Financial analysis of biogas utilization: input cattle, pig feces and coffee waste in Karo, Indonesia

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Abstract. The community’s need for renewable energy was very urgent. In addition, efforts to preserve the environment from waste caused biogas technology feasible to apply. This study aims to provide biogas technology with minimal cost and utilize agricultural waste that were coffee and livestock waste. The study was conducted from July to October 2016. The theoretical and empirical methods used in this study were included data from officials resources, field survey on 16 biogas locations, focus group discussion and interview with stakeholders. Data were tabulated by Excel Program which then were analysed by SAS. Parameters were included Production Cost, Production Result, Profit Loss Analysis, Revenue Cost Ratio (R/C Ratio), Return On Investment (ROI), Net B/C, and IRR. The result of this research showed that the application of bioplastic gas with cow dung and coffee waste as bioplastic gas input cause the best results.

1. Introduction

Increased populations of the poor were also triggered by natural disasters, such as the eruption of volcanoes. In Karo District, since 2013, Mount Sinabung erupted, resulting in about 350 families had to move, which previously had run out of capital because the crops had failed several times as the impact of the eruption.

In Karo Regency, according to CBS [1] population of cattle and buffalo were 17,325 head. Most of cattle and buffalo feces were discharged into the environment on the puIDRoses to be compost naturally which in the processing would emit Green House Gases (GHG) and create an impact to the aesthetic of the environment Ginting [2]. According to Clark [3] GHG emissions from ruminant livestock comprised as much as 40% of total agricultural emissions.

| Table 1. Cattle and buffalo feces production 2013 in Karo |
|-----------------------------------------------|
| **Number of Cows and buffalo** | 17,325 head |
| Cow and Buffalo Weight/head | 450 Kg |
| Number of feces / head | 25 Kg |
| Total feces | 433.125 kg |

One way to mitigate GHG was by using biogas technology which according to Ginting [4] would gave benefits to farmers either energy for cooking, coffee roasting or fertilizer. Moreover, Ginting [2] mentioned that as Indonesia was one of the biggest GHG emitter in the world and committed to reduce its greenhouse gas (GHG) at the UNFCCC (Conference of the United Nation Framework Convention
on Climate Change), Indonesia had to pay an effort to captured GHG than to freely discharged. By capturing GHG which, i.e CH4, it could used as renewable energy which would help Indonesia in saving its fossil fuel. Li et.al [5] found that in China, energy from livestock feces was equivalent to 20% of natural gas used.

Indonesia was under energy crisis. Utilization of organic waste as an alternative energy raw material was one of the answers to the energy crisis. People in Karo regency paid an average of IDR 22,000 per 3 kg LPG gas tube in one week just for cooking. Therefore, Karonese who use biogas would get cost savings on buying fuel. In addition, bio gas technology produces slurry which was ready made liquid fertilizer to cultivate agricultural commodities.

| Table 2. Coffee Waste in Karo |
|--------------------------------|
| **Year** | **Number of Coffee Production** | **Number of Coffee Waste** |
| 2014    | 4823 Kg                         | 1688.05 Kg                  |

Source : CBS [6]

In Karo Regency CBS [6], there were 4,823 ton of coffee production. According to Siswati [7], the processing of coffee beans produced 35% of coffee waste which was a source of organic material cellulose content and was available abundantly in Indonesia.

2. Materials and Methods

The research was conducted in Karo District on 16 units of bio gas and this research was conducted from July to October 2016. The theoretical and empirical methods used in this study were included data from officials resources, field survey on 16 biogas locations, focus group discussion and interview with stakeholders. There were 3 types of biodigesters, i.e. (A) plastic tube; capacity 4,950l, (B) fiber; capacity 7,500l and (C) concrete; capacity 9,000l. Data were tabulated by Excel Program which then were analyzed by SAS. Parameters were included Production Cost, Production Result, Profit and Loss, Revenue Cost Ratio (R/C Ratio), Return On Investment (ROI), NPV, Net B/C, and IRR. Arikunto [8] stated the survey was a critical observation or inquiry to get a good description of a particular problem in an area. Questionnaire was a way of collecting data by giving a list of questions or statements to the respondent. The execution of the research included preparation, preliminary survey, analysis of survey data and interviews, tabulation of data, concluding data.

