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Introduction of Anaerobic Co-Digestion Technology to Generate Liquid Biofertilizer for Developing Organic Agriculture in Lambeugak Village, Cot Glie, Aceh Besar

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Abstract

Purpose: This community service aims to apply anaerobic co-digestion technology to produce liquid organic fertilizer.

Method: This anaerobic co-digestion technology is carried out by combining two substrates including animal manure and agricultural residues in one anaerobic reactor. In principle, an anaerobic reactor will decompose liquid waste from livestock waste and solid waste from agricultural processes. A mixture of livestock waste and agricultural process waste that has been processed in an anaerobic reactor will be able to produce organic fertilizer.

Practical Applications: This technology is applied not only to produce bio-fertilizer but also to introduce waste management practice among farmers by controlling environmental pollution. The pollution is typically caused by neglected livestock waste and burning residues resulted from agricultural processes.

Conclusion: This practice may effectively generate liquid organic fertilizers from processing agricultural wastes anaerobically, and also could significantly reduce the environmental pollution caused by agricultural processes.

Introduction

The high price of fertilizer accompanied by a scarcity of fertilizer supply is also an inhibiting factor for agricultural communities in terms of developing their agricultural businesses, especially secondary crop farming which also requires the availability of fertilizer in large quantities (Komarek et al., 2017). People in Lambeugak Village, who are dominated by the lower middle class who make their living as farmers, are really feeling the impact of the increase and scarcity of fertilizer. The difficulties faced by the community were exacerbated by the increase in fuel prices which resulted in an increase in the price of fertilizer above a reasonable and appropriate price for small farmers. So with the application of anaerobic co-digestion of agricultural waste and livestock waste it will be a solution for farming communities.

So far, the people of Gampong Lambeugak have never made liquid organic fertilizer. To help overcome the shortage and scarcity of fertilizer, local people only use waste from livestock manure and compost from plant remains. There are also some people who spread livestock manure directly on plantations and agricultural land. This is really dangerous because livestock waste that has not gone through a treatment process can damage the environment (Hollas et al., 2024). This includes having a strong odor, containing germs and containing components that cannot be absorbed by agricultural land (Akinbile et al., 2016; Sakadevan and Nguyen, 2017). Apart from that, people also tend to burn waste directly from their agricultural processes. This of course must be avoided because it will have a bad impact on the environment by producing air pollution and green house gas emissions (Minooei and Mokshapathy, 2017; Deshpande et al., 2023). Besides, uncontrolled burning of crop residues on agricultural land allows the spread of fired residues which can cause forest fires (Juárez-Orozco et al., 2017; Phairuang et al., 2017).

Therefore, with agricultural and livestock waste available in large quantities, it has great potential for developing agricultural sector in Aceh Besar Regency especially in Lambeugak Village. Apart from that, the process of making this environmentally friendly liquid organic fertilizer does not require high technology and can be applied and practiced by anyone, both men and women. So far, the potential raw materials for making liquid organic fertilizer have never been used by the people of Gampong Lambeugak. Even agricultural waste such as straw, corn harvest waste and waste resulting from other agricultural processes are only burned.

Apart from making liquid organic fertilizer, the aim is to utilize waste from agricultural and livestock processes, it can also reduce the dependence of farmers, especially secondary crop farmers, on chemical fertilizers sold on the market. This program can also aim to train and improve people's skills in making liquid organic fertilizer so that it can be a solution when there is a shortage of fertilizer and increasing fertilizer prices on the market. In the process of making organic fertilizer using an anaerobic reactor, the community not only produces quality organic fertilizer but also produces biogas which can be used as alternative energy in various applications such as for cooking, small-scale electricity generation for home lighting and other agricultural purposes. With this program, the use of waste from agricultural and livestock processes can be developed seriously so that it will lead to an increase in people's income. It is also expected that this activity can take place continuously (sustainably) so that Lambeugak Village in the future can become a center for the production of liquid organic fertilizer to meet fertilizer needs in the cities of Banda Aceh, Aceh Besar and surrounding areas.

The aim of this service is to apply anaerobic co-digestion technology to make liquid organic fertilizer by utilizing livestock waste and agricultural waste in the form of rice straw and corn harvest waste. It is hoped that making liquid fertilizer using an anaerobic digestion reactor can motivate people to utilize waste that is wasted and damages the environment into products that have economic value.

Method

The method used in this service program is the use of descriptive analysis method

which is a method of going directly to the community accompanied by a literature method which is guided by the farmer group work program. This consists of several work stages including: (1) Preparation Stage, (2) Implementation Stage, (3) Development Stage, (4) Trial and evaluation stage.

