Science and Technology-Based Farm on Biogas Digester for Rural Development

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Abstract

The study (project) focused on the construction of a Biogas Digester at the farm of the Magsasaka Syientista, Mr. Maximo Rabanal, in Brgy. Pantay Daya, Vigan City. The objective of the study was to showcase the use of biogas using wastes of swine.

An eight cubic meter digester was designed and constructed to contain the wastes produced by 15 to 20 swine. It has a dimension of 3 m (depth) x 2 mx 2 m. Inlet and outlet of liquid wastes are positioned 2.75 m from the floor. Fresh waste and water receptacle were constructed with dimensions measuring 60.96 cm x 60.96 cm, with a depth of 45.72 cm. The wastes are drained through the digester and degraded into methane and other gases. The gases are trapped by a gate valve outside the chamber. Sediments are collected from the bottom and air dried organic fertilizer. Effluents from the digester are directed to a second receptacle with a volume of 1.34 cubic meter that will supply the needed organic fertilizer.

An amount of P 83,266.00 was needed in the construction of a one unit biogas. Financial analysis showed that to be able to compensate the expenses spent for the construction of the biogas project, a 6.52 years payback period is computed. However, if the owner is to venture into a business such as bagnet production, a lesser payback period is computed (J.89 years).

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Introduction

Background of the Study

Backyard hog raising is one of the added sources of income of small holder farmers in Jlocos Sur. Farmers usually raise 2-10 heads of swine for ready source of cash for the family; and some had already ventured in a medium-scale production to cope up the demand of pork and other value adding products such as longanisa, pork chicharon and the like.

One of the by-products that can be produced from organic wastes of swine is biogas. It is a very stable gas which is non-toxic, colorless, odorless, inflammable gas produced from biomass decomposition. The composition of different gases in biogas are: methane (CH_4), 55-70%; carbon dioxide (CO_2), 30-45%; hydrogen sulphide (H_2S), 1-2%; nitrogen (N_2), 0-1%; carbon monoxide (CO) traces; and oxygen (O_2) traces.

Biogas burns with a blue flame. It has a heat value of 500-700 British Thermal Unit (BTU)/R3 (4,500-5,000 kcal/m') when its methane content is in the range of 60-70%. The vatue is directly proportional to the amount of methane contains and this depends upon the nature of raw materials used in the digestion. Since the composition of this gas is different, the burners designed for coal gas, butane or Liquified Petroleum Gas (LPG) when used, as "biogas burner" will give much lower efficiency. Therefore, specially designed biogas burners are used which give a thermal efficiency of 55-65%.

Biogas has a small percentage of hydrogen sulphide. The mixture may vary slightly smell df rotten egg, which is not often noticeable especially when being burned. When the mixture of methane and air (oxygen) are burnt, a blue flame is emitted, producing a large amount of heat energy. Because of the mixture of carbon dioxide in large quantity, the biogas becomes a safe fuel in rural home and prevents explosion as well.

The decomposition (fermentation) process for the formation of methane from organic material (biodegradable material) involves a group of organisms belonging to the family-'methane bacteria' and is a complex biological and chemical process. Biogas production involves two major processes consisting of acid formation (liquefaction) and gas formation (gasification). However, these two broad processes can further be divided, which gives four stages of anaerobic fermentation inside the digester. They are hydrolysis, acidification, hydrogenation and methane formation. At the same time for all practical purposes, one can take the methane production cycle as a three stage activity namely, hydrolysis, acidification, and methane formation.

There are two benefits derived from biogas. They are tangible and intangible benefit. Tangible benefits account for the monetary values acquired. These include the

savings for the fuel, feed materials and fertilizers. These benefits are in the fom of savings because the amount that was allocated for this purpose was not spent because of available biogas. The other type of benefits are the intangible benefits which we can not put money value on it. These include the promotion of the conservation of natural resources by not cutting trees for firewood, and controlling pollution by proper waste disposal. These benefits are more rewarding beacuse you have given man the right to live in a fresh, clean and beautiful environment.

Thus, a Science and Technology-based farm on biogas digester will be tried at the Magsasaka Siyentista farm to showcase the technology for hog raisers and entrepreneurs.

General Objectives

The general objective was to conduct an S & T-based project and showcase the use of biogas using wastes of swine.

Specifically, the project aimed to:

I. Showcase the technology on biogas, and
2. Demonstrate to hog raisers and farmers the benefits that can be derived from using biogas.

Expected Output

The biogas is expected to be showcased and adopted by swine raisers and farmers in the locality.

