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Empowerment of Farmers through Biogas Utilization to Achieve Energy Self-Sufficiency Village

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Abstract: The empowerment of livestock farmers through the utilization of cow manure biogas plays a crucial role in addressing environmental pollution and enhancing rural energy self-sufficiency. This study aims to analyze the empowerment strategy of farmer groups (KTT) in Sruni Village, Musuk District, Boyolali Regency, Central Java, Indonesia, through a participatory biogas utilization program. A survey method using Participatory Rural Appraisal (PRA) was employed with 45 respondents determined by census sampling. Data were collected through observation, interviews, and Focus Group Discussions (FGD), and analyzed using SWOT analysis. The results of the SWOT analysis indicate that internal strengths include the economic value of biogas, environmental benefits, and the availability of livestock waste, while weaknesses include a lack of skills, insufficient government support, and limited financial resources. External opportunities encompass potential for educational tourism, economic creativity development, and energy substitution. Threats include technical constraints such as installation damage and gas pressure hazards. Based on the SWOT matrix, the recommended strategies emphasize capacity building, technological improvements, strengthening farmer institutions, and promoting biogas as an alternative energy source. The recommended empowerment strategies involve enhancing farmer capacity, optimizing biogas management, improving installation technology, and promoting biogas as an alternative energy source. This study concludes that strategic empowerment interventions can significantly contribute to the realization of energy self-sufficient villages and circular rural economies.

Keywords: Biogas Utilization; Energy Self-Sufficiency Village; Farmer Empowerment; Participatory Rural Appraisal; SWOT Analysis

Introduction

In Central Java, cattle farming remains a primary livelihood for many rural communities, including in Sruni Village, Musuk District, Boyolali Regency. The village is home to approximately 14,336 cattle, comprising 13,100 dairy cows and 1,236 beef cattle. While livestock farming is economically vital, it poses significant environmental challenges, particularly from unmanaged cow manure. Globally, livestock waste management has become an integral issue within the renewable energy and climate change discourse. According to the International Energy Agency (IEA, 2023), the livestock sector contributes nearly 14.5% of total global greenhouse gas emissions, primarily from enteric fermentation and manure decomposition. Each cow produces around 8-10 kg of manure daily, contributing to the release of ammonia (NH3), methane (CH4), and nitrous oxide (N2O), which cause air pollution and intensify greenhouse gas effects (Huda & Wikanta, 2018). This condition highlights the urgent need for sustainable waste management practices.

Biogas production from anaerobic digestion of livestock waste offers a practical, eco-friendly solution. With a high methane content of 4,800 to 6,700 kcal/m^3, cow manure is an efficient source of renewable energy. Biogas not only reduces environmental pollution but also provides alternative energy for rural households, contributing to economic savings and environmental conservation. Sruni Village has been developing a Biogas-Based Energy Self-Sufficiency Village (Desa Mandiri Energi, DME) program since 2010, collaborating with governmental and private institutions to provide training and technical support. However, the program faces challenges, including limited technical

skills among farmers, insufficient financial resources, and infrastructure inefficiencies, which hinder the maximization of biogas utilization.

Given these conditions, this study aims to analyze the strengths, weaknesses, opportunities, and threats (SWOT) associated with biogas utilization in Sruni Village. Furthermore, it seeks to formulate strategic empowerment initiatives to optimize biogas production and utilization, supporting the realization of a sustainable Energy Self-Sufficiency Village (DME) model that can enhance rural livelihoods and contribute to Indonesia's renewable energy transition.

Materials and Methods

This study, titled "Empowerment Model of Livestock Farmer Groups through Cow Manure Biogas Program," was conducted in Sruni Village, Musuk District, Boyolali Regency, Central Java, from March to April 2024.The materials used in this study include:

1. Respondents consisting of members of livestock farmer groups (Kelompok Tani Ternak, KTT) in Sruni Village.
2. Research instruments in the form of questionnaires, which had been statistically validated in a previous study by Nurtanti (2022).
3. Documentation tools for field observations.

Research Methods

This research employed a Participatory Rural Appraisal (PRA)-based approach to identify respondent characteristics and empowerment factors. The location was selected through a preliminary survey, followed by an identification process to determine the research sample. Sample size determination was calculated using the formula from Nurtanti and Indreswari (2023). Data collection methods included observation, interviews using structured questionnaires, and Focus Group Discussions (FGD). Data analysis was conducted using descriptive quantitative methods.

