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Utilization of cow dung for biogas to improve livestock breeders and MSME entrepreneurs' economy

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ABSTRACT

Sriwulan Village, located in Limbangan District, Kendal Regency, is home to both cattle farmers and several Micro, Small, and Medium Enterprises (MSMEs). The village has a farmer group named Ngudi Kawruh, managing around 20 cows. However, cow dung in the area has become a source of air pollution, and the four MSMEs still rely on Liquefied Petroleum Gas (LPG) for production. One effective solution to this issue is converting cow dung into biogas, which offers both environmental and economic benefits. This community service program aims to introduce appropriate technology for processing cow dung into biogas using biodigesters. The biogas is stored in portable containers, such as truck inner tires, while the biodigester output, in the form of slurry, is utilized as solid organic fertilizer. The program provides education on these concepts through posters, videos, demonstrations, and YouTube links to ensure broad community understanding. By implementing this technology, the program not only addresses environmental concerns and reduces dependence on LPG but also significantly enhances the economic potential of both the villagers and MSME entrepreneurs, promoting sustainable development.

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1. INTRODUCTION

Sriwulan Village is one of 16 villages located in Limbangan District, Kendal Regency, Central Java Province, with an area of 1.44 km^2 or 2.01 percent of the total area of Limbangan District. Sriwulan Village has one of the villages that the smallest population the smallest population, with 728 people (1.97 percent), consisting of 352 men and 376 women. This village is located on the slopes of Mount Ungaran, with 73.58 Ha of rice fields and 24.46 Ha of gardens/dry fields, making the residents' livelihoods as farmers/planters and livestock workers (Badan Pusat Statistik Kabupaten Kendal, 2022).

According to personal communication, the Village Head and Carik Sriwulan, Sriwulan Village has two farmer groups named Ngudi Kawruh and Ngudi Rahayu with 40 members each and the empowered livestock is 25 beef cattle. However, the cow sheds are still simple, so the village officials are making

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improvements, starting with the one belonging to the Ngudi Kawruh farmer group. In addition, Sriwulan Village already has four (4) Micro, Small, and Medium Enterprises (MSMEs) that are members under one name, namely Arenan Kalikesek MSMEs with production in the form of tiwul, sugar palm fruit, palm sugar, and coffee where the sugar palm MSMEs already has a Household Industry Product (HIP) permit and a halal label. These four MSMEs use Liquified Petroleum Gas (LPG) as fuel for the production process and use as many as three cylinders per day, according to the explanation from Carik Sriwulan.

Beef cattle are managed communally, but if the dung is left alone in the pen for about 14 days to remove methane gas, it can later be used as manure (Al-Qusyairi et al., 2022; Safitri et al., 2023). On the other hand, cow dung will continue to increase and accumulate every day if it is not immediately utilized further (Pratiwi et al., 2019; Praharasti et al., 2023) and will cause an unpleasant odor so that it will become a medium for the development of flies and mosquitoes if not managed (Subadyo, 2017). A cow weighing 454 kg excretes 30 kg of dung and urine per day, so it can be estimated that 50 cows produce 1.5 tons per day (Putra et al., 2017). Cow dung can be used as biogas as a substitute for fossil fuels (Irfan et al., 2023) in addition to biohydrogen (Damayanti et al., 2020).

Biogas is a gas produced from organic matter decomposed through anaerobic fermentation in the form of methane gas (CH_4) used as fuel (Pratiwi et al., 2019). Landfill gas has about 50 percent CH_4 content, while more advanced waste treatment systems will produce biogas with 55-75 percent CH_4 content. The percentage of CH_4 in biogas from the experiment was determined through laboratory testing (Aysia et al., 2012). The calorific value of 1 m^3 of biogas is approximately 6000 watts per hour, which is equivalent to 0.5 liters of diesel oil, making it suitable as an environmentally friendly alternative fuel (Pratiwi et al., 2019).

