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Community Participation in Utilizing Livestock Waste Biogas to Support Sustainable Energy Development

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ABSTRACT

The development of livestock waste biogas technology as an alternative energy source can solve the problem of energy supply and solve the problem of livestock waste contamination to the environment. The utilization of biogas requires community participation, especially in filling and maintaining the digester. This study aims to analyze the level of community participation in biogas and analyze the factors that influence it. This research was conducted in Boyolali Regency, considering that the cattle population in this district is very high, namely 86,363 dairy cows and 86,988 beef cattle, so that the potential for biogas raw materials is high. Respondents of the study were 60 people who used livestock waste biogas. The research method used is descriptive quantitative, with survey data collection techniques, and the data were analyzed descriptively and multiple linear regression test. The results showed that community participation in biogas development began at the planning, implementation, or construction stages of biogas installations and the use of biogas as an energy source. The most significant community participation was at the consultation level (36%). The results of the multiple linear regression test obtained the value of the equation Y=1,835+0,092X1+0,083X2-0,006X3+0,078X4+0,024X5. The results of the F test show that the value of Fcount>Ftable (3.38 > 2.89) means that the variables of education, number of livestock, income, experience, and intensity of counseling together affect participation. In contrast, the results of the t-test show that the variable partially influences the participation number of livestock, income, and power of extension. This study concludes that the most significant community participation in the use of biogas is in consultation, and community participation can be increased through increasing the number of livestock as biogas raw material providers and assistance through counseling activities.

1. INTRODUCTION

Energy availability is an absolute necessity in various aspects of human life; energy is also used to support sustainable national development. Currently, energy management has been seen as an aspect that does not stand alone but is closely related to various factors, such as climate change, economic and social development, poverty eradication, food security, health, environmental management, to defense and security [1]. As a natural resource, energy must be utilized as much as possible for the community's prosperity, and its management must refer to the principles of sustainable development. Currently, energy management has been seen as an aspect that does not stand alone but is closely related to various aspects, such as climate change, economic and social development, poverty eradication, food security, health, environmental management, to defense and security. The population of Indonesia which continues to increase will cause the national energy demand to increase, one of which is the energy demand in the household sector.

Per Government Regulation No. 79 of 2014 concerning the National Energy Policy (KEN) which mandates that to achieve an optimal primary energy mix, a 25% contribution from new and renewable energy (EBT) is required by 2025. One of the alternative energy sources that are feasible to be developed as a response to the negative implications of the use of fossil fuels that are increasingly depleting their use is biogas. Waste from cattle farming can be utilized optimally in the development of biogas technology. Biogas is a gas produced from the decomposition of organic materials by microorganisms under anaerobic conditions. Biogas is a mixture of gases produced from the decomposition of organic materials through biological processes under anaerobic conditions [2]. In general, biogas consists of 50-70% methane (CH_4) gas, 30-40% carbon dioxide (CO_2) gas, 5-10% hydrogen (H_2) and other gases in small amounts. Biogas weighs about 20% lighter than air. Biogas is colorless but produces a blue color when burned (like LPG) with a combustion temperature between 650-750 C. The caloric value of biogas is about 20 mega joules/m [3].

National energy consumption, especially fuel, continues to increase in line with the pace of economic growth and population growth. In addition to these two factors, the increase in fuel consumption is also influenced by wasteful or inefficient public consumption patterns [4], one of which is controlled by low prices due to subsidies, while from the production side. Indonesia's petroleum since 1995 has experienced a significant decline, from an average of 1.6 million barrels per day to an average of about 778 barrels per day in 2018 (National Energy Balance of the Ministry of Energy and Mineral Resources, 2019). Since 2004, Indonesia has become a net oil importer country, which means that the volume of oil and fuel is higher than its exports. National energy demand or consumption also continues to increase, one of which is energy demand in the household sector [5].