Population and Sample

The research population consisted of livestock farmers who have utilized biogas in their daily activities. In Sruni Village, 50 farmers were identified as active biogas users. The sample size was determined using the formula (Nurtanti & Indreswari, 2023):

$n = N / (N * d^2 + 1)$

Where:

n = sample size

N = population size (50)

d = precision level (0.05 or 95% confidence interval)

Calculation:

$n = 50 / (50 * 0.05^2 + 1) = 44.4$ (rounded to 45 samples)

Thus, a total of 45 respondents were selected as the sample for this study.

Data Collection Techniques

Data were collected using questionnaires to gather information on respondents' income, business contributions, and perceptions regarding the implementation of biogas utilization on economic factors. The Likert scale was used to evaluate respondents' understanding and acceptance of biogas implementation, as shown in Table 1.

Table 1. Likert Scale Evaluation Categories

Response	Score	Interval	Category
Do not understand / Strongly Disagree	1	1.00-2.00	Poor
Less understand / Disagree	2	2.01-3.00	Not Poor
Fairly understand / Neutral	3	3.01-3.50	Moderate
Understand / Agree	4	3.51-4.50	Good
Strongly Understand / Strongly Agree	5	>4.50	Very Good

(Source: Nurtanti & Indreswari, 2023)

Data Analysis

To determine the empowerment strategies of livestock farmer groups through the cow manure biogas utilization program in achieving energy self-sufficiency in Boyolali Regency, SWOT analysis was employed. SWOT analysis evaluates internal and external environmental factors to develop strategies that maximize strengths and opportunities while minimizing weaknesses and threats. The data were then processed using a SWOT analysis matrix, as shown in Table 2.

Table 2. SWOT Analysis Matrix

External Factors	Strengths (S)	Weaknesses (W)
Opportunities (O)	SO Strategy: Utilize strengths to seize opportunities	WO Strategy: Minimize weaknesses to seize opportunities
Threats (T)	ST Strategy: Utilize strengths to overcome threats	WT Strategy: Minimize weaknesses to avoid threats

(Source: Aisah & Herdiansyah, 2020)

Results and Discussion

A. Respondent Characteristics

The characteristics of the respondents utilizing cow manure biogas are presented in Table 3.

Table 3. Characteristics of Agni Mandiri Farmer Group Members

Characteristics	Number (Persons)	Percentage (%)
Age		
20-30 years	2	2.2%
31-40 years	2	2.2%
41-50 years	18	40%
>50 years	23	51.1%
Farming Experience		
<1 year	0	0%
1-5 years	3	6.7%
6-10 years	5	11.1%
>10 years	37	82.2%
Education Level		
No Schooling	2	4.4%
Elementary School	21	46.7%
Junior High School	9	20%
Senior High School	10	22.2%
Diploma	0	0%
Bachelor Degree	3	6.7%
Master/Doctorate	0	0%
Family Members		
<2 persons	2	4.4%
2-5 persons	36	80%
>5 persons	7	15.6%
Occupation		
Farmer & Breeder	42	93.3%
Trader/Entrepreneur	1	2.2%
Private Sector Employee	2	4.4%
Civil Servant	0	0%

(Source: Primary Data, 2024)

The data indicates that the majority of biogas users are over 50 years old (51.1%), which falls within the productive age category (15-64 years) as per Indonesian labor law. Most respondents have over 10 years of farming experience (82.2%), which enhances their practical knowledge and openness to innovation. Educational attainment is predominantly elementary school level (46.7%), with only 6.7% holding a bachelor's degree. A family size of 2-5 members is most common (80%), which supports the availability of family labor for farming activities. Most respondents work as farmers and breeders (93.3%), indicating high potential for

biogas utilization as they possess sufficient livestock and waste resources.

B. SWOT Analysis

Internal Factors

1. Strengths

The analysis revealed that key internal strengths include the economic value of biogas, environmental benefits, and its potential as an alternative energy source. Most respondents agree that biogas is more economical than other fuels (66.7%) and significantly beneficial in reducing waste pollution (55.6%). The majority of respondents (57.8%) categorized biogas as an excellent alternative energy source. These findings align with Widodo et al. (2014) who emphasized biogas as a potential renewable energy derived from livestock and agricultural waste.

