Utilizing Cattle Livestock Waste for Biogas Energy Production in Barito Kuala Regency, South Kalimantan

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Abstract. Farmers have traditionally used livestock waste, such as feces or urine, in a limited capacity as organic fertilizer. Biogas can be generated from this waste and used as a long-term source of renewable energy. The research purpose is to determine the use of beef cattle waste as a source of energy via biogas in tidal land, with a case study in Barambai and Rantau Badauh Districts, Barito Kuala District, South Kalimantan. A survey was conducted in September 2018 in the villages of Kolam Kiri Dalam, Barambai District, and Danda Jaya, Rantau Badauh District, Barito Kuala Regency, which have a tidal agro-ecosystem and serve as a center for the development of the Bali cattle in intensive rearing system. The intensive maintenance system makes it simple to collect and use livestock waste. Since the manure has accumulated in the cage, making it easier to remove, this condition differs from others that are still semi-intensive and widespread. The result demonstrate that farmers gain benefit from biogas because livestock waste is utilized to prevent environmental pollution and they save Rp. 1,920,000 per family per year in Kolam Kiri Village and Rp. 1,530,000 per family per year in Danda Jaya Village. Farmers' assessments of economic and environmental factors strongly agree, and their assessments of social factors are quite agreeable and useful. Since biogas is expensive to built, it hasn't been widely adopted, but if the government offers financial assistance to farmers, they will adopt it.

Keywords: livestock waste · biogas · energy

1 Introduction

The world's energy requirements will rise in line with population and economic expansion. From 2002 to 2025, global energy consumption would rise by 57% [1], with developing countries bearing the brunt of the increase. However, the energy supply is still heavily reliant on fossil fuels such as oil, natural gas, and coal. Indonesia has a wealth of natural resources, including the potential for plentiful fossil and non-fossil energy sources. However, according to the energy sustainability index, Indonesia's energy system is not well managed, with the country ranking 73rd out of 129 in terms of energy management in 2013. The usage of fossil energy sources such as oil, gas, and coal continues to dominate the majority of household energy needs [2]. The issue of energy

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availability and emissions from fossil fuels puts pressure on every country to create and use renewable energy promptly [3]. The government's aim in the National Energy Policy (KEN) through PP 79/2014, namely the ideal target of the new and renewable energy mix (EBT), is 23% in 2025 and 31% in 2050, with biomass and its derivatives, including biogas, being one of the sources of EBT utilized [4] Biomass is an organic resource that can be converted into energy by transforming biological materials. Biomass may be easily collected and used directly to assist the environment because it is made from resources that are no longer in use or trash [5]. Through the use of biogas, animal waste has been used as energy, particularly in rural regions as livestock centers; handling livestock waste through the use of biogas can bring added value that is helpful to farmers and the environment [6].

Barito Kuala is one of the South Kalimantan regencies having a tidal swamp agroecosystem. There is a regional policy for cattle breeding that is designed and bred is Bali cattle in cattle farming. The majority of system maintenance is done intensively. This is consistent with the use of biogas, which facilitates the removal and collection of livestock excrement from the cage. In most other locations, cattle husbandry is still semi-intensive and vast. Biogas has a high potential as an energy source, and it is one answer to the constraints of energy sources in both households and business [7]. On a domestic scale, 2–4 head of livestock may supply around 25 kg/day of manure, which is enough to use a reactor tube with a capacity of 2500–5000 L. This capacity can create biogas equivalent to 2 L of kerosene per day and can cover the energy needs of one rural household with 6 family members [8]. Biogas was first used as an alternative energy source to kerosene and firewood [9].

In Indonesia, the majority of biogas use is limited to cooking activities, despite the fact that biogas contains the principal constituent CH4, which can be utilized as fuel in electricity generation due to its relatively high calorific value of 23,880 Btu/lbm [10]. A pilot project utilizing biogas as a fuel to generate energy is viable. Construction of biogas power plants, such as those being built in China and Japan, requires collaboration between the government and the private sector. Furthermore, additional research is needed on the use and modification of biogas propulsion engines to make them more relevant to the household size [10].

The usage of biogas can help to solve environmental pollution concerns produced by diesel fuel, such as air pollution, soil pollution, and global warming [11]. Biogas is simple to use, especially in rural places where cattle are raised. In relation to these issues, the use of animal manure is optimized in order to reduce costs while maintaining livestock productivity [12]. The purpose of this study is to investigate the benefits of beef cattle manure as a source of energy through biogas in tidal land, using Barito Kuala Regency in South Kalimantan as a case study.