Energy derived from fossil materials (unrenewable energy) is one of the sectors that contribute to the second greenhouse gas emissions after land use and forestry. Greenhouse gas (GHG) emissions to date have reached an alarming stage, so that if they cannot be controlled, they will have a negative impact on the lives of all of us, humanity today, and for generations to come. Therefore, currently, we need energy that is sustainable and does not harm the environment, namely renewable energy [6]. Renewable energy sources are necessary to overcome the crisis in energy reserves such as oil and coal. Various alternative energy sources have been developed, including wind energy, hydro energy, and geothermal energy [7]. However, limited funds for capital investment and complex technology development make implementing these energy sources difficult [8].

The development of livestock waste biogas technology as an alternative energy source can solve the problem of energy supply and solve the problem of livestock waste contamination to the environment [9]. Biogas should reduce gas emissions in Indonesia because it is carbon-neutral, so it doesn't produce gas emissions. Furthermore, any consumption of biogas that replaced the usage of fossil fuels will lower CO_2 gas emissions [10]. This is in line with the concept of sustainability in the use of renewable energy (EBT). Renewable energy utilized must-have requirements that include aspects of sustainability, regional development, and environmental friendliness [11]. Sustainability is defined as energy that can be used continuously without a time limit so that it does not collide with the problem of limited energy resources. At the same time, regional development is a regional development that seeks to develop independence based on the advantages that exist in each region. In addition, the environmentally friendly aspect enhances the concept of energy independence which strives to be in harmony with the environment, does not have a destructive impact in the future, and is not exploitative.

In Indonesia, household biogas is applied mainly as substitute for LPG (liquefied petroleum gas) following kerosene-to-LPG conversion program initiated by government in 2007. The policy of this conversion program was regulated under President Regulation No. 104/2007 on The Rules, Distribution, and Price Determination for 3 kg LPG bottle, Regulation of Ministry of Energy and Mineral Resources No. 021/2007 on The Implementation, Supply, and Distribution of 3 kg LPG bottle, and President Regulation No. 28/2008 on The Price of 3 kg LPG Bottle for Domestic and Micro Scale Business [12].

The current economic development orientation is not only focused on the efficiency and effectiveness of natural resource utilization but is also related to sustainability aspects [13]. Several studies have stated that the concept of empowerment is essential for a sustainable development process. According to Kongqui, sustainable development through an empowerment mechanism can be carried out through a strategy to utilize the local economy, including renewable energy. In Indonesia, biogas development programs began in the early 1970 [14]. The development aims to utilize waste and other biomass to find energy sources other than firewood and kerosene. The program has not been widely developed in the community, and this is because the community was still able to buy kerosene and gas. There was a subsidy policy from the government [15]. Besides, that other energy sources such as firewood were still widely available. However, at this time, biogas is an alternative that is widely used by people from the lower-middle-class economy, especially people who work in the livestock sector. Biogas is one type of alternative energy that is appropriate to be used to meet energy needs in rural areas. In addition, biogas technology is an effective way insupporting sustainable livestock farming by converting livestock waste into sustainable energy and organic fertilizer [16].

The adoption of biogas technology has remained low despite Indonesia as an agriculture country has an abundance of organic resources for biogas production. It is roughly estimated that the installed capacity of biogas utilization in Indonesia is less than 1% of the existing biogas potential. Furthermore, less than 50% of installed biogas digesters in developing countries including Indonesia were operational due to many factors such as inadequate technical support, inappropriate technologies, and lack of institutional capacity of the main stakeholder [17, 18]. Efforts to implement the development of biogas as a source of EBT still encounter many obstacles and obstacles It has not provided optimal and satisfactory results. Several reasons that become obstacles include:

•The lack of socialization.

•Filling the digester and maintenance of complicated and less practical installations.

•The lack of knowledge about installation maintenance.

