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Circular Economy-Based Livestock Waste Management Transformation through Participatory Action Research in Maskuning Kulon Village

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Abstract : *Livestock waste management in rural areas remains a problem that impacts environmental pollution due to the suboptimal utilization of organic waste. This condition was found in Maskuning Kulon Village, Pujer District, Bondowoso Regency, where cow dung waste is still dumped into rivers, potentially reducing environmental quality and public health. This community service activity aims to increase community knowledge, awareness, and participation in livestock waste management by utilizing cow dung into biomass briquettes combined with the application of rocket stoves as an appropriate technology based on local potential. The method used is Participatory Action Research (PAR) with stages of planning, implementation, evaluation, and reflection that actively involve the community through observation, interviews, participatory discussions, outreach, training in biomass briquette making, and demonstrations of rocket stove use. The results of the activity show an increase in community understanding of organic waste management, growing awareness to utilize livestock waste as an alternative energy source, and increased community skills in producing and using biomass briquettes. The participatory approach also encourages changes in community behavior in more environmentally friendly waste management and strengthens the utilization of local resources. Thus, the implementation of Participatory Action Research can be an effective community empowerment strategy in supporting sustainable livestock waste management while strengthening the implementation of a circular economy at the village level.*

Introduction

Waste and sewage management is a challenge still faced by many rural areas in Indonesia. Although most villages have abundant natural resources and livestock, waste management is still carried

out conventionally, thus not providing added value to the community. This situation results in environmental pollution and the loss of opportunities to utilize waste as an economically valuable resource. Therefore, community empowerment efforts are needed through approaches that can transform waste into useful products..

Maskuning Kulon Village is a village with a high level of cattle farming activity, resulting in large amounts of livestock waste. Observations during the Community Service Program (KKN) revealed the practice of dumping cattle waste into drains and rivers. This situation has the potential to cause environmental pollution, degrade water quality, produce unpleasant odors, and impact public health if not managed properly.

On the other hand, livestock waste has the potential to be utilized as an alternative energy source through biomass processing. One such utilization is the production of biomass briquettes, which are used in conjunction with rocket stoves for a more efficient and environmentally friendly combustion technology. This waste utilization is expected to reduce environmental pollution, increase the economic value of livestock waste, and support the realization of a community-based circular economy in Maskuning Kulon Village.

Maskuning Kulon Village is one of the villages located in Pujer District, Bondowoso Regency. This village has an area of approximately 2,807,708 m² with land use dominated by agricultural land at 65%, while 26% is a residential area and 11% is in the form of yards and other land uses. Administratively, Maskuning Kulon Village consists of 5 hamlets, namely Krajan, Krasak, Pujer, Tajung, and Paleran Hamlets, which are divided into 5 RW (each hamlet consists of 1 RW) and 20 RT (Krajan 4 RT, Krasak 5 RT, Pujer 4 RT, Tajung 4 RT, Paleran 3 RT). Based on village profile data, the population of Maskuning Kulon Village is 4,527 people consisting of 2,233 men and 2,294 women, with a total of 1,802 heads of families. Geographically, this village borders Mangli Village to the north, Sukokerto Village to the south, Maskuning Wetan Village to the east, and Mengok and Alas Sumur Villages to the west. The community's socioeconomic conditions are dominated by the agricultural sector. This is evident in the livelihoods of the residents, who mostly work as farm laborers (1,604 people) and farmers (892 people), while others work as traders, civil servants, private teachers, industrial workers, and various other professions.

Economically, the majority of the community earns a living as farmers and livestock breeders, along with small businesses, trade, and the service sector. Cattle farming activities generate significant amounts of organic waste. If not managed properly, this waste can cause environmental pollution. However, when utilized optimally, this waste has economic value as a raw material for alternative energy and environmentally friendly products. The community has also utilized corn cob waste as a medium for mushroom cultivation, demonstrating the potential for utilizing local resources to support a circular economy.

