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Production Technology of Rice Husk-Based Charcoal Biobriquettes Through Carbonization Process in a Rural Environment in Pasie Laweh Nagari, Lubuk Alung District

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ABSTRACT
This community service program aims to develop rice husk-based charcoal biobriquette production technology through a carbonization process in Pasie Laweh Nagari, Lubuk Alung District. The initiative sought to address the underutilization of rice husk waste, which is abundant in the region due to significant rice farming activities. By converting agricultural waste into eco-friendly biobriquettes, the program provided an alternative energy source while enhancing the economic value of waste for local farmers. The implementation involved training, technology transfer, and hands-on mentoring, resulting in the production of biobriquettes with a diameter of 2 cm, height of 5 cm, and a burning duration of 2–3 hours per unit. The program achieved a 95% participation rate, with active involvement from farmers, youth groups, and local MSMEs. Economic benefits include a 40% reduction in fuel costs for businesses and 30% savings for households. The success of the program highlights the potential of biobriquettes as a sustainable energy solution and underscores the importance of community empowerment, institutional support, and technological innovation in rural development.

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1. INTRODUCTION

Agriculture is one of the most important sectors supporting rural economic development in Indonesia [1] . Many rural communities depend on agricultural activities as their primary source of income and livelihood. Along with the increase in agricultural production, the amount of agricultural waste generated also continues to increase every year. One of the agricultural wastes commonly produced in rice farming areas is rice husk [2] . Unfortunately, rice husk waste is often underutilized and only disposed of or burned openly by the community.

The improper management of rice husk waste can create environmental and health problems for rural communities. Open burning activities may produce smoke pollution that affects air quality and public health. In addition, the accumulation of agricultural waste can reduce environmental cleanliness and create inefficient waste management systems [3] . On the other hand, rice husks actually contain potential economic value if processed properly into useful products [4] . Therefore, the utilization of rice husk waste is an important issue that needs serious attention from both researchers and local communities.

Renewable energy development has become one of the global strategies to reduce dependence on fossil fuels and minimize environmental pollution. The increasing price of conventional fuels such as LPG gas and firewood has encouraged communities to seek alternative energy sources that are more affordable and environmentally friendly [5] . One of the renewable energy products that can be developed from agricultural waste is biobriquettes. Biobriquettes are solid fuels produced from biomass materials through certain processing techniques [6] . The use of biobriquettes can help communities reduce energy costs while supporting environmental sustainability.

Rice husks are considered suitable raw materials for biobriquette production because they are abundant,

inexpensive, and easy to obtain in agricultural regions [7] . Rice husks also contain carbon elements that can produce heat energy after undergoing a carbonization process [8] . The carbonization process converts rice husks into charcoal materials with better combustion quality and longer burning duration. This process also reduces smoke emissions compared to the direct burning of raw agricultural waste. As a result, rice husk biobriquettes can become an effective alternative fuel for households and small businesses.

Nagari Pasie Laweh in Lubuk Alung District is one of the areas with considerable rice farming activities in West Sumatra Province. Most residents in this area work as farmers who produce rice throughout the year. This agricultural activity generates a significant amount of rice husk waste after the milling process. However, the majority of rice husks produced are still not utilized optimally by the local community. Many farmers only pile up or burn the rice husks without processing them into products with economic value.

The abundance of rice husk waste in Nagari Pasie Laweh presents both challenges and opportunities for the local community. On the one hand, unmanaged agricultural waste may contribute to environmental pollution and inefficient waste handling. On the other hand, rice husks have the potential to be processed into renewable energy products that can improve community welfare. The conversion of rice husks into biobriquettes can create additional sources of income for farmers and small business actors. Therefore, innovation in rice husk waste processing is highly needed to support sustainable rural development.

Figure 1. Rice Harvest Area in West Sumatra 2021-2022
Source: https://sumbar.bps.go.id/ [9]

Several previous studies have discussed the utilization of agricultural waste as raw materials for renewable energy products [10] . Research related to rice husk biobriquettes generally explains the combustion characteristics, calorific value, and efficiency of biomass fuels. Some studies also indicate that rice husk biobriquettes have relatively stable burning performance and can be used as substitutes for charcoal or firewood [11] . In addition, renewable energy utilization programs have been proven to increase environmental awareness among rural communities [12] . These findings indicate that agricultural waste has considerable potential to support sustainable energy development.