2. Weaknesses

Key internal weaknesses identified include limited government outreach (48.9%), insufficient technical skills among farmers (40%), and financial constraints (40%). Biogas installations are also prone to blockages (48.9%), which can hinder operational efficiency. These challenges highlight the need for enhanced technical assistance and farmer capacity building (Octafiansyah, 2015).

External Factors

1. Opportunities

External opportunities include the potential to develop Sruni Village as an educational tourism site for biogas (68.9%) and the possibility of replacing conventional energy sources (55.6%). The program also encourages the development of Energy Self-Sufficiency Villages (DME) and supports rural economic growth through creative economy initiatives (Destiningrum et al., 2018).

2. Threats

Major threats include the vulnerability of biogas installations to damage (55.6%) and safety concerns regarding high gas pressure (53.3%). However, these risks can be mitigated through technological improvements and proactive maintenance strategies (Runtuni & Dewanti, 2019).

SWOT Strategy Formulation

Berikut saya buatkan narasi paragraf yang terstruktur dan mengalir untuk bagian **SWOT Strategy Formulation**: Based on the SWOT matrix analysis, several strategic interventions have been formulated to empower livestock farmer groups in maximizing the potential of biogas utilization while addressing the challenges encountered. The **Strength-Opportunity (SO) strategies** focus on leveraging the availability of livestock waste to reduce environmental pollution and foster the development of energy self-sufficient villages. By optimizing biogas production, the community can not only mitigate waste management issues but also stimulate local creative economies and entrepreneurship through value-added biogas by-products, such as organic fertilizers and eco-friendly energy solutions.

The **Weakness-Opportunity (WO) strategies** emphasize the need for continuous capacity-building initiatives to enhance farmers' technical knowledge and practical skills in managing biogas systems. Training programs and workshops are essential to ensure that farmers can effectively operate and maintain biogas installations, thus improving system efficiency and sustainability. Additionally, efforts to enhance livestock business management practices will lead to increased productivity, improved income levels, and a more robust integration of biogas into farming operations.

The **Strength-Threat (ST) strategies** aim to counteract external risks by developing robust, durable, and cost-effective biogas installation technologies. By enhancing the reliability and safety of biogas systems, farmers will be better equipped to minimize operational disruptions and hazards. Furthermore, optimizing the use of biogas as a cheaper and eco-friendly alternative to conventional fuels will reduce dependency on fossil fuels, making biogas a competitive and attractive energy source for rural households.

Lastly, the **Weakness-Threat (WT) strategies** address the need for extensive community outreach

and education campaigns to raise awareness about the environmental and economic benefits of biogas. By fostering a deeper understanding among farmers and the broader community, these initiatives aim to overcome resistance and misinformation regarding biogas technology. In addition, strengthening farmers' comprehension of biogas as a viable solution to escalating fossil fuel prices will encourage greater adoption and long-term sustainability of biogas programs in rural areas.

Conclusion

The program benefits from the availability of production facilities but faces challenges related to limited formal education and insufficient government support. Opportunities lie in biogas adoption as a renewable energy source, enhancement of livestock production, and contribution to the growth of decentralized modern energy, while threats include fragile installations and low community awareness. Strategic recommendations such as improving biogas quality, advancing installation technology, strengthening farmer groups, enhancing farm management, and promoting biogas as an alternative energy are essential to foster knowledge transformation, empower local communities, and ultimately establish Sruni as an Energy-Independent Village.

References

Destiningrum, D., Senjawati, N. D., & Murdiyanto, E. 2018. Pemberdayaan Masyarakat Berbasis Desa Wisata (Studi Kasus di Desa Wisata Kadisobo II, Desa Trimulyo, Kecamatan Sleman). *Seminar Nasional "Inovasi Pangan Lokal Untuk Mendukung Ketahanan Pangan,"* April, 42-48.

Elizabeth, R. (2021). Biogas, Renewable Energy Mendukung Pertanian Bioindustri. *Journal of Scientech Research and Development*, *3*(1), 001-015.

Indriani, Y. N., Maulina, S. S., Ikhsan, A. N., & Ni'mah, L. (2019). Peningkatan Kualitas Biogas Limbah Pabrik Tahu Kelurahan Mentaos Dengan Metode Absorbsi Menggunakan Ba (Oh) 2. *Jurnal Konversi*, *8(2)*, 25–30.

Mappiratu, M., & Sikanna, R. (2013). Kajian teknologi produksi biogas dari sampah basah rumah tangga. *Natural Science: Journal of Science and Technology*, *2*(1).