To produce biogas, a series of tools known as digesters or biogas reactors are needed (Sunyoto et al., 2016). Digesters are generally tubular and serve as containers for anaerobic fermentation. Based on the filling method, biogas reactors can be divided into two types, namely batch feeding and continuous feeding (Wahyuni, 2017). The reactor built is a fixed dome type biodigester as a place for the biogas manufacturing process. This type of reactor has many advantages, including cheaper construction costs and easier maintenance than floating reactors (Arifan et al., 2019; Kartikasari, 2020). Cow dung biogas can produce 0.023-0.040 m^3 per kg (Pratiwi et al., 2019). Meanwhile, household-scale biogas can be formed with only 2-3 cow dung of 4m^3 per day (Dewi, 2018; Irfan et al., 2023) with 4-5 family members (Goendi et al., 2008) or the equivalent of 2 kg of LPG per day (Arifan et al., 2019; Kartikasari, 2020). One of the advantages of biogas because it does not produce odors during fermentation because it has gone through biological stages, namely hydrolysis, acidification, and CH4 (Suyitno et al., 2010).

Unfortunately, the cow dung has not been used correctly, especially in Sriwulan Village. Therefore, this service activity is to process cow dung into biogas using appropriate technology in the form of making biodigesters as well as their installations and equipment as well as biogas storage devices so that they can be carried anywhere, especially to MSMEs to support production so that they can improve the welfare of Sriwulan Village residents.

2. METHODS

Based on the problems partners face, treating cow dung waste appropriately by applying biodigester technology that produces biogas and organic fertilizer for the Ngudi Kawruh Farmers Group, Sriwulan Village, Kendal Regency, is necessary. This activity was held on July 15, 2024, at the Sriwulan Village Hall, Limbangan District, Kendal Regency. It was attended by the community, especially farmers, breeders, and MSME actors in Sriwulan Village, Limbangan District, Kendal Regency, consisting of 21 people.

The implementation of service activities consists of the survey and field analysis stage, making biodigesters, fermentation stages, trial and socialization stages, and demonstrations. The field survey stage was carried out with the village, namely the Village Head and Village Secretary. After the agreement was obtained, the Community Service Team immediately manufactured a biodigester with a volume of 6 m^3 for one month (Figure 1). The finished biodigester is then tested by putting cow dung into the biodigester and fermented to produce biogas. Slurry, a by-product of biogas, is used as an organic fertilizer by drying it first. As for mobility, portable biogas storage uses truck inner tubes to meet the production needs of MSMEs (Figure 2).

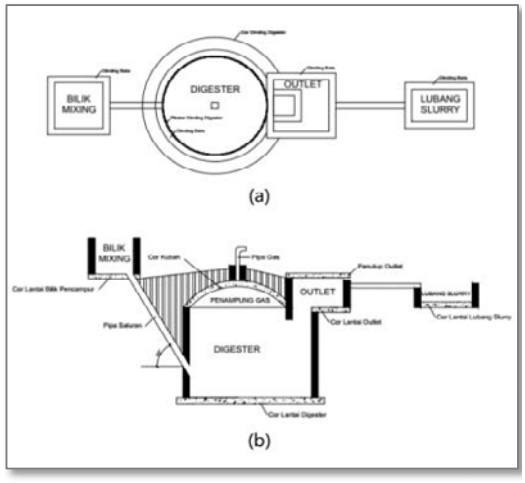

Figure 1. Design of the fixed dome biodigester: (a) Top view; (b) Side view

Figure 1 shows that this type of biodigester is the most widely applied in Indonesia because it is cheap and has construction materials consisting of bricks, sand, and cement arranged in an airtight cavity. This type has three parts: first, a digester as a place to digest biogas material and simultaneously as a home for both acid-forming and methane-forming bacteria. Second. Fixed dome as a place to collect gas. Finally, waste in the form of slurry (Singgih & Yusmiati, 2018).