Acceptance of innovation means not only knowing but can actually be implemented or applied correctly and live it. Acceptance of innovation can usually be observed directly by others as a reflection of changes in attitudes, knowledge, and skills [19]. Acceptance of biogas technology is influenced by internal and external factors. Internal factors are factors that come from within the individual. Individuals receive processes and choose everything that comes from outside and determine which ones will be accepted and which will not be accepted. External factors are factors that come from outside the individual, in the form of a stimulus to shape and change attitudes. These factors include age, education, income, number of livestock ownership, livestock experience, and cosmopolitan level, while external factors that affect biogas acceptance are counseling, institutional support, and motivation from outside [20]. Based on this description, this research was carried out to analyze the factors that influence public acceptance of livestock manure biogas technology.

To achieve the success of sustainable development, community participation in implementing the product is very necessary. The product can run continuously, but the results will be very different if the action is supported by community participation [21]. Likewise, in the development of biogas energy, it requires the involvement of the user community because, in its utilization, biogas will produce energy if the raw material is filled with livestock manure continuously. Participation that grows in society is influenced by many factors, which can be categorized into internal factors (from within the individual) such as age, income, education, perception, motivation, and external (from external/environmental elements) such as communication, social climate, economy, politics & culture, both in family life, association, games, school and community, the opportunity to participate and the freedom to take the initiative and be creative. Based on the description above, this study aims to analyze the level of community participation in biogas and analyze the factors that influence it.

2. METHOD

2.1 Research design and site

The type of research used in this research is explanatory quantitative research. This type of research explains the effect of the independent variables, namely education, number of livestock, income, experience, and intensity of counseling, on the dependent variable, namely the level of community participation in the use of biogas. The research was conducted in Boyolali Regency, Central Java Province, Indonesia, to determine the location of the study by purposive sampling. The consideration used in determining the site is that the cattle population in this district is very high, namely 86,363 dairy cows and 86,988 beef cattle. The potential for biogas raw materials is highv [22].

2.2 Population and research sample

The population in this study were cattle breeders in Musuk District, Ampel District, Cepogo District, and Sambi District, Boyolali District, which used biogas as an energy source. Respondents of the study were livestock manure biogas users who had used biogas for at least two years, totaling 60 people.

2.3 Data analysis

The analysis used in this research is descriptive analysis and multiple linear regression analysis. Descriptive analysis is used to measure the level of community participation in biogas utilization. The story of community participation in the sustainable use of biogas was analyzed descriptively, concerning the Arnstein concept (A Ladder of Citizen Participation), the Arnstein Level has explained on Table 2. Based on three aspects of the discussion, namely knowledge, benefits, and attendance levels in filling and maintaining biogas, with the following criteria of participation rate measurement criteria has been show in Table 1.

To find out the factors that influence community participation in biogas utilization, multiple linear regression analysis was carried out, which mathematically the regression model was as follows [23]:

$$Y=a+b1X1+b2X2+b3X3+b4X4+b5X5+e \quad (1)$$

Description:
Y: Community Participation in Biogas Utilization
a: Constanta
X1: Education
X2: Total Livestock
X3: Biogas Utilization Experience
X4: Income
X5: Extension Intensity
e: Standard Error

To determine the factors that influence or have no effect either simultaneously or partially, the regression test is continued with the f test and t-test [24].

Table 1. Participation rate measurement criteria refer to arnstein's concept

Level	Knowledge	Benefit	Presence
Citizen Control	Know	Know	Present
Diligated	Know	Know	Initiative
Power	Know	Know	Present
Partnership	Know	Know	Initiative
Placation	Know	Know	Present
Consultation	Don't	Know	Initiative
Informing	Know	Know	Volunteer
Therapi	Don't	Don't	Volunteer
Manipualtion	Know	Know	Volunteer
	Don't		Forced
	Know		Forced

