Economic Feasibility of a Biogas System in a Small Palestinian Poultry Farm

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Keywords
Biogas energy • Farm scale digester • Economic feasibility • Poultry manure • Benefit-cost analysis • Palestine

1 Introduction

Palestine practically depends on external sources of energy. Around 80% of energy sources come from neighboring countries (Ismail et al. 2013); it relies on Israel for 100% of its fossil fuel imports and for 87% of its electricity imports (Juaidi et al. 2016). According to (Abu Hamed et al. 2012), The conversion of poultry manure and other animal wastes into biogas have the potential to meet the needs of 20% of the rural population in Palestine, and the conversion of agricultural residue into biofuel could replace 5% of the imported diesel. The poultry production sector in Palestine is the biggest contributor to the total agricultural output and the most important agricultural sector. According to the Palestinian Bureau of Statistics (PCBS 2013), the total number of broilers and layers were 33 million in 2013, which equates approximately 665 million tons of poultry manure available for energy production. Accordingly, Biogas technology could be one of the most important options that could transform the poultry manure into a valuable source of energy reducing simultaneously the manure quantities. However, the development of such technology in Palestine remains low, because of the lack of information on its economic feasibility. A small pilot-scale digester was constructed with a working volume of (0.5 m^3) and built a design in about 10 years in a small Palestinian poultry farm in Beit Ur Al Foqa village of Ramallah district.

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The digester was operated under mesophilic condition (30–45 °C), this was achieved using a solar water heating system. The process was fed semicontinuously with poultry manure once a day. The biogas production volume, pH, and the content temperature were measured every day, while the biogas quality (methane concentration) was measured every week (Ali and Al-Sa`ed 2017). The goal of this study was to assess the economic feasibility of expanding biogas systems in Palestine under realistic conditions, by analyzing data from a recently implemented biogas system in a farm scale. The results of the study could be used to assess the feasibility of farm scale biogas systems in other farms in the region that share similar climatic characteristics and economic factors. Other farmers especially in Palestine could directly benefit from the economic analysis presented here as they would have similar, if not exactly the same conditions. This could be a suitable source of inspiration for the construction of a cheap and efficient biogas system.

2 Materials and Methods

In order to evaluate the economic viability of the biogas system the analysis of the main economic parameters were carried out, namely, benefit-cost ratio (BCR), payback period (PBP), internal rate of retain (IRR), and net present value (NPV). Costs and benefits of the biogas system were calculated. The future value of costs and benefits was determined based on a constant pricing method. A discount rate of 4% was used, and the economic life of the biogas system was considered to last 10 years.

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3 Results and Discussion

A typical analysis of cost and benefit for the biogas system is illustrated in Table 1. The installation cost of the biogas system was $2400. Annual biogas generation from the system was 39.95 m^3, and the total methane produced during the study period was approximately 25.57 m^3. Based on an annual biogas generation, the farmer would receive around $445 as energy savings from the biogas installation system. This amount was calculated based on the price of natural gas used for heating before the installation of a biogas system. In addition, farmers would obtain approximately $430 from using bio-fertilizers as an alternative of chemical fertilizers or from selling the produced bio- fertilizers.

Table 1 Cost- benefit analysis of biogas system in a small Palestinian poultry farm

Parameters	Amount ($)
a. *Capital cost*	
Tanks	143
Valves, pipes, and connection	702
Solar system (solar unit, heat exchanger …)	226
Waste collection tub	100
Pump	157
Agitators	69
Storage balloon	129
Sensors (thermometer, pressure meter, and biogas flow meter)	194
Miscellaneous	334
Workers expert construction	346
Total	2400
b. *Annual cost*	
Water consumption (1.4$/$m^{3)}$	26.1
Depreciation on biogas storage balloon at 10%	15.7
Depreciation on pump at 10%	12.9
Depreciation on sensors at 10%	19.4
Total	74.1
c. *Annual income*	
Saving from using biogas as an alternative to natural gas	420
Income from biogas production (1.5$/$m^3$)	24.6
Income from bio-fertilizers (10.7 kg/a day at 0.11$/kg)	429.6
Total	874.2
d. Net annual income (c − b)	800.1

The results of the economic analysis on the biogas system at the study farm suggest that the project is profitable since the BCR is larger than 1. The NPV, PBP, and IRR of the system are $4088, 3 year and 31.1%, all indicating that the project is profitable. The benefits of the project are expected to increase if benefits from saving the poultry and the environmental benefits were taken into account. However, the analysis was based on data obtained from the study farm which is very small compared to other Palestinian poultry farms, and if the system were extrapolated to other farms on different sizes, the extra cost should be included, for instance, labor cost, transport, energy consumption or land investment. Many studies showed that biogas plants were financially viable if applied in the large scale (Curletti et al. 2015), as the energy production increases. However, the study of (Abbas et al. 2017) showed that biogas plants in a small scale is more beneficial than in a large one because of labor-saving benefit. In fact the small scale farmers had some extra time and did not need to hire any extra labor for operating the system, which makes it more profitable. The requirement of land investment also slightly influenced the feasibility, as the requirement of land investment slightly decreases the feasibility according to (Wresta et al. 2015). The results of this study can help to establish optimal feasibility parameters for a farm-scale biogas plant using poultry as a substrate. The estimated annual energy production and other economic parameters could be based on the same method used for this module.

4 Conclusion

The primary objective of this study was to assess the economic feasibility of expanding farm scale biogas systems in Palestinian poultry farms under a realistic condition, by analyzing data from a recently implemented system on one Palestinian poultry farm. The annual amount of biogas generation was 39.95 m^3, the result of the system economic analysis suggests that the project is profitable since the BCR is larger than 1. The NPV, PBP, IRR all indicate that the project is profitable. The conclusion of this study proved the feasibility of a biogas system installation on a Palestinian farm. The results of the study together with its economic analysis could be used to assess the feasibility of biogas systems at other farms in Palestine or in neighboring countries that share similar climatic characteristics and economic factors. Installing biogas systems on a poultry farm not only generates renewable energy used for heating, but also can be used as an effective tool to raise the level of awareness of the poultry farmers towards renewable energy and sustainable efforts in general.

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