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SCIENCE AND TECHNOLOGY FOR THE COMMUNITY UTILIZATION OF APPROPRIATE TECHNOLOGY FOR THE DEVELOPMENT OF LIVESTOCK WASTE BIOBRIQUETTE IN SRIWULAN VILLAGE, KENDAL REGENCY

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Abstract

Most of the residents of Sriwulan Village work as freelance farmers and cattle breeders. The large number of cattle breeders in Sriwulan Village has resulted in the accumulation of cow manure in several parts of the village, causing unpleasant odors. Moreover, cow manure can damage the ozone layer and contribute to global warming. One of the efforts to utilize cow manure waste is by converting it into briquettes, which can serve as an alternative energy source. Briquettes are solid fuels made from biomass containing carbon, with high calorific value and the ability to burn for extended periods. In the production of briquettes, other mixed materials are required, including other organic materials such as charcoal and tapioca flour as a binder. The community's limited access to information regarding cow manure waste management and the briquette-making process has led to an increasing accumulation of cow manure waste. The aim of this community service is to provide education and equipment to the residents of Sriwulan Village regarding cow manure briquettes and their production process until they are ready for use. This allows the community to utilize cow manure as a solution to waste problems while also improving the economy of Sriwulan Village. This initiative has successfully increased understanding and interest, especially among cattle breeders in Sriwulan Village, in utilizing cow manure for briquettes. The program resulted in briquettes with a calorific value of up to 4,941.84 Cal/g after calorific value testing.

Keywords: Briquettes; cow manure; biltes

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A. INTRODUCTION

Energy is a fundamental necessity for every member of society in their daily activities. According to the Indonesian Ministry of Industry Regulation (2008), the government's kerosene-to-LPG (Liquified Petroleum Gas) conversion program

has led the Indonesian population to shift from using kerosene to LPG (Suharto;, SutanHaji;, and Sunarsih 2016). The increasing annual energy demand in Indonesia is not proportional to the available energy supply. This issue arises due to several factors, including population growth, economic expansion, inefficient energy use, and suboptimal energy resource management (Berek 2019). Indonesia has abundant renewable alternative energy sources, including waste materials or biomass such as wood waste, rice husks, straw, bagasse, coconut shells, palm kernel shells, and livestock manure (Santosa, Mislaini, and Anugrah 2010). Specifically, cattle farm waste holds significant potential for further development (Irmayani, Yusriadi, and Arifuddin 2017). One possible approach to alternative fuel development is utilizing biomass-based fuel, such as cow manure briquettes (Suharto;, SutanHaji;, and Sunarsih 2016). The utilization of biomass waste, particularly cow manure, as a briquette-based alternative fuel can serve as a substitute for fossil fuels or LPG (Purwaningsih, Saragih, and Santoso 2024).

Sriwulan Village is located in Limbangan District, Kendal Regency, Central Java Province. The village has a population of 720 people, consisting of 355 males and 365 females. Due to the large number of cattle farmers in Sriwulan Village, the local community faces the issue of excessive accumulation of cattle manure. The expansion of livestock farming has resulted in increased livestock waste production. Ruminant livestock waste significantly contributes to environmental pollution, including soil and surface water contamination as well as atmospheric emissions (Kasworo, and Izzati 2013). Each cow produces approximately 8–10 kg of manure per day or 2.6–3.6 tons per year (Purwaningsih, Saragih, and Santoso 2024). Indonesia's beef cattle population is estimated at 10.8 million, while the dairy cattle population ranges between 350,000 and 400,000. Given that each cow generates an average of 7 kg of dry manure daily, the total dry manure production in Indonesia reaches approximately 7 million kilograms per day (Kasworo, Izzati, and Kismartini 2013). This substantial potential necessitates proper manure management. Analytical studies have shown that cow manure contains cellulose (22.59%), hemicellulose (18.32%), lignin (10.20%), total organic carbon (34.72%), total nitrogen (1.26%), C:N ratio (27.56:1), phosphorus (P) (0.73%), and potassium (K) (0.68%) (Purwanta and Nataniel 2018). The digestion process in cattle produces approximately 4000 kcal/g of energy and a significant amount of methane gas (CH4), which is essential for briquette production (Purwanta and Nataniel 2018). Methane (CH4) from cow manure is a major contributor to the greenhouse effect, making unmanaged livestock waste a significant environmental concern (Khusna et al. 2017). Cow manure serves as an ideal substrate for biogas or fuel production, as it naturally contains methane-producing bacteria in substantial quantities (Siki and T.B. 2020).

