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Utilization of Livestock Manure as Biogas and Liquid Organic Fertilizer (LOF) in Sumbermulyo Village, Pesanggaran, Banyuwangi

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Abstract

Biogas is a natural gas produced through anaerobic bacteria breakdown of organic materials. Organic materials can include livestock manure, domestic waste, and other organic waste that bacteria can decompose under anaerobic conditions. Sumbermulyo is one of the villages in the Pesanggaran sub-district of Banyuwangi Regency, where the majority of the population works as dragon fruit farmers and goat herders. The current phenomena in the area include the scarcity of subsidized urea fertilizer and Liquified Petroleum Gas (LPG). An alternative approach is to utilize goat manure as a source of methane gas, which can be used as a substitute for LPG. The objective of this community service project is to establish a biogas processing pilot project in the Sumbermulyo Village, Pesanggaran sub-district, which the community can implement. Additionally, it aims to analyze the total N, P, K content in the wet sludge from the digester as liquid organic fertilizer. The method used involves constructing a biogas digester on the land owned by one of the farmer groups and evaluating the gas production. The digester is built using a concrete model (fixed dome) in the shape of an airtight dome. The construction of the digester takes 14 days until it is ready for use. Up to the 10th day of use, the highest pressure is obtained on day -10, with a pressure of 107,486.76 N/m2 or 1.06 atm. Chemical analysis of the liquid organic fertilizer shows that the total N, P, K content is as follows: 0.032%, 0.009%, 0.144% for the sample from the test digester, and 0.044%, 0.005%, and 0.195% for the sample from the reference digester.

Keywords: *biogas, digester, dragon fruit, organic fertilizer*

INTRODUCTION

Sustainable agricultural land management is an essential issue for improving the economic well-being of the community. This is underpinned by Law Number 41 of 2009 concerning the protection of sustainable food crop agricultural land (PLPPB). One crucial aspect of this system is the utilization of agricultural land that is in harmony with nature. This refers to a farming system that doesn't harm, alter, is harmonious, and balanced with the agricultural environment while adhering to natural principles and not causing environmental pollution. The Pesanggaran sub-district is one of the largest sub-districts in Banyuwangi Regency. The majority of its population is engaged in agro-industrial agriculture, with dragon fruit as the primary product. The total average production is approximately 82.8 kTons per year. From the data, almost 95% of paddy fields have been converted into dragon fruit cultivation. Even some communal forest areas have been converted for dragon fruit cultivation. According to the report from the Agricultural Extension Agency (BPP) of Pesanggaran sub-district, in the last five years, most dragon fruit cultivation areas have a pH level of 3-4 (normal soil pH is 6-8). The soil has hardened, making it difficult to absorb water, and soil fertility has decreased. The use of urea fertilizer, with the main component being nitrogen and zeolite as the binder, is identified by the BPP as one of the main causes. As a result, many plants are susceptible to diseases, and the fruit easily gets damaged.

One sustainable alternative recommendation is to restore soil fertility through the utilization of organic fertilizer obtained from the local community. Many dragon fruit farmers also raise goats, some of which are fed with plants from the dragon fruit fences and support plants. This ease of access to feed can create a sustainable cycle. The goat dung can be used to make organic fertilizer. Some recommendations from the Agricultural Extension Agency (BPP) of Pesanggaran sub-district

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include converting this livestock manure into biogas to meet household energy needs. Consequently, the still-wet sludge can be used much more quickly as liquid organic fertilizer.

The goal of this community service, in collaboration with the Agricultural Extension Agency (BPP) of Pesanggaran, is to provide training and assistance, along with partial financing for the construction of biogas facilities that can produce liquid organic fertilizer and energy for farmers. In addition to the partners, several students will be involved in the biogas construction, safety awareness in biogas utilization, training in the use of liquid organic fertilizer, and monitoring the impact of liquid organic fertilizer on soil fertility.

MATERIAL AND METHOD

The equipment used in this community service includes chemical beakers, a hot plate, a set of distillation equipment, an analytical balance, droppers, volumetric pipets, and burettes. The materials used are sulfuric acid (H_2SO_4), nitric acid (HNO_3), hydrochloric acid (HCl), Conway indicator, and distilled water.

The stages carried out for empowerment are as follows:

- Creating a systematic roadmap and conducting initial visits for problem identification and partnership initiation, involving the Agricultural Extension Agency (BPP) of Pesanggaran sub-district.
- Analyzing needs.
- Establishing success indicators.
- Program implementation.
- Target audience guidance, which includes farmer groups.
- Monitoring and evaluation.

