BIO-DIGESTER INSTALLATION PROGRAM TO IMPROVE ENERGY SECURITY: INITIATING VALUE CHAIN MODEL FOR DAIRY FARMERS IN CIATER

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ABSTRACT

Biogas is a renewable energy source which utilizes animal manure and converts it into combustible biogas for cooking and lighting. This study aims to investigate the eligibility and readiness of farmers in Subang to install bio-digester and subsequently identify the value chain model for the installation. Survey was used to identify the primary activities of dairy farmers and to evaluate the characteristics of farmers who have used biogas. Interviews were used to identify support activities in the value chain model. 120 respondents were selected and interviews were conducted to identify the support of (KPSBU) to build biogas reactor in the area. Contingency test from the survey data showed that there are relationships between the use of bio-digester and number of household members; number of dairy cows owned and the length of period for being KPSBU member. Thus value chain model is developed based on the support from KPSBU and for the farmers that have household members more than 5 persons and have joined KPSBU membership for at least 3 years.

Keywords*: biogas, bio-digester, sustainability, value chain model, dairy farmer.*

1. INTRODUCTION

Biogas is a renewable energy source which utilizes animal manure and converts it into combustible biogas for cooking and lighting. BIRU (Biogas Rumah or Indonesia Domestic Biogas) is one program funded by HIVOS (Humanist Institute for Co-operation with Developing Countries) with Technical Assistance from SNV (Netherlands Development Organization) that installs biogas converters (or bio-digester) in houses in cattle farm villages, including in Ciater. Dairy farm village in Ciater is a potential area to generate their own renewable energy. As a village with abundant biomass sources, Ciater Dairy Farm Village should be able to generate their renewable energy from biogas sources. Some dairy farmers have already installed bio-digester to utilize cow manure for cooking fuel. These farmers have also used the energy (in a limited application) for their lighting sources. However, there are many other dairy farmers who have not utilized cow manure and dump the manure to the sewage system. This leads to unhygienic and unsustainable condition.

The high cost of cooking gas purchase may motivate local community to install bio-digester or to use the manure as biogas energy sources.

There are two types of bio-digester that mainly used in Indonesia, fixed dome and floating drum bio-digesters. Both bio-digesters have dome shape. The main difference between these bio-digesters is in the gas chamber. Figure 1 shows the shape of both bio-digesters.

The fixed dome bio-digester has a separate slurry pit (on its left hand side), the gas holder stays in the main dome. The floating drum bio-digester has a gas holder that floats. It moves up when the gas (methane) is produced and sinks back again if the gas has been consumed.

In West Java, Indonesia, bio-digester installation has been found in many locations, including Subang. Most of the bio-digesters are installed using BIRU program collaborated with KPSBU (Koperasi Peternak Sapi Bandung Utara or North Bandung Dairy Farmer Cooperatives). This program offers installment for bio-digester installation. The procedure of installing bio-

digester is as follow: (1) eligible farmers contact KPSBU coordinator in their area and asked for assessment, (2) The coordinator assessed whether the farmer is eligible for loan, (3) When the farmer is approved to get the loan, coordinator contact biogas contractor to estimate the cost of installation, (4) KPSBU asked HIVOS for subsidy and pay the contractor first payment for installation, (5) The contractor built the bio-digester and (6) After the installation, the farmer pay the installment through KPSBU that is automatically deducted from their milk sales.

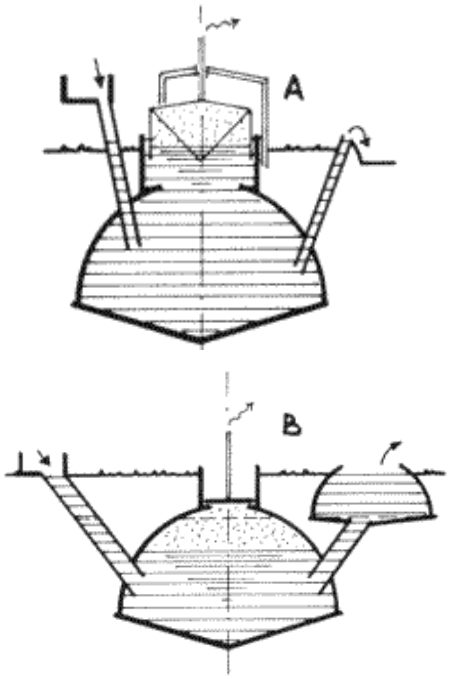

Figure 1: Types of bio-digester (A) floating drum (B) fixed dome (Energypedia, 2012)