Based on observations, interviews, and the inculturation process during the Community Service Program (KKN), the main problem in Maskuning Kulon Village lies in the suboptimal management of organic waste. Some residents still dump livestock waste into rivers and have not utilized biomass waste as an alternative energy source due to limited knowledge, skills, and simple technology. Yet, livestock waste and agricultural biomass represent a local resource that can be developed into valuable products through a community empowerment approach.

Based on these conditions, this community service activity aims to increase public awareness and participation in organic waste management through the use of cow dung as biomass briquettes and the application of rocket stoves as appropriate technology that supports sustainable environmental management.

Method

This community service activity uses a descriptive qualitative approach, employing the Participatory Action Research (PAR) method. The PAR approach was chosen because it emphasizes active community involvement as partners in every stage of the activity, from problem identification and planning to implementation and evaluation, as an effort to realize change that meets community needs.(Ginanjar et al., 2025).

The community service program was conducted in Maskuning Kulon Village, Pujer District, Bondowoso Regency, East Java, from June to July 2026 as part of the Community Service Program (KKN) at Sunan Ampel State Islamic University, Surabaya. The location was selected based on initial

observations indicating the potential for abundant cow dung waste, which has not been optimally utilized as an alternative energy source. Furthermore, residents still practice conventional waste disposal and burning, potentially causing environmental pollution.

The stages of implementing community service refer to the Participatory Action Research (PAR) approach as explained by(Aditya et al., 2022), which includes mapping and identifying problems, Focus Group Discussions (FGDs), program action preparation, program socialization, program implementation, monitoring, and program evaluation. In implementing community service in Maskuning Kulon Village, these stages are adapted to field conditions and simplified into four main stages: planning, implementation, evaluation, and reflection.

During the planning stage, the KKN team conducted field observations, interviews, and identified potential and problem areas with the village government and community. Based on the identification results, a program design was developed, including the utilization of cow dung waste into biomass briquettes and the application of rocket stoves as a more efficient combustion technology. The program design was then discussed with the Village Head, village officials, hamlet heads, and the community, resulting in an agreement that the program was appropriate to the needs and conditions of Maskuning Kulon Village. The implementation stage was carried out through socialization activities, demonstrations of biomass briquette making, and the application of rocket stoves. Furthermore, a joint evaluation and reflection were conducted to assess the program's achievement, identify obstacles during implementation, and formulate improvement efforts as a follow-up to the community service activities.

RESULTS AND DISCUSSION

Observations show that livestock waste management remains a major issue in Maskuning Kulon Village. Some livestock farmers in Krasak Hamlet still dump cow manure directly into the river, while downstream communities continue to use the river for domestic needs. Furthermore, household waste is still dumped in open areas, worsening environmental quality. These conditions indicate that the problem is not solely influenced by community behavior, but also by limitations in the waste management system.

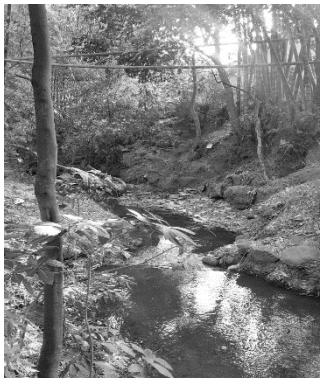

Figure 1. Condition of the river flow which is the location for livestock waste disposal

Through social communication with the community, it was discovered that until the implementation of the Community Service Program, Maskuningkulon Village did not have a Temporary Waste Disposal Site (TPS) that could be used by all residents. The only available waste management facility is located in the Pujer Market area and is intended for traders. This situation limits the community's ability to manage household and livestock waste, leading to frequent dumping of waste into the environment. This finding aligns with various studies that show that limited waste management infrastructure in rural areas is a contributing factor.

influence people's behavior in disposing of waste into the environment(Zubaidah et al., 2025)

Figure 2. Discussion with the Head of Maskuning Kulon Village and Field Supervisor Lecturers