3. Results and discussion

The results of production cost, profit and loss, R/C Ratio and ROI research on bio gas production using plastic, fiber and concrete biodigester per month were showed in Table 3.

| Table 3. Recapitulation of biodigester research on Production Cost, Production Result, Profit Loss/month |
|---------------------------------------------------------------|
| Biodigester type | Raw Materials | Production cost (IDR) | Profit (IDR) | Profit and loss (IDR) |
|-----------------|---------------|------------------------|--------------|-----------------------|
| (A) plastic tube; capacity 4,950l | Cow feces | 485,125 | 768,240 | 283,115 |
| | Cow and coffee waste | 485,125 | 854,670 | 369,545 |
| | Cow, pig and coffee waste | 485,125 | 825,210 | 340,085 |
| (B) fiber; capacity 7,500l | Cow | 839,575 | 1,161,780 | 322,205 |
| | Cow and coffee waste | 839,575 | 1,293,780 | 454,205 |
| | Cow, pig and coffee waste | 839,575 | 1,267,380 | 427,805 |
| (C) concrete; capacity 9,000l | Cow | 1,073,276 | 1,396,800 | 323,524 |
| | Cow and coffee waste | 1,073,276 | 1,555,170 | 481,894 |
| | Cow, pig and coffee waste | 1,073,276 | 1,522,170 | 448,894 |
In this research the production of gasbio was converted to LPG. MEMR [9] recommended the use of gasbio to replace LPG as Indonesia obtains much additional foreign exchange from exporting LPG. The use of biogas will be helpful in supporting more LPG exports.

Table 5 showed that plastic tube biodigester produced the best R/C and ROI. This was because the cost of making biodigester plastic was the cheapest. Also affecting R/C and ROI were gas and slurry production. Biodigester plastic tube, fiber and concrete have a balanced efficiency so that gas and slurry production of the three types was more influenced by the volume of stuffing. According to Pindyck et.al [10] R/C was used in an attempt to find out whether or not it was reasonable to proceed to the next period or otherwise discontinued because it was not feasible. R/C ratio was feasible if R/C Ratio was greater than 1. R/C Ratio was break even if R/C Ratio equal to 1. R/C ratio was not feasible if R/C Ratio less than 1. Ginting et.al [11] found that R/C on the use of goat feces and bagasse yielded R/C between 1.19 and 1.90. The use of biogas was feasible was associated with the cost of raw material which was cheap and the results, i.e gas and slurry were good. In this study all feasible

### Table 4. Production cost of biodigester/month (IDR)

| Biodigester type                  | Depreciation of biodigester | Raw material cost | Labour cost | Total cost  |
|----------------------------------|------------------------------|-------------------|-------------|-------------|
| (A) plastic tube; capacity 4,950l| 65,125                      | 330,000           | 90,000      | 485,125     |
| (B) fiber; capacity 7,500l       | 158,575                     | 501,000           | 180,000     | 839,575     |
| (C) concrete; capacity 9,000l    | 203,276                     | 600,000           | 270,000     | 1,073,276   |

### Table 5. Biogas, Slurry and Total Production from every biodigester type

| Biodigester Type with Raw Materials | Biogas Production (m3) | Biogas Production (IDR/kg)/Day | Slurry Production (l/day) | Slurry Production (IDR/day) | Total Production (IDR/month) | R/C | ROI (%) |
|------------------------------------|------------------------|--------------------------------|---------------------------|----------------------------|-------------------------------|-----|---------|
| (A) plastic tube; capacity 4,950l  |                        |                                |                           |                            |                               |     |         |
| Cow feces                          | 1.65-0.79              | 5,808                          | 165                       | 19,800                     | 768,240                       | 1.58| 58      |
| Cow feces and coffee waste         | 2.47-1.19              | 8,689                          | 165                       | 19,800                     | 854,670                       | 1.76| 76      |
| Cow. pig feces and coffee waste    | 2.19-1.05              | 7,707                          | 165                       | 19,800                     | 825,210                       | 1.70| 70      |
| (B) fiber; capacity 7,500l         |                        |                                |                           |                            |                               |     |         |
| Cow feces                          | 2.49-1.19              | 8,726                          | 250                       | 30,000                     | 1,161,780                     | 1.38| 38      |
| Cow feces and coffee waste         | 3.74-1.79              | 13,126                         | 250                       | 30,000                     | 1,293,780                     | 1.54| 54      |
| Cow. pig feces and coffee waste    | 3.49-1.67              | 12,246                         | 250                       | 30,000                     | 1,267,380                     | 1.50| 50      |
| (C) concrete; capacity 9,000l      |                        |                                |                           |                            |                               |     |         |
| Cow feces                          | 3-1.44                 | 10,560                         | 300                       | 36,000                     | 1,396,800                     | 1.30| 30      |
| Cow feces and coffee waste         | 4.5-2.16               | 15,839                         | 300                       | 36,000                     | 1,555,170                     | 1.44| 44      |
| Cow. pig feces and coffee waste    | 4.2-2.01               | 14,739                         | 300                       | 36,000                     | 1,522,170                     | 1.41| 41      |

