PengabdianMu: Jurnal Ilmiah Pengabdian kepada Masyarakat
Volume 10, Issue 8, Pages 1929-1935 Agustus 2025 e-ISSN: 2654-4385 p-ISSN: 2502-6828
https://journal.umpr.ac.id/index.php/pengabdianmu/article/view/9435
DOI: https://doi.org/10.33084/pengabdianmu.v10i8.9435

Community Empowerment Strategy of Pondok Agung, Kasembon Sub-district through Biogas Technology to Reduce Cattle Waste Pollution in Water

Yunita Maimunah [1,2*,]

Yuni Kilawati [1,2,3,]

Adharul Muttaqin [4,]

Attabik Mukhammad Amrillah [1,2]

Dany Primanita Kartikasari [5]

[1]Faculty of Fisheries and Marine Science, Universitas Brawijaya, Malang, Indonesia

[2]ENFISHMO, Universitas Brawijaya, Malang, Indonesia

[3]Laboratory Research Center, Universitas Brawijaya, Malang, Indonesia

[4]Faculty of Engineering, Universitas Brawijaya, Malang, Indonesia

[5]Faculty of Informatics and Commmunication, Universitas Brawijaya, Malang, Indonesia

email: unita.m@ub.ac.id

Kata Kunci
Reaktor Biogas
Perariran
ABCD Approach

Keywords:
Biogas reactor
Water
ABCD Approach

Received: March 2025
Accepted: June 2025
Published: August 2025

Abstrak

Proyek biogas berbasis masyarakat di Kecamatan Kasembon berfokus pada pemanfaatan kotoran ternak sebagai sumber energi terbarukan dan penghasil pupuk organik, dalam rangka meningkatkan kesejahteraan masyarakat dan mengurangi dampak negatif terhadap lingkungan. Melalui pendekatan Asset-Based Community Development (ABCD), proyek ini mengidentifikasi aset lokal, seperti lahan dan kotoran ternak, dan memberdayakan masyarakat setempat dalam pemeliharaan sistem biogas. Proses produksi biogas menghasilkan energi yang ramah lingkungan dan mengurangi ketergantungan pada LPG. Selain itu, pupuk organik yang dihasilkan dari limbah biogas dapat digunakan di bidang pertanian untuk meningkatkan produktivitas dan kesehatan tanah. Implementasi ABCD mendorong kolaborasi antara masyarakat, pemerintah dan universitas, dan menciptakan peluang ekonomi baru melalui penjualan pupuk organik. Namun, tantangan seperti ketergantungan pada bantuan eksternal, kebutuhan modal awal yang tinggi, dan keterbatasan teknis menjadi penghalang keberlanjutan jangka panjang.

Abstract

The community-based biogas project in Kasembon sub-district focuses on utilising livestock manure as a renewable energy source and organic fertiliser producer to improve community welfare and reduce negative environmental impacts. Through an Asset-Based Community Development (ABCD) approach, the project identifies local assets, such as land and manure, and empowers the local community to maintain the biogas system. The biogas production process produces environmentally friendly energy and reduces dependence on LPG. In addition, the organic fertiliser made from biogas waste can be utilised in agriculture to improve productivity and soil health. The implementation of ABCD encourages collaboration between the community, government, and university, and creates new economic opportunities by selling organic fertiliser. However, challenges such as dependence on external assistance, high initial capital requirements, and technical limitations hinder long-term sustainability.

PENDAHULUAN

The concentration of livestock production in Indonesia can be attributed to a favourable climate, farming traditions and supportive infrastructure. This provides an important source of income for rural households, as cattle can be reared for milk, meat and dairy products that are sold in local markets or processed into value-added products. This contributes to the economic well-being and livelihoods of rural communities (Kusmiyati *et al.*, 2023). Agriculture and livestock production are

How to cite: Maimunah, Y., Kilawati, Y., Muttaqin, A., Amrillah, A, M., Kartikasari, D, P. (2025). Community Empowerment Strategy of Pondok Agung, Kasembon Sub-district through Biogas Technology to Reduce Cattle Waste Pollution in Water. *PengabdianMu: Jurnal Ilmiah Pengabdian kepada Masyarakat*, **10**(8), 1929-1935. https://doi.org/10.33084/pengabdianmu.v10i8.9435

important sectors in meeting national food needs, but intensive production often generates large amounts of waste, particularly livestock waste. This waste includes both solid and liquid manure, which, if not properly managed, can cause various environmental problems. Improper handling or storage of cow dung can lead to contamination of the soil, water, and air.