2 Material and Methods

A survey was used to perform this research in the villages of Kolam Kiri Dalam, District Barambai, and Danda Jaya, District Rantau Badauh, District Barito Kuala. These two villages were given help in the form of biogas as a tool to allow them to use 40 units of animal waste as an energy source. The Plantation and Livestock Service Office, the Mining and Energy Office, and the Environment all provide help in the form of biogas.

Focus Group Discussions (FGD) and interviews were used to conduct the research. Farmers who manage beef cattle businesses and received biogas support were interviewed. There were as many as 30 respondents. The information gathered in the form of beef cattle farming, biogas utilization, and public impression of biogas. The collected data was tallied and descriptively examined.

3 Result and Discussion

3.1 Agriculture Activity Analysis

The beef cattle population in Barito Kuala Regency in 2020 is 8,177 heads distributed across 12 subdistricts. The district with the largest livestock population is Wanaraya, with 4,122 heads, followed by Barambai, with 1,618 heads. In the Rantau Badauh subdistrict of Barito Kuala Regency, the cattle population is 288 heads, ranking sixth [13]. In terms of its cattle development policy, the Barito Kuala Regency is unique, as it is home to the Bali cattle breeding center with an intense raising method.

Kolam Kiri Dalam Village is one of the 17 km^2 communities in the Barambai District with a population of 1,821 people. The rice planting area in this village is 670 hectares, with a yield of 3,180 tons. The oil palm and rubber plantations in this village cover 105 hectares and 296 hectares, respectively. Existing farmer organizations include two Gapoktan and thirteen farmer groupings [14]. 24 km^2 in size, Danda Jaya Village is situated in the Rantau Badauh District. Paddy fields cover 1,419 hectares and yield 3,900 tons; other crops include oil palm on 35 hectares, rubber on 4 hectares, and coconut on 1 hectare. Small quantities of vegetables (chili, tomato, cucumber) and local fruits are also available. Existing farmer institutions include two Gapoktan and twenty-nine farmer groups [15].

Farmers cultivate rice, plantations (oil palm/rubber), horticulture (oranges or vegetables), and cattle (1–5 heads/household) on a small scale. The rice grown is both local rice for personal consumption and premium rice for sale (only planted once per year). Plantation goods are a source of revenue for families since they generate weekly income. Cattle as an investment that can be cashed in when necessary. Income from the sale of cattle can be used for school expenses, celebrations, home repairs, and the purchase of automobiles and motorcycles.

3.2 Cattle Cultivation

Farmers feed forage in an intensive system in which cows are housed throughout the day. Generally, cattle are kept as breeding stock, and sales of livestock are conducted based on demand. Some breeders are attempting to fatten bulls for Eid al-Adha consumption. Farmers always sell either 6- to 12-month-old calves or adult cattle on an annual basis. If more than five broods are owned, sales range from one to three tails.

According to the findings of the interview, the forage provided in the form of natural grass and superior grass cultivated in a yard or garden is the most desirable. There are two daily feedings of forage weighing between 20–30 kg per adult cow. In general, breeders do not supply more feed because grazing fodder is abundant. Some breeders provide

cassava as supplementary feed. Breeders cultivate exceptional grass on an average of two wholesales or 0.06 hectares each home. Commonly planted varieties of exceptional grass include Brachiria, Setaria, Elephant grass, and odot elephant grass. While drinking water is available from wells in the late afternoon and evening.

The cow mating system involves both Artificial Insemination (IB) and natural mating. The period between calves spans from 11 to 15 months, with an average of 12 months. The cages are built of wood, and while some are communal, the majority is individual and located near the house. Intensive maintenance systems make it easier for farmers to manage their livestock and collect the resulting waste. These animal feces have the potential to be utilized as fertilizer and a biogas source. Animal dung will be collected routinely at the barn's edge to prevent livestock from stepping in it, or if farmers have more acreage, a facility for processing organic fertilizers will be constructed.

3.3 Biogas Utilization

Farmers in the village of Kolam Kiri Dalam began using biogas produced from cow manure in 2012, with government aid from the Mining and Energy Office of South Kalimantan Province supplying 40 4 m^3/unit biogas generators. To qualify for biogas support, farmers must have at least three adult cattle to provide adequate manure for biogas production. The South Kalimantan Province Mining and Energy Service, Plantation Service, and the Environment each contributed 40 units of biogas to farmers in Danda Jaya Village.

