

Cocoa Seedling Cultivation (*Theobroma Cacao*) Using Bokashi Fertilizer Media as an Environmentally Friendly Solution

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Abstract: *This community service project, conducted in Bugel Hamlet, Karangrejo Village, focuses on improving cocoa farming through the use of bokashi fertilizer as an environmentally friendly alternative to chemical fertilizers. The project aims to enhance soil fertility and cocoa seedling growth while promoting sustainable agricultural practices. Using Participatory Action Research (PAR), local farmers were actively involved in the planning, implementation, and evaluation phases. The research methodology included observation, interviews, and field studies. Results showed that bokashi fertilizer significantly improved soil health, increased cocoa productivity, and fostered a better balance of soil microorganisms compared to chemical fertilizers. The project empowered local farmers by providing them with an eco-friendly solution for enhancing cocoa farming, with the potential to increase productivity, support local economic growth, and contribute to long-term environmental sustainability.*



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INTRODUCTION

The cocoa plant, scientifically known as *Theobroma cacao*, is a perennial crop native to the Amazon basin in South America but is now extensively cultivated in various tropical regions, including Indonesia. The introduction of cocoa to Indonesia by the Spanish in the mid-16th century marked the beginning of its agricultural significance in

the region. However, the journey of cocoa in Indonesia has faced challenges, including a decline in export volumes in the 19th century due to pest infestations and agricultural difficulties (Mounya & Chowdary, 2024). The improvement in cocoa productivity and production is closely linked to proper crop management practices. Recent research indicates that effective fertilization techniques can significantly enhance cocoa yield and soil fertility (Förste et al., 2023).

Indonesian cocoa has the potential to compete in the global market, especially if farmers follow meticulous fermentation processes. This potential aligns Indonesian cocoa with that of renowned origins such as Ghana (Krauss & Barrientos, 2021). Cocoa farming in regions like Bugel Hamlet plays a vital role in the local economy, with cocoa cultivation occupying a substantial portion of farmers' land and serving as a critical source of income and export. The crop significantly contributes to the nation's foreign exchange earnings, ranking behind palm oil and rubber (Fajriani et al., 2024). As of 2021, Indonesia is recognized as one of the largest cocoa producers in the world, typically ranked fourth after Côte d'Ivoire, Ghana, and Nigeria (Zachra & Kusnadi, 2024).

Nonetheless, challenges persist in cocoa production, including threats from pests and diseases that can affect both yield and quality (Ogunya, 2024). Reports indicate that these issues exacerbate economic pressures on local farmers (Hernandez & Granados, 2021). Recent studies suggest that implementing adaptive agricultural practices and improved pathogen management strategies could significantly bolster cocoa outputs. This aligns with broader sustainability trends aimed at enhancing the resilience of cocoa farming systems (Martínez et al., 2025; Prazeres et al., 2021).

Bugel Hamlet is also home to various crops, demonstrating the diversification of local agriculture, with cocoa serving as the primary economic driver (Fajriani et al., 2024). The dynamics of land allocation in this region highlight the agricultural and financial importance of cocoa cultivation. Research indicates that engaging farmers in capacity-building initiatives, like farmer field schools, can substantially enhance their skills and productivity in cocoa farming (Alain, 2024). This is crucial in addressing the socio-economic challenges faced by cocoa farmers, who often deal with unstable market conditions and the impacts of climate change (Prazeres et al., 2021).

As cocoa production evolves, leveraging technology and sustainable practices is essential. Innovations in agroforestry, which integrate cocoa with other crops, have emerged as beneficial strategies to improve resilience against climatic and economic stresses (Martínez et al., 2025). This multifaceted approach not only enhances productivity but also contributes to environmental sustainability by mitigating deforestation and promoting biodiversity (Figueiredo et al., 2024).

Adhering to these evolving standards is pivotal for the future of cocoa farming in Indonesia and globally. The dual goals of improving local productivity and ensuring environmental sustainability will shape the trajectory of the cocoa sector.

METHOD

The community service activity is located in Dsn. Bugel, Ds. Karangrejo, Kec. Kendal, Kab. Ngawi, East Java, and is scheduled to take place between February and March 2025. The partner for this activity is the *Kelompok Tani "Tani Makmur"* in Dsn. Bugel. Data collection for this project will employ various methods, including observation, interviews, and documentation, which are integral to the Participatory Action Research (PAR) methodology. This approach will ensure that the community is actively involved in the research process, allowing for a more comprehensive understanding of the challenges and potential solutions in cocoa farming.