Lembaga Studi Pembangunan Peternak Indonesia had conducted an initial survey to dairy farmers in several villages in Subang: Ciater, Jalan Cagak, Kasomalang and Sagala Herang (Yayasan Sahabat Cipta, 2011). The survey showed that there were 194 farmers but only 95 farmers who had or are using bio-digester for collecting the manure.

The high cost of installation is one of the main reasons for not using bio-digester beside limited land owned to build the bio-digester. The installation cost of bio-digester is ranging from 6 to 10 millions IDR depending on the size. This cost applies to the fixed dome bio-digester that is mainly installed in Indonesia. Although HIVOS has subsidized those who want to install bio-digester for 2 millions IDR and helped farmers to access installment program to pay the cost, not all farmers are eligible for the installment and eager to apply the loan program.

This study aims to investigate the eligibility and readiness of farmers in Subang to install bio-digester and subsequently identify the value chain model for the installation. By understanding the value chain model, recommendations for more installation can be given to relevant stakeholders.

2. THEORETICAL BACKGROUND

The theoretical background covers the literatures about value chain model.

2.1. Value Chain Model

Value chain, as represented in Figure 2 is activities that give added value to the company in the form of a product or a service (Porter, 1985).

There are two main activities mentioned by Porter (Porter, 1985) it the value chain analysis: primary activities that are directly related to the product or service sold by the company and support activities that help the company to perform the primary activities.

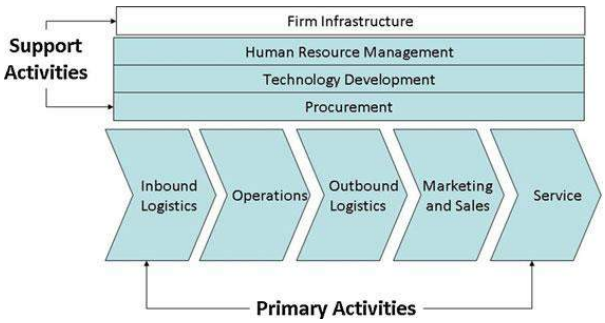

Figure 2: Value Chain Model (Porter, 1985)

The primary activities include the process of receiving materials (inbound logistics), value added process or production activities (operations), distribution (outbound logistics), sales and marketing and post-sales service and maintenance. Porter value chain model is designed for businesses or for-profit companies and is not created for sustainability focus. This paper investigate value chain model for community

engagement in biogas program and for sustainability focus. Walsh suggested to adapt the primary activities by combining with Maslow's hierarchy of needs to balance the social, economic and environmental pillars of sustainability (Walsh, 2011). Walsh model is proposed to monitor the achievement of sustainable development (See Figure 3). The primary activities refer to the achievement of human needs, starting from social, economic and environmental sustainability reflected by all needs based on Maslow's hierarchy.

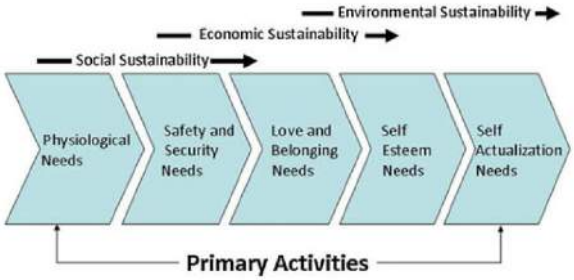

Figure 3: Primary activities of Walsh Model to support sustainable development (Walsh, 2011)

While Walsh focused on the primary activities in value chain model, McPhee and Wheelers (McPhee & Wheeler, 2006), Vurro et al. (2009) and Bloom and Hinrichs (2011) proposed new insights in support activities, to create non-traditional value chain model. These studies support value chain for sustainable programs. McPhee and Wheeler explicitly added external network as a support activity. In terms of the infrastructure and external network, Bloom and Hinrichs recommended a framework that emphasizes the commitment to the welfare of all stakeholders, strategic partnerships and the role of trust and shared governance. Similarly, Vurro et al. looked at more structured approached, by identifying the difference between the role of the main organization, its commitment in creating value chain and collaboration with related organizations that lead to strong sustainable focus.