The potential energy obtained from animal feces in a given region can be approximated by multiplying the average amount of energy obtained from a single livestock (cow/buffalo/goat/sheep) per day by the total number of animals in the region. If 15 kg of livestock dung per cow per day may create 1 m of biogas [16] and 6 kg of manure, then a minimum of three cows can produce up to 144 m of biogas and 96 kg of manure, yielding a maximum of 80 biogas [17] in Pakistan showed that one biogas unit measuring 10 m^3 saves approximately 92,062 PKR per year or the equivalent (Rp 6,095,425.02) when compared to burning conventional fuel for the same capacity. If all animal dung in Barambai District is converted to biogas, the potential yield is between 558.21 and 970.8 kg per day, whereas in Rantau Badauh District, the yield ranges between 99.36 and 172.8 kg per day. According to earlier study, 1 kg of cow dung produces between 0.023 and 0.04 m^3 of biogas every day [18].

Based on interviews, it is known that biogas provides farmers with numerous benefits, including a source of fuel oil and lighting (as an alternative to PLN electricity), a reduction in cooking costs, and the production of solid and liquid fertilizers. The amount of liquid fertilizer produced every week is approximately 40 L, and the amount of granular fertilizer is up to 3 sacks per week. However, there are still limitations to the usage of biogas, such as the need for water to convert livestock dung into biogas (2 parts water to 1 part livestock manure). During the dry season, when water availability is extremely restricted, this creates a concern. Another issue is the high cost of biogas production, as well as the difficulty in obtaining replacement parts or damaged equipment. If only biogas is leaking, farmers can still repair the problem.

According to Table 1, the usage of biogas provided Rp 1,920,000,000 per year each household in the hamlet of Kolam Kiri. This sum does not include the contribution of

Table 1. Estimated economic value of biogas utilization per year in the village of Kolam Kiri Dalam, Barambai District, Barito Kuala Regency, South Kalimantan

No	Description	Quantity	Price (Rp)	Value (Rp)
	Desa Kolam Kiri			
1	Gas cost reduction	36 unit	20.000	720.000
2	Liquid fertilizer	1920 L	250	480.000
3	Solid fertilizer	144 package	5.000	720.000
	Total			1.920.000
	Desa Danda Jaya			
1	Gas cost reduction	60 unit	20.000	1.200.000
2	Liquid fertilizer	840 L	250	210.000
3	Solid fertilizer	24 package	5.000	120.000
	Total			1.530.000

savings as a source of electricity, as savings are only used when the electricity from PLN is turned off. The incalculable value of the use of biogas is the rise in soil fertility owing to the use of liquid and solid fertilizers; in addition, the environment is cleaner due to the optimum utilization of livestock waste. This study agrees with [19] that the use of biogas provides energy cost efficiency in the household, biogas that uses cattle and goats is 41.37 percent if assessed in rupiah equivalent to savings of 120,000 rupiah per month, while using chicken/duck livestock by 20.68% or equivalent to savings of 60,000 rupiah per month.

Based on this research, it is known that the use of biogas can add value, reduce the need to acquire fuel (gas), and produce organic fertilizers that can be used on horticultural crops (oranges, chilies and vegetables as well as rubber and palm oil). According to [20], the development of livestock-based biogas can provide farmers with additional value. Farmers have relied solely on meat and chicks as sources of income from their livestock businesses until now. According to [21], the usage of biogas can lessen people's reliance on fossil fuels (elpiji) and is anticipated to abolish the practice of cutting down trees for cooking fuel. In addition, it can discourage the practice of dumping animal excrement straight into rivers, which can lead to water and air pollution.

3.4 Public Opinion

According to the interview, the greatest impediment to the use of biogas is the high cost of production, as expressed by all respondents. Farmers employ biogas due to government help; biogas cannot be implemented if farmers are required to produce their own. In addition, farmers who disagreed with the assertion that biogas might cut lighting/electricity costs remarked that the issue of biogas technology remained complex (score 2). For other questions, farmers provided a variety of replies, although in general they exhibited moderate to high agreement (scores 3–5) (Table 2).

Table 2. The economic, environmental, and social perspectives of farmers on biogas application.