Observation

The observation technique involves direct observation of the cocoa farms within the *Kelompok Tani "Tani Makmur"* in Dsn. Bugel. This includes collecting data related to land management practices, the use of bokashi fertilizer, and its impact on cocoa plants. Observations will also cover land clearing and the health of cocoa trees, providing essential insights into the current agricultural practices used by the farmers (Mounya & Chowdary, 2024). This phase will serve as the foundation for understanding the current state of farming practices and identifying areas for improvement.

Interviews

Interviews will be conducted with key stakeholders, particularly the cocoa farmer, Mr. Bejo Rahmat, to gain deeper insights into his experiences with managing cocoa farms using bokashi fertilizer. These interviews will explore the challenges he faces, the benefits he perceives, and his recommendations for improving farming practices (Förste et al., 2023). The interaction with local farmers will allow for a richer understanding of the community's needs and how bokashi fertilizer has been integrated into their agricultural routines.

Documentation

This method will involve gathering secondary data from research reports, journals, and other relevant documents regarding cocoa farming and the use of organic fertilizers. These documents will provide context and additional knowledge on the subject, enriching the understanding of the community's practices and the broader agricultural trends in Indonesia. The literature review will support the findings from the observation and interview phases by providing external validation and a comparison to broader trends in cocoa cultivation (Krauss & Barrientos, 2021).

Data Analysis

The collected data will be analyzed using a qualitative descriptive approach based on the principles of PAR. This will include several stages of analysis:

1. **Descriptive Analysis:** The findings from the observation and interviews will be presented descriptively, focusing on how bokashi fertilizer is applied in the management of the cocoa farms. The data will be compiled into clear narratives explaining the farming practices observed and the farmer's experiences (Zachra & Kusnadi, 2024).
2. **Qualitative Analysis:** The interview and observational data will be analyzed to identify patterns in bokashi fertilizer usage, including its benefits and any challenges faced by farmers. This analysis will help to understand the effectiveness of bokashi in enhancing soil fertility and cocoa plant health, as well as highlight any issues that need to be addressed in future interventions (Prazeres et al., 2021).

Phases of Community Engagement Activities

The community engagement process follows a structured series of phases:

1. **Initial Engagement and Needs Assessment:** The first phase focuses on establishing trust and rapport with the cocoa farmers of Bugel Hamlet. This phase involves meeting with the community leaders and farmer groups to understand their challenges and needs regarding cocoa farming and the use of organic fertilizers (Ogunya, 2024). A baseline survey will be conducted to assess the current state of cocoa farming.
2. **Co-Planning Workshops:** After the needs assessment, the project team and the community members will collaborate to set SMART (Specific, Measurable, Achievable, Relevant, Time-bound) goals for the improvement of cocoa farming practices. This phase encourages active participation from farmers, ensuring that the project interventions are relevant and tailored to their specific circumstances (Hernandez & Granados, 2021).
3. **Implementation of Agricultural Interventions:** Based on the action plan, the community will begin implementing new agricultural practices, such as improved pest control and the use of bokashi fertilizer. The farmers will apply these methods in their fields, and the project team will provide ongoing support to monitor progress and address challenges as they arise (Fajriani et al., 2024).
4. **Monitoring and Evaluation:** Throughout the implementation phase, the project team will continuously monitor the outcomes of the interventions. Feedback sessions will be held with the farmers to gather insights into the effectiveness of the practices and to make adjustments as needed (Martínez et al., 2025). This phase ensures that the project remains flexible and responsive to the community's needs.
5. **Sustainability and Capacity Building:** The final phase focuses on building the capacity of the farmers to sustain the improvements made in cocoa farming practices. Training sessions will be held to empower farmers with the knowledge

and skills needed to continue using bokashi fertilizer and other sustainable practices independently, ensuring the long-term sustainability of the project (Prazeres et al., 2021).

This community service project, implemented using Participatory Action Research, aims to enhance cocoa farming practices in Bugel Hamlet through collaborative planning, the introduction of sustainable agricultural techniques, and community-led interventions. The engagement of local farmers in the planning and implementation process ensures that the interventions are practical, relevant, and effective, while the continuous monitoring and evaluation phase will allow for adaptive management, ultimately contributing to the resilience and sustainability of cocoa farming in the region.