Although many studies have examined biobriquette production, most previous research focused primarily on laboratory-scale testing and technical analysis. Limited studies have explored the implementation of biobriquette production technology directly within rural communities through participatory approaches. Previous research also rarely emphasized the importance of community empowerment, training activities, and continuous mentoring in supporting sustainable production. As a result, many rural communities still lack the practical knowledge and technical skills required to process agricultural waste effectively. This condition indicates that there is still a research gap regarding community-based renewable energy implementation in rural areas.

In addition to the limited community-based studies, previous programs also faced several limitations related to sustainability and technology adoption. Some renewable energy programs only focus on short-term training without providing long-term mentoring for participants. Other studies did not involve local institutions and village governments actively in the implementation process. As a result, the sustainability of the programs after the research period often becomes weak. The lack of institutional collaboration also limited the expansion and commercialization potential of biobriquette products in rural communities.

Practical problems related to energy consumption are also experienced by households and small business actors in Nagari Pasie Laweh. Many food vendors, satay sellers, and households still depend heavily on conventional fuels that continue to increase in price. This condition affects operational costs and household expenditures significantly. At the same time, locally available agricultural waste remains underutilized despite its energy potential. Therefore, practical and affordable solutions are necessary to help communities reduce fuel expenses while using local resources efficiently.

Community empowerment programs play an important role in improving public participation and technological independence in rural areas. Through training and mentoring activities, communities can gain practical knowledge and direct experience in producing renewable energy products independently. Participatory

approaches also encourage stronger community involvement in identifying local problems and developing appropriate solutions. Furthermore, community participation increases the sense of ownership toward the sustainability of development programs. Therefore, the implementation of community-based biobriquette production technology can provide both social and economic benefits for rural communities.

This research is important because it addresses environmental, economic, and energy-related problems simultaneously through the utilization of agricultural waste. The study not only focuses on the technical process of producing rice husk biobriquettes but also emphasizes community participation and technology transfer. This program is expected to help communities improve waste management practices while reducing dependence on expensive conventional fuels. In addition, the implementation of biobriquette production technology may create new economic opportunities for local farmer groups and MSMEs. The findings of this study can also contribute to the development of sustainable renewable energy programs in other rural areas.

Based on the background and existing research gaps, this study aims to develop and implement rice husk-based charcoal biobriquette production technology through a carbonization process in Nagari Pasie Laweh, Lubuk Alung District. The study also aims to evaluate the level of community participation and the effectiveness of training and mentoring activities during the program implementation. Furthermore, this research seeks to analyze the economic and environmental benefits obtained from the utilization of rice husk waste as alternative renewable energy. Through this study, the community is expected to gain practical skills and greater awareness regarding sustainable agricultural waste management. Ultimately, this research is expected to support rural community empowerment and renewable energy development in Indonesia

2. METHOD

This research employed a descriptive participatory method using the Participatory Rural Appraisal (PRA) approach, combined with community-based participatory strategies alongside descriptive qualitative and quantitative methods. The study aimed to implement and evaluate the production technology of rice husk-based charcoal biobriquettes in Nagari Pasie Laweh, Lubuk Alung District. The participatory approach was chosen because the program emphasized active community involvement in every stage of the activity, starting from problem identification, training implementation, production assistance, and program evaluation. This approach enabled the community to participate directly in the learning and production process, thereby increasing their understanding and skills regarding renewable energy utilization. In addition, the descriptive method was used to describe the implementation process, community participation, and the outcomes of the program regularly [13] . Quantitative data were also used to measure participation rates, production results, and the economic benefits experienced by the community [14] .

The research was conducted in Nagari Pasie Laweh, Lubuk Alung District, Padang Pariaman Regency, West Sumatra Province. The location was chosen because the area has considerable rice farming activities that produce abundant rice husk waste every year. In addition, the local community still has limited knowledge and technology related to the utilization of agricultural waste as renewable energy sources. The implementation of the program was carried out over a period of three weeks, covering preparation, training, mentoring, and evaluation activities. The activities involved collaboration with village government officials, farmer groups, youth organizations, women's groups, and local MSMEs. This collaboration was intended to strengthen community participation and ensure the sustainability of the program.