Similar to Bloom and Hinrichs (2011), the applied research of Mmasa and Msuya (2012) identified the linkage between actors, infrastructure and processes to strengthen value chain in sweet potatoes agriculture.

For biogas installation program, the primary activities are more domestic activities related to cooking and other use of biogas for replacing non-renewable energy at home. There are no specific operations and logistics, thus, the primary activities defined by Walsh is more relevant to this program. For support activities, there are many stakeholders involved, such as HIVOS as the subsidy giver, KPSBU who coordinates the installation program, the biogas installation contractor and the farmers as the main actor and perform the primary activities. The other three stakeholders should be categorized as external network but as an integrated one.

Since the biogas installation program encourages the use of renewable energy from cow manure, the program should be seen as a sustainability initiative. Relevant to of integrated structure offered by Vurro et al. and Bloom and Hinrichs in looking at infrastructure and network, (and considering existing Porter's value chain model), the support activities should be defined as: (1) commitment to the welfare; (2) strategic partnerships; (3) trust and shared governance; (4) technology development; and (5) procurement. Thus the value chain model offered in this study is represented in Figure 4.

Support Activities	Commitment to welfare
	Strategic partnership
	Trust and shared governance
	Technology development
	Procurement

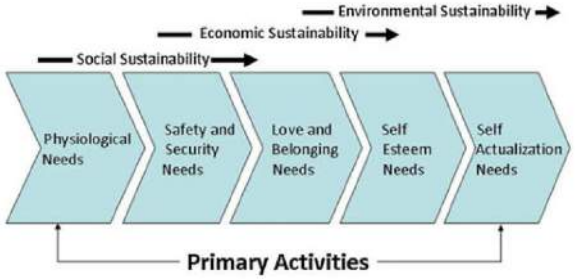

Figure 4: Biogas Installation Value Chain Model (Source: Bloom & Hinrichs, 2011)

3. RESEARCH METHOD

To identify the value chain model for biogas installation program, the study was

conducted using both questionnaires and interviews. Questionnaires were used to identify the primary activities of dairy farmers and to evaluate the characteristics of farmers who have used biogas. Interviews were used to identify support activities in the value chain model.

The questionnaires were designed to complement the study conducted in 2011 (Yayasan Sahabat Cipta, 2011) From the previous study there were data about the socio economic status of dairy farmers in Subang, the handling process of cow manure as well as the maintenance of cows in this area. The questionnaires in this study extend the previous study with the identification of the maintenance of biogas, the use of biogas and the financial benefits of biogas for the households.

Questionnaires were distributed among dairy farmers in Subang. To avoid any bias of the responses, the respondents were guided when filling the questionnaires. Respondents were randomly selected from dairy villages in Subang: Ciater, Jalan Cagak, Kasomalang and Sagala Herang. 120 respondents were selected; when farmers were not available to survey, the other farmers were subsequently selected randomly. Although the sampling design was based on simple random sampling, there were some areas excluded due to difficulty to access considering the time and survey budget. The data collection was done in two weeks in November 2013.

Interviews were conducted to identify the support of the cooperative (KPSBU) and their current efforts to build biogas reactor in the area. Also, interviews were used to identify the impacts of community engagement program in biogas installation in the area.

Interviews were conducted with the Head of KPSBU in Lembang and one staff member of KPSBU and 2 NGO workers who involve with biogas installation program to find out the situation of dairy farmers and biogas installation program. The interviews were conducted in December 2013 and January 2013.

