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Utilization of Coconut Shells for Briquettes in Gondowulan Village, Kepil District, Wonosobo Regency, Through an Empowerment Approach

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A B S T R A C T
This research focuses on community empowerment in utilizing coconut shells for briquette production among farmer groups in Mendongan and Pawulon Hamlets, Gondowulan Village. The village has significant potential from coconut plantations; however, unused coconut shells accumulate and may contribute to environmental problems, including mosquito breeding sites. The KKN PPM UGM team implemented a participatory action research approach through five empowerment stages: leaflet development, socialization, video-based visualization, demonstrations and training, and provision of briquette production tools and technology. The program encouraged farmer groups to transform coconut shells into valuable briquettes. Sustainable development requires continued support from village governments, sub-district authorities, and relevant agencies to strengthen community-based coconut shell utilization.

INTRODUCTION

Coconut cultivation represents an important agricultural activity in many rural communities in Indonesia, particularly in areas with suitable agroecological conditions. Gadingsukuh Village, located in Kepil District, Wonosobo Regency, Central Java Province, is one of the rural areas with significant potential for coconut-based agricultural development. The village is characterized by hilly topography and dry land that supports community plantations. Coconut trees are distributed across almost all residents' gardens, creating a natural landscape closely integrated with the local agricultural lifestyle. This potential indicates that coconut resources require appropriate upstream and downstream management to increase their economic value and reduce environmental impacts.

The coconut farming sector in Gadingsukuh Village involves approximately 72 coconut farmers. Most farmers have implemented partial upstream–downstream management by harvesting coconut sap and processing it into coconut sugar. Among these farmers, 61 farmers are involved in two production pathways, namely coconut sugar production and allowing several coconut stems to be harvested by collectors, while 11 farmers only participate in a single coconut production pathway. A total of 417 coconut stems have been utilized in the local production system. Although coconut cultivation provides economic benefits, intensive coconut processing activities generate substantial organic waste, particularly coconut fiber and coconut shells (Anis et al., 2026; Lestari et al., 2025). Without appropriate management, these residues may accumulate and create environmental problems, particularly in agricultural and residential areas where coconut processing activities are concentrated (Anggraini et al., 2026).

The accumulation of coconut processing residues can be observed in several areas around residents' plantations and processing sites. Coconut fiber and coconut shells represent the dominant organic wastes generated from coconut utilization activities. Figure 1 illustrates the accumulation of coconut shell waste and coconut fiber waste resulting from coconut processing activities in the community area.



Figure 1. Coconut shell and coconut fiber waste generated from coconut processing activities

Coconut fiber and coconut shells are organic wastes produced during coconut processing activities. Although local communities have traditionally utilized these materials as substitutes for firewood, their current utilization remains limited. Coconut fiber is generally processed into household products such as floor brooms, whereas coconut shells are commonly converted into charcoal for cooking fuel. Coconut shell charcoal has also been recognized as a potential raw material for activated charcoal production (Sari & Ariani, 2021). However, conventional utilization has not fully addressed the increasing accumulation of coconut shell waste, indicating the need for innovative processing technologies that can generate higher economic value while reducing environmental risks (Gustiawan & Kurniawan, 2024).

From an environmental health perspective, the accumulation of coconut shell waste in residential yards and plantation areas represents a potential risk. Coconut shells have a concave structure that allows rainwater to accumulate and create temporary stagnant water pools. These conditions may provide suitable breeding habitats for mosquito vectors. Previous studies have identified that mosquito breeding sites may occur in various water-holding containers, including swamps, water drums, used buckets, used tires, and coconut shells (Manik et al., 2020). Therefore, unmanaged coconut shell waste may contribute not only to environmental cleanliness problems but also to public health risks associated with vector-borne diseases such as dengue fever and malaria.

The potential health risk is particularly relevant in Kepil District, where malaria surveillance data indicate the presence of malaria transmission risks. Based on data from Kepil Health Center (2024), a total of 771 suspected malaria cases were recorded in 2020, consisting of 596 cases from Kepil I Health Center and 175 cases from Kepil II Health Center. Microscopic examination was performed on all suspected cases (596 cases in Kepil I and 175 cases in Kepil II). Laboratory confirmation was conducted for 200 cases, including 100 cases from each health center. Five malaria-positive cases were identified, with all confirmed positive cases reported from Kepil II Health Center, while no positive cases were detected in Kepil I Health Center. Although the number of confirmed cases was relatively low, the presence of mosquito-vector-related diseases remains a concern because environmental conditions, high rainfall intensity, and water-holding waste materials may support mosquito breeding processes.

