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The Economic and Financial Feasibility of a Biodigester: A Sound Alternative for Reducing the Environmental Impact of Swine Production

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1. Introduction

The modern landscape is one where environmental impact encroaches upon our quality of life. The search for viable technologies which both alleviate and lessen environmental pollution has become a priority, especially in the arena of production. Business, as with society, is now focused on minimizing environmental degradation, reviewing its strategies, structures and responsibilities. Tinoco (2001) explains that this modern responsibility is defined by the environmental and social demands of our day, where it is not merely a question of profit but also social conscientiousness. Business is now geared towards the interests of society, where environmental policy features high on its agenda.

It seems that human being has the tendency to risk his existence and wellbeing when the environmental impact of business proves a constant disruption to our natural world. Rural swine production and the environmental dangers it poses, is one example: waste, in remaining exposed releases methane gas into the atmosphere. As Brilhante and Caldas (1999) on this point, over the last few decades the dissipation of gasses has been affected by such practices, resulting in an increased concentration of carbonic gas (CO²); methane (CH₄); chlorofluorocarbons (CFCs), nitrous oxide and atmospheric ozone. As we now know, these gasses disrupt the energetic equilibrium of the Earth's atmosphere, and by consequence, our climate system.

Swine production has contributed substantially to Brazilian trade; it has received large investment incentives from genetics and other technologies, in order to provide and ensure a quality product. Panty (2008) highlights, that Brazil and its State of Santa Catarina have a

model integrating both industry and producer, where specialists and rural farmers are well attuned to the competitive advantages of swine production.

Rural producers of swine do however face a lack of financial assistance in their search for an environmentally friendly solution. But an alternative is available, one able to reduce the endangerment of even more natural resources. Various “techniques” bringing to light and lessening the environmental effects of swine waste have been developed and put into practice. For instance, the process of biodigestion transforms methane gas into carbon dioxide, lessening environmental impact. The implementation of a biodigester means that waste can be reused and transformed into a renewable resource, proving an important mechanism for both business (finance) and society (the environment) alike. In other words, the biodigester is today’s alternative solution for the rural farming industry, capable of minimizing the environmental effects of swine production. Waste on each farm, can be ably “re-directed” benefiting financial return; and where the farmer’s quality of life is enhanced economically and financially, so too is that of the population at large who rely on the natural world for sustainability and survival. Indeed, we not only have the importance of increased productivity and the ensured success of new markets, but of being alert to a challenging future of sustainability and social responsibility.

Our research assesses the financially and environmental viability of installing a biodegster on a farming property. We divide our present study into 7 subsections, not counting the introduction. Beginning with *Environmental Management* we seek to contextualize the discourse and importance of our research by drawing upon recent literature in order to underline the contemporary shift in practice – namely the move towards more environmentally sensitive and socially sympathetic business strategies. Environmental strategy is vast becoming the defining characteristic of market competitiveness, and the success of a business to be environmental conscious and aware in its strategy and decision making, will prove the measure of its market edge and value. Our third section, *Swine Production and the Environment*, introduces the readership to the unique global positioning of Brazilian swine production and the very real possibilities of introducing Biodigestion as a viable and important measure ensuring both environmental integrity as well as cost effectiveness for the farming business. Section four, *Biodigesters*, introduces anaerobic biodigestion as the natural mechanism for both farming and environmental integrity. We seek to detail this anaerobic process and set out the processes and procedures of installing a functional biodigester on farming properties. Our sections on *Methodology* and the *Interpretation of Data* introduce the reader to the sampling method and data specifics of the herd studied. We then follow on with a section dealing with initial investment into the biodigester project, detailing the projected return and revenue, this, qualifying such investment as both environmentally timely and financially cost-effective for the business.

We conclude our study by underlining the necessity and urgency of biodigestion for swine producers, this, supported by the modern context of social conscientiousness and the benefit of sound financial return in line with our research projections.

2. Environmental management

The more our environment is damaged, the more our planet earth is compromised. We are witnessing, and experiencing, the progressive extinction of fauna and floral species, the pollution of groundwater and global warming.