In the village of Kasembon sub-district, livestock farmers do not fully understand how to handle and manage livestock waste. Limited resources and knowledge have led some to discharge livestock waste into rivers or water bodies. Chemical Oxygen Demand (COD) decreases as levels increase because bacteria need oxygen to oxidise or break down organic and inorganic molecules, the dissolved oxygen in the water. The respiratory process of aquatic organisms is also affected by a decrease in dissolved oxygen. Dissolved oxygen levels in water are significantly affected by the aeration process. If there is too much turbidity in the water, the process is disrupted. Because sunlight is blocked by high turbidity, the regeneration process of groundwater oxygen is disrupted, inhibiting photosynthesis and allowing the growth of harmful microbes such as salmonella (Saputra, 2017).

Livestock production generates solid waste in the form of cow dung at a maximum of 25 kg/day/head and liquid waste of 100-150 litres/day/head. This waste, if not properly managed, can contaminate groundwater, which is the main source of clean water for the community (Ilma 2023). On the other hand, livestock waste actually has great potential to be utilised as an alternative energy source, particularly biogas. Biogas is produced through the anaerobic fermentation process of livestock manure and can be used as fuel for cooking, lighting, or even power generation. In addition to producing energy, this process also produces organic fertiliser that is beneficial to the agricultural sector.

Through the application of biogas technology, the problem of livestock waste disposal can be addressed more effectively. The use of biogas not only helps to reduce environmental impacts, but can also improve community welfare through energy cost savings and increased agricultural productivity.

Therefore, Doktor Mengabdi/DM (Doctoral Activities) activities aim to:

1. Utilise livestock manure effectively to reduce aquatic environment pollution.
2. Building the independence of cattle farmers in the management of livestock waste and its utilization for daily needs

By utilizing local expertise, resources, and community cooperation, cattle ranchers may manage and control waste using the Asset-Based Community Development (ABCD) approach. Farmers can see the potential uses of cattle manure, such as composting, biogas production, and organic fertilizer, rather than seeing it as a problem. Communities may develop sustainable trash solutions that benefit local economies and the environment by outlining the resources that are accessible, such as agricultural cooperatives, seasoned farmers' wisdom, and current garbage management technologies. Farmers are encouraged to pool resources, exchange best practices, and develop creative waste management techniques that lower pollution and boost output thanks to this asset-based strategy.

Forming farmer cooperatives to pool resources to purchase biogas digesters—which turn manure into renewable energy for farm operations—could be a useful way to apply the ABCD strategy to cattle waste management. Furthermore, farmers can work with local companies and agricultural specialists to expand the production of organic fertilizer, converting trash into a lucrative product. Farmers can learn effective waste management practices, such composting methods or water recycling systems for cleaning cattle sheds, with the use of educational workshops and knowledge-sharing websites. Cattle producers can reduce their environmental impact and generate income by concentrating on local strengths and community-driven solutions, turning waste management into a benefit rather than a liability.

METODE

Metode kegiatan pengabdian terdiri dari 2 sub bab yaitu alat dan bahan serta metode pelaksanaan. Sub bab tersebut ditulis tanpa numbering maupun bullet. Cantumkan alat-alat besar atau khusus yang digunakan dalam kegiatan pengabdian. Derajat dan spesifikasi untuk setiap bahan harus dicantumkan. Bagian ini juga memuat jalannya pelaksanaan kegiatan pengabdian yang secara spesifik dilaksanakan. Alur kerja yang sederhana tidak perlu dibuat skema. Cara kerja yang sudah

umum tidak perlu dijelaskan secara detail. Langkah pelaksanaan kegiatan yang panjang dapat dibuat dalam subbab tahapan-tahapan kegiatan dengan menggunakan numbering angka arab.

Methods of Doctoral Activities using Asset-Based Community Development (ABCD), which is a methodology focused on sustainable community-driven development that emphasizes leveraging existing strengths and resources within a community rather than addressing its deficits. Developed by John L. McKnight and John P. Kretzmann in the 1990s, ABCD encourages communities to identify and mobilize their inherent assets to foster social and economic improvements (Ward, 2023).