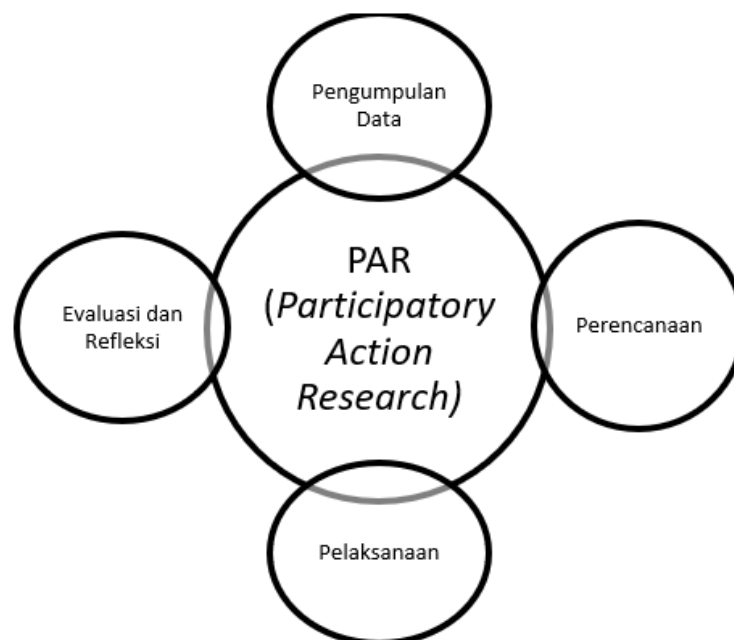


Figure 1. Community Service Research Flowchart

RESULT

Introduction to the Cocoa Farming and Bokashi Fertilizer Production Process

The community service activity focuses on the cocoa farming practices in Bugel Hamlet, Desa Karangrejo, Kecamatan Kendal, Kabupaten Ngawi, East Java. The primary activity involves educating local cocoa farmers about sustainable agricultural practices, particularly the production of organic *bokashi* fertilizer and the proper planting techniques for cocoa seeds. This initiative is aligned with Participatory Action Research (PAR), where community members are actively involved in both the planning and execution of the activities.

Bokashi Fertilizer Production Process

The production of *bokashi* fertilizer is an essential step in improving the soil quality for cocoa farming. The process requires several materials and tools to create an organic fertilizer that enhances soil fertility and boosts cocoa plant health. The materials include 20 bags of animal manure (from cows, goats, and chickens), 5 bags of rice husk charcoal, 5 kg of rice bran, EM4 (effective microorganisms), molasses (sugarcane molasses), and water. The tools used in this process include a tarpaulin, buckets, and a hoe.

The process begins by mixing 15 bags of animal manure with rice husk charcoal and rice bran. The mixture is then watered with a solution of molasses and EM4 dissolved in water. Additional manure is added on top of the mixture and watered again. The mixture is stirred thoroughly to ensure even distribution. Once the materials are well-mixed, the mixture is covered with a tarpaulin and left to ferment for 14 days. During this fermentation period, microorganisms work to break down the organic matter into a nutrient-rich fertilizer suitable for use in the cocoa farm.

Cocoa Planting Process

In parallel with the production of *bokashi* fertilizer, the cocoa planting process follows a series of carefully planned steps. The process starts with splitting the cocoa fruit open and extracting the white cocoa beans. The beans are then soaked in water for 48 hours to encourage the growth of roots. After soaking, the outer layer of the beans is carefully peeled off to reveal the root, which is essential for the seedling's development.

The next step is preparing the planting media. This includes mixing soil with *bokashi* fertilizer to improve its fertility. The mixture is then placed in small polybags, and the soil is packed down gently. After filling the polybags, the soil is watered, and a small hole is made using a finger to plant the cocoa bean. The cocoa seed is placed with the root facing downwards and covered gently with soil, ensuring that the top of the seed remains exposed.

According to Sugianto (as cited in Asriyani, Rauf, and Lapanjang, 2020), the use of superior cocoa clones should be accompanied by improvements in their growing environment, particularly in terms of nutrient availability. In this context, *bokashi* fertilizer not only improves soil structure but also provides essential nutrients and increases the activity of soil microorganisms, which are critical for the cocoa plant's development.

Monitoring and Evaluation Process

The monitoring and evaluation phase is an ongoing process that extends beyond the initial planting and fertilizer application. After the practical sessions, the expert continues to monitor the progress of the cocoa seedlings. Farmers receive guidance and feedback on the management of the seedlings and the proper use of *bokashi* fertilizer over the course of one month. This period allows for the observation of any issues or challenges

faced by the farmers, particularly concerning the fermentation process of the *bokashi* and the growth of the cocoa plants.

The monitoring involves regularly checking the condition of the seedlings and assessing the effectiveness of the *bokashi* fertilizer. Feedback from the community is critical in identifying any areas that need adjustment, ensuring that the techniques introduced are being applied effectively. The success of the project will be determined by the health of the cocoa seedlings and the ability of the *bokashi* fertilizer to improve soil fertility, providing a sustainable solution to the community's agricultural challenges.