In the face of these threats, is environmental management which aims to minimize environmental impact and maintain the wellbeing of people by redefining practices, processes and procedures for private, public and rural life. Good, proper working conditions and environmentally sound products complying with environmental laws and regulations fall to the responsibility of environmental management, as does the proper handling of waste produced in rural areas and the legal remit within which organizations can operate. This said, environmental management seeks to strike the legal and ethical balance between quality, productivity and competitiveness with the minimization of environmental degradation. Thus, for Moura (2000), the workings of environmental management involve putting specialized concepts and management techniques into environmental practice.

An environmental management system also signals greater competitiveness for the business which can equally retain and attract modern, learned consumers, whilst meeting the growing demands of external markets. Barbieri (2007) tells us that environmental management is defined by its administrative guidelines and key activities such as the planning, direction, control, and allocation of resources. Its main objective, furthermore, is to achieve positive, environmental results by reducing and eliminating the damage caused by human practices, or indeed to prevent such damage from even arising now and in the future.

This is why companies are now looking to develop and implement environmental management at the core of their operations in order gain an environmental advantage over market competitors, in strict accordance with the principles of sustainable development. Thus in retaking the concept of Barbieri, Tinoco and Kraemer (2004), we can assert that the role of environmental management is to effectively minimize and eliminate the environmental risks of private, public and rural businesses.

Companies can therefore meet the demands of the environment (and likewise of society), by tallying the expenditure of resources with legislation, restoring the natural resources extracted from the environment.

In this context, environmental management underlines the importance of environmental certification and accreditation which aims to help companies engage with, and commit to, the environment. Ribeiro (2006), for example, states that it is necessary to determine the particular strategy of implementing guidelines so as to more broadly define a company's environmental status and profile. Here, tools such as economic planning can be implemented into environmental programs that seek to change the current management system. Such programs, moreover, must be constantly checked through environmental audits. Yet aside from the virtues of the environmental management model, there is a

constant need for businesses to be aware of the rapid changes which are occurring in information technology and strategic cost initiatives.

Indeed, models are constructed using the concepts defined by companies to guide and achieve goals. Barbieri's findings (2007) underline that the adoption of a model is critical because activities can be developed by different people at different times, in different places and through different ways of perceiving and positioning crucial issues. Companies can create their own environmental management models or take advantage of the various generic models that have been with us since the mid-1980s.

We see then that companies are finally coming into the age of environmental awareness, where standards and environmental legislation feature high on the agenda of those wanting to be maintain a market edge, nationally and internationally. We have a new series of standards defining our environmentally sensitive and fragile modernity, where the environmental status of a particular company has become the internationally accepted standard, seal and guarantee.

3. Swine production and the environment

For Marion (2002 p. 24) rural business, "explores the productive capacity of soil through the cultivation of land, as well as breeding and processing of certain agricultural products". The author classifies such rural activity as (1) agricultural; (2) zootechnical; and (3) agro-industrial. Similarly, Araújo (2003, p. 31) points out that, "agro-industries are businesses defined by the processing, handling and transformation of natural agricultural products into commercially packaged goods." Such businesses – deemed "agro-industries" by Marion (2002) and Araújo (2003) – are those which transform the agricultural/zootechnical product: the process of breeding, raising and slaughtering pigs for example, is for the purpose of transforming and commercializing derivatives. In a strictly economic context, the swine industry plays an important role in the movement of the food and supply chain. Sobestiansky (1998) shows then, that the modern swine industry is primarily focused on the production of pigs for slaughter and / or the breeding of livestock.

One of the most evident changes occurring both worldwide and in the Brazilian pig industry is the linear trend where a decrease in the number of production systems runs parallel to an increase in the number of system matrices. In terms of international agriculture, Brazil has the specialized workforce capable of producing technology that ensures a competitive advantage – it is a country fit to compete on equal terms with any other in the agricultural business, heavily investing in research and production strategies. The work of Gonçalves and Palmeiras (2006) shows us that the Brazilian swine industry has received greater international attention for its advantageously competitive edge: swine production in Brazil has lower costs than its major worldwide competitors; its system of production is vertically integrated (meeting agro-industrial demand); foodstuffs and basic grains such as soybeans and corn are plentiful, and there is technological investment.