Several methods used in presenting material include lecture, demonstration, discussion and direct practice methods. The lecture method is used to explain operational systems and the tools and machines used. The demonstration method was carried out to explain how to use and operate an anaerobic reactor for making liquid organic fertilizer. The discussion method is used to discuss and discuss problems and difficulties faced both among participants and between participants and the service program team. The provision and delivery of material begins with theory and continues with direct practice.

Training on making liquid organic fertilizer includes how to operate an anaerobic reactor as well as processing the composition of waste that will be fed into the reactor to produce quality organic fertilizer. Further, it is also necessary to pay attention to the quality of the waste that will be used by separating waste that contains materials that inhibit the decomposition process, such as waste that contains sand and stones and waste that contains antiseptics or pesticides. Things that also need to be considered are that the final product produced must contain the nutrients needed by plants, be safe for the land and the environment and have a high selling value.

The partners involved also actively participate to make this service program a success. Their involvement includes providing the time, place and raw materials needed, finding a marketing network for liquid organic fertilizer, producing liquid organic fertilizer and marketing products in a sustainable manner.

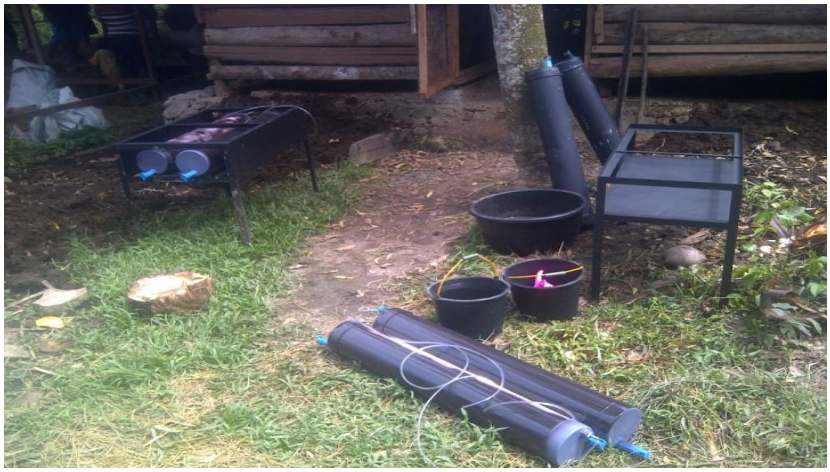
Result

The results of the community service activities carried out by partners in Lambugak village have been carried out well. The activity began with a friendly meeting with partners with the agenda of determining the training schedule to be held. Partners welcomed the training activities and local village officials were also present at the event.

The tool is made using a paralon pipe with a length of about 1 meter. A heater is installed inside the pipe which functions to stabilize the temperature inside the tube if it rains outside. This heater is also equipped with a thermostat sensor where the temperature can be maintained at 320C. If the environmental temperature is below that, the heater will turn on automatically and when it reaches the desired temperature, the heater will automatically turn off. Temperature conditioning in this reactor is very necessary because the microorganisms used to make liquid fertilizer live at the optimum temperature, namely the mesophilic temperature (30-35oC). If the operational temperature is below than the temperature range, the microbes' metabolic activities will be disrupted and they will even die. The image of the reactor for making liquid fertilizer is shown in Figure 1.

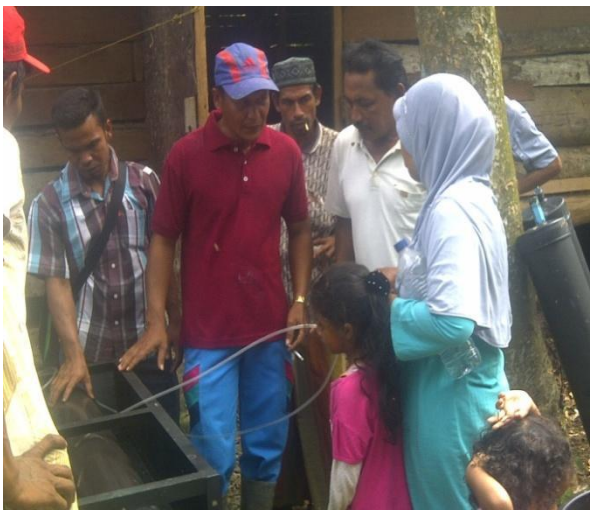
Figure 1. The reactors introduced to the farmers in Lambeugak Village

The reactors are operated for 20 days to produce liquid organic fertilizer. Material is



introduced from the intake pipe at the end of the rector up to 10% to full (head space). This head space is used to provide space for gas produced from cow dung. Every 2 days the lid from one end of the rector is opened to release gas and then closed again. There were six rectors given to partners with a size of 20 liters each. Organic liquid fertilizer is obtained with a maximum of 30 liters. This product has a high concentration so it can be mixed with water at a ratio of 1:3. An explanation of all this material is provided in the training. Figure 2 shows training activities are performed.