Table 2. Definition of arnstein level

Level	Description
Citizen Control	Initiation comes entirely from the community, both in the planning, implementation, operation, responsibility, financing, and maintenance processes.
Diligated Power	Initiations have come from the community to carry out planning, implementation, operation, responsibility, financing, and maintenance by asking for help from related parties.
Partnership	Initiation has come from the community, but related parties still assisted the planning due to the similarity of roles.
Placation	The community has done it voluntarily, already knows the benefits, there is a desire to have an opinion, and the community is welcome to submit suggestions regarding this matter. Still, only part of the opinion is accepted.
Consultation	The community has done it voluntarily, already knows the benefits, the community can make suggestions about it, but there is no guarantee that it will be accepted.
Informing	The community has received information about the benefits of management activities but has not been allowed to express opinions and submit proposals
Therapi	The community carries out activities to utilize livestock waste biogas because they are forced to and already know the benefits.
Manipualtion	The community carries out livestock waste biogas because they are forced and do not know the benefits.

3. RESULT AND DISCUSSION

3.1 Biogas development potential in Boyolali

The concept of sustainable development goals (SDGs) has four pillars, namely social, economic, environmental, legal, and corporate governance. The SDGs are a statement of the results of the agreement of 189 heads of state who are members of the United Nations and have 17 global goals covering various social and economic development issues, including poverty, hunger, health, education, climate change, water, sanitation, energy, environment, and social justice. According to Wibawa, the energy development potential must optimally utilize renewable energy resources available in the local area in a structured and sustainable manner, starting from data collection on available potential, integrated system planning to the management system. The development of energy resources must be an integral part of the community's economy's development in a comprehensive manner (economy of scale) and not be carried out partially or sporadically.

Boyolali Regency is one of 35 regencies in Central Java that has high potential in animal husbandry, especially cattle. This can be seen from the number of cattle population, which is relatively high. According to data from the Central Statistics Agency for Boyolali Regency, in 2018, beef cattle were 86,988 heads, and dairy cattle were 86,363 heads. Geographically, Boyolali Regency is located between 110º22' - 10º50' East Longitude and 7º7' - 7º36' South Latitude, with an altitude between 75-1,500 meters above sea level. Boyolali Regency is very suitable for the development of biogas technology, besides being supported by a high population of cattle so that the availability of biogas raw materials is sufficient. According to Paimin [25], a suitable temperature for the biogas formation process ranges from 20-40°C, and the optimum temperature is between 28-30°C; Boyolali Regency has a temperature between 23-32°C and a humidity of 70-95%. The majority of biogas digesters in Boyolali Regency are fixed dome with varying sizes between $13m^3$ to $30m^3$. The cost of making a biogas digester is quite large (around Rp. 1,000,000, - per m^3, so that in the procurement of digesters it is usually a program of assistance or grants from the government, CSR companies, universities, and other parties, however, there are many people who make it manually). self-help or with independent funds. The digester made can not only be used by one household, but can be used with several households or livestock groups.

Animal waste treatment is one of the efforts that provide many benefits. On the one hand, waste treatment will reduce the impact of contamination on the environment. On the other hand, waste treatment will provide benefits because the processing can be used as fuel. Biogas is a feasible fuel to operate economically, significantly to reduce environmental pollution in rural areas [26].

Biogas is one of the many types of renewable energy sources that are needed by society today because biogas energy can be obtained from household wastewater, liquid manure from chicken farms, cows, pigs, organic waste from markets, the food industry, and other trash. Biogas production enables sustainable agriculture with renewable and environmentally friendly process systems. Biogas provides several benefits, including being able to help reduce greenhouse gas emissions, save people's expenses, increase people's income, reduce the use of wood and kerosene, create a clean environment, reduce the volume of waste disposed of, minimize pollutant seepage, maximize the recycling process, minimize contamination of water sources, reduce air pollution. The resulting fertilizer (slurry) is clean and rich in nutrients.