The subjects of this study consisted of community members who participated directly in the biobriquette production program. The participants included farmer groups, youth organizations, women's family welfare groups (PKK), and micro, small, and medium enterprises (MSMEs) in Nagari Pasie Laweh. These groups were selected because they are closely related to agricultural activities and household energy utilization in the village. In total, the participants involved were community representatives who attended socialization sessions, technical training, and hands-on production practices. The involvement of various community groups aims to create broader dissemination of knowledge and strengthen local production networks. The participants also played a role in evaluating the feasibility and benefits of the biobriquette products.

The sources of data in this study consist of primary data and secondary data. Primary data were obtained directly from the participants through observations, interviews, discussions, and evaluation activities conducted during the implementation of the program [15] . The primary data included information related to community participation, production activities, product utilization, and perceived economic benefits after using biobriquettes. Secondary data were obtained from village administrative documents, agricultural reports, previous studies, journals, and relevant literature related to renewable energy and agricultural waste management. These secondary data were used to support the analysis and strengthen the theoretical background of the study. The combination of primary and secondary data helps provide comprehensive information regarding the implementation of the program.

Several data collection techniques were used in this study to obtain accurate and comprehensive information. The first technique was observation, which was conducted during training sessions, carbonization

processes, biobriquette production practices, and product utilization by the community. Through direct observation, researchers were able to identify participant involvement, production procedures, and the effectiveness of the training activities. The second technique was interviews conducted with community participants, village officials, and MSME actors to gather information regarding their experiences, challenges, and responses toward the program. Interviews were conducted in a semi-structured manner to allow participants to express their opinions more openly. This technique provided deeper insights into the social and economic impacts of the program.

In addition to observations and interviews, documentation techniques were also used in this study. Documentation included photographs of activities, attendance lists, training materials, production records, and community participation reports during the implementation process. These documents served as supporting evidence for the implementation and outcomes of the program. Furthermore, questionnaires were distributed to participants to measure their understanding, satisfaction, and responses toward the biobriquette production activities. The questionnaires contained several indicators related to training effectiveness, ease of production, product quality, and economic benefits. The use of multiple data collection techniques aims to improve the validity and reliability of the research findings.

In an effort to overcome the problem of rice husk waste management in Pasie Laweh Village, Lubuk Alung District, this community service program will be implemented through several systematic stages as follows:

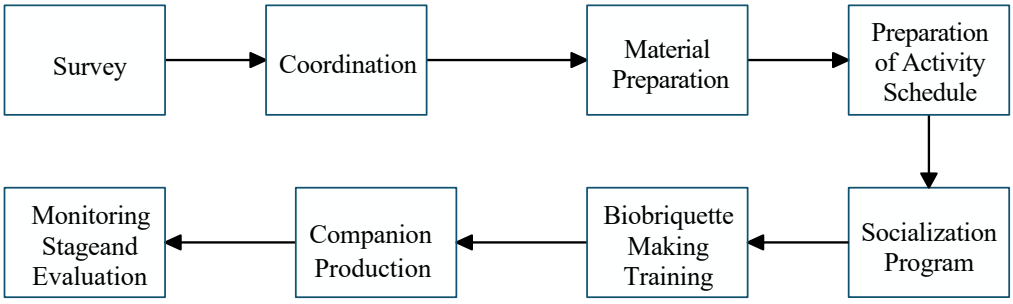

Figure 2. Problem solving framework

2.1 Preparation Stage

The initial stage involved a preliminary survey to identify regional conditions, potential rice husk waste, and community challenges related to agricultural waste utilization. This stage also involved coordination with the village government, community leaders, and relevant parties to secure support for the project. Additionally, an activity schedule was developed, tools and materials were prepared, and training materials were developed.

a. Conduct a preliminary survey to identify the potential of rice husks and the existing conditions of the target community.
b. Coordination with the village government and local community leaders
c. Preparation of training materials and required tools
d. Preparation of activity schedules that are adjusted to community activities

Figure 3. Pasie Laweh Village Head Office

2.2 Implementation Stage

The implementation phase is carried out through outreach activities and technical training. The outreach aims to provide the public with an understanding of the benefits of biobriquettes as an alternative energy source, the economic potential of rice husk waste, and the production process.

a. Socialization Program
   1) Introduction to the concept of biobriquettes and their benefits
   2) Explanation of the economic potential of rice husk processing
   3) Explanation of the stages of making biobriquettes

Figure 4. Explanation of making biobriquettes

b. Biobriquette Making Training
   1) Collection and drying of rice husks
   2) The process of carbonization of rice husks
   3) Rice husk charcoal refining
   4) Mixing with adhesive
   5) Briquette printing

c. Drying of biobriquette products

Figure 5. Process of carbonization of rice husks

d. Production Assistance
   1) Hands-on practice of making biobriquettes
   2) Product quality evaluation
   3) Product packaging and labeling

Figure 6. Hands-on practice of making biobriquettes

e. Monitoring and Evaluation Stage

Following the training, participants received intensive mentoring in the biobriquette production process. This mentoring included practical training in manufacturing, product quality evaluation,

technical consultation, and product packaging and labeling. This phase aims to improve the community's ability to produce standardized and sustainable products.