Key Principles of ABCD are:

1. Community Assets Focus: ABCD prioritizes the identification of assets over needs. This includes recognizing the skills, experiences, and resources that community members already possess, which can be harnessed for development efforts.
2. Community Empowerment: The approach empowers residents by encouraging them to utilize their own resources and capabilities, fostering a sense of ownership and responsibility for community development. Tim melakukan survey terhadap asset dan sumberdaya peternak untuk menentukan Lokasi Pembangunan reactor biogas..
3. Social Capital: ABCD places significant importance on social relationships and networks as vital assets. Building connections among individuals and groups enhances community cohesion and facilitates collaboration. Kolaborasi Tim DM dengan peternak serta pemerintah setempat, dilakukan dengan menganalisis asset dan sumberdaya yang dimiliki dan pemanfaatannya.
4. Participatory Approach: The methodology aligns with participatory development principles, where active involvement and empowerment of community members are central to the process

Therefore, lecturers/students must respect the main role of the community. Lecturers/students and the community must work together in a participatory manner to make social change (Afandi *et al.*, 2022).

Activities were carried out in Pondok Agung , Kasembon Sub-district as a pilot project location for 3 months in August-November 2024. Materials and tools for the manufacture of Biogas reactors are prepared with technical personnel who are experts in their fields.

HASIL DAN PEMBAHASAN

The activity starts with an exploration of information related to Community Assets Focus, through a discussion with the Chairperson of the Kasembon Sub-district PKK (Pemberdayaan Kesejahteraan Keluarga/Empowering Family Welfare) mobilising team, Mrs Reni Aristawati, S.Pi. from the results of the discussion, the problem of limited knowledge in livestock waste management was obtained. Farmers dispose of waste generally in waters or spread livestock waste on agricultural land for fertiliser. This action certainly greatly affects the decline in water quality, especially in households that use groundwater. In general, cattle in Pondok Agung Hamlet are smallholder livestock and there is no industrial management involving smallholder farmers as Partners.

Furthermore, the identification of assets owned such as the availability of land and resources. For community empowerment activities, the location and farmers who can be trained or play an active role in the project as a mobiliser were determined. The biogas reactor was built in Mr Khoirul's house as an individual who can support and be involved in the biogas project (Figure 1). Following this, a site survey is conducted to identify suitable locations for biogas installations. The survey assesses environmental conditions and considers factors such as proximity to livestock sources and accessibility for maintenance. This step is crucial as it ensures that the installation will meet both technical requirements and community needs effectively.

Figure 1. Survey of Biogas Reactor Construction Site

Based on the identified assets, Mr Khoirul plays a role in the community according to his expertise and resources, namely the farmer contributing livestock manure as biogas raw material and the land provider for the construction of biogas reactors. He collaborated with the DM technical team who acted as trainers or technicians. Thus, Social Capital is formed through social realtionship and network as vital assets.

Once the site is determined, the next step is selecting an appropriate biogas model based on the community's technical capabilities and financial resources. The selection process involves discussions with community members to ensure that the chosen model aligns with their expectations and capabilities. Kegiatan ini merupakan implementasi dari Key Principles of ABCD yaitu Social Capital. The construction phase engages local laborers under the supervision of a team from Brawijaya University. This approach not only provides employment opportunities but also fosters community involvement in the project. The biogas digester is built using cast concrete without an iron frame, ensuring durability. Each layer of the digester is treated with waterproofing materials and leak-proof paint to enhance longevity. Quality control measures are implemented throughout construction to ensure that the system will function effectively over time. From the results of the analysis of model selection and reactor manufacturing process, the reactor model made is able to be used to accommodate livestock lombah up to 20 cows.

Stages of development by making the base of the digester. The base of the dome is made permanent with 3 (three) layers to prevent leaks and holes. Then, it is continued by making the dome permanently using cast concrete with a certain thickness and without an iron frame. The final stage of finishing the digester is cement coated and painted with anti-leakage paint to strengthen its durability. Figure 2. shows workers finishing the digester structure that has been built.

Figure 2. Biogas reactor construction process

The construction of the Biogas Reactor by utilising available resources such as local materials and local labour. This is intended for cost efficiency and technical labour. In addition, it is also a step in the cadre of technical personnel, so that in the future there is no need to bring in technical personnel from outside Kasembon Sub-district, which can have implications for the high cost of technical personnel.

After construction, a trial run of the biogas system is conducted to assess its performance. The produced gas is tested for its usability in cooking and lighting, ensuring it meets the expected standards. Following successful trials, the system is formally handed over to beneficiaries, accompanied by training sessions designed to educate them on proper operation and maintenance practices (Figure 3). This training is essential for ensuring that users can effectively manage the system, thereby maximizing its benefits. It also aims to build self-reliance, so that farmers are able to overcome small problems that may arise without having to rely on external assistance.

