Bulgarian Journal of Agricultural Science, 21 (No 2) 2015, 257–260
Agricultural Academy

ELECTRIC ENERGY PRODUCTION FROM SWINE DEJECT: ANALYSIS OF FINANCIAL FEASIBILITY WITH THE USE OF MONTE CARLO SIMULATION FOR THE IMPLANTATION OF BIO-DIGESTER IN BRAZIL

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Abstract

CATAPAN, A., A. SOUZA, D. C. CATAPAN and J. H. HARZER, 2015. Electric energy production from swine deject: analysis of financial feasibility with the use of Monte Carlo simulation for the implantation of bio-digester in Brazil. *Bulg. J. Agric. Sci.*, 21: 257–260

The goal of the research is, using technical analysis of investments, determine the point of balance, in number of animals, to enable the implantation of bio-digesters for the generation of electric energy with the use of swine deject. As methods, interviews were held with owners of farms, examination of worksheets of costs and budget control with suppliers for the cash flow Project. Then, it was calculated the indicators of viability and it was made the simulation of Monte Carlo to measure the sensibility of the parameters of entrance. The results of the research pointed that the point of balance are 1009 swines. Considering the premises of Monte Carlo Simulation and considering that p(Net Present Value < 0) = p(Internal Return Rate < Minimum Tax of Attractiveness) needs to be at most 0.20, it is suggested to implant the bio-digester in properties with at least 1075 swines.

Key words: bio-digesters, swines, financial viability

Introduction

In recent times, the environmental issue appeared as focus of requirements of public agencies, No Government Organizations and more recently of consumers and society (Catapan et al., 2012). From these concerns, there was a redirection for the researches to seek the sustainable development. Summarizing, it seeks to reduce the environmental impact in way that is economic viable, environmental correct and socially acceptable.

The pork industry is one of the most important productive chains of the food industry existing in Brazil, with squad of swine of about 39.3 million heads (IBGE, 2013). The total production of dejects in swine farms is very variable, depending mainly on the number and category of the animals (piglet, females lactating or in gestation, growing males, males breeding) installations, equipment, and cleaning programs adopted on each farm. The composition and the volume of dejects have a key role for the planning and establishment of programs and techniques of treatment and storage of dejects, besides the aggregation of value to the manures produced. The interest on the utilization of organic residues (manures) generated in the pork industry has been increasing, for the energetic exploitation of biogas (product generated by the decomposition of organic residues) indicating the existence of a potential to develop methods that allow the properties to become energetically independent (Catapan et al., 2011).

But in order to become energetically independent the property needs to have effective handling installations, storage and treatment of dejects. However, the storage of dejects many times is confused with treatment, although many ways of storage don't promote any actions on this way. Conceptually, the storage consists in putting dejects in the right storages during a certain time, with the objective of ferment the bio-

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mass (way of anaerobic digestion) and reduce the pathogenic present. Nevertheless, since it's not a treatment system, it is under the parameters required by the environmental legislation to launch in water glasses and its use as fertilizer requires special care (Seiffert, 2007).

According to Catapan et al. (2011), the system of collect, storage and treatment of dejects is precarious and there are only a few producers that own an intensive system of production with some level of technology. From the research made by these authors related to the destiny of dejects, from the 261 swine producers totalizing 100% – 53.26% throw the dejects in the tillage without previous treatment; 15.32% piled the dejects in some part of the property, let them dry under the sun so they throw it in the tillage; only 14.95% of the producers store the dejects on manure heaps and after the fermentation process they send them to the tillage; 11.11% accumulate the dejects in the property and 5.37% use it for other destinations, for example, as source of food for the fish farming.

These evidences show that is necessary the rupture of current patterns of production, which allows incorporating the routines and costs of a correct environmental management of production, enabling an effective handling of dejects and their discharges. This way the environmental management is the set of actions carried out by the society, or by part of it, with the goal to protect, restore, conserve, and use the environment on a sustainable way (Seganfredo, 2007).

Throw bio-digesters, that transform biogas in energy, it can be generated a new renewable energy. The big problem to execute the implementation of these bio-digesters is the costs of acquisition and implementation of equipment for the energy generation.

Inside this context that emerges the research question of this article that summarizes in: What is the point of balance, in number of animals, to financially enable the implementation of a bio-digester for the generation of electric energy with the use of swine dejects in Brazil?