Figure 2. Training process conducted by farmers

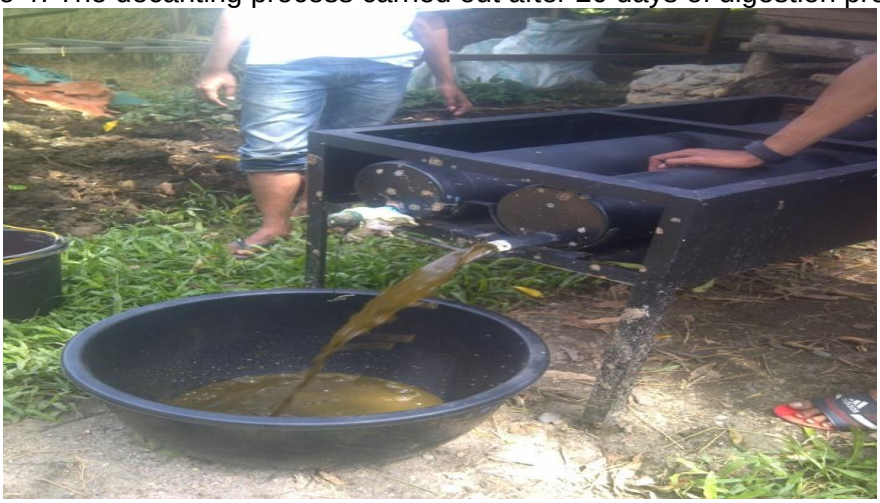


The training begins with an explanation from the service team leader about how the tools work. The training continued with a question and answer session with the training participants. The training participants were quite enthusiastic, as shown by the many questions asked by residents about tools, the benefits of liquid fertilizer, and the condition of the tools during the rainy season. The service team answered all questions from residents so that the training took place interactively. The training continued with the installation of equipment directly at the service location, and trials were carried out on the process of making liquid fertilizer using livestock manure as the main raw material. The installation of the equipment was carried out directly on the residents' cattle farm, approximately 1 km from the location of the material presentation (village sharpening). Direct practice of installing tools and making liquid fertilizer lasted until the afternoon. The activity of making organic liquid fertilizer from cow dung waste and agricultural products is shown in Figure 3.

Figure 3. Preparation for feeding substrates into anaerobic reactors

Removal of liquid organic fertilizer from the reactor was carried out after 20 days of fermentation of cow dung and agricultural waste in the bioreactors. The activity of releasing liquid organic fertilizer products is shown in Figure 4. The community looks enthusiastic in this activity of releasing liquid organic fertilizer products. In one production, 90 liters of organic liquid fertilizer will be obtained which can be melted with a ratio of 1:3 so that it can produce a total of 270 liters of liquid fertilizer that is ready for use.

Figure 4. The decanting process carried out after 20 days of digestion process



Discussion

The reactor for making organic liquid fertilizer is attached to a rack made of iron. This shelf has a slanted position. The slope of this rack makes it easy to insert and remove liquid fertilizer samples. This slope is also needed for heating conditioning, so that the reactor can utilize solar energy (sunlight). The digester and rack used are painted black so that the reactor and rack can absorb and collect heat, so that energy for heating the reactor does not require electrical energy (Nugrahani, et al., 2018). At both ends of the reactor, it is also equipped with a lid that can be opened to enter and remove material. This section also provides a small hose for the gas to escape from the tube. This gas can be used as a sustainable and renewable energy source in the form of biogas (Czekała, 2022). But in this service this biogas has not been utilized.

From all the agenda of activities carried out by the community service team, it can be seen that partners welcomed the activities and were satisfied with the training provided. The

community service team also recommends making biogas using cow manure as raw material. The community service team encourages that biogas to be used as raw material for gas for village residents, just as this liquid fertilizer can be used by residents as raw material for organic fertilizer for the local community's secondary crops.

It is expected that this liquid fertilizer can make a contribution to society in times of fertilizer difficulties, and can also be an alternative to using chemical fertilizers. Now is the time to encourage farmers to switch to using organic fertilizers and abandon chemical fertilizers. We convey this phenomenon to partners so that it opens up partners' insight into the importance of switching from the use of chemical fertilizers to organic fertilizers. So in the end it is hoped that Lambugak village will become a model land for secondary crops using organic fertilizer which will ultimately produce organic agricultural products.

Conclusion

From the results of community service activities carried out, the farmers gained knowledge about techniques for making organic fertilizer from livestock waste and agricultural waste using a co-digestion bioreactor. Production of organic liquid fertilizer reaches half a ton (540 liters) per month, and around 1.5 tons (1590 liters) per month is ready for use. The service team recommends using organic liquid fertilizer from cattle farming waste and organic waste as fertilizer for residents' secondary crops in Lambeugak village.

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