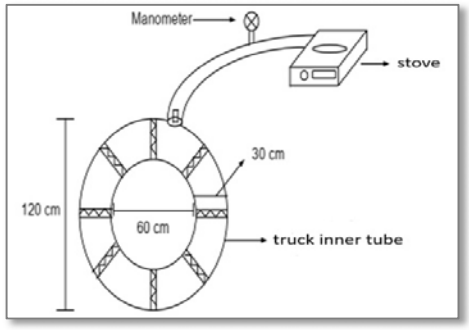

Figure 2. Biogas storage tank from the inner tube of a truck (Anwar et al., 2018)

Figure 2 shows that the truck's inner tube is connected to the stove using a plastic hose and equipped with a manometer to detect the presence of biogas. The procedure follows: biogas from the biodigester is injected into the tire to the maximum.

Before the socialization, the service team experimented to find out whether cow dung can produce biogas marked by the appearance of fire if it is ignited with a match. In the biodigester, a pipeline is made to channel gas to make it easier to utilize. The flow chart of cow dung processing using biodigester technology is presented in Figure 3, while the flow chart of organic fertilizer processing is seen in Figure 4.

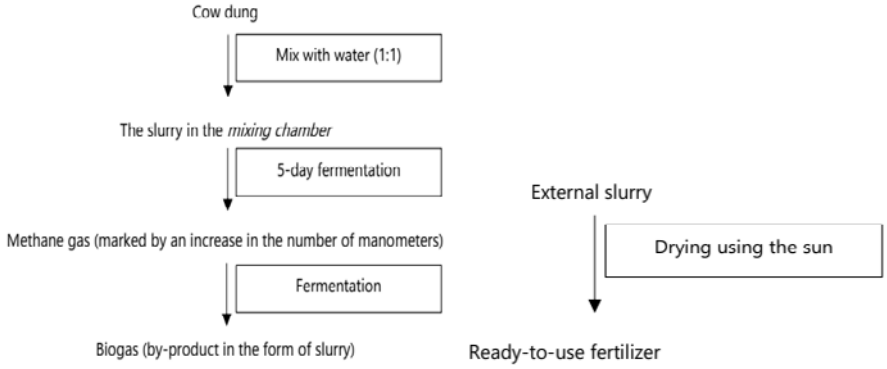

Figure 3. Flow chart of processing cow dung into biogas
Figure 4. Flow diagram of slurry processing into organic fertilizer

Based on Figure 3, the biogas formation process begins with mixing water and manure with a ratio of 1:1. This aims to produce biogas. After being mixed, the slurry is put into the biodigester to ferment for 14 days. During the fermentation process, the slurry is pushed out when gas begins to form. Therefore, it is necessary to continuously put in cow dung while mixing it with water to produce biogas.

Based on Figure 4, it can be seen that the slurry, which is the output of the biodigester when dried with the help of sunlight, can be used as a solid fertilizer. However, its nutrients need to be adjusted to the Indonesian National Standard (SNI) 19-7030 2004.

Socialization Stages

The next stage is the implementation of socialization and demonstrations to the Ngudi Kawruh farmer group. The use of cow dung, how to utilize biogas, and the use of slurry in fertilizer were explained at this stage. The stages of socialization are described in Table 1.

Table 1. Socialization stages

Stages of Socialization	Activities	Purpose
1	Introduction of biogas & biodigester	Introducing biogas and biodigester in general to the Ngudi Kawruh Farmer Group Community
2	Cow dung processing	Providing knowledge on how to manage cow dung into biogas and fertilizer
3	Demonstration of the use of biogas stoves	- Providing knowledge on how to use biogas stoves - Providing knowledge on how to use the inner tube as a gas container
4	Q&A with the community	Providing opportunities for the public to ask about things that are not known

Implementation Stage

Presentation

The presentation stage was carried out by explaining the tools and materials needed and the products to be produced. This presentation was made so that residents would first understand the beginning of processing cow dung waste into products that can be used. Before explaining the process of processing cow dung into biogas and fertilizer, all tools, materials, and products were shown to residents.