The increasing amount of coconut shell waste and its potential environmental consequences highlight the need for technological interventions that integrate environmental management and community economic development. Coconut shells are categorized as biomass resources with potential for renewable energy production (Samhuddin et al., 2021). Previous studies have demonstrated that coconut shells can be converted into charcoal and activated charcoal (Sari & Ariani, 2021), while other studies have explored their potential as alternative energy materials. However, these approaches have generally focused on material characteristics, production processes, or technological performance rather than community-based implementation.

Several previous studies have investigated the utilization of agricultural waste into valuable products. Sari and Ariani (2021) examined coconut shell

utilization as charcoal and activated charcoal materials, while Gustiawan and Kurniawan (2024) emphasized the economic value obtained from coconut waste utilization. Similarly, Samhuddin et al. (2021) highlighted the potential of coconut shell biomass as a renewable energy source. However, a research gap remains regarding how coconut shell processing technology can be effectively transferred and adopted by rural communities, particularly farmer groups, as part of a community empowerment strategy. Existing studies provide evidence regarding technological potential but provide limited discussion regarding social processes, knowledge transfer, skills development, and community capacity building required for sustainable adoption.

Therefore, community empowerment through appropriate technology intervention is required to bridge the gap between technological potential and practical community application. In this context, the KKN PPM UGM JT 047 Kepil unit introduced coconut shell charcoal briquette technology as an approach to address environmental problems while developing productive economic activities. Coconut shells were prioritized because their larger physical size compared with coconut fiber creates greater accumulation problems in residential and agricultural areas and increases the possibility of becoming mosquito breeding media (Hanumanthappa et al., 2026; Sujatha & Balakrishnan, 2026). Furthermore, limited community knowledge regarding coconut shell processing technology indicates the need for structured empowerment activities to improve knowledge, skills, and confidence among local farmer groups.

This study aims to analyze the community empowerment process in implementing briquette technology for coconut shell waste management in Gondowulan Village, Kepil District, Wonosobo Regency. Specifically, this research examines how knowledge transfer, training, demonstrations, and technological assistance contribute to improving community capacity in transforming coconut shells into value-added briquette products.

Theoretically, this study contributes to the development of community empowerment and appropriate technology implementation literature by demonstrating how local agricultural resources can be transformed into environmentally sustainable and economically valuable products through participatory approaches. Practically, this research provides an empowerment model for farmer groups, village governments, and related stakeholders in managing coconut shell waste through briquette production technology. The findings are expected to support environmental health improvement, waste reduction, renewable energy utilization, and strengthening of rural economic activities based on local agricultural potential.

IMPLEMENTATION AND METHODS

Research related to the manufacture of briquettes has been carried out previously by E. Budi (2017), who emphasized the contribution of coconut shell charcoal briquettes in reducing dependence on oil and gas fuels. In this study, coconut shell charcoal briquettes are made through a process that involves cleaning, burning, grinding, printing, and drying. The results of this study show that coconut shell charcoal briquettes are smokeless, clean, easy to pack, and support the solution of pollution and alternative energy problems.

Similar research was also carried out by Maryono et al. (2013), which examined the quality of coconut shell charcoal briquettes by reviewing the starch content. Unlike previous research, this study focuses on testing the quality of briquettes through several process stages, such as carbonization, grinding, filtering, mixing of adhesive materials, molding, and pressing. From the research, it was found that the moisture content ranged from 3.46–5.57%, the ash content ranged from 7.49–9.94%, and the content of substances lost at a temperature of 950^{o}C ranged from 2.86–4.77%.

Research conducted by Anis et al. (2022) related to the manufacture of briquettes has also been carried out on wood chips. In this study, wood powder was processed into charcoal using a modified drum furnace, then mixed with tapioca flour adhesive before molding and drying. This study shows that wood powder from industrial waste frames can be used as an alternative raw material in making briquettes.

Previous research that has been carried out is research on a laboratory scale. The tests carried out concern the materials used for briquettes, the process of making briquettes, and the quality of briquettes. The difference in research of KKN PPM UGM unit JT 047 Kepil District emphasizes more on the transfer of knowledge and skills in making coconut shell briquettes to the people of Gondowulan. The actions taken are through education and pilots. This process is carried out with a community empowerment approach.

