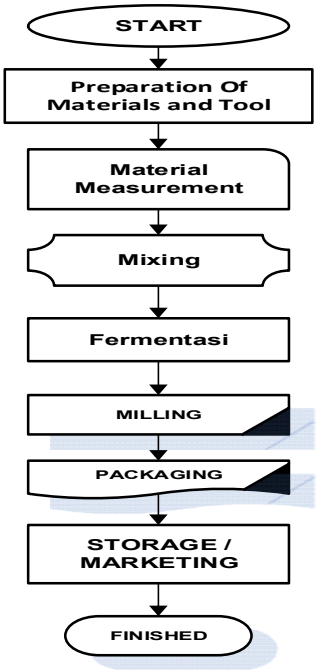

Figure 4. Stages of making solid organic fertilizer

The training continued with the production process of Liquid Organic Fertilizer (LOF), using livestock manure (KOHE) as the main ingredient. The stages of the LOF production process are outlined according to the scheme presented in Figure 4.

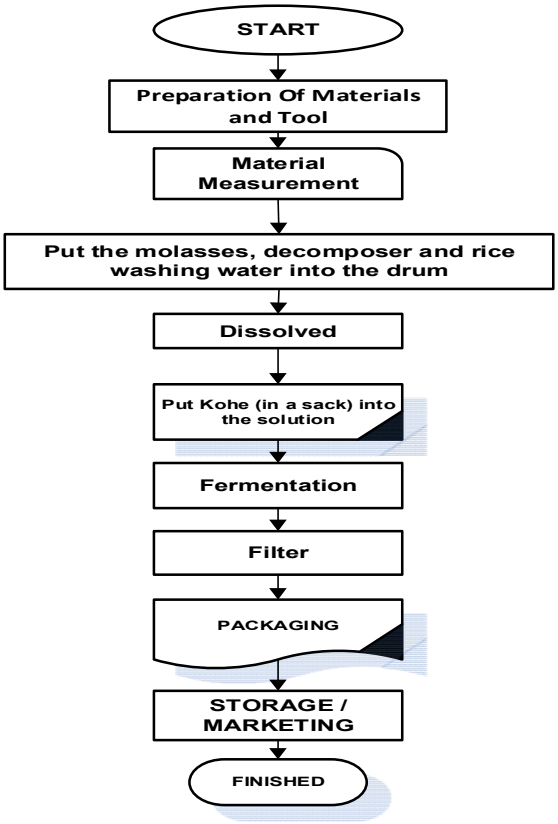

Fig. 3. Stages of making liquid organic fertilizer

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4. CONCLUSION

Based on the explanation above, it can be concluded that the limited production of organic fertiliser in Bodag Village, Kare District, is a major constraint on the development of sustainable agriculture and on improving crop productivity, particularly cacao, the village's flagship commodity. The community's low technical capacity, inadequate processing facilities, and the suboptimal use of organic waste have resulted in insufficient availability of environmentally friendly fertilizers. Therefore, targeted interventions—such as training, mentoring, and strengthening production facilities—are needed to enhance the community's capacity to produce organic fertilisers, improve soil fertility, and sustain agricultural productivity.

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