Maryam, M., Paly, M. B., & Astati, A. (2016). Analisis faktor-faktor yang mempengaruhi penentu pendapatan usaha peternakan sapi potong (Studi kasus Desa Otting Kab. Bone). *Jurnal Ilmu dan Industri Peternakan*, *3*(1) melaluipola kemitraan broiler. Dalam Jurnal Agrisaintifika. Volume6, Nomor 2, Hlm.57-65.

Nejat, P., Jomehzadeh, F., Taheri, M., Gohari, M., & Abd Majid, M. (2015). A global review of energy consumption, CO2 emissions and policy in the residential sector (with an overview of the top ten CO2 emitting countries). *Renew. Sustain. Energy Rev*, 43, 843-862.

Ningrum, A. S. (2016). Kontribusi pendapatan usaha ternak sapi perah terhadap total pendapatan rumah tangga di Desa Singosari dan Desa Sruni Kabupaten Boyolali Provinsi Jawa Tengah. *Geo Educasia*, *1*(3).

Ningtyas, D. W. (2023). *Pemberdayaan Masyarakat Melalui Pengembangan Desa Mandiri Energi (Studi Kasus Di Desa Mundu Kecamatan Tulung Kabupaten Klaten)* (Doctoral dissertation, UNS (Sebelas Maret University)).

Nurtanti, I, dan Indreswari, R. (2022). Analisis factor-faktor keberdayaan peternak

Octafiansyah, R. (2015). *Perancangan Digester Biogas berdasarkan pengaruh Penambahan 10% Bekatul terhadap Efisiensi Removal Air Limbah dan Produksi Biogas (Studi Kasus: Bulaksumur Residence* (Doctoral dissertation, Universitas Gadjah Mada).

Prayitno, H. T. (2014). Strategi pemanfaatan kotoran sapi. *Jurnal Litbang: Media Informasi Penelitian, Pengembangan dan IPTEK*, *10*(1), 43-51.

Purnomo, S. H., Rahayu, E. T., & Tanti, I. N. (2016). Model Pemberdayaan Kelompok Wanita Tani Ternak Dalam Budidaya Ayam Buras Di Kecamatan Banyudono Kabupaten Boyolali. Sains Peternakan: Jurnal Penelitian Ilmu Peternakan, 14(1), 1-12.

Purwowibowo, Kris Hendrijanto, P. A. S. 2018. *Peningkatan Kapasitas Manusia Sebagai Fokus dari People Centered Development*. Jurnal Aristo, 5(6).

Putra, B., (2017). Analisis SWOT Sebagai Strategi Meningkatkan Keunggulan Pada UD. Kacang Sari di Desa Tamblang (*Jurnal Pendidikan Ekonomi Undiksha*) 9(2). file:///C:/Users/ASUS/Downloads/adminpe,+397-406.pdf

Rakib, Muhammad. Agus Syam. 2016. Pemberdayaan Masyarakat Melalui Program *Life Skill* Berbasis Lokal untuk Meningkatkan Produktivitas Keluarga Di Desa Lero Kecamatan Suppa Kabupaten Pinrang. *Jurnal administrasi publik*, volume 6 No. 1

Runtuni, S. Y, dan Dewanti K. A. (2019). Pemanfaatan biogas dan dampaknya terhadap kesejahteraan keluarga peternak sapi perah di Mojosongo, Boyolali. *PARAMETER: Jurnal Pendidikan Universitas Negeri Jakarta, 31*(2), 81-95.

Sari, AI, Suwarto S, Suminah S, Purnomo, SH. *Empowering the Community in the Use of Livestock Waste Biogas as a Sustainable Energy Source. J*

Taufiq, dkk. 2016. Sistem Pengembangan "Desa Mandiri Energi" (DME) di Desa Sumber Bendo, Saradan Kabupaten Madiun. Jurnal Keteknikan Permintan service dan Biosistem (Volumr 4 no2), p 236 sd 125. Usaha Peternakan Sapi Potong (Studi Kasus Desa Otting Kab. Bone). Jurnal Ilmu dan Industri Peternakan. 3(1).

Warsito, S. H., Widodo, O. S., & Wulandari, S. (2018). Pengetahuan manajemen peternakan dan pemanfaatan hasil ternak sebagai sumber gizi masyarakat di Kecamatan Baron Kabupaten Nganjuk. *Jurnal Layanan Masyarakat Universitas Airlangga*, *2*(2), 69-71.