Cow dung processing

At this stage, it is done so that residents know that cow dung can be used in various valuable products to become biogas and organic fertilizer. In addition, this was carried out to increase public knowledge regarding how to process cow dung using biodigesters.

Demonstration of the use of biogas stove

The demonstration stage shows how the biodigester is processed, used, and maintained so that gas is continuously produced. The service group practiced processing cow dung, from cow dung still in the cage to being put into a biodigester. Furthermore, it was also explained how to use biogas processed from cow dung waste so that residents can use it by connecting directly to the stove or using tires as gas storage containers. In addition, the service group also explained how to take care of a good biodigester, this is done so that the biodigester that has been built can be cared for wisely by residents so that it can be used for a long time.

Closing

The service group conducted a question-and-answer session for all participants who attended the socialization of processing cow dung waste into biogas and fertilizer. This question-and-answer session was carried out to ensure that all participants who attended understood what had been explained by the service group. In addition, residents should try to use biogas directly to implement the explanation that has been conveyed.

Evaluation

It is carried out by conducting direct supervision by the service team on partners in implementing biogas, both from biodigesters and inner tubes, as part of the evaluation stage of the service program that has been carried out to assess the level of success.

3. RESULTS AND DISCUSSION

Result

This community service program activity was carried out on July 15, 2024, at the Sriwulan Village fertilizer house and attended by 21 people. Activities start with socialization and an approach to the community, biogas from cow dung waste for home needs, and biogas using inner tubes as gas shelters. The event began with the opening, remarks from the Head of Sriwulan Village and the Head of the Community Service Team for Lecturers, followed by the delivery of material related to biogas and

biodigesters, then socialization related to how to use biogas from biodigesters (Figure 5) which was directly channelled through pipes and from inner tubes. The use of cow dung waste that is socialized to the community produces biogas and organic fertilizer from the biodigester slurry that residents can use.

Figure 5. Location of the biodigester

Socialization and approach to the community

The service team group carries out the socialization stage. Starting with socialization to farmer groups, where farmers are no strangers to cow dung processing with the material presented is how to process cow dung waste into biogas. The service team made a scheduled arrangement (Table 2), from making bio digesters to socializing so that the community could find out the length of the fermentation process of cow dung and produce biogas that was ready to use.

Table 2. Schedule for making biodigesters to socialization

Implementation 1	
Biodigester design	- The service team coordinates with village officials regarding the plan to make biodigesters - Surveying the place where the biodigester is built
Implementation 2	
Biodigester Development	- Purchase of raw materials for the manufacture of biodigesters - Construction of biodigester for 1.5 months
Implementation 3	
Biogas production	- The service team put cow dung with a mixture of water into the biodigester to ferment before the implementation of socialization
Implementation 4	
Socialization to the community	- The service team socialized related to the meaning of biogas, how biogas is formed, how to use biogas using ordinary stoves and inner tubes as well as questions and answers as an indicator of understanding for the community
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Socialization and approach to the community (Figure 6) about how to process cow dung waste, which has benefits that can be used as biogas fuel and organic fertilizer. The service team conveyed how to put cow dung into a biodigester and ferment it for a long time to produce good gas and fire pressure. The service team socialized the pressure to produce good gas and fire at a minimum pressure of 6-7 kPa.

Meanwhile, according to Anwar et al. (2018), a portable biogas tank from an inner tube with a pressure of 1 psi has a volume of 3.8148 m^3 and a burning time of 20:16 minutes. The expected output at this stage is increasing community knowledge, as represented by the Ngudi Kawruh farmer group, Sriwulan Village, Limbangan District, and Kendal Regency.

Figure 6. Socialization of processing cow dung waste into biogas

Socialization of the use of biogas for home needs

This socialization (Figure 7) is an experiment on gas results produced from cow dung waste using a stove. The gas produced was flowed using a pipe centralized in the fertilizer house of Sriwulan Village. The end of the pipe is a hose that can be inserted into the stove. This experiment was carried out to prove that the gas produced can be used for cooking needs. Biogas (cow dung) contains 50-75 percent methane gas (CH_4) as a fuel to replace LPG (Dewi, 2018; Irfan et al., 2023; Naimah et al., 2022) and has a blue flame like the color of LPG flames (Naimah et al., 2022).