The laboratory stages involve analyzing the content of liquid organic fertilizer, including:

Total Nitrogen Analysis

The analysis of Total Nitrogen (N) content is performed using the Kjeldahl method. The Kjeldahl method starts with sample destruction. Approximately 0.5 grams of the sample is placed in a Kjeldahl flask and mixed with 25 mL of concentrated sulfuric acid (H_2SO_4). The sample is then destructed at approximately 350°C for 2 hours until a clear solution is obtained. The sample is distilled for about 10 minutes. The distillate is collected in 10 mL of 1% H_3BO_3 and a few drops of Conway indicator. The distillate is titrated with 0.1N HCl. The determination of the total N content in the fertilizer is calculated using the formula provided.

Total Phosphate Analysis

The analysis of total phosphate is carried out by destructing the sample as in the nitrogen analysis stage. Then, 1 mL of the sample is pipetted into a chemical test tube and mixed with 9 mL of distilled water until homogeneous. The diluted sample is pipetted 1 mL and placed in a chemical test tube, and standard P is added in various concentrations. The sample is then mixed with 9 mL of a color-generating reagent. The P content is calculated using a standard curve method.

Total Potassium Analysis

The analysis of total potassium begins with weighing 0.5 grams of the sample, followed by the addition of concentrated sulfuric acid and concentrated nitric acid. The mixture is heated using a hot plate. Then, 2.5 mL of concentrated sulfuric acid is added until the sample turns black. Nitric acid is added gradually until the acid is no longer black. After that, the sample is diluted with distilled water to a volume of 50 mL, shaken, and then filtered. The potassium content is determined using ICP (Inductively Coupled Plasma) analysis.

RESULT AND DISCUSSION

The community service activity began with the identification of issues in Sumbermulyo Village, Pesanggaran sub-district, Banyuwangi Regency, where the majority of the population works as dragon fruit farmers and goat herders. The identified problems included a decrease in soil fertility associated with the scarcity of government-subsidized fertilizers. This led to the soil becoming more acidic, resulting in a decline in the quality of dragon fruit harvests. Additionally, residents who owned livestock faced challenges in disposing of manure. Based on the analysis of these issues, in collaboration with partners and local farmer groups, it was agreed to conduct a pilot project for the construction of a biogas digester.

A biogas digester is a natural gas generated from the anaerobic breakdown of organic compounds. The organic compounds used in this context are livestock manure. The digester's output includes biogas and liquid organic fertilizer. Biogas can be used as a substitute for LPG for daily household needs, while liquid fertilizer can be used to enhance the soil fertility for dragon fruit cultivation. These two outputs play a crucial role in improving the local economy. The funds allocated for LPG and fertilizers can be saved or used for other purposes.

The digester was constructed using a fixed dome model with specific specifications: a total volume of 8 m3, a dome height of 2.1 m, and a diameter of 2.99 m. The detailed design of the digester can be seen in Figure 1. The fixed dome digester is the most widely used type in Indonesia. It consists of two parts: the digester, which serves as the material digestion chamber, and the fixed dome, which acts as a gas storage chamber.

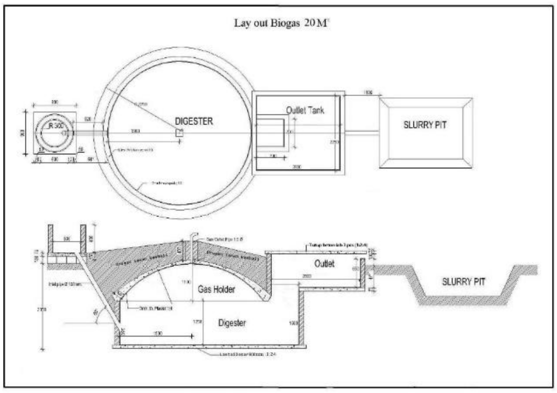

Figure 1. *Digester Design*

The construction process of the reactor began with excavating the ground to a certain depth, followed by building the reactor walls, and finally, casting the dome (Figure 2). The operation of the fixed dome digester begins with filling the inlet tank with livestock manure or other organic materials. The manure is transported to the digester through an inlet pipe. Inside the digester, the manure is processed to produce gas, and all the gas is collected in the concrete dome. When the gas pressure is full, it flows automatically to the stove through the main gas pipe. Simultaneously, all the manure is directed to the outlet. The sludge resulting from this process can be used as natural fertilizer and potentially generate additional income.