Monitoring is conducted periodically to assess the progress of program implementation, the level of community participation, and any obstacles encountered during the production process. Evaluations are conducted on the quality of the biobriquette products, the effectiveness of the training, the community's skill level, and the sustainability of the program after implementation.

1) Regular monitoring of program sustainability
2) Evaluation of the quality of the products produced
3) Assistance in business development
4) Preparation of program reporting progress reports.

2.3 Target Audience

In selecting partners to be fostered in this PKM program, the PKM Team has substance that is considered. The considerations are based on the following categories:

Figure 7. Target Audience

2.4 Activity Implementation Method

2.4.1 Approach Method

Program devotionpublic This uses a number of method approaches to ensure the effectiveness of program implementation:

a. Participatory Rural Appraisal (PRA)
b. Involving the community in identifying potential and problems
c. Mapping resources and constraints with the community and community needs-based program planning
d. Learning through direct practice
e. Intensive assistance during the production process and Continuous evaluation and improvement
f. Ongoing mentoring and periodic monitoring
g. Technical and management consulting and evaluation of program development

2.4.2 Implementation Procedure

a. Socialization and Group Formation Stage (Week 1)
    1) Meeting with community leaders and village government
    2) Socialization program to target communities
    3) Formation of working group
    4) Preparation of activity schedule with participants
b. Technical Training Phase (Week 2)
    1) Introduction to tools and materials for making biobriquettes
    2) Practices of collecting and processing raw materials
    3) Rice husk carbonization process training
    4) Biobriquette making practice
    5) Rice husk charcoal refining
    6) Mixing with adhesive
    7) Briquette printing
    8) Drying and quality testing
c. Product Development Phase (Week 3)
    1) Standardization of production processes
    2) Product variation development
    3) Packaging and labeling
    4) Product quality testing

Figure 8. Briquette printing

3. RESULTS

The community service program for making rice husk-based biobriquettes in Nagari Pasie Laweh has been successfully implemented with the active participation of the local community. The activity, which lasted for three weeks, has produced biobriquettes with a capacity of 2 kg on the day of community service, with product specifications in the form of briquettes with a diameter of 2 cm and a height of 5 cm which have an effective burning time of 2-3 hours per unit.

The use of biobriquettes by the community has covered various sectors, from traders who use 10-20 briquettes per day, households who report reduced use of LPG gas, to food stalls that use it to grill fish and chicken. The use of biobriquettes has helped business actors save fuel costs compared to the use of conventional fuels.

The level of community participation in this program reached 95% of the total targeted participants, with high enthusiasm shown through active participation in discussions and practices of making biobriquettes. The community also showed initiative by forming independent production groups committed to continuing sustainable biobriquette production.

3.1. Biobriquette Production

The program lasted three weeks, encompassing socialization, technical training, production practice, mentoring, and monitoring and evaluation. Participants participated in all stages of biobriquette production, from raw material collection to drying the final product. Based on observations during the training, participants were able to practice the production steps again after the demonstration. The production process includes:

- Collection and drying of rice husks
- Rice husk carbonization process
- Rice husk charcoal refining
- Mixing adhesive materials
- Briquette printing
- Product drying.

During the program, the team succeeded in producing biobriquettes with the following specifications:

Table 1. Biobriquette specifications

SN	Indicator	Value
1	Production capacity	2 kg
2	Diameter	2 cm
3	Height	5 cm
4	Drying time	2-3 days
5	Burning time	2-3 hours

Observations showed that participants were beginning to be able to carry out the molding and drying processes independently by the end of the training. Activity documentation also demonstrated active participant involvement during the carbonization and biobriquette molding practices.