In retrospect, market realities and the accelerated growth of a global economy meant that agro-industrial businesses had to seek improvements and overhaul their organizational structures in order to guarantee market presence and competitiveness. The swine industry was by no means an exception to this trend, requiring both injections of investment into its processes and new facilities. As Leite (2008) makes clear, swine production underwent change because technological innovation became the rule-of-thumb for a new generation of engineers focusing on the economic and environmental viability of such practices. Zuin and Alliprandini (2006, p. 255) similarly assert that, “over the years innovation and invention proved powerful tools in achieving better efficiency in farming systems.” An equally important factor to this is the partnerships established between pig farmers and agro-industrial businesses, which have ensured the commercialization of production and added market value to the final product. Yet Mior (2005) equally points out that at the close of the 1990s in the western region of Santa Catarina, partnerships between agro-industries and swine producers heralded a new epoch in pig production, by reducing the number of contracts at the same time as increasing production.

According to findings from the Associação Catarinense de Criadores de Suínos (2011), Brazil has 2,460 matrices for the housing of swine, where production sprang from 2,708 million tons in 2003 to 3,240 million in 2010 – this, an increase of 19.65% in merely five years, signaling market growth and the importance of swine in the supply chain. Yet the concentration of pig herds on small rural farms nevertheless carries environmental impacts owing to the vertical model of production adopted by Brazil, which is characterized by partnerships with industry.

Generally, animal waste is treated in liquid form: water runs into deposits which are stored and the soil then used as organic fertilizer (EMBRAPA, 2008). This model coupled with the growth of swine production in Brazil heightens the risks of environmental degradation whereby the measures for treating swine waste are not only costly but require constant precision – mishandled waste can lead to water, soil and air pollution with both an unwelcome stench and mosquitoes.

In addition to industry and urbanization (domestic sewage), swine production is monitored by regulatory bodies and environmental agencies, so much so that the law clearly identifies the environmental dangers of such practices (GUIVANT e MIRANDA 2004). This is due to the large number of contaminants found in effluents which represent a potential source of air, water and soil contamination. Indeed, due to the high concentration of livestock at these rural sites, swine waste can easily exceed the capacity of local ecosystems, potentially disrupting the natural environment and human health through organic matter; nutrients; pathogens; odors and microorganisms generated in the atmosphere (PEREIRA, DEMARCHI e BUDINO, 2009).

A series of requirements can therefore be provisionally laid out, aimed at preventing and correcting increased environmental degradation. Among these we can list:

1. The need to maintain a permanent boundary of preservation set at a distance of 30 meters, with distances between dwellings and settlements of at least 300 meters, and distances to roads at least 50 meters (Bezerra, 2005).
2. The need to prohibit and monitor the dumping of waste and/or effluents from any polluting source, including waste from livestock, into Class I rivers intended for domestic supply. Such material may be released directly or indirectly into Class II and III rivers only after appropriate treatment and having satisfied the conditions, standards and requirements set forth by government Decree (RESOLUÇÃO CONAMA nº 357, from 17th March, 2005).
3. The need to research ways of combining the use of waste for crops (fertilizers), or for the production of energy. This would reduce the degree of environmental pollution in line with the realities faced by rural farmers. Given this context, some environmental problems could be solved if environmental measures for swine production were effectively researched and put into practice. However, not all swine producers have the awareness or financial resource to treat waste correctly.

4. Biodigesters

Seganfredo (1999) notes that the continuous use of large quantities of swine waste as fertilizer has proven environmentally detrimental, not only in terms of air pollution but in terms of the progressive accumulation of nutrients in the soil and the presence of excess nitrates in water. Likewise Sampaio et al. (2010) show that the mismanagement of remaining waste water can lead to an excess of pig manure in the soil (depending on the capacity for absorption some of these nutrients may lead to water contamination).

Nogueira (PALHARES, 2008) therefore does well to remind us that in 1086 the Englishman Humphrey Davy identified a gas rich in carbon and carbon dioxide resulting from the decomposition of manure in humid places. Released into the atmosphere, the gas attacks the ozone layer and causes global warming. Jordan (2005) states, moreover, that methane - one of the gases produced by the degradation of waste - is twenty-one times more volatile than carbon dioxide (CO₂).

It is precisely here that the process of anaerobic biodigestion can prove the necessary environmental solution in that it destroys pathogenic organisms and parasites. In this way the treatment of waste by such means carries great advantages, transforming harmful gasses into a source of energy (bio-gas) *for the better*. In addition to this, solid matter decanting in the bottom biodigesting tank acts as biofertilizer, with liquid matter the (treated) mineralized effluent. Nogueira (1986) further points out that such a process offers multiple advantages. The production of fuel gas; the control of water pollution and odor; the elimination of pathogens from organic matter and the preservation of fertilizer are the immediate benefits of such waste removal. We can likewise emphasize that anaerobic digestion helps to minimize negative environmental impact, at once reducing relative risks and improving quality of life issues.