3.2 Community participation in biogas utilization

Understanding community empowerment is a strategy that focuses on how to provide a proportional role so that people are willing and able to play an active role in social activities. This effort requires a learning process to change people's attitudes and to arouse enthusiasm and desire. Belief in their abilities can increase the power of self-help individuals and groups to improve their destiny [27]. The community learning process in fostering the spirit of participation can occur anywhere under any conditions through the involvement of stakeholders in every aspect and stage of life. The role of stakeholders and facilitators in increasing community participation is determined by how far their level of mastery is in the empowerment process, starting from planning, decision making, implementation, utilization of results, and evaluation of program activities [28].

Participation is an action to take part in an activity to obtain its benefits. Participation can also be interpreted as participating a person or group of community members in a program. In the development of livestock waste biogas, participation begins at the planning stage (location selection), implementation or construction of a biogas installation/digester, as well as the utilization (filling and maintenance of the digester) biogas as an energy source, as well as the use of slurry as fertilizer.

3.2.1 Participation in the planning stage

Community participation is important in development planning, this is in line with the opinion of Conyers in Wirawan et al. [29], which suggests three main reasons why community participation in planning has a very important nature:

1. The community is a tool to obtain information about the conditions, needs and attitudes of the local community.
2. The community will trust the development activity program more if they are involved in its preparation and planning, because they will know more about the ins and outs of the activity program and will have a sense of belonging to the activity program.
3. to encourage public participation because there will be an assumption that it is a democratic right if the community is involved in development.

In every development planning, it is necessary to have a contribution in the form of thoughts, ideas, criticisms and suggestions voluntarily from the community for a development so that in every decision making there is a socialization of the community must also be involved. Community participation at the planning stage can be shown in participation in socialization or counseling activities regarding biogas energy from livestock manure and involvement in site selection. Through socialization or counseling, the community becomes aware of information about the benefits of biogas, determining the location of the digester, how to manufacture the digester, filling and maintaining biogas installations. The process of selecting the location of the land is crucial for biogas development because it must consider several aspects, such as being close to the cage to make it easier to fill. The construction of a biogas digester must have a lower place than the cage so that water and animal manure can flow into the digester. Soil density also needs to be considered because it affects the excavation process; it can prolong the excavation process if the soil is too hard. Wahyudi [30] in his research found the reason why farmers have not adopted technology, 33% of them are due to the unavailability of land to build digesters. The construction of 1 $9m^3$ digester unit requires a field with a minimum diameter of 3m.

Community participation in the planning stage is also very necessary to shape public perceptions and attitudes towards biogas. The views of individuals and communities towards a program are strongly influenced by various things, as stated by Suharyat [31] that everyone has different perceptions and attitudes towards an object. Therefore, the development of community attitudes is expected to shape positive community behavior, including in the use of biogas. Prior to using biogas technology, farmers applied dry lot system to manage their manure while the rest dumped waste into river. These are considered simpler and cheaper treatment methods compared to others. Dry lot is a manure management system whereby manure, in particular cow dung, is stacked in uncovered areas with or without pavement and the accumulated dung will be removed periodically [32]. Farmers use collected dung to fertilize their own land or sell it to other farmers. This type of manure management is still applied by non biogas adopters.

3.2.2 Participation in the implementation phase

At the stage of implementing community development, they must involve themselves in the form of financial and labor, because the role of the community is very important. When planning and implementation are underway, of course, supervision or control in the form of suggestions and criticism from the community is very important to oversee the course of a program of development activities. At the implementation stage, community participation can be done through participation in the biogas digester construction process. In the manufacture of a fixed dome type digester, the activities carried out include: Making a lay-out of a biogas reactor; Hole digging; Leveling and hardening/casting of the base; Making construction of digester and gas reservoir; Construction of outlets and inlets; Make a slurry container construction; Piping or installation of gas lines from the dome to the stove.

3.2.3 Biogas utilization stage

In the utilization stage, participation can be shown by filling the digester with animal manure that has been mixed with water in a 1:1 ratio. The digester is supplied to a whole state marked by the discharge of sewage in the drain pipe. Filling the digester with manure must be done continuously so that biogas can produce energy. Maintenance of biogas installations (digester, lines, and stoves) is also essential so that the structure is not clogged, which causes gas not to escape.