Community empowerment is an action carried out by parties who have the ability and ability to relate to scientific substance and skills that are in accordance with the problems faced by the community, which aims to provide proportional solutions through certain stages so that the community can know, understand, approve, be able, and can do well. The concept of development is very related to the concept of empowerment because almost every development is followed by a process of community empowerment (Santosa et al., 2024, 30). Community empowerment is not just about meeting basic needs but is more oriented towards maximizing resources so that economic growth increases and prospers.

Empowerment, according to Sulistiyani (2018), is a process that shows a series of systematic actions or steps and reflects the gradual change of society, which includes knowledge, attitude, and practice. Empowerment is carried out to provide knowledge and skill transfer in making briquettes from shells. This study uses the participatory action research (PAR) method. PAR is action research that involves the community, has a focus on community activities, is asset-based, acknowledges community knowledge, and provides space for the community to express itself (Miller et al., 2020. 107). Participatory action research (PAR) as part of action research, namely "systematic collection and analysis of data for the purpose of taking action and making changes" by generating practical knowledge (McDonald, 2012, 36).

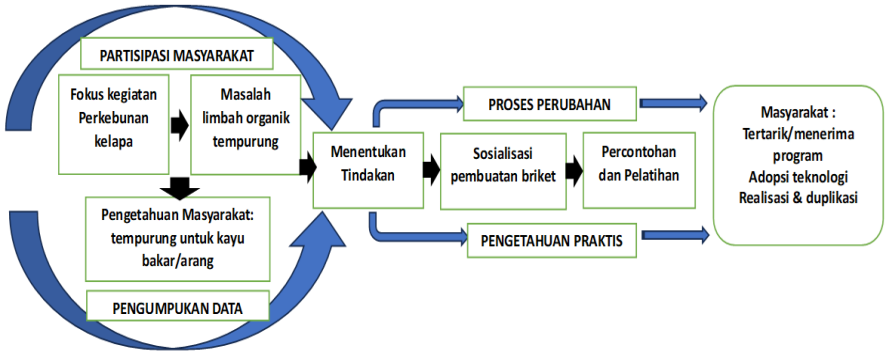


Figure 2. Participatory Action Research for Community Empowerment

Community participation and data collection go hand in hand. In general, farmer groups have knowledge about the benefits of shells as fuel for cooking in the kitchen. From interviews with the public, it is known that no community is familiar with coconut shell briquettes. "What we know is that coconut shells can be made from charcoal, or for firewood directly" (community leader, August 2, 2024).

The formulation of the problem was carried out by identifying the main challenges and needs faced through site reviews and interviews with community leaders. By understanding the root of the problem comprehensively, the scope of the problem and solutions are clear and on target. Careful and precise formulation of problems allows the maturation of strategies in community empowerment related to the use of coconut shell waste (Aziz et al., 2024; Onokwai et al., 2025).

The determination of action was carried out by taking into account data showing that the community had used coconut shells for firewood and agreed to process the shells through briquette technology intervention. The manufacture of briquettes is carried out to obtain added value technically and economically. Socialization in the community is carried out by involving various farmer groups and community leaders. The socialization aims to enrich the community's knowledge and understanding regarding the manufacture of briquette products from coconut shells (Fahruddin et al., 2024; Sujatha & Balakrishnan, 2026; Unal et al., 2024).

Community empowerment in the use of coconut shells is generally divided into two main stages, namely socialization of briquette making and piloting and practicing in making briquettes (Manatura et al., 2025; Zhang et al., 2023). From these two activities, there was a transfer of practical knowledge to provide solutions to coconut shell organic waste. This process gradually results in changes, namely knowledge increases, attitudes are positive, and skills increase (Almafie et al., 2024; Irshad et al., 2024; Nemeth et al., 2023).

The process went smoothly, and the change took place gradually. The community is interested and accepts the program. The follow-up that occurred was the adoption of briquette-making technology. There is a growing

enthusiasm, so that there is a realization of briquette making in the community in a sustainable manner, and there are duplicates.