Figure 3. Training on Cattle Waste Management

This community service programme produces concrete benefits in the form of renewable energy and economical organic fertiliser. The use of biogas technology from livestock manure offers an environmentally friendly solution to address waste and energy challenges in the community. By utilising livestock manure effectively, farmers no longer discharge waste into water bodies, thereby reducing environmental pollution that often results from direct disposal of manure onto land or water. Untreated livestock waste can produce methane gas, which is utilised to meet the gas needs of 2 (two) households.

In addition to producing renewable energy in the form of biogas, the fermentation process in the digester also produces organic fertiliser that is very beneficial for local agriculture. These organic fertilisers are rich in essential nutrients for plants and can be used by farmers as an alternative to commercial chemical fertilisers. The use of organic fertiliser from biogas waste can also improve soil health and long-term agricultural productivity, as it improves soil structure and increases natural fertility.

On the other hand, with the presence of biogas as an energy source, where Mr Khoirul and his family do not need to buy LPG (Liquefied petroleum gas) anymore for kitchen needs. Thus, community independence has been built through the utilisation of methane gas from biogas, as an affordable and sustainable alternative energy source for household needs, such as cooking. By utilising biogas, the community can reduce spending on LPG purchases, as well as contribute to efforts to reduce dependence on increasingly limited fossil fuels.

ABCD implementation is not just about creating immediate change but also developing the capacity of the community to continue to develop and grow independently. Through this approach, communities have the skills, knowledge and networks they need to tackle future challenges without relying too heavily on external assistance.

The implementation of ABCD (Nel, 2020; Oliver & Stout, 2022) through this DM activity also provides positive benefits, among others:

1. Reduction of Environmental Pollution
   This biogas project helps reduce environmental pollution caused by livestock waste. Livestock manure that previously polluted soil and water is processed into biogas, reducing unpleasant odours as well as potential groundwater contamination. Thus, the project contributes to the health of the neighbourhood.
2. Provision of Alternative Energy Source

Biogas produced from the digester provides an environmentally friendly and sustainable alternative energy source. Communities can use biogas for household purposes, such as cooking or lighting, thus reducing dependence on fossil fuels or LPG which are expensive and have a negative impact on the environment.

3. Local Economic Development
   By-products of the biogas process, such as organic fertiliser, can be sold or utilised by local farmers, increasing local agricultural productivity. This opens up new economic opportunities for the community and creates an additional source of income, ultimately improving community welfare.
5. Increased Community Capacity and Independence
   With training on biogas maintenance and organic fertiliser management, communities are becoming more independent in managing the energy and fertiliser they need. Farmers also learnt new skills, which increased their capacity to engage in environmental and energy management activities more broadly.
6. Strengthening Collaboration and Community Engagement
   The project relies on the Asset-Based Community Development (ABCD) method, which encourages communities to collaborate and utilise their local assets. This strengthens social attachment, collaboration, and a sense of belonging to the project, which is important for long-term sustainability.

The future challenges of this biogas initiative present several critical issues that may affect its long-term sustainability. One significant challenge is the limitation in technical knowledge and maintenance capabilities. Although the community has received training, their expertise remains limited. In the event of technical problems, such as digester leakage or pipe system damage, repairs may be difficult to carry out independently, especially in remote areas with limited access to technicians or spare parts. Another major concern is the high initial capital required for the construction of the biogas system. The cost of materials and installation tools is considerable, making it difficult for communities to gather the necessary funds. Dependence on external financial assistance also poses a risk, as long-term sustainability may be threatened if continuous funding is unavailable. Furthermore, the project initially relies on support from external entities, such as the government, NGOs, or Brawijaya University. This dependency could become problematic if such support diminishes or stops, as the community may not yet be fully prepared to manage the project independently.

Additionally, internal conflicts may arise regarding the division of roles and the utilization of local resources. Disputes could emerge if there is a perception of unfair distribution of benefits, such as farmers who provide manure feeling disadvantaged compared to those who directly benefit from the biogas energy. Ensuring fair and transparent benefit-sharing mechanisms is crucial to prevent such tensions. A further challenge is maintaining long-term community interest and commitment. Over time, enthusiasm may decline, particularly if the benefits of the biogas system do not seem to outweigh the effort required for maintenance. If interest wanes, the project's sustainability could be jeopardized, and the biogas infrastructure may deteriorate or cease functioning altogether. These challenges will play a crucial role in determining the long-term success of biogas utilization by cattle farmers in Kasembon sub-district. Addressing these issues effectively will be essential to ensuring that the project remains viable and beneficial to the community in the future.