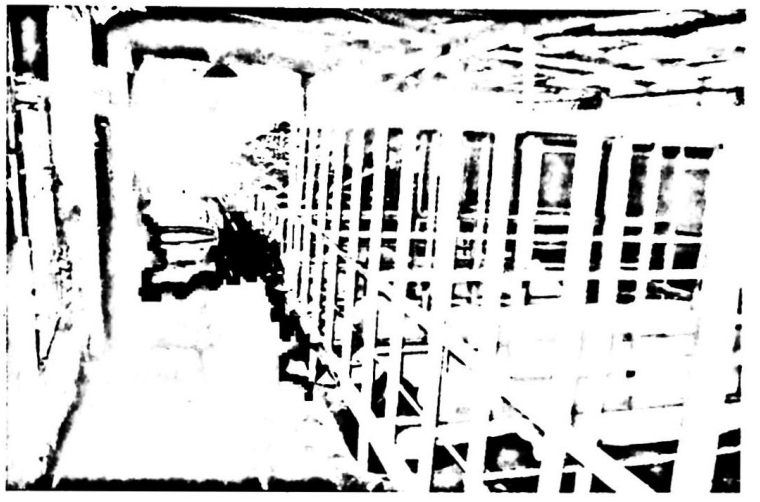
Implementing Mechanisms

The project was conceptualized through planning sessions among the implementors and cooperators. It was implemented in the MS farm with the presence of the technical experts and monitored by the Partner Member Agencies (PMA) and the consortiumer and finally by Philippine Council for Agriculture and Natural Resources Research and Development (PCARRD).

Detailed Technology

An eight cu.m. digester was constructed to accommodate wastes generated by 15-20 swine. The digester has a depth of 3m. Inlet and outlet of wastes and liquid components arc positioned 2.75 m from the floor. It has a square 60.96 cm x 60.96 cm fresh waste and water receptacle of depth 45.72 cm (1.5 ft) . The wastes are drained through the digester and degraded into methane and other gases. The gases are trapped by a gate valve outside the chamber. Sediments are collected from the bottom and air dried organic fertilizer. Effluents from the digester are directed to a second receptacle , 1.34 cu. m in capacity that will supply the needed organic fertilizer.

The newly constructed 8 cu.m. biogas digester at the S&T based Jann in Pantay Daya, Vigan City.



The 15-head piggery in the S&T-based farm in Pantay Daya, Vigan City.

The 60.96 cm x 60.96cm (2'x 2') fresh waste and water receptacle.

Biagas production is not a cheap source of energy at first, however, the adoption of anaerobic technology provides number of valuable products. A capital of about P83, 266.00 is needed for the complete construction of the biogas digester. This includes the costs of materials as well as the costs of labor for the construction of the project.

Before the completion of the biogas digester, the cooperator consumes a tank of LPG in just 20 days for his one-burner stove for their daily cooking of food which totaled

to P 12,766 per year. Considering the high price for LPG, the biogas digester is a viable solution to problem on energy needs. At present, a tank of LPG costs P 640.00. Financial analysis of the project showed that to be able to compensate the expenses spent for the construction of the biogas project; a 6.52-year payback period is computed. However, the biogas project provided energy source for the production of IO kg pork per day required 48 tanks per year amounting to P 1,200 . The household consumption and the bagnet production summed up to P43,966 per year, thus, manifested a computed payback of 1.89, less than a year.

Table I. **The payback of the biogas project.**

Mode of Usage	Cost of Biogas Digester	Cost of LPG consumed per vear	No. of LPG tanks consumed	Payback (years)
Household Use only	P 83,266	12,766	I tank for 20 days	6.52
Household with Bagnet production	P 83,266	43,966	48	1.89

Some of the businesses where investors could go into is food business. Vigan is famous for its *bagnet*. Cooking of food such as *bagnet* and chicharon requires large amount of energy in order to attain the desired crispiness. Thus, it would be justifiable for a medium-scale piggery owner to construct a biogas digester, and at the same time, be engaged into businesses requiring the utilization of fuel for frying. They, thus, offer the additional advantage of reducing fuel costs.

Other indirect benefits derived include organic effluents which could be used as organic fertilizer for agricultural crops. Vegetables like ampalaya *(Momordica charantia)*, pepper *(Capsicum annuum)*, pechay *(Brassica chinensis)* and eggplant *(Solamum melongena)* planted by Mr. Maximo Rabanal show that liquid effluents from the digester when drained to the crops manifested robust growth and manifested annual net income of P100,00.00 for two planting seasons of ampalaya, eggplant and pepper, while 3 planting seasons of pechay.

Ampalaya applied with digester effluents as organic fertilizer.

Table 2. A comparison on the net income from vegetables using the S &T based farm practice to the MS practice.

Technology/Practice	Land Area (sq. m.)	Duration (year)	Net Income (in pesos)
Vegetables applied with effluents (S&T based farm)	8,000	1	100,000
Vegetables without effluents (MS Practice)	8,000	1	60,000

Table 3. Return of investments of the S & T farm biogas project

	Cost of the Investment (Biogas)	Profits, Benefits (per year)	Cost-Benefit Ratio
Household and vegetables	P 83,266	P 112,766	1.35
Household, vegetables and Enterprise (Bagnet)	P 83,266	P 488,966	**5.88**

Recognizing the problems on environmental degradation, pollution, and health problems, the biogas technology is an alternative solution. The foul odor in the air was eliminated by the intervention. These conditions led to incidence of respiratory ailments and related disorders due to inhalation of carbon monoxide, methane and hydrogen disulfide. In the operation of the intervention, the air odor was improved, which is an important element in strategies to uplift the levels of health and environmental preservation, protection and sustainability.