Materials and Methods

The work started with a field research in swine farms where the systems of production were based on a complete cycle (two farms) and ending (one farm). The farms are located in the city of Lapa, Parana, Brazil and Castro, Parana, Brazil. There were chosen farms in the location because in these cities is the biggest production of swine in Paraná, besides the accessibility. The visits were held to know the bio-digesters and their monthly expenses (maintenance, cleaning, operation etc.).

In order to identify the monthly expenses with maintenance, cleaning, and operation interviews were held with farm owners and, also, with an examination of worksheets of expenses control made by the properties. Moreover, budgets were made with many suppliers of bio-digesters to understand and measure the expenses with implementation.

The maintenance and the depreciation of this system were also verified with the suppliers (expenses, time of maintenance, and time of depreciation, among others). To analyses the viability, it was used Monte Carlo Simulation, with Crystal Ball software, since some premises of entrance represent values that can be variables.

Results and Discussion

Primarily, before the financial viability of bio-digesters implementation, it will be calculated the Minimum Tax of Attractiveness (MTA) for the project. For it, it was used market taxes, found on Table 1. The monthly average of the profits obtained is 0.61%. Considering that the biggest the risk of a certain project the biggest must be the risk prize added to the MTA, since the investor disposes to apply the capital in projects more risky seeking greatest returns and, therefore, should opt for the superior MTA, it was assumed, from this, a MTA of 0.7% a month.

To calculate the quantity of tons of biogas/year derived from the anaerobic decomposition of manure, it was considered the volume of manure that each animal unity generates a day (2.23 kg/day) and the volume of biogas generated by kg of dejects (0.062 m^3) (Barrera, 1993; Catapan et al., 2012).

To calculate the quality of methane produced by year in tons, you must use the total of biogas produced and the

Table 1
Taxes for the calculation of MTA

Investiment	Profitability (anual), %	Profitability (monthly), %
Special Itaú RF	7.19	0.60
HSBC FIC Fixed Income Private Credit	7.58	0.63
HSBC FIC Fixed Income LP Fixed in advance	7.14	0.60
BB Fixed Income Long Term	6.86	0.57
BB FI Long Term Prem	6.88	0.57
BB FI Long Term Parc	7.10	0.59
BB FI Long Term	7.10	0.59
CEF FIC Investor FI Long Term	7.78	0.65
CEF FIC Supreme FI Long Term	7.85	0.65
Average	7.28	0.61

Table 2

Detailed investments and outputs of the cash-flow

Investiments	Value, $	Output	Value, $	Variation (Crystall Ball), %
Generator	95 000.00	Wages	1800.00	–
lake	4000.00	Charges	900.00	–
Bio-digester	64 800.00	Maintenance	1000.00	5
Infrastructure	15 000.00	Cleaning	200.00	5
		Expenses	200.00	5
Total	178 800.00	Total	41 000.00	

Table 3

Memories of calculation for the financial variability

Description	Values	Variatiom (Crystall Ball), %
Volume of dejects a day (kg)	2.25	10
Number of animals	1009	–
Total volume of dejects a day (kg)	2270,89	–
Total volume of dejects a month (kg)	68 126.82	–
Conversion rate (swine)	0,063	10
Volume (m^3)	4.292	–
Conversion rate (methane-swine)	60%	10
Methane Volume (m^3)	2575	–
Conversion rate KWh	5.5	–
Total of KWh generated	14 164	–
Value of KWh, $	0.479857	–
Monthly recipe generated, $	6796.49	–

value correspondent to the percent of methane existing in the biogas (66% for swine) (Carvalho and Nolasco, 2006). Then, you must multiply the quantity of methane generated by the tax of conversion for KWh, which is 5.5 KWh by m^3. Finally, you multiply by the value charged by the energy concessionaire for the use in the own property and not for commercialization. Table 2 presents the investments and the outputs considered for the cash-flow.

The value of 5% for the expenses with maintenance, cleaning, and general expenses was proposed based in interviews with owners. It will serve as parameter of variation of these premises for the calculation of the Net Present Value (NPV) in Crystal Ball. The justification for these variations is that the expenses can change some months. The wages and the charges have fixed nature. Now, it's presented the calculation of financial viability for the animals.

Table 3 presents the memory of calculation in order to find the monthly recipe generated, considering a Net Present Value, meaning that the total of entrance is equal to the total of output in the cash-flow.