RESULTS AND DISCUSSION

There are five main steps taken by the KKN PPM UGM Sub Unit Gondowulan team in empowering the community for the use of coconut shells as briquette materials, namely making leaflets, socialization, piloting, demonstrations, and training in making briquettes. Each of these activities has the goal of making the community empowerment process institutionalize the processing of coconut shells into briquettes to be sustainable. This empowerment uses a participatory action research approach. The actions carried out by the KKN team always involve the community at every stage.

Table 1. Community empowerment in the use of coconut shells for briquettes

No	Activity	Goal
1	Leaflet manufacturing	Preparation of materials and references for sustainability
2	Socialization of briquette making	The use of shells for briquettes and seeing the community's interest in making briquettes
3	Video pilot	Visualization of the process of making briquettes from shells
4	Demonstrations and training	Implementation of actions and the practice of making briquettes
5	Technology facilitation	Handover of tools for making shell briquettes

Source: Processed from primary data, Wonosobo, 2024.

Empowerment begins with knowledge transfer. A leaflet is a means that provides guidelines to the community to understand the use of coconut shells for briquettes. The leaflet was made by a team consisting of three students of the Gondowulan subunit. The creation of leaflets by the team through a short discussion. The leaflet contains some information that provides an initial overview of the use of coconut shells for briquettes (de Oliveira Alves et al., 2026; Souidi et al., 2025).

The leaflet explains the ingredients that need to be prepared for making briquettes. In addition, the leaflet also contains information about the benefits of coconut shell briquettes, as well as the procedure for making coconut shell briquettes. Community empowerment began with the distribution of leaflets containing practical guides on briquette making. This leaflet serves as an initial reference for participants to understand the basic steps required in the process of making briquettes. Furthermore, the presentation of material on the manufacture of biopellets and briquettes was delivered to provide deeper insight into alternative technologies in local resource management. The presentation of this material provides an important theoretical and practical context, explains how each technology works and its application in a practical way, and can be integrated into daily activities.

The implementation of empowerment is directly carried out by socializing the making of briquettes. This event was held on August 5, 2024, at the residence of the Head of Pawulon Hamlet, which was attended by approximately 20 people consisting of members of the Mendongan Hamlet farmer group and the Pawulon Hamlet farmer group. The presence of residents from these two farmer groups shows enthusiasm and interest in briquette-making activities from coconut shells. This socialization provided comprehensive information about the process of making briquettes from coconut shells, as well as the benefits that can be obtained by the local community from the use of this local material.

The enthusiastic attitude and interest of the socialization participants in the use of shells for briquettes was marked by the dynamics of the discussion during the delivery of material by the KKN team. The community's response is "These briquettes are something new, providing solutions for the environment and becoming an alternative energy in the village. Quite economical. The yard environment is also clean." (Participant 1, August 5, 2024). In addition, there are several questions and requests for detailed explanations about the procedure for making briquettes from coconut shells. Both interactive discussions between residents and discussions between residents and KKN students were dynamic, as seen in the socialization atmosphere.



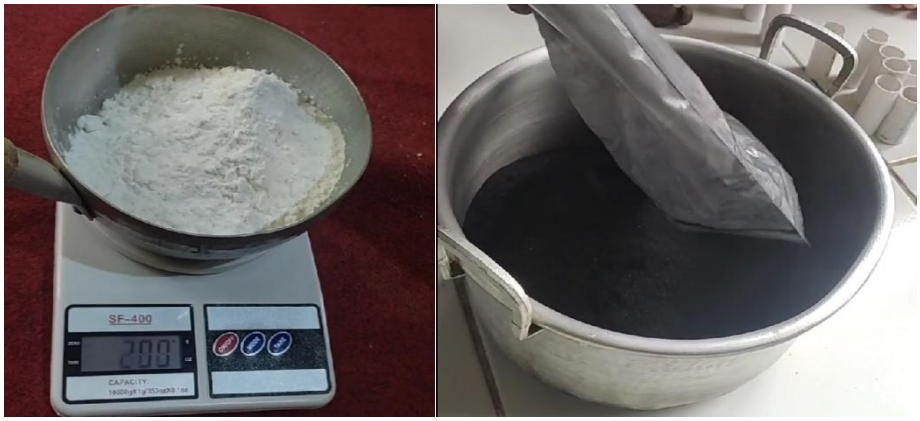
Figure 3. Socialization Activities for Making Briquettes from Shells
Source: KKN PPM UGM Sub Unit Gondowulan I, Wonosobo, 2024

After the knowledge transfer is carried out, it is necessary to follow up on empowerment with skill transfer. To improve participants' understanding as well as provide skills, visual pilots and props are needed. The material was delivered with a video performance that demonstrated the process of making briquettes visually. This video helps participants to see the steps firsthand and better understand the process of making coconut shell briquettes.