Participation in the use of biogas is also accompanied by the use of slurry for plant fertilizers. Economic benefit was estimated from LPG saving due to biogas utilization for cooking and slurry digestate utilization for Replacing chemical fertilizers [33]. Utilizing biogas output in the form of liquid slurry is also significant because if the slurry is not utilized, it will accumulate in the outlet hole so that biogas production cannot be optimal. Slurry digestate is an important link between biogas and agriculture [34]. Therefore, biogas installation must be accompanied by organic fertilizer production and smallholder agriculture.Bio-slurry as an organic fertilizer has a relatively high organic matter content which helps improve soil structure, namely N content of 1.321%, P content of 0.859%, and K content of 1.074% [35].

The study results show the level of community participation by referring to the level of involvement according to Arstein, which can be seen in Table 3.

Based on Table 3, it can be seen that the highest level of community participation in the use of biogas is at the Consultation level (31.7%). This means that most of the community has filled and maintained the digester voluntarily, already knows the benefits of biogas, and the community can make suggestions. It was related to biogas development, although there is no guarantee of acceptance. Isbandi in a book on participatory planning based on community assets states that participation is a voluntary contribution from the community to the project even without participating in decision making, and participation is the involvement of the community in the development of themselves, their lives, and their environment. The lowest level of participation is at the therapy level (8.3%), where the community already knows information about biogas but is still forced to use it. This condition is usually because the biogas digester used is a program of assistance from various parties (government or other stakeholders) without much community involvement in making the digester so that the sense of ownership and responsibility as users is lacking.

Table 3. Level of community participation in biogas utilization

Level Partisipasi	Respodent Total	Precentage
Citizen Control	8	13,3
Diligated Power	6	10
Partnership	5	8,3
Placation	8	13,3
Consultation	19	31,7
Informing	9	15
Therapi	5	8,3
Manipualtion	0	0
Total	60	100

Conyers in Wirawan et al. [29], in the theory of community participation, reveals that the importance of the role of the community in development planning is that the community will have confidence in the program of development activities if they are involved in the process of preparation and planning until its implementation. The community will better understand the conditions of programs and activities and have a sense of belonging to these programs and activities. Citizen participation includes citizens' access to identify local priorities and plan and implement programs by placing citizens as key actors, both as implementers and beneficiaries in the local governance process [36].

In the participatory approach, community participation is limited in terms of physical participation. Still, involvement allows them to assess the problems and potentials in their environment and then determine the activities they need. When society is strong, the role of outsiders is diminished. That is why the participatory approach is also known as the community empowerment approach.

3.3 Factors affecting participation in biogas utilization

Angell says that growing participation in society is influenced by many factors, including internal factors within the individual such as age, gender, education, occupation and income, and experience. In addition, factors that influence community participation in a program can come from external/environmental elements. According to Holil, 4 points affect community participation from outside/environment, namely intensive communication; social, economic, political, and cultural climate; Opportunity to participate; and Freedom to take the initiative and be creative. The results of multiple linear regression analysis of the influence of independent variables (education, number of livestock, income, experience, and intensity of extension) on the dependent variable, namely the level of farmer participation, resulted in the following regression equation:

$$Y=1{,}835+0{,}092X1+0{,}083X2+0{,}006X3-0{,}078X4+0{,}024X5 \quad (2)$$

From the regression equation above, a constant value of 2.355 is obtained. This value states that if the independent variable or acceptance of biogas technology is considered stable, then the acceptance value of biogas technology is 1.835.