Figure 7. Demonstration of the use of biogas stoves

Socialization of the use of biogas using inner tubes as gas storage

In this activity, representatives from the Community Service Team demonstrated how to use the inner tube as a gas storage container (Figure 8). Thus, using inner tubes as a mobile biogas reservoir benefits MSMEs and Kalikesek tourism, which is ±1 km from the biodigester location.

Explanations and mechanisms related to how to process and use biogas stoves can be watched at the YouTube link https://youtu.be/Ydff7GzW1h4. Meanwhile, in the implementation of socialization, the output of community understanding through questionnaires is presented in Figure 9.

The public understands the meaning of biogas with an understanding score of 8.5. In addition, the community also understands how to produce biogas with a value of 8.5; understanding of how to apply

biogas with a score of 8; understanding of the use of biogas stoves with a score of 8.1; understanding of the use of inner tubes as a place for biogas with a value of 8; and understanding related to the use of slurry into organic fertilizer with a value of 8.2.

Figure 9. Understanding of the Sriwulan Village Community regarding biogas

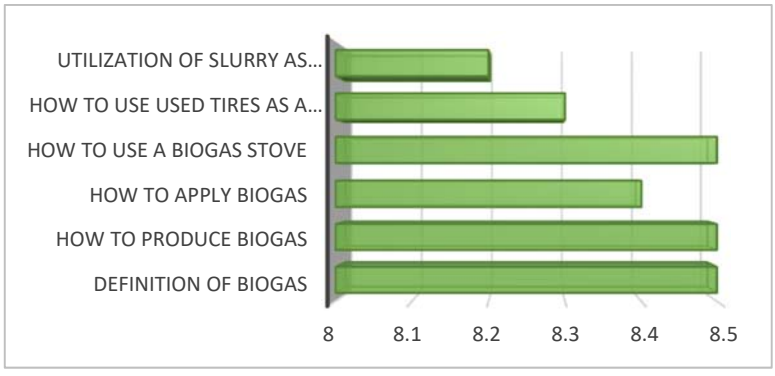

Figure 8. Demonstration of the use of inner tubes as gas reservoirs

Discussion

Community empowerment activities such as processing cow dung into biogas have been carried out a lot. However, the program's sustainability is often an obstacle because of the need for continuous maintenance and processing. Community Service, which is carried out by the community service team, carries out activities that focus on farmers and breeders in Sriwulan Village, which can guarantee that the sustainability of this program will continue. In addition to farmers and breeders, socialization was also carried out in the community around the biodigester because the surrounding community can use the results of the biogas for daily use. Biogas with a volume of 1 m^3 is comparable to 0.4 kg of diesel, 0.6 kg of gasoline, or 0.8 kg of wood charcoal (Dharma & Ridhuan, 2014), which means that residents and MSMEs of Sriwulan Village can save Rp 46,000 per week (Irfan et al., 2023). The activity of community empowerment in processing cow dung into biogas is based on the results of interviews conducted with village heads and several farmers and breeders when conducting a survey.

One of the complaints that could not be resolved in Sriwulan Village was the cow dung waste still piled up and left alone. The target of this activity is the Sriwulan Village farmer group and the community who are still unfamiliar with activities related to cow dung processing and biogas. Meanwhile, in the surrounding community, the material presented was about using biogas that can be used daily. Biogas production carried out in Sriwulan Village is the focus of the development of the village itself because

there is also a Kalikesek Tourism Village in Sriwulan Village, which can support the fuel needs of the tourist village.

To make it easier for the community to know how to operate the biodigester, the service team made a pamphlet to be given to the community. In the pamphlet, there is some information on the procedure for making biogas using a biodigester presented in Figure 10.