A good empowerment requires demonstrations and training in making briquettes to be carried out directly by actively involving the community. At first, the KKN team made briquettes in front of the participants, with the stages of the process from start to finish. Participants can see the process practically as demonstrated by the KKN team. In this training, there is a dynamic interaction. Participants are involved in preparing training venues and supporting equipment. The Gondowulan subunit KKN team acted as a resource person after

introducing themselves, then began to conduct a demonstration of making briquettes from coconut shells.

First, the resource person explained the equipment and technology used for the briquette-making process. Second, the resource person explained the materials needed for making coconut shell briquettes. Third, practicing the steps of work starting from pouring materials, stirring, heating, and printing briquettes. The following image is a visualization of the first action step:



(a) (b)

Figure 4. Material mixing and stirring process

The empowerment action step directly shows the process of making briquettes from coconut shells technically. The interaction of resource persons and participants took place in Gondowulan Village. The resource person guided the preparation of the main ingredients. "Ladies and gentlemen, let's prepare the materials. Try to pay attention to these are coconut shell charcoal, tapioca flour, water, and briquette molds. Once these materials are prepared, the next step is to measure or weigh them. Coconut shell charcoal is weighed as much as 1 kg, tapioca flour as much as 200 grams, and water as much as 200 ml. Precise measurements are essential to ensure that the briquette dough has an optimal consistency and can produce high-quality briquettes." (source, August 5, 2024).

Participants pay attention to the first stage of the process and practice stirring so that they can feel the concentration of the material and the level of leveling of the material with water. This step is carried out thoroughly so that it is truly understood and can be practiced. "That's how practical the process of making this ingredient mixing...(Participant, August 5, 2024). "Thank you for helping in stirring the materials; let's continue for the next action step..." (resource person, August 5, 2024).



(a) (b)

Figure 5. The process of heating with heat until it is thick

The transfer of skills in this empowerment is continued in the second step. "Ladies and gentlemen, in this second step, tapioca flour has been mixed with water; we heat it over medium heat until it thickens. Don't forget to keep stirring, Mr. IBu. This process requires special attention so that the flour and water mixture thickens perfectly, forming a strong adhesive for mixing charcoal. After the flour mixture thickens, this mixture is stirred with the weighed charcoal until the dough is even and not sticky. Good consistency of the dough is essential to ensure the resulting briquettes are of the desired quality." (source, August 5, 2024).

In this second step, it can go smoothly. All participants paid attention while discussing that this material was interesting. All participants responded positively to this briquette-making training material and practice. "Well, ladies and gentlemen, the time has come for us to take the third step, which is to print briquettes. Anyone interested in printing practice?" (source, August 5, 2024). Many participants also scattered forward to practice.



(a) (b)

Figure 6. The final step is the molding of the dough into briquettes.

The next empowerment process is the third or final step. "Ladies and gentlemen, this is the last step, namely molding the dough into briquettes. The perfectly mixed and heated dough is fed into the briquette mold, and the molding process is carried out under strong pressure to ensure that the briquettes are well

formed. The denser the mold is made, the better the quality of the briquettes produced." (source, August 5, 2024). From this training practice, briquette products that can be printed with small prints amounting to about 30 pieces are obtained.

From the implementation of community empowerment carried out, participants responded. The participants can ask various questions and discuss further issues related to the manufacture of coconut shell briquettes. This session involved participants in an interactive and dynamic manner, in the form of questions and answers. The resource persons provided an opportunity for participants to get clarification and share experiences. There were several questions submitted by the participants, including techniques and tips used so that the shell briquettes produced are of high quality, the value of benefits as an alternative to energy, future marketing opportunities, technical management of farmer groups to develop briquette products, support for tools and technology, and support for government stakeholders in mentoring and coaching.

The questions submitted are very many and related to implementation. Several explanations delivered by the speakers can strengthen public understanding of briquette making and its practical applications. From the results of this discussion, it can be concluded that the participants had the following responses.