4. RESULT AND DISCUSSION

BIRU suggests that the need of gas for daily activities per person is around 0.33-0.40 m^3. One 6 m^3 bio-digester can produce biogas between 1.6 and 2.4 m^3, thus it will suffice the needs of more than 5 persons. Biogas is distributed to the stove or inside the house using a long PVC piping.

In Ciater, there are many farmers who have not yet installed bio-digester due to several reasons, for instance: the high cost of bio-digester and lack of awareness and knowledge about bio-digester. The lack of knowledge is due to low education level of the farmers or the family.

The price of installing one 6 m^3 bio-digester is about 6.6 million IDR in 2012. When the farmers were informed about the price of the installation, they could not figure out that the cost will actually be paid off by free biogas produced and used as the replacement of the price of LPG gas. Also, they do not have information that the installation cost can be paid in installment if they can prove that they have stable household income from the milk they sell to KPSBU. Thus, a financial analysis for farmers to utilize bio-digester is needed to identify if it is feasible to install it.

4.1. Farmers and Bio-digester Characteristics

Biogas users can be categorized into three types: first, the fixed dome bio-digester, second, the floating dome bio-digester and third, the ex-users of any bio-digesters. The floating dome bio-digester users are the pioneer that installed when biogas was first introduced in this area. For the last three years (from 2009), all newly bio-digesters installed are the fixed dome one as it is safer and more efficient in generating biogas.

The previous survey in 2011 (Yayasan Sahabat Cipta, 2011) shows that 194 farmers in Ciater used bio-digesters and all of them are between 18 and 66 years old. They have been farmers from 1 to 3 years and also KPSBU members during these periods. Most of their education level is elementary school, they have attended training about dairy farming. They have 1 to 3 dairy cows. They use the manure for fertilizer. Some of them used bio-digesters for cooking and lighting.

The survey conducted in this study shows that the characteristics of the farmers have not significantly changed. The survey then is used to identify if there are significant parameters of farmers characteristics that are strongly related to the preference of using bio-digester.

Thus, contingency test was used to identify the relationship between the use of bio-digester and (1) number of household members; (2) education level; (3) age of the farmers' spouse, (4) number of dairy cows owned and (5) the length of period for being KPSBU member.

From the contingency test conducted, it is proven that all five above attributes significantly relate to the ownership of bio-digester.

Figure 5 and Figure 6 show the proportion of farmers who own bio-digester and not. Figure 5 show the proportion based on ownership of bio-digester and the number of household members. It is shown that households that consists of more than 5 members tend to use bio-digesters than those who have less household members. In Figure 6, it is shown that farmers who are KPSBU members tend to own bio-digesters.

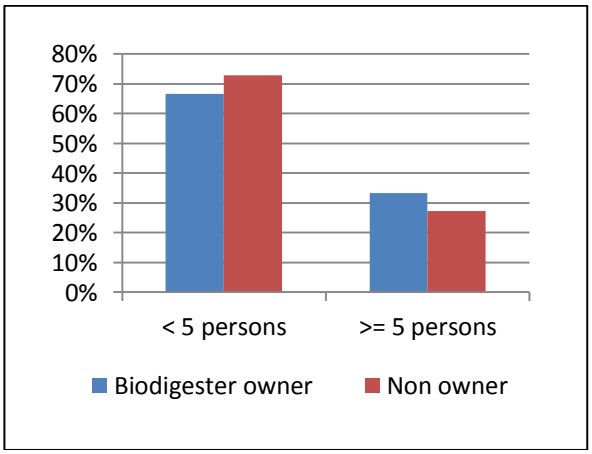

Figure 5: Number of household members vs bio-digester owners

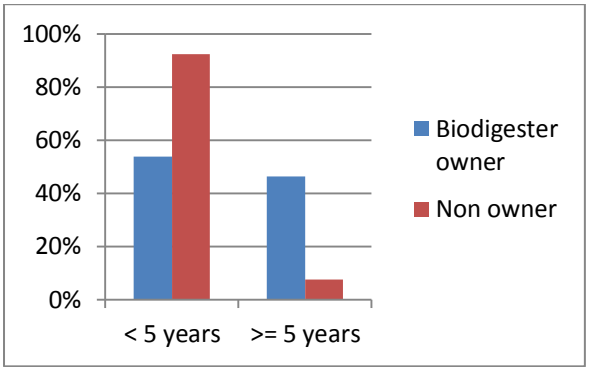

Figure 6: Number of KPSBU membership vs bio-digester owners

Table 1: Association of bio-digester ownership and farmers characteristics

Farmers attribute	Contingency coefficient	Associ-ation
Age of the spouse	0.232	weak
Education level	0.198	weak
Income	0.273	weak
Number of dairy cow ownership	0.267	weak
Length of period of being farmer	0.241	weak
Length of KSPBU membership	0.406	medium