3.2. Utilization by the Community

findings show that the biobriquettes produced are starting to be used by several community groups for household needs and small businesses. The use of biobriquettes was found in three main user groups:

3.2.1 Satay Seller

Five satay vendors have begun using biobriquettes as their primary fuel. They use an average of 10–20 briquettes per day. Interviews revealed that the vendors use biobriquettes to maintain a stable combustion during grilling.

3.2.2 Household

Twenty-five households used biobriquettes for cooking, particularly for foods that require longer heating times. Several households reported a reduction in LPG use after using biobriquettes.

3.2.3 Food stalls

Three food stalls have begun using biobriquettes to roast fish and chicken. Users report improved fuel efficiency compared to previous methods.

4. DISCUSSION

The findings of this study indicate that community participation played an important role in supporting the successful implementation of rice husk biobriquette production technology in Nagari Pasie Laweh. The high level of participation, reaching 95%, demonstrates strong community acceptance of renewable energy technology introduced through the program. This finding supports the principles of Participatory Rural Appraisal (PRA), which emphasize active community involvement in identifying problems, implementing interventions, and evaluating development outcomes. Through participatory engagement, community members become active actors rather than passive recipients, which contributes to stronger ownership and sustainability of the program.

The results are consistent with previous studies indicating that participatory approaches improve technology adoption and increase community empowerment in rural development programs [16] . However, this study extends previous research by demonstrating that community-based renewable energy initiatives become more sustainable when accompanied by continuous mentoring rather than short-term training alone. The formation of independent production groups observed during the program suggests that mentoring activities encouraged greater technological confidence and community self-reliance.

Furthermore, the successful production of biobriquettes with a burning duration of two to three hours indicates the practical feasibility of rice husk biomass as an alternative energy source for households and small businesses. This finding supports biomass energy theory, which explains that carbonization processes increase the combustion quality and energy efficiency of agricultural waste by improving carbon content and combustion stability [16] . The adoption of biobriquettes by satay sellers and food stall owners further demonstrates the practical applicability of renewable energy products in real-life rural economic settings. Unlike many previous studies focusing on laboratory-scale technical testing of calorific value and combustion characteristics, this study contributes by demonstrating the direct implementation of rice husk biobriquette technology within a rural community setting.

Figure 9. Pasie Laweh sub-district community

In terms of economic impact, the findings indicate that biobriquettes provided early financial benefits for households and small-scale business actors through reduced fuel dependence. This finding aligns with the concept of circular economy, where agricultural waste is transformed into economically valuable products [17] . Rice husks, which were previously discarded or openly burned, were converted into useful energy products that simultaneously addressed environmental and economic concerns [18] . However, while the findings indicate promising economic benefits, the short duration of implementation limits the ability to evaluate long-term sustainability and economic performance comprehensively.

This study provides several important implications for theory, practice, and policy. Theoretically, the findings strengthen the relevance of participatory approaches such as PRA in supporting renewable energy adoption in rural communities. Practically, the implementation model used in this study can be replicated in other agricultural regions with abundant biomass waste resources. From a policy perspective, local governments may

consider integrating rice husk biobriquette production into village waste management programs, MSME development initiatives, and renewable energy policies aimed at reducing reliance on conventional fuels.

Despite these contributions, several limitations should be acknowledged. First, the study was conducted over a relatively short implementation period of only three weeks, limiting the evaluation of long-term sustainability and adoption. Second, the study did not include laboratory testing related to calorific value, ash content, or emission performance of the biobriquette products. Third, the study focused only on one rural area, thereby limiting the generalizability of findings to other regions with different socioeconomic and environmental characteristics. Therefore, future research should incorporate longer-term monitoring, laboratory-based product testing, and broader comparative studies to better understand the sustainability and scalability of rice husk biobriquette technology in rural communities.

5. CONCLUSION

The community service program for making biobriquettes from rice husks in Nagari Pasie Laweh has been successfully implemented with satisfactory results. The high participation and enthusiasm of the community is reflected in the presence of 95% of participants in each activity and the formation of independent production groups that are committed to continuing the program sustainably.

The use of biobriquettes has had a positive impact on society, especially in the economic aspect by reducing fuel costs by up to 40% for business actors and 30% for households. This program has also succeeded in creating added value from previously unused agricultural waste.

The transfer of technology and knowledge to the community has been effective, as demonstrated by the ability of participants to produce quality biobriquettes and manage production independently. The support of the village government and positive responses from users are important capital for the sustainability of this program.

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