Despite these challenges, the identification process also demonstrated that Maskuningkulon Village possesses significant local resource potential to support independent problem-solving. Livestock activities generate abundant amounts of cow dung, while agricultural activities provide rice husks as biomass waste that has not been optimally utilized. Furthermore, the community has developed mushroom cultivation using corn cobs as a medium, demonstrating local experience in utilizing agricultural waste to create products with economic value. This potential serves as a crucial asset in program development, as the solutions designed do not need to rely on raw materials from outside the village but instead utilize resources readily available within the community. This aligns with the empowerment principle in PAR, which emphasizes developing solutions based on local potential and capacity for greater acceptance and sustainability.(Hafizoh et al., 2026)

Figure 3. Local potential of Maskuningkulon Village in the form of mushroom cultivation using corn cobs as a medium.

Based on the results of these observations and social communication, it is understood that the root of the waste management problem in Maskuningkulon Village is a combination of limited infrastructure, community habits, and the suboptimal utilization of local resources. Therefore, the solution to be developed must not only focus on providing technology, but also be able to build community awareness and utilize the biomass potential available in the village. The results of the analysis in the To Understand stage then became the basis for designing a program to utilize cow dung waste into biomass briquettes, combined with the construction of a rocket stove as an appropriate technology in the To Plan stage.

Based on the identification and analysis results from the To Understand stage, program development was carried out by considering the root causes of the problem, the potential of local resources, and the needs of the Maskuningkulon Village community. The To Plan stage was implemented through participatory discussions with the village government, livestock farmers, and the community to determine the most appropriate form of activity for the village's conditions. The planning process not only focused on solving environmental pollution problems but also aimed to produce solutions that could be implemented independently by the community in the long term. This approach aligns with the principles of Participatory Action Research (PAR), which places the community as the primary subject in the decision-making process, thereby increasing participation, a sense of ownership, and program sustainability.(Rais et al., 2025).

The deliberations resulted in an agreement that the program would utilize cow dung waste into biomass briquettes, combined with the construction of a rocket stove as an appropriate technology. The program was chosen based on the abundant availability of livestock waste and rice husks in

Maskuningkulon Village, allowing all raw materials to be sourced locally. In addition to reducing pollution from direct waste disposal, utilizing biomass into briquettes also adds value to previously underutilized organic waste. Meanwhile, the rocket stove was chosen because it has higher combustion efficiency, produces lower smoke emissions, and is more fuel-efficient than open combustion or conventional furnaces.(Butar et al., 2025).

In addition to developing the technology concept to be implemented, the planning phase also produced an activity plan that included waste management outreach, biomass briquette-making training, rocket stove demonstrations, and community evaluations. The activity stages were systematically designed to help the community understand the relationship between waste management, alternative energy use, and environmental conservation. The program, not only focused on technology use but also encouraged behavioral changes toward sustainable environmental management.(Nayan et al., 2022).

The To Act stage is the implementation of the action plan agreed upon with the community. The activity begins with outreach regarding the impact of environmental pollution caused by livestock waste, the importance of organic waste management, and the potential use of cow dung as a raw material for making biomass briquettes. Outreach is conducted communicatively through material delivery, discussions, and questions and answers so that the community can understand the relationship between livestock waste, environmental health, and the potential for its use as an alternative energy source. This educational approach aims to build community awareness before entering the practical stage so that the empowerment process is not only oriented towards results, but also towards increasing capacity.(Butar et al., 2025).

Figure 4. Presentation of Material

Following the outreach activities, the community participated in training on biomass briquette production, which included drying cow dung, mixing it with rice husks as biomass, adding adhesive, molding, and drying the briquettes before using them as fuel. The entire process was conducted in a participatory manner, with guidance from the Community Service Program (KKN) team, allowing the community to gain hands-on experience in processing waste into more valuable products. This hands-on activity is expected to improve community skills and open up opportunities for utilizing waste as an alternative energy source and a product with economic value.

Figure 5. Rocket Stove Inauguration

This was followed by the construction and demonstration of the rocket stove's use. The community was involved in the assembly process, an introduction to its working principles, and a trial run of biomass briquettes as fuel. The demonstration demonstrated that the rocket stove produces more stable combustion with lower smoke emissions than open combustion. In addition to increasing fuel efficiency, this technology also contributes to reducing air pollution and the volume of organic waste discharged into the environment.(Butar et al., 2025).