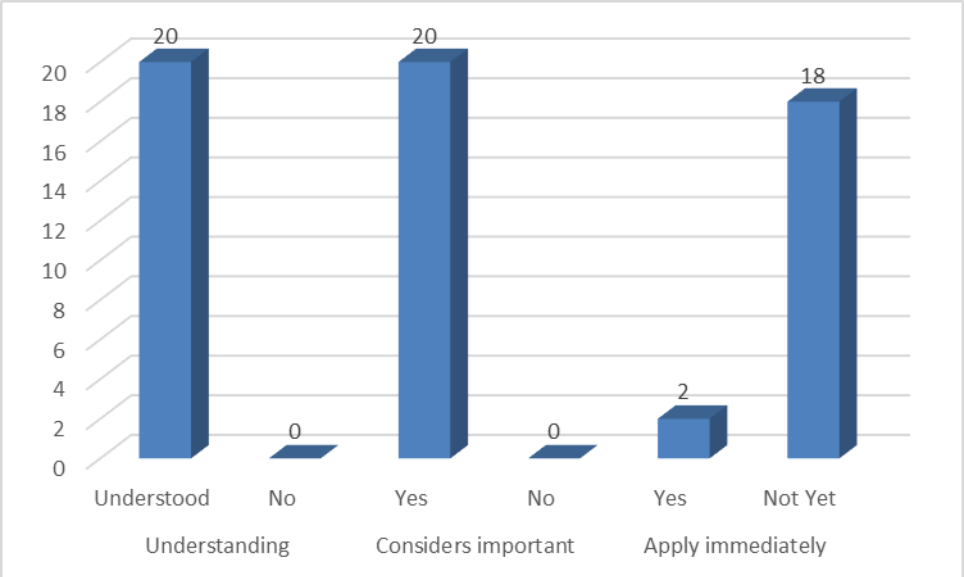


Figure 7. Participants' responses to the material for making shell briquettes
Source: Processed from primary data, Gondowulan Kepil Wonosobo, 2024

There were 100% of participants who stated that they understood the material well. In addition, 100% also view that making coconut shell briquettes is important. However, there are still obstacles to implementation in the near future. There are only 2 people (10%) who are interested and will soon apply coconut shell briquette making technology, while the majority of participants, namely 18 people (90%), will not apply this technology in the near future. From the results of further interviews, it is known that two people who are interested in immediately implementing this are influential community leaders.

Meanwhile, the other 18 people are members of the community who, usually, if moved, will still follow the decisions of community leaders.

An intensive approach was carried out by the Gondowulan subunit KKN team to the two figures to mobilize members of farmer groups in particular and the community in general. In order to motivate the two figures, the KKN team handed over the tools and technology for processing coconut shell briquettes. With this technology and equipment, the two figures will immediately rally the support of farmer groups, so that the activity of making coconut shell briquettes becomes part of productive activities in the farmer groups of Mendongan Hamlet and Pawulon Hamlet.

In order to encourage realization in the near future, the role of government stakeholders is needed to support and facilitate farmer groups. In addition, more intensive training and mentoring support is needed, both technical training and those related to management, business, and marketing. The stakeholders who have the competence to assist other than the village government and the sub-district are the Agriculture Office and the Community and Village Empowerment Social Service.

CONCLUSIONS AND RECOMMENDATIONS

Community empowerment in the use of coconut shells in Gondowulan Village, using a participatory action research approach, which includes five activities. The activities carried out are leaflet making, socialization, visual demonstrations through videos, demonstrations, and training, as well as the submission of tools and technology. The implementation of empowerment was carried out on August 5, 2024, and has succeeded in providing understanding to 100% of participants, all of whom also consider it important, but only 2 people (10%) will immediately apply this briquette technology. The two figures who will soon apply this briquette technology will make coconut shell briquette making activities as part of the productive activities of farmer groups. In order to strengthen this motivation, the KKN PPM UGM subunit of Gondowulan handed over tools and technology to the two figures.

It is recommended to hold training sessions that focus on the development of briquette businesses, as well as involve relevant parties with authority in the management of business licensing and other legal aspects. This training will not only help the community in improving technical skills in the briquette production process but also provide a deeper understanding of the legal procedures needed to establish and manage a briquette business legally and sustainably. With the support of related agencies, it will be easier for the community to start a briquette business in accordance with applicable licensing standards so that it can be marketed more widely and contribute to improving the local economy.

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