Briquettes represent a viable alternative fuel that can address the energy crisis by utilizing readily available materials (Mau, Bira, and Tahuk 2020). Charcoal briquettes also offer economic benefits, as they can be produced through simple processes, possess high calorific value, and have abundant raw material availability in Indonesia, making them competitive with other fuels (Purwaningsih, Saragih, and Santoso 2024). Briquette production involves mixing cow manure with a binder and molding it into cylindrical, cubical, or other desired shapes using a pressing tool (Anugrah and Wisnujati 2021). Briquettes offer higher heat output, are odorless, clean, and long-lasting (Berek 2019). Compared to biogas production, converting cow manure into briquettes is more efficient and easier to implement (Khusna et al. 2017). The primary objectives of producing cow manure briquettes are to enhance fuel quality, facilitate handling and

transportation, and minimize material loss in the form of dust during distribution (Siki and T.B. 2020).

B. METHOD

This community service program applies an applied technology approach to empower the residents of Sriwulan Village, Limbangan District, Kendal Regency, in utilizing cow manure waste as an alternative energy source in the form of biobriquettes. The activities include counseling, training, workshops, mentoring, and hands-on practicums to equip participants with the necessary knowledge and skills for biobriquette production. The program integrates lecturers, students, and local farmers, fostering knowledge transfer and sustainable implementation. Lecturer activities include socialization and counseling on biomass energy and its economic potential, training on biobriquette production covering material preparation, mixing, molding, drying, and combustion testing, mentoring participants to ensure independent production, and providing technical assistance to evaluate biobriquette efficiency. Meanwhile, students participate in fieldwork, assist in biobriquette production, engage in Desa Binaan (Community Service Program), and support data collection and participant evaluation.

The program collaborates with the residents of Sriwulan Village, a rural area where most households engage in cattle farming and agriculture. The village has 720 residents, including 355 males and 365 females. Due to the high number of cattle farmers, cow manure accumulation poses a serious waste management challenge. This program directly benefits at least 20 local cattle farmers by introducing an innovative and sustainable approach to livestock waste utilization.

The implementation follows three main phases: pre-activity preparation, activity implementation, and monitoring & evaluation. The pre-activity phase involves an initial survey to assess the community's knowledge and challenges regarding cow manure waste management, preliminary discussions with village leaders and cattle farmers, procurement of necessary equipment such as biobriquette presses, mixers, and drying tools, and preparation of raw materials like cow manure, charcoal, and tapioca flour (as a binding agent). The activity implementation phase consists of structured training and workshops conducted in July 2024 at the Sriwulan Village Community Center, covering topics such as biomass energy introduction, cow manure processing, hands-on practice in mixing and molding, drying and combustion testing, and product commercialization. Participants were actively involved in every step of the production process to ensure they could replicate it independently.

The monitoring and evaluation phase includes both during and post-activity assessments. During the activity, participants underwent pre-test and post-test evaluations to measure their knowledge improvement. Post-activity assessments were conducted through interviews, direct observations, and feedback surveys to assess adoption rates and challenges in biobriquette production. A follow-up study was conducted two months after implementation to observe sustainability efforts and ensure that community members continued the practice.