The program's implementation demonstrated active community involvement at every stage, from outreach and briquette-making practices to demonstrations of rocket stove use. This participation demonstrates that the PAR approach empowers communities to become not only beneficiaries but also key actors in addressing environmental issues in their villages. Thus, the program's implementation not only resulted in innovative, appropriate technologies but also strengthened the community's capacity to manage waste independently and support more sustainable environmental management.(Rais et al., 2025).

The To Change stage is the final stage in the Participatory Action Research cycle, assessing the extent to which program implementation has driven real change in the community's knowledge, attitudes, and behavior regarding livestock waste management. After participating in outreach and training on biomass briquette production and rocket stove use, the community demonstrated an increased understanding of the impacts of pollution caused by dumping cow dung into rivers and the benefits of processing waste into alternative energy sources. This change in knowledge was accompanied by a change in attitude, namely a growing awareness that livestock waste is not merely waste but a resource that can be processed into valuable products. This condition aligns with the finding that participatory-based education can bridge the gap between knowledge and concrete actions in managing household and livestock waste (Yudiana & Setyono, 2026).

Behavioral changes were also evident in the willingness of several livestock farmers in Krasak Hamlet to no longer dispose of cow dung directly into the river and instead began collecting the waste as raw material for making biomass briquettes. Some training participants even took the initiative to continue their briquette-making practices independently outside of mentoring activities, and used rocket stoves for daily cooking. These changes demonstrate a shift in the community's role from being a beneficiary to an active participant in environmental management, while also opening up opportunities to utilize livestock waste as a new source of economic value for the village community. This reinforces the principle that active community participation in local resource management is key to achieving a sustainable economy (Ariescy et al., 2025).

However, the sustainability of the changes achieved still requires continued support, given that the program has only been running for a relatively short time. Support from village governments, farmer and livestock groups, and ongoing mentoring are crucial factors to ensure that the practice of utilizing cow dung waste into biomass briquettes does not stop at the trial stage but develops into a new, institutionalized habit at the community level. The limited waste management facilities, previously a root cause of the problem, also need to be addressed through the provision of supporting infrastructure to ensure that the behavioral changes that have been formed can be sustained in the long term (Zubaidah et al., 2025).

Overall, the To Change phase demonstrates that the PAR approach implemented in Maskuning Kulon Village not only produces appropriate technology products such as biomass briquettes and rocket stoves, but also encourages a transformation in community awareness and behavior toward better environmental management. This change serves as a crucial foundation for the sustainability of local-based community empowerment programs and supports the realization of a circular economy concept in Maskuning Kulon Village (Rais et al., 2025).

Conclusion

A community service program in Maskuning Kulon Village implemented through a Participatory Action Research (PAR) approach has successfully increased community awareness and participation in livestock waste management based on local potential. The use of cow dung and rice husks as raw materials for biomass briquettes, combined with the application of rocket stoves, provides

an alternative solution to environmental pollution problems caused by direct waste disposal into rivers and open burning. In addition to producing appropriate technology that is simple, easy to implement, and more efficient in the combustion process, this program also encourages changes in community knowledge, attitudes, and behavior towards more environmentally friendly waste management.

The program's success is supported by active community involvement from problem identification through planning, implementation, and evaluation, fostering a sense of ownership in the program. However, the program still has several limitations, including the relatively short mentoring period during the Community Service Program (KKN), the lack of adequate waste management facilities, and the inability to evaluate the program's long-term impact and sustainability. Therefore, ongoing mentoring from the village government, livestock groups, and other stakeholders is needed to ensure that waste utilization into biomass briquettes and the use of rocket stoves can be implemented consistently and developed into a sustainable community empowerment program. Further development can also be directed at improving the quality and production capacity of biomass briquettes, strengthening the economic aspect through the formation of community business groups, and replicating the program in other villages with similar livestock waste potential.

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