To measure the association between the ownership of bio-digester and the other attributes, contingency coefficient is used. Table 1 shows the association, and it is shown that although those 5 attributes have significant relationship with the ownership of bio-digester, only the length of KPSBU membership that has relatively medium association.

Based on the survey, it can be identified that the characteristics of current farmers who own bio-digester are as follow:

Table 2: Bio-digester Owners Characteristics

Source of information about biogas	Mostly KPSBU (47 from 54 farmers)
Length of the use of biogas	Maximum: 7 years Average: 2 years
Land needed to install biogas	Average: 4.35 sq m
Decision maker	Self or family
The use of bioslurry (waste from biogas)	Fertilizer (27 of 54) or dumping (27 of 54)

The survey also reveal that the main reason for the farmers to install bio-digester is the cooking as LPG is hard to find (16 cost

efficiency of energy use for cooking (34 of 54), the easiness of access biogas for respondents). The others said that the use of bio-digester is safer than LPG, the influence of neighbors and also the responsibilities from purchasing cow in installment. KPSBU had initiated a program for its member which the member can buy a package of dairy cow and bio-digester in installment with the aims of encouraging the use of bio-digester.

4.2. Financial Evaluation of Bio-digester Installation

Financial evaluation is carried out to identify the economic sustainability of using biogas. The condition for financial evaluation is as follow:

1. Dairy cows owned per household are 5;
2. The number of household members are 5;
3. The price of subsidized LPG (3 kgs) is 17,000 IDR;
4. The bio-digester installed is 6 m^3 size.
5. The manure produced per day is based on the minimum production: 100 kgs;
6. Only 60% of the manure (60kgs) is filled into the bio-digester;
7. The portion of dried bioslurry (bioslurry from biogas waste which is already separated from the water content) will be sold as fertilizer. The slurry produced everyday is 50% of the manure (50% content is water), or 30 kgs.

Three different scenarios are compared for the financial evaluation:

1. The monthly LPG consumption of 9 kgs replaced by biogas and without selling the bioslurry as fertilizer at all.
2. The monthly LPG consumption of 9 kgs replaced by biogas and the bioslurry is sold at 40 IDR per kg.
3. The monthly LPG consumption of 9 kgs replaced by biogas and the bioslurry is sold at 8,000 IDR per bag of 30 kgs.

The financial evaluation is examined using net present value (NPV). The period of investment is 15 years and the cost of bio-digester installation is 4.6 million IDR, from the installation cost of 6.6 million deducted by subsidy from HIVOS 2 million IDR. Dairy farmers pay the installation cost by installment from KPSBU (from authorized bank) with the interest rate of 8%, paid monthly.

Based on the above data, Table 3 shows the financial feasibility of the use of bio-digester.

Table 3: NPV of the scenarios

Scenario	NPV
(1) No bioslurry is sold	Rp 1.418.781
(2) Bioslurry is sold as fertilizer at 40 IDR per kg	Rp 2.159.682
(3) Bioslurry is sold as fertilizer sold at 8,000 IDR per bag of 30 kgs	Rp 6.358.121

It is shown that all scenarios are feasible from the NPV perspective, although the value of money received is not much, unless they can sell all the bioslurry produced as fertilizer.

4.3. Value Chain Model of Dairy Farmers with Bio-digester

From the previous data, it is shown that KPSBU has major role in bio-digester installation, shown by most of the bio-digester users got information from KPSBU and there is relationship between being a KPSBU member and owning bio-digester.