The value of the variable regression coefficient is as follows:

a. The X1 regression coefficient (education level) of 0.092 means that every increase in the level of farmer education by 1 unit will increase community participation in biogas by 0.092, assuming other independent variables are constant.

b. The regression coefficient X2 (number of livestock) is 0.083, meaning that every 1 unit increase in the number of animals will increase community participation in biogas by 0.083, assuming other independent variables are constant.

c. The X3 regression coefficient (experience using biogas) is 0.006, meaning that every 1 unit increase in the number of livestock will increase community participation in biogas by 0.006, assuming the other independent variables are constant.

d. The X4 regression coefficient (income level) is -0.078, which means that for every 1 unit increase in the income level of farmers, it will reduce community participation in the farmer's biogas for biogas -0.078, assuming the other independent variables are constant.

e. The X5 regression coefficient (intensity of extension) of 0.024 means that every increase in the power of extension attended by farmers by 1 unit will increase community participation in biogas by 0.024, assuming other independent variables are constant.

Based on the determination test (R2), the results were 0.584 or 58.4%. This shows that the percentage contribution of the influence of the independent variable (education, number of livestock, income, experience, and intensity of extension) to the dependent variable (acceptance of biogas technology) is 61.2%. At the same time, 38.68% is influenced by other variables that are not included in this model. The value of the termination coefficient that is close to one means that the independent variables provide almost all the information needed to predict the variation of the dependent variable [37].

Table 4. T test calculation results factors affecting participation in biogas utilization

Variable	t_{hitung}	t_{tabel}	Sig.	Ket
Education	0,910	1,670	0,115	Not Significant
Total of livestock	2,559	1,670	0,006	Significant
Biogas Utilization Experience	1,312	1,670	0,232	Not Significant
Farming Income	1,822	1,670	0,037	Significant
Extension Intensity	3,882	1,670	0,001	Significant

The result of the F test based on shows that the Fount value is 3.38, at a significance level of 5% with df 1 (number of variables-1) = 5 and df 2 (n-k-1) = 60, then the f table value is 2.89. The data shows the importance of F count 3.38> 2.37. It is said that the regression coefficients are jointly significant at the 5% significance level. Based on the calculation, the independent variables (education, number of livestock, income, experience, and intensity of extension) together affect the dependent variable (participation in biogas utilization).

Based on the results of the t-test in Table 4, it is known that the variable number of livestock, income, and intensity of counseling have a significant effect on farmer participation in the use of biogas. In contrast, education and livestock experience variables have no effect. The variable number of cattle has a significant impact on farmer participation in biogas utilization. This indicates that the more livestock kept, the more sustainable the availability of biogas raw materials will be. Irmawati et al. [38] stated that the number of livestock strongly influences biogas technology because it will determine the amount of biogas produced every day. There is no shortage of feces as a filler for the biogas digester. Biogas on a household scale with 2-4 livestock or a supply of approximately 25 kg/day of manure is sufficient to use a reactor tube with a capacity of 2500-5000 liters which can produce biogas equivalent to 2 liters of kerosene/day. And able to meet the cooking energy needs of a rural household with six family members.

The income level variable has a significant effect on participation in biogas utilization. The benefit of using biogas is fulfilling household energy at a meager cost because it utilizes livestock manure. This is very meaningful for those who have low-income levels. The use of biogas can also reduce the cost of cooking fuel for the people who use it. Community expenditures can be reduced along with the help of biogas, so monthly fees are more efficient. The cost of buying gas can be diverted for other household needs; thus, livestock business using biogas contributes to the income of the farmer's family. Musanif as an energy source 1m^3 of biogas is equivalent to 0.62 liters of kerosene or 0.46 kg of LPG, 0.52 liters of diesel, 0.80 liters of gasoline, and 3.50 kg of firewood. A family size anaerobic cowdung biogas digester with 5 heads of cow potentially reduced greenhouse gas emissions by 2674.8kg CO_2 equivalent per year compiled of 1592.8 kg from CH4saving due to manure management, 468 kg from LPG saving, and 614kg from fertilizer saving. In addition, the biogas utilization also provided annual economic benefit of 1,450,970 IDR/year 111.6 USD/year [33]. Purnomo et al. in their study stated that the contribution of revenue from biogas utilization to the total income of livestock business was 8.03% for beef cattle and 7.1% for dairy cattle.