Tables of Participant Motivation

To evaluate the effectiveness of the training, participant motivation before and after the sessions was assessed. Below are the motivation levels of the participants regarding both *bokashi* fertilizer production and cocoa planting:

Table 1. Participant Motivation in Bokashi Fertilizer Production

No.	Indicator	Before Session (%)	After Session (%)
1.	Interest in Making Bokashi Fertilizer	60	80
2.	Understanding of Bokashi Fertilizer Making	40	90
3.	Understanding of Bokashi Fertilizer Benefits	40	90

Table 2. Participant Motivation in Cocoa Planting

No.	Indicator	Before Session (%)	After Session (%)
1.	Interest in Cocoa Planting	60	80
2.	Understanding of Cocoa Seedling Planting	40	90

From tables 1 and 2, demonstrate a significant increase in both interest and understanding of both the production of *bokashi* fertilizer and the cocoa planting process. The results highlight the positive impact of the training sessions, suggesting that the participants are now more motivated and knowledgeable about sustainable farming practices.

The *bokashi* fertilizer production and cocoa planting activities in Bugel Hamlet are part of a broader effort to empower local farmers by introducing sustainable agricultural practices. Through the use of Participatory Action Research (PAR), the community actively participates in each step, from the planning to the evaluation phases. The use of organic fertilizers, such as *bokashi*, combined with improved planting techniques, not only enhances the soil quality but also contributes to the overall sustainability of cocoa farming in the region. The ongoing monitoring and evaluation process ensures that the community continues to benefit from these practices, leading to improved agricultural productivity and environmental sustainability.

DISCUSSION

The research findings on the management of cocoa farms in Bugel Hamlet, utilizing *bokashi* fertilizer, reveal significant positive impacts on soil quality and plant productivity. This section will discuss the primary findings related to the effectiveness of *bokashi* fertilizer as an environmentally friendly solution, along with an analysis of the factors influencing its successful implementation. The initial step in managing a cocoa farm involves the planting and nurturing of cocoa seedlings, a process that is enhanced by the use of organic fertilizers like *bokashi*.

The importance of improving cocoa productivity is highlighted by the need to optimize the fruiting process in cocoa cultivation (Suprpto, 2018). In the case of smallholder cocoa farms, productivity is often hampered by aging trees, which leads to a decline in yields and a reduction in overall farm viability (Ibnu, n.d.). Cocoa trees, particularly those that are older, contribute to suboptimal yields, which ultimately require rejuvenation through better seedlings and improved farming practices. In line with this, the use of *bokashi* fertilizer can significantly contribute to soil fertility, providing the necessary nutrients to support the health and growth of cocoa plants.



Figure 2: Cocoa Farm of Kelompok Tani Makmur in Bugel Hamlet.

Decreased cocoa yields are influenced by several factors, including the attack of plant pests and diseases, such as the cocoa fruit borer (*PBK*), the quality of cocoa seedlings, post-harvest handling, and overall farming systems (Siahaan, Simanjuntak, & Purba, 2024). The introduction of *bokashi* fertilizer into cocoa farming provides a promising method to address these challenges by improving soil quality and enhancing the availability of essential nutrients for the plants.

The use of *bokashi* in cocoa seedling propagation has shown to be an effective method for enhancing seedling growth and quality. *Bokashi*, made from organic materials, improves soil fertility by replenishing essential nutrients and enhancing the biological, chemical, and physical properties of the soil. The involvement of *Kelompok*

Tani Tani Makmur under the leadership of Mr. Bejo Rahmat in direct training and practical application of *bokashi* is a key factor in the success of this intervention. As organic fertilizers, *bokashi* promotes biological activity within the soil, creating an environment conducive to healthy plant growth (Sugiarto, Lapanjang, & Madauna, 2024).

Advantages of Bokashi Fertilizer Over Chemical Fertilizers

One of the significant advantages of *bokashi* fertilizer over chemical fertilizers is its ability to enhance soil fertility naturally without damaging the ecosystem. Unlike chemical fertilizers, which can lead to soil degradation and pollute the environment, *bokashi* enriches the soil by increasing its microbial population. These microorganisms are essential for maintaining soil health as they break down organic matter, making it more accessible to plants. The fermentation process involved in the production of *bokashi* further boosts the microbial activity in the soil, which not only improves soil structure but also helps in long-term soil fertility (Krauss & Barrientos, 2021).



Figure 3: Mixing Bokashi Fertilizer.