No	Question	Strongly disagree	Disagree	Simply agree	Agree	Strongly agree
	Economy					
1	Biogas reduces fuel/cooking costs (%)			6.67	10.00	83.33
2	Biogas helps reduce costs for lighting (%)		16.17	83.33		
3	Biogas helps reduce fertilizer purchases (%)			66.67	33.33	
4	Added value of biogas (%)				16.67	83.33
5	The cost of making bogas (%)	100.00				
	Environment					
1	Utilization of manure (%)				16.67	83.33
2	Biogas helps environmental pollution (%)			16.67	66.67	16.67
3	Biogas helps reduce environmental pollution from flies (%)			16.67	66.67	16.67
4	Utilization of liquid and solid waste produced from biogas (%)					100.00
	Social					
1	Biogas technology (%)		16.67	66.67	16.67	
2	Application of biogas in rural areas (%)			16.67	66.67	16.67
3	Benefits of biogas (%)				16.67	83.33

With the category of highly agree, both the economic and environmental values are excellent. The farmer's assessment of biogas from an economic perspective reveals that he strongly supports the use of biogas as a renewable energy source and finds it to be fairly beneficial, with a score of 4.77, based on a 5-question survey. Environmentally speaking, the responses to four questions indicate that biogas reduces environmental pollution from livestock waste, both in terms of odors and flies, and creates waste for organic fertilizer, with an average value of 4.66. From a societal perspective, it is largely agreed that biogas technology may be implemented in rural regions and gives benefits with a mean score of 3.94. The community can generally accept biogas from an economic, environmental, and social standpoint. However, farmers must have understanding regarding the maintenance and utilization of biogas. The challenge that farmers have, according to [22], is that they

lack the knowledge to utilize animal manure as biogas material. Therefore, training is required in order to convert animal manure into a fuel source.

4 Conclusion

This research leads to the conclusion that farmers in the villages of Kolam Kiri and Danda Jaya benefit from the use of biogas to the tune of Rp 1,920,000/year/family and Rp 1,530,000/year/family, respectively. Cost prohibits farmers from producing their own biogas, which has prevented them from doing so. The economic and environmental components of biogas are viewed positively by farmers (strongly agree), while the social side is viewed as acceptable and beneficial.

References

1. Walisiewicz, M. Energi Alternatif : Panduan Ke Masa Depan Teknologi Energi. (2004).
2. B. K. DPR RI. Rancangan Undang-Undang Energi Baru Dan Terbarukan. (2018).
3. Fattah, F. dan A. A. Kahfi. Potensi Kotoran Ternak Sapi Di Desa Kedung Dalem Sebagai Energi Alternatif , Yaitu Sebagai Bahan Pembuatan Biogas Pengganti Minyak Tanah/Gas LPG Sebenarnya Cukup Besar Namun Belum Banyak Dimanfaatkan , Bahkan Dapat Menimbulkan Masalah Pencemaran Dan Kes no. 33. (2017).
4. Fitriana, I., Anindhita, A. Sugiyono, L. M. A. Wahid dan Adiarso. Outlook Energi Indonesia 2017 : Inisiatif Pengembangan Teknologi Energi Bersih. Badan Pengkajian dan Penerapan Teknologi. (2017).
5. Nusantoro, S. dan A. Awaludin. Pemanfaatan Limbah Ternak Sebagai Sumber Energi Terbarukan (Renewable Energy) Dalam Upaya Menuju Masyarakat Mandiri Energi. Polije Proc. Ser., pp. 161–165, 2020, [Online]. Available: https://proceedings.polije.ac.id/index.php/ppm/article/view/127. Last accessed 2022/10/01.
6. Sarwani, S., Nardi, E. A. Nurzaman, M. Marjohan dan H. Hamsinah. Penerapan Ilmu Manajemen dalam Pengembangan Agroindustri Biogas dari Limbah Kotoran Sapi yang Berdampak pada Kesejahtraan Masyarakat Desa Sindanglaya Kec. Tanjungsiang, Kab. Subang," J. Abdi Masy. Humanis, vol. Vol. 1 no, pp. 75–86. (2020).
7. Rahmat, M.B. Potensi Sumber Energi Terbarukan dan Pupuk Organik dari Limbah Kotoran Ternak di Desa Sundul Magetan. in Seminar MASTER PPNS. pp. 175–182, [Online]. Available: http://journal.ppns.ac.id/index.php/SeminarMASTER/article/view/870. Last accessed 2022/10/01.
8. Kaharudin dan F. Sukmawati. Petunjuk Praktis Manajemen Umum Limbah Ternak untuk Kompos dan Biogas. Balai Pengkajian Teknologi Pertanian Nusa Tenggara Barat. (2010).
9. Simamora, S. Salundik, S. Wahyuni dan S. Surajudin. Membuat Biogas : Pengganti Bahan Bakar Minyak & Gas Dari Kotoran Ternak/Suhut Simamora. Agromedia Pustaka. (2006).
10. Yulianto, A., A. N. Adi, dan H. L. Priyambodo. Studi Potensi Pemanfaatan Biogas Sebagai Pembangkit Energi Listrik di Dusun Kaliurang Timur, Kelurahan Hargobinangun, Pakem, Sleman, Yogyakarta. J. Sains dan Teknol. Lingkung., vol. 2 Nomor 2, pp. 83–89. (2010).
11. Wahyuni, S. Menghasilkan Biogas dari Aneka Limbah. Cetatkan P. Agromedia Pustaka. (2011).
12. Meidiana, C., Z. A. Perdanasari dan D. Dinanti. Pemanfaatan Kotoran Ternak Sebagai Energi Terbarukan Melalui Pembangunan Biodigester Komunal. Rekayasa Mesin, vol. 11 No. 3, no. September, pp. 383–393, 2020, [Online]. Available: https://rekayasamesin.ub.ac.id/index.php/rm/article/view/701. Last accessed 2022/10/01.