From the interview with the Head of KPSBU in Lembang, he stated that he always supported the farmers to have bio-digesters, and all area coordinator (from KPSBU) will always liaise dairy farmers with the contractors of bio-digester installation. KPSBU carefully assess the eligibility of the farmer to install bio-digester, from the availability of land, ability to pay the installment. KPSBU also liaises the farmers with the contractor and with the bank for installment, and with HIVOS for subsidy. In means that KPSBU plays a significant role in maintaining social and economic sustainability of bio-digester installation.

The interview conducted with two NGO workers who involve in biogas awareness program revealed that some food companies are willing to assist dairy farmers to install

bio-digester as their CSR (corporate social responsibility) program.
From these findings, a value chain model for dairy farmers in Ciater is designed. The support activities for this value chain model can be identified as in Table 4.

Table 4: Support activities

Support activities	**Remarks**
Commitment to welfare	There is commitment from KPSBU Assistance from company CSR
Strategic partnership	Cooperative HIVOS gives subsidy through authorized bank, the bank will have the list of eligible customer from KPSBU, KPSBU pays the installment to the bank from money deducted from milk production of the farmers (that is purchased by KPSBU)
Trust and shared governance	Area Coordinator from KPSBU liaise all the process between KPSBU and farmers; coordinator has good relationship with farmers in his area. There are shared responsibilities among coordinator, KPSBU, and banking institutions, to assist the success of bio-digester installation.
Technology development	The bio-digester installed only the fixed dome as it is safer and generated more efficient biogas.
Procurement	Contractor is selected by KPSBU based on their credentials. Contractor is connected to the bank for installation payment after the job done, based on the approval from the farmers and based on the authorization from KPSBU.

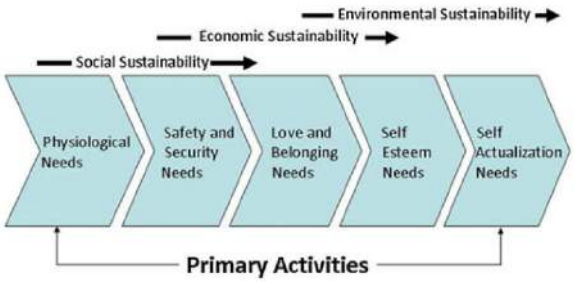

Figure 7: Primary Activities of Value Chain Model

From the primary activities, the bio-digester installation program show social sustainability, from KPSBU, company which have CSR program, donor organization (HIVOS), and the area coordinator. There is also social sustainability shown that some farmers get information about bio-digesters from neighbor, and many of them made decision in a collective way although most are from family decision, the smallest unit of social strata.

From the economic sustainability, it is shown that the installation of bio-digester does not incur cost to farmers if it is seen in a longer period of time, due to saving from LPG purchase. Furthermore, the LPG price tends to increase over the period of time. Thus, the saving may be even higher. Dairy farmers can have more benefit if the can sell the fertilizer to crop farmers.

From the environmental sustainability, it is obvious that the use of bio-digester prevents the methane release to the atmosphere, which means it prevent the greenhouse effect. However, farmers may not see this benefit as their primary activities in terms of the bio-digester use is still more in the provision of basic needs: access to low budget energy and income generation, which is still in physiological, safety and security needs.

5. CONCLUSION

Biodigester has been introduced to dairy farmers in Ciater and a small numbers of farmers have used it, especially those who have more dairy cows, those who have more than 5 household members and those who have been KPSBU members for a quite long period.

From the survey, analysis and value chain creation, it is shown that bio-digester installation is important to install due to the benefits of social, economic and environmental sustainability.

However, many farmers have not yet installed them as their focus is more in the bacis need provision, while they cannot identify the benefit of biogas installation in these needs. The farmers who have installed the bio-digester have enjoyed the economic benefit: as most of them are quite big familty, they enjoy the saving of purchasing LPG as they use biogas for cooking.

The value chain model for bio-digester installation shows that the the support activities are important to encourage more bio-digester installation. It is shown that KPSBU has a major role to increase the number of bio-digesters in Ciater area.

6. ACKNOWLEDGMENT

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