The variable intensity of extension has a significant effect on participation in biogas utilization. The passion for extension shows the frequency with which a farmer gets information on biogas technology through extension programs, whether delivered by the government, universities, or other institutions. On average, farmers have participated in biogas counseling two times. Sumbayak [39] stated that the intensity of extension is significant in the innovation adoption process. Reinforced by Halim et al. [40] that farmers who are actively involved in socialization or counseling and the technical development of biogas technology are people who develop biogas technology. Active breeders are very knowledgeable about the technical knowledge and workings of biogas technology. However, not all farmers generate biogas sustainably. The role of participatory breeders and extension workers must be in synergy so that the impact of extension can be achieved optimally [41]. Prabayanti [42] stated that farmers who have a high frequency of access to communication channels, the more knowledge they can get about innovations to implement or adopt these innovations. Local government support in mentoring and extension programs supports the successful delivery of technology so that farmers can adopt it [43], The variable intensity of extension has a significant effect on the acceptance of biogas technology. The intensity of extension shows the frequency with which a farmer gets information on biogas technology through extension programs, whether delivered by the government, universities, or other institutions. On average, farmers have participated in biogas counseling 2 times.

Sumbayak [39] stated that the intensity of extension is very important in the innovation adoption process. Reinforced by Halim et al. [40] that farmers who are actively involved in socialization or counseling, as well as technical development of biogas technology are people who develop biogas technology. Active breeders are very knowledgeable about the technical knowledge and workings of biogas technology. However, not all farmers develop biogas sustainably. The role of participatory breeders and extension workers must be in synergy, so that the impact of extension can be achieved optimally [41]. Prabayanti [42] stated that farmers who have high frequency of access to communication channels, the more knowledge they can get about innovations so that they implement or adopt these innovations. Local government support in the form of mentoring and extension programs supports the successful delivery of technology so that farmers can adopt it [43]. Having enough information and support from the government is an effective way for early adopters to deal with the uncertainty and the risk of adoption the biogas technology. Therefore, the government should provide other types of active support (e.g., funding, training and technical assistance) to promote biogas technology. The government should encourage and attract the private sector to be involved in promoting biogas technology by providing facilities such as tax and custom exemption, laws in order to make the biogas sector commercially sustainable and market oriented.

4. CONCLUSION

Based on the results and discussion, it can be concluded as follows:

(a) In the development of livestock waste biogas, participation begins at the planning stage (location selection), implementation or construction of a biogas installation/digester, as well as the utilization (filling and maintenance of the digester) biogas as an energy source, as well as the use of slurry as fertilizer.

(b) The highest level of community participation in the use of biogas is at the Consultation level (31.7%), this means that the majority of the community has done filling and maintenance of the digester voluntarily and already knows the benefits of biogas, the lowest level of participation is at the therapeutic grade (8.3%), where the community already knows information about biogas, but its use is still forced.

(c) Community participation in biogas utilization is influenced by the number of livestock, income level, and intensity of extension

The value of the variable regression coefficient is as follows:

The X1 regression coefficient (education level) of 0.092 means that every increase in the level of farmer education by 1 unit will increase community participation in biogas by 0.092, assuming other independent variables are constant. The regression coefficient X2 (number of livestock) is 0.083, meaning that every 1 unit increase in the number of animals will increase community participation in biogas by 0.083, assuming other independent variables are constant. The X3 regression coefficient (experience using biogas) is 0.006, meaning that every 1 unit increase in the number of livestock will increase community participation in biogas by 0.006, assuming the other independent variables are constant. The X4 regression coefficient (income level) is -0.078, which means that for every 1 unit increase in the income level of farmers, it will reduce community participation in the farmer's biogas for biogas -0.078, assuming the other independent variables are constant. The X5 regression coefficient (intensity of extension) of 0.024 means that every increase in the power of extension attended by farmers by 1 unit will increase community participation in biogas by 0.024, assuming other independent variables are constant.

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