Note: LPG Price IDR. 7,333.33/kg ; Slurry Price based on NPK Price : IDR 12,000,-/kg : 250 ml slurry equal to 2.5 g NPK
treatments indicated as sustainable business. The highest biogas production was from the use of cow feces combined with coffee waste. According to Ginting [4] which previously was mentioned by Zhang et al [12] coffee waste contained a lot of glucose which triggered acetate to be formed as well as biogas/CH4.

The best ROI in this study was by biodigester plastic tube with an average ROI about 68%. This caused by the cost of plastic tube was cheaper. In this study almost all capital could be returned fastly. Pindyck et.al [10] said a faster attempt to return capital was a better undertaking. Of all the treatments, the used of cattle feces with coffee waste was the best. This was related to larger gas production.

Table 6. Recapitulation of biodigester research on Net B/C, IRR /Month

| Biodigester Type | Raw Materials     | Parameter | Analysis Results | Mark as |
|-----------------|-------------------|-----------|------------------|---------|
| (A) plastic tube; capacity 4.95l  | Cow feces         | Net B/C   | 6.07             | feasible |
|                  |                   | IRR       | 127.04%    | feasible |
|                  | Cow feces and coffee waste | Net B/C | 7.93          | feasible |
|                  |                   | IRR       | 132.15%    | feasible |
|                  | Cow.pig feces and coffee waste | Net B/C | 7.30          | feasible |
|                  |                   | IRR       | 130.71%    | feasible |
| (B) fiber; capacity 7.500 | Cow feces         | Net B/C   | 3.53          | feasible |
|                  |                   | IRR       | 50.99%      | feasible |
|                  | Cow feces and coffee waste | Net B/C | 3.53          | feasible |
|                  |                   | IRR       | 51.00%      | feasible |
|                  | Cow. pig feces and coffee waste | Net B/C | 3.53          | feasible |
|                  |                   | IRR       | 50.99%      | Feasible |
| (C) concrete; capacity 9.000 | Cow feces         | Net B/C   | 7.81          | Feasible |
|                  |                   | IRR       | 38.46%      | Feasible |
|                  | Cow feces and coffee waste | Net B/C | 6.84          | Feasible |
|                  |                   | IRR       | 38.81%      | Feasible |
|                  | Cow. pig feces and coffee waste | Net B/C | 6.97          | Feasible |
|                  |                   | IRR       | 38.75%      | Feasible |

According to Nachrowi [13] B/C and IRR indicated whether the business was useful to be implemented. B/C showed the amount of benefits compared to cost/investment. In this study, B/C and IRR values indicated the utilization of biogas was very useful to be implemented. Osak et.al [14] found that utilization of biogas for farmers in remote area supported its economic value because farmers obtain savings by utilizing biogas and slurry. Slurry alone would lead to savings on Indonesia government because its fertilizers subsidizing to farmers Osorio et.al [15]. The fertilizer subsidy was huge in 2013 of IDR 25.9 trillion.

Based on the Money Market Information Center (PIPU) [16] it was known that the average deposit interest rate of all state banks was 7.5%. Therefore, the results of this study was very useful considering the IRR obtained all greater than the average deposit rate.
4. Conclusions
Plastic tube biodigester produced the best R/C and ROI. This was because the cost of making biodigester plastic was the cheapest while it also produced abundant biogas and slurry. B/C and IRR were feasible to be implemented by all type of biodigesters. The best gas production was by utilized cow feces and coffee waste.

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