Profitability

The table presents the cost of production for the construction of a one (I) unit biogas digester.

	Materials Needed	Cost
I pc.	Concrete Pipe	P 750.00
500 pcs	CHB for the construction of 6 cu.m. biogas digester	18,795.00
10 pcs	CRO	12,254.00
80 bags	*Portland* cement	18,947.00
I pc	PVC pipe for biogas fittings	900.00
7 pcs	*Lusob primera*	4,870.00
16m	Stainless Steel	2,150.00
	Total	P **58,666.00**
Labor Cost		
Wages of laborers in the construction of the biogas digester		P 20,100.00
Wages of laborer in the construction of water recycling septic tank		4,500.00
	Total	24,600.00
	Total Cost of Production	**83,266.00**

For household uses:

Cost of biogas construction per unit...	83,266.00
Cost of LPG	640.00
Cost of LPG per month	1,066.60
Cost of LPG per year	12,766.00
Payback (years)	**6.52**

For the Bagnet Enterprise:

Cost of Biogas construction per unit...	83,266.00
Cost of LPG for household	12,766.00
Cost of bagnet production per year	
kg bagnet per day per year)	2,880.00
No of LPG tanks per year	48
Cost of LPG per year	31,200.00
Cost of LPG of household & bagnet production...	43,966.00
Payback in years (household & bagnet prod).....	**1.89**

Return of Investment

Cost of investment.	..	83,266.00
Savings from fuel(household & bagnet)	..	43,966.00
Income from organic vegetables produced	..	100,000.00
Income from bagnet production (1,200/day)	..	345,600.00
ROI (household use)	**..**	**1.35**
ROI (household+ enterprise)	**..**	**5.88**

Promotional Activities

After the completion of the project on December 2008, a field day was held in the S&T farm hosted by the Ayusan Norte Farmers Information Technology Services (FITS), the Partner Member Agencies (PMA) -UNP and the MS which was participated by the implementors, cooperators, coordinating agencies and target clients. The clients were the chief executive, the city council, Department of Agriculture and barangay captains of LGU Vigan, farmers, hog raisers and entrepreneurs. The entrepreneurs include longaniza and bagnet makers who are using LPG and firewood in frying bagnet but will adopt the biogas as their fuel in cooking their commodities.

People from the National Goverment Office (NGOs) and media include DZNS, DZVV and press officers of Department of Agriculture (DAR) and the OPAI of UNP attended to broadcast and disseminate the establishment and the operationalization of the biogas digester. This is a project that will not only augment their income via biogas fuel; but will also eliminate the unhealty odor by confining the pollutants and re-use the effiuents generated by the facility into an organic liquid fertilizer for the vegetable farms, thus, an environment friendly project.

The PMA and the MS presented the biogas technology to the field day participants. Flyers on biogas technology were distributed. Six hundred follow up flyers in English and Iluko printed in colored were published and distributed locally after three weeks.

A studio broadcast interview of the PMA by DZVV and DZNS were conducted to inform the public on the existing and functional biogas digester in the S & T farm of MS under the juristiction of the Ayusan Norte Vigan FITS Center.

Technology Adoptors

The first technology adoptor was Mrs. Rebecca Palomares of Bahet, San Ildefonso, Ilocos Sur. She manages 100-head piggery farm. The second adoptor was Mr. Reylord Tabisula of Camestisoan, Sto. Domingo, llocos Sur. He manages a 75-head piggery farm. The third is Mrs. Jocelyn Peria of Puroc A Bassit, Vigan City. She had just completed the facility through the assistance of Department of Science and Technology (DOST)..

Magsasaka Siyentista (MS) Experiences

The Magsasaka Siyentista was observant on the proper determination of the height of drainage holes to allow gas production. He monitors the span of time required to produce a blue flame.

He was so insistent on the application of effiuents into agricultural crops, thus, manifested a high increase of produce and a higher income .

Problems Encountered

There was no earlier data used on how many heads arc needed to operate and to generate enough biogas to light a stove at a particular area and volume of digester, thus. led to the inaccurate number of days waiting before it fully gave off flame.

There were no data at hand on how high the drainage holes within the chambers in order for the constructors to have allowed an immediate production of methane gas.

Lessons Learned

An exact positioning of the drainage holes at the separating walls of the chambers to create a perfect generation of methane gas to allow an exact prediction of gas generated was identified, thus, avoiding guess and doubts.

A group of households can be provided with readily available energy coming from a single source - a piggery farm having a digester.

Many environmental benefits were felt and identified upon the operation of the biogas technology.

Recommendations

Make a follow up study to determine the exact heights of drainage holes and the exact volume and area of digester that will suit to a specified number of heads/pigs that will sustain waste production .

There is a need to quantify the environmental benefits felt in the operation of the biogas project in the locality.