13. BPS Kecamatan Rantau Badauh, Kecamatan Rantau Badauh Dalam Angka 2021. Badan Pusat Statistik Kabupaten Barito Kuala. (2021).
14. BPS Provinsi Kalimantan Selatan, Kalimantan selatan dalam angka 2021. PT. Grafika Wangi Kalimantan. (2021).
15. BPS Kecamatan Barambai, Kecamatan Barambai Dalam Angka 2021. Badan Pusat Statistik Kabupaten Barito Kuala. (2021).
16. Yaqoob, H. The potential of sustainable biogas production from biomass waste for power generation in Pakistan. J. Clean. Prod., vol. 307, p. 127250, 2021, https://doi.org/10.1016/j.jclepro.2021.127250. (2021).
17. Amjid, S.S., M. Q. Bilal, M. Shahzad, and N. A. Hussain. Biogas, renewable energy resource for Pakistan. Renew. Sustain. Energy Rev., vol. 15, no. 6, pp. 2833–2837, 2011, [Online]. Available: https://econpapers.repec.org/scripts/redir.pf?u=http%3A%2F%2Fwww.sciencedirect.com%2Fscience%2Farticle%2Fpii%2FS1364032111000089X;h=repec:eee:rensus:v:15:y:2011:i:6:p:2833-2837. Last accessed 2022/10/01.
18. Widodo, T.W., A.N.A. Asari, dan E.R. Pemanfaatan Limbah Industri Pertanian Untuk Energi Biogas. pp. 182–192. (2007).
19. Biyatmoko, D. dan B. Wijokongko. Persepsi Masyarakat Kabupaten Banjar Terhadap Pemanfaatan Energi Biogas dan Kualitas Pupuk Limbah Biogas. EnviroScienteae, vol. 7, no. 1, pp. 1–5. (2011).
20. Sutrianto, S., A. S.Aku dan M. A. Pagala. Analisis Potensi Energi Terbarukan Limbah Kotoran Dari Ternak Sapi Di Kecamatan Kusambi Kabupaten Muna Barat Provinsi Sulawesi Tenggara," Jitro, vol. 3 No.2, pp. 64–71, 2016. [Online]. Available: https://media.neliti.com/media/publications/98639-ID-analisis-potensi-energi-terbarukan-limba.pdf. Last accessed 2022/10/01.
21. Sahbana, M.A. dan A. Suyatno. Pemanfaatan Limbah Sapi Perah Untuk Biogas Sebagai Energi Terbarukan Pada Kelompok Peternak. Semin. Nas. Pengabdi. Kpd. Masy. Univ. Kanjuruhan Malang, vol. 0, no. 0, pp. 80–888, 2017, [Online]. Available: https://ojs.unm.ac.id/semnaslpm/article/view/18284. Last accessed 2022/10/01.
22. Santoso, A., S. Sumari, S. Marfuah, M. Muntholib dan R. Retnosari. Pemanfaatan Limbah Sapi Perah Untuk Biogas Sebagai Energi Terbarukan Pada Kelompok Peternak. Graha Pengabdi., vol. 2 No. 2, pp. 114–123, 2020, [Online]. Available: http://journal2.um.ac.id/index.php/jgp/article/view/13343/5558. Last accessed 2022/10/01.