C. RESULT AND DISCUSSION

The community service program conducted by the team from Universitas Negeri Semarang (UNNES) was successfully implemented in Sriwulan Village, Kendal Regency, from July 15 to 19, 2024. The four-day program aimed to facilitate socialization and training sessions, with a key focus on utilizing cow manure waste in Sriwulan Village to produce biobriquettes as an alternative energy source. Documentation is presented in Figure 1.

Figure 1. Opening of Community Service Activities in Sriwulan Village

On the first day, the program commenced with an opening ceremony, followed by socialization and training on biobriquette production. The session was attended by 25 local cattle farmers, along with Sriwulan village officials. The lecture on cow manure waste utilization for biobriquette production was delivered by Radenrara Dewi Artanti Putri, S.T., M.T., and was accompanied by student-led demonstration sessions. Documentation is presented in Figure 2. The training covered the potential optimization of cow manure waste by converting it into briquettes using locally available materials. At the end of the session, the UNNES community service team donated equipment, including a manure grinder and drying oven, to Sriwulan Village. This initiative aimed to enable the village to develop and utilize cow manure waste for sustainable biobriquette production.

Figure 2. Socialization and Demonstration Session for Making Biobriquettes

To evaluate the fuel quality and energy efficiency of the produced biobriquettes, calorific value testing was conducted on four different briquette samples: pure cow manure briquette (Ori), cow manure–charcoal mixture (Oreo), cow manure–sawdust mixture (Hazelnut), and cow manure–charcoal–sawdust composite briquette (Mix). The calorific value of each sample was tested using a Parr Bomb Calorimeter 6400 at the Integrated Laboratory of Diponegoro University, Semarang. The purpose of this test was to quantify the energy output of the briquettes during combustion and assess their compliance with energy standards. The detailed test results are presented in Table 1.

Table 1. Results of Calorific Value Analysis on Cow Manure Briquettes

No	Test Sample	Calorific value (Cal/g)
1	Ori	2.961,52
2	Hazelnut	3.760,76
3	Oreo	4.941,84
4	Mix	4.455,34

From the table 1, it is evident that the calorific value varies across different samples. The pure cow manure briquette (Ori) exhibited the lowest calorific value at 2,961.52 Cal/g, while the cow manure–sawdust mixture (Hazelnut) recorded a calorific value of 3,760.76 Cal/g. The cow manure–charcoal–sawdust composite (Mix) had a calorific value of 4,455.34 Cal/g, whereas the cow manure–charcoal mixture (Oreo) demonstrated the highest calorific value, reaching 4,941.84 Cal/g.

These results indicate that the combination of cow manure and charcoal is highly effective in producing briquettes with the highest calorific value. Furthermore, the calorific value of the cow manure–charcoal mixture is close to the calorific value standard for briquettes set by the Indonesian National Standard (SNI), which is 5,000 Cal/g (Aljarwi, Pangga, and Ahzan 2020).

D. CONCLUSION

The implementation of the training and demonstration activities on cow manure waste processing into briquettes was evaluated as highly satisfactory by both the community service team and the participants, as indicated by high attendance and strong engagement during the sessions. The socialization methods employed significantly enhanced the participants' understanding of the cow manure waste processing techniques for biobriquette production. Moreover, the simple biobriquette production method demonstrated during the training successfully produced high-quality briquettes with a calorific value of up to 4,941.84 Cal/g. The majority of participants expressed a strong interest in adopting cow manure briquette production as an alternative energy source, recognizing its potential to reduce livestock waste in Sriwulan Village.

It is essential for cattle farmers to enhance their knowledge of cow manure waste processing, enabling them to reduce waste accumulation in livestock areas while utilizing available materials to produce alternative energy sources within Sriwulan Village. Furthermore, local government officials are encouraged to support and facilitate the community, particularly cattle farmers, to develop and implement sustainable manure processing practices, ultimately contributing to the economic and environmental advancement of the region.

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