Figure 2. *Digester Construction Process in the Field*

Figure 3 illustrates the products obtained from the construction of the digester reactor. Simultaneously, biogas (a), liquid organic fertilizer (b), and a power source (c) are obtained. Products (a) and (b) are the target products of this community service activity. Product (c) is an additional product that is not included in the target. The conversion of biogas into electricity can occur because the methane gas concentration and pressure are sufficiently high. The presence of this additional product (c) can be used for lighting, thus reducing expenses for electricity. The exact voltage obtained is not yet known, so further research is needed to calculate the generated voltage. If the voltage generated is sufficiently high, it has the potential to be used for illuminating dragon fruit plants at night, considering that dragon fruit cultivation requires a significant amount of power for each harvesting cycle. A 0.25-hectare field requires a cost of IDR 600,000 for a period of 3 weeks.

The liquid organic fertilizer obtained is then analyzed for the content of Nitrogen (N), Phosphorus (P), and Potassium (K). The liquid organic fertilizer from the test digester is compared to the liquid organic fertilizer from the long-operating digester. The results show content levels of 0.032%, 0.009%, 0.144% for the test digester and 0.044%, 0.005%, and 0.195% for the reference digester. Both the test and reference digesters have relatively low levels of total N, P, and K because the liquid organic fertilizer was collected on the 6th day after the slurry filling. Therefore, further studies are needed regarding the fermentation duration and its effect on N, P, and K levels. According to the research by Rahmah et al. (2021), longer fermentation times lead to higher levels of N, P, and K.

Figure 3. *Digester Output Products*

The results of this community service activity are then shared with the local community (Figure 4). The community outreach is attended by members of farmer groups and local residents. Key points emphasized during the outreach include the use and operation of the digester as well as safety measures when using it.

Figure 4. *Biogas Technology Dissemination*

IMPACT OF ACTIVITIES

The impact of this project on the community can be substantial and includes the following:

- Improved Soil Fertility: One of the main issues identified in the community was the declining soil fertility. By producing liquid organic fertilizer from the biogas digester, the project can help improve soil quality and fertility. This, in turn, can lead to increased agricultural productivity, benefiting local farmers.

- Environmental Benefits: The use of biogas as an alternative to LPG for household energy needs can have positive environmental impacts. It reduces the reliance on fossil fuels and lowers greenhouse gas emissions, contributing to a cleaner environment.
- Economic Empowerment: The project can provide additional income opportunities for the community. Farmers can sell excess liquid organic fertilizer as well as utilize the biogas for cooking, reducing their expenses on LPG. Moreover, the potential for generating electricity from biogas adds to the economic benefits.
- Waste Management: The project offers a solution to the problem of livestock waste disposal. By converting livestock manure into biogas and liquid organic fertilizer, the community can effectively manage waste and minimize environmental contamination.
- Community Education: The community outreach and training sessions mentioned in the text can have a significant impact on local knowledge and skills. The community members can learn how to operate and maintain the biogas digester and ensure safety, contributing to their capacity building.
- Sustainable Agriculture: The project aligns with the principles of sustainable agriculture and contributes to long-term agricultural practices that respect the environment and maintain the balance between farming and nature.
- Reduced Dependency on Subsidies: By producing their own organic fertilizer and reducing their reliance on government-subsidized fertilizers, the community can become more self-reliant and reduce the impact of fertilizer shortages.
- Energy Independence: The use of biogas for household energy needs reduces the community's dependence on external energy sources, contributing to energy independence.

Overall, the project's impact on the community is multi-faceted, addressing agricultural, economic, environmental, and educational needs. It promotes sustainable practices, empowers the community, and can lead to a more prosperous and self-sufficient future for Sumbermulyo Village.

CONCLUSION

Based on the results and discussions, the following conclusions can be drawn:

The construction of a biogas digester in Sumbermulyo Village, Pesanggaran sub-district, Banyuwangi Regency, is a promising prospect as an alternative renewable energy source. This is essential, considering the challenges faced by farmers in accessing subsidized fertilizers, the scarcity of LPG, rising electricity tariffs, and more.

In addition to liquid organic fertilizer, the fixed dome reactor simultaneously produces biogas and electricity. Analyzing the content of liquid organic fertilizer on the 6th day revealed respective levels of N, P, K as 0.032%, 0.009%, 0.144% for the test digester and 0.044%, 0.005%, and 0.195% for the reference digester.

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