Figure 10. Biogas pamphlet

The processing of cow dung waste into biogas also produces slurry left over from processing. Slurry, which is an output of cow dung biodigester, is a semi-solid/mud material (tends to be solid) that is light brown in color, sticky and clayey in texture, and odorless (Singgih & Yusmiati., 2018). This slurry has the potential to become an organic fertilizer because it contains Nitrogen (N), Phosphorus (P), and Potassium (K) elements of 0.8 percent, 0.2 percent, and 0.82 percent and is in accordance with the minimum of Indonesia National Standard (SNI) 19-7030-2004 regarding compost quality, namely 0.4 percent, 0.1 percent, and 0.2 percent (Yanti et al., 2019).

The resulting slurry can also be reprocessed into fertilizer (Figure 11), which can also support the fertilizer needs of farmers or local residents who need fertilizer for plants. Not only can it be used for personal use, but it can also be sold by packaging and putting stickers on the packaging (Figure 12) so that it can be resold. In this way, the processing of cow dung waste into biogas is the right solution to the complaints of problems in Sriwulan Village with cow dung into biogas, then processing the by-products of biogas in the form of slurry into fertilizer that can be used personally and resold by the people of Sriwulan Village.

Figure 11. Socialization of organic fertilizer from slurry
Figure 12. Organic fertilizer packaging sticker

The results of the Ngudi Kawruh Farmer Group in Sriwulan Village, Kendal Regency are high in the enthusiasm of the community for the existence of biodigesters. The community accepts the existence of alternative fuels in the form of biogas which can be an alternative to LPG. Theoretically, the use of biogas for a household consisting of 4-5 members can save 3 kg of LPG per day or the equivalent of IDR 25,000. The service team symbolically provided equipment to the Sriwulan Village Community in the form of biodigesters, stoves, inner tubes and other supporting equipment (Figure 13).

Figure 13. Provision of supporting equipment in the use of biogas

4. CONCLUSION AND RECOMMENDATIONS

This integrated activity involves village officials. Starting from cow dung, which has been a problem for residents of Sriwulan Village, Limbangan District, Kendal Regency, especially the Ngudi Kawruh farmer group and UMKM, it is helpful because it is converted into biogas through biodigester technology, portable biogas storage in the form of truck inner tubes, and biodigester external slurry as solid organic fertilizer. Socialization and questionnaire activities as a form of evaluation of understanding related to biogas have enlightened residents of Sriwulan Village. Various questions submitted by residents include the minimum number of cows, biodigester maintenance, the use of biogas from biodigesters and inner tubes, and fertilizer for fruit plants. Coincidentally, a fruit seedling production building was built near the biodigester to increase sales at the Kalikesek tourist attraction. The cost that can be saved when biogas is applied by the Ngudi Kawruh Farmers Group and the Sriwulan Village community, especially MSMEs as a substitute for LPG is IDR 25,000 per day. The response from farmers and residents, especially MSMEs, after participating in this activity was enthusiastic because they had seen firsthand that biogas from biodigesters and inner tubes could be used for cooking. Biogas can be used as an alternative to new renewable energy to become cooking fuel to replace LPG on the market. In addition, by-products in the form of pulp/slurry can also be an organic fertilizer business opportunity that can be marketed. Community assistance needs to receive serious attention and be directly involved in the management of biodigesters, especially the Ngudi Kawruh Farmers Group so that they can continue to run and refill cow dung so that they can continue to produce biogas. The success of the implementation of the activity has been achieved as seen from the question-and-answer session where residents asked many questions about knowledge and filling out surveys related to understanding the process and use of biogas.

There needs to be further socialization related to distributing biogas from biodigesters to residents' homes. Monitoring the results of sustainable activities also needs to be carried out to observe and find out the development, progress, and obstacles that occur in order to maintain the business of producing biogas. Increasing the number of balloons/inner tubes is better as biogas storage is used for MSMEs. In addition, it is necessary to review whether using inner tubes for biogas containers is effective for cooking for a long time because the gas inserted into the inner tube will run out in at least 10-15 minutes according to experiments.

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