The benefits of using *bokashi* extend beyond soil fertility. Plants growing on soil enriched with *bokashi* fertilizer experience faster growth, higher nutrient content, and improved resilience against pests and diseases. This leads to a more robust cocoa crop with higher yields. Additionally, the use of organic fertilizers like *bokashi* is more environmentally sustainable, as it avoids the harmful effects of chemical fertilizers, such as contamination of water sources and degradation of soil health over time.

Implications for Cocoa Farming in Bugel Hamlet

The findings from Bugel Hamlet underscore the effectiveness of *bokashi* as a sustainable agricultural practice that aligns with the principles of Participatory Action Research (PAR). In this approach, the active involvement of the community ensures that

the practices introduced are contextually relevant and are based on local knowledge and experiences. The partnership with *Kelompok Tani Tani Makmur* and Mr. Bejo Rahmat is a prime example of how local expertise can be harnessed to improve farming practices and promote sustainability.

Furthermore, the PAR approach emphasizes the continuous involvement of the farmers throughout the process, from the planning and implementation phases to the ongoing monitoring and evaluation. This collaborative approach not only empowers the community but also ensures that the interventions are adapted based on feedback and real-world conditions (Förste et al., 2023). By integrating *bokashi* into the community's agricultural practices, Bugel Hamlet's cocoa farmers are gaining the tools they need to increase productivity sustainably, contributing to both economic and environmental sustainability.



Figure 4: Fermentation of Organic Fertilizer.

The use of *bokashi* fertilizer in cocoa farming in Bugel Hamlet demonstrates its potential as an effective and environmentally friendly solution to improve soil fertility and enhance cocoa productivity. By addressing key challenges such as soil degradation and pest control, *bokashi* provides a sustainable alternative to chemical fertilizers. The success of this initiative is further amplified by the active involvement of the farming community in the process, ensuring that the practices introduced are both practical and effective. This case study highlights the importance of community-driven agricultural interventions in promoting sustainability, aligning with the broader goals of PAR to foster local empowerment and long-term resilience in cocoa farming systems.

CONCLUSION

The implementation of *bokashi* fertilizer in the propagation of cocoa seedlings has proven to be an effective method for enhancing seedling growth in Bugel Hamlet. The results indicate that the use of *bokashi* fertilizer significantly improves soil fertility, which, in turn, supports better plant health and faster growth. However, it is essential to tailor the type and dosage of the fertilizer to achieve optimal results. The appropriate combination of organic and inorganic fertilizers could further enhance the growth of cocoa seedlings and contribute to higher yields in the long term.

In addition, the sustainability of cocoa production in Indonesia faces significant challenges, particularly due to the declining productivity of aging cocoa trees. Addressing this issue requires a multi-faceted approach, with a focus on revitalizing cocoa farms through the use of superior cocoa seeds. Introducing new, high-yielding varieties of cocoa to farmers will be a crucial strategy for improving productivity and ensuring the long-term viability of the cocoa sector. As highlighted by previous studies, using superior clones and improving soil fertility with organic fertilizers such as *bokashi* can help express the genetic potential of cocoa plants, ultimately enhancing their performance (Sugiarto, Lapanjang, & Madauna, 2024).

From a theoretical perspective, this project aligns with the principles of Participatory Action Research (PAR), where community involvement plays a central role in the success of the intervention. By actively engaging local farmers, the project not only empowers them to improve their farming practices but also ensures that the solutions are contextually appropriate and sustainable. This participatory approach fosters local ownership of agricultural improvements, which is essential for long-term success and resilience in cocoa farming.

RECOMMENDATION

Based on the findings of this community service activity, several recommendations can be made for further enhancing cocoa farming in Bugel Hamlet and other similar regions:

1. **Optimizing Fertilizer Use:** Future efforts should focus on fine-tuning the application of both organic and inorganic fertilizers to achieve the best results. More research into the ideal combinations and dosages will be beneficial in maximizing the effectiveness of these fertilizers.
2. **Revitalizing Cocoa Farms:** The introduction of superior cocoa clones and the improvement of existing farm management practices should be prioritized to address the decline in productivity. This could include the use of improved seedlings and the adoption of new agricultural techniques that enhance plant health and yield.
3. **Sustainable Agricultural Practices:** The use of organic fertilizers, such as *bokashi*, should be promoted further as part of a broader strategy to make cocoa farming

more sustainable. These practices not only improve soil quality but also support environmental sustainability by reducing dependence on chemical fertilizers.

4. Capacity Building: Continuing the education and training of farmers, especially in organic farming practices, is crucial. Providing ongoing support through workshops, field schools, and hands-on training can help farmers adopt best practices more effectively.

By focusing on these strategies, the cocoa farming community in Bugel Hamlet can improve its productivity, sustainability, and resilience, contributing to the overall growth of Indonesia's cocoa sector.

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