The community-based biogas project development activities have had a significant impact on both the community and the surrounding environment. By processing livestock manure into biogas, the community is able to reduce environmental pollution due to livestock waste, which previously polluted groundwater and air. In addition, the biogas produced provides an environmentally friendly alternative energy source, reduces dependence on fossil fuels such as LPG, and saves household costs. The by-product of organic fertiliser also improves the quality of agricultural soil, resulting in increased agricultural productivity and opening up new economic opportunities for the community. The project's existence has also increased community capacity through training in technical skills for biogas maintenance, which supports community self-reliance and empowerment. On the other hand, challenges also emerged, such as the initial dependence on external assistance, the risk of technical problems, and the need for long-term maintenance capital. With strong collaboration between the community, Brawijaya University and the Pondok Agung Village Government and Kasembon Sub-district

Government, the positive impact of this project can continue to be felt and bring sustainability in energy provision, waste management, and improving the welfare of local communities.

KESIMPULAN

This biogas project has had a significant positive impact on the environment and economy of the community in Kasembon sub-district. By utilising livestock manure for biogas production, the project successfully reduces water and air pollution and provides a cost-effective alternative energy source. The ABCD approach enables the community to actively participate and build technical capacity in managing biogas, thereby enhancing community self-reliance in the long run. In addition, the by-product of organic fertiliser supports the local agricultural sector, which has a positive impact on the village economy. However, the sustainability of the project depends on the community's ability to overcome challenges, including technical and capital limitations, and minimise reliance on external assistance. With continued collaboration between the community, government and university, the biogas project is expected to be a long-term solution for waste management and energy provision at the local level.

UCAPAN TERIMA KASIH

We would like to thank Directorate General of Research and Development Development of the Ministry of Research, Technology, and Higher Education and the Institute for Research and Community Service Brawijaya University, Malang who have cooperated and supported in the implementation of the DM program. Kasembon sub-district head, village officials and Mr. Khoirul's family for their support in the preparation and implementation of the program.

REFERENSI

Afandi, A., Laily, N., Wahyudi, N., Umam, M. H., Kambau, R. A., Siti Aisyah Rahman, M. S., Jamilah, Kadir, N. A., & Syahruni Junaid, Serliah Nur, Rika Dwi Ayu Parmitasari, Nurdiyanah, Jarot Wahyudi, M. W. (2022). Metodologi Pengabdian Masyarakat (J. W. Suwendi, Abd. Basir (ed.); 1st ed.). *Direktorat Pendidikan Tinggi Keagamaan Islam Direktorat Jenderal Pendidikan Islam Kementerian Agama RI*.

Ilma, Izana Saffana. (2023). Kajian Pencemaran Lingkungan Airtanah Akibat Limbah Perternakan Sapi Di Desa Pengkolrejo, Kecamatan Japah, Kabupaten Blora. Tesis , Universitas Gajadh Mada

Kusmiyati, K., Wijaya, D.K., & Hartono, B.J.R. (2023). Advancements in Biogas Production from Cow Dung: A Review of Present and Future Innovations. *World Chemical Engineering Journal*, **6**(2), 50-56. http://dx.doi.org/10.1051/e3sconf/202344804005

Nel, H. (2020). Stakeholder_Engagement_Asset-Based_Community-Led_D. *Social Work*, **56**(3), 0–3. http://dx.doi.org/10.15270/56-4-857

Oliver, M. D., & Stout, M. (2022). Examining natural resource management through a community development theoretical lens. *Community Development*, **53**(2), 130–149. https://doi.org/10.1080/15575330.2021.1946575

Saputra, L. (2017). Pengaruh Limbah Peternakan Sapi Terhadap Kualitas. Universitas Muhammadiyah Surakarta

Ward, S. (2023). Using theory-based evaluation to understand what works in asset-based community development. *Community Development Journal*, **58**(2), 206–224. https://doi.org/10.1093/cdj/bsab046

Werkneh, A. A. (2022). Biogas impurities: environmental and health implications, removal technologies and future perspectives. *Heliyon*, **8**(10), e10929. https://doi.org/10.1016/j.heliyon.2022.e10929