The calculation of the number of animals was held with the use of the tool Scenario-Achieve Goal of Excel, considering the variation of the number of animals' parameter and setting NPV with approximately 1009 animals. Based on this recipe generated, the cash-flow of the project is illustrated on Table 4.

On the past cash-flow (60), it is considered the entrance of 40% of the investment's value as residual value, that is to say that 40% of the invested value at zero moment still remain by the end of the project. It wasn't considered the costs with freight seeing that there are farms with number of animals obtained on this research, therefore, it is not considered the need of transportation of dejects from many different properties. From this cash-flow, the NPV obtained is zero and the Internal Return Rate (IRR) calculated is equal to the MTA presented, in other words, from this number of animals calculated that the financial

Table 4
Cash-flow

Month	0	1	2	…	60
Entrance	–	6796.49	6796.49	6796.49	78 316.49
outflow, $	178 800.00	4100.00	4100.00	4100.00	4100.00
Cash-flow, $	- 178 800.00	2696.49	2696.49	2696.49	74 216.49

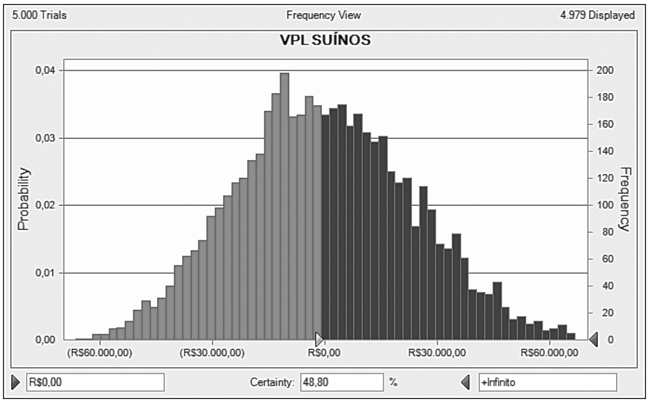

Fig. 1. Monte Carlo simulation for NPV

viability to implant the bio-digesters exists. Now, it will be considered the premises of parameter variation for the Monte Carlo Simulation.

The Monte Carlo simulation (Figure 1) was held with 5000 interactions and with the interval of confidence of 95%. The NPV for the swine dejects has resulted in an average of R$ 174.98 with the minimum of $ 74 529.93 and the maximum of $ 84 527.56 (DP = $ 23 303.88). The Monte Carlo simulation indicates that even with the interval of 95% sure the NPV must be situated between –$ 46 728.74 and –$ 46 432.78. The probability of the NPV is bigger than zero is 0.4830. The average IRR for the swine is 0.69% with the minimum of –0.50% and maximum of 1.94% (DP = 0.36%) and, according to the results of the 5000 interactions with Monte Carlo situation, the IRR must result, 95% sure, between –0.03% and 1.41%. The probability of the IRR being smaller than the MTA is 0.517, indication a considerable high risk of not recovering the invested capital, in case of the number of animals of 1009 animals.

The factors that most impact in the results of NPV and IRR for the swine dejects are: (i) % of methane (34.2%); (ii) Volume of dejects (33.1%) and; (iii) the tax of conversion considered high for many investors. Supposing that the investor can assume a maximum risk of 20% of losing money on the project, therefore p(NPV < 0) = p(IRR < MTA) must be, at most, equal to 0.20, running one more time the Monte Carlo simulation, with the minimum number of swine to fulfill the premise is 1075 animals. On this scenario, it is obtained the probability of NPV bigger than zero of 0.8021, with 95% sure that it will be between –$ 27 845.13 and $ 70 383.83. That way, the chance of the investor losing money is 19.79%.

Received May, 3, 2014; accepted for printing January, 7, 2015.

Conclusion

The purpose of this research was to find the minimum number of animals that a rural property needs to enable the implementation of a bio-digester to generate electric energy. From this analysis of financial viability with the calculation of NPV and IRR, it was found the minimum number of 1009 swine in a deterministic scenario.

Considering the Monte Carlo simulation, with the variation of some parameters, the probability that the NPV > 0 is 0.4830 and the probability that the IRR < MTA is 0.5170. Inside this context, understanding that the p(NPV < 0) = p(IRR < MTA) = 0.517 for the project with 1009 swine, and admitting that the investor accepts the maximum risk of 20% of chance to lose money, the minimum number of swine to meet the premises is 1075 animals. That way, it should be implanted a bio-digester, considering a maximum risk of 20% of losing money, in property that has, at least, 1075 swine.

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