A digester is essentially built from a tank sealed with canvas suitable for storing waste. The process of biodigestion occurs in rotating fashion where organic matter enters through the side and anaerobic fermentation taking place without the presence of air. The result of this process is the transformation of methane into carbon dioxide.

The biogas storage balloon is used for the intake and utilization of highly corrosive gases which require beneficiation treatment. Such processing is essential and increases their efficiency, for without it the use of biogas is not recommended. The process has specific stages of washing; cooling and compression. Finally, there is the intake of biogas by the storage (balloon), as evidenced in Figure 2.

The liquid effluent resulting from this process then exits the digester for maturation ponds wherein the release of gases is completed: even after waste digestion in the machine, some substances still remain and must be released into the atmosphere so that the liquid can be used for fertilization.

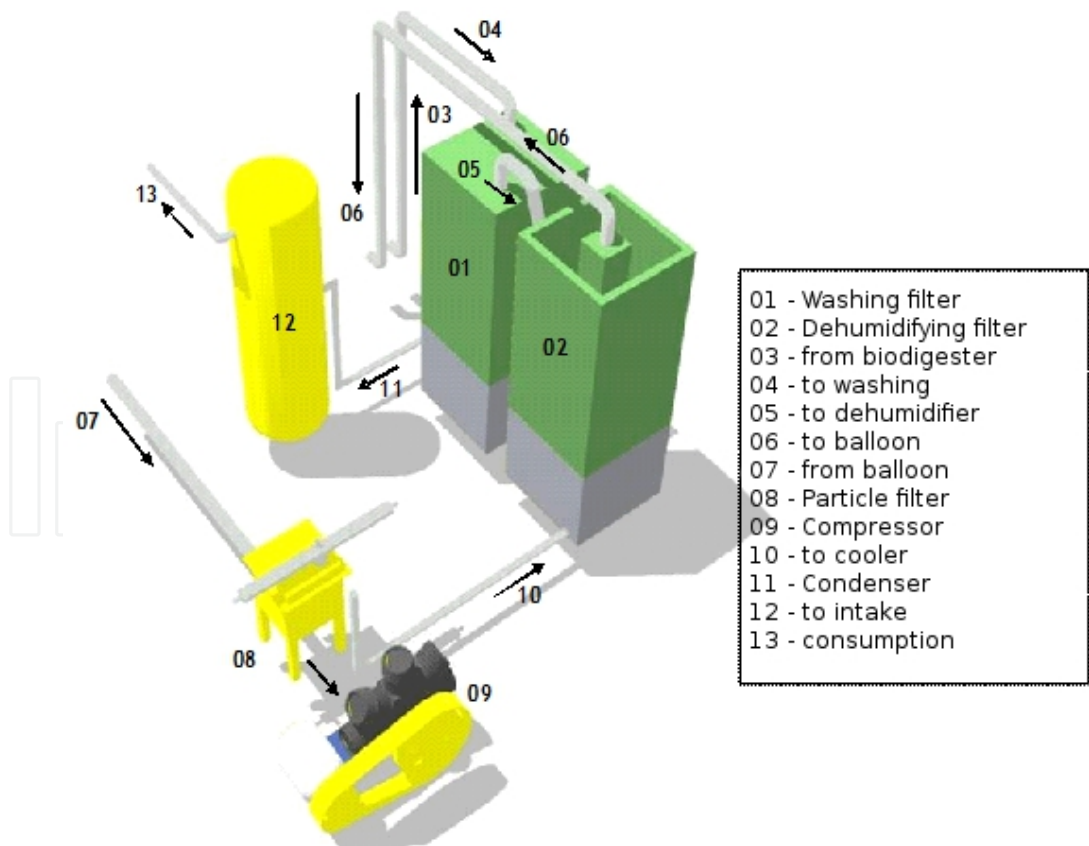
As Nogueira explains (1986) waste is transformed by agitation which distributes the substrate and bacteria, efficiently using the volume of the biodigester and reducing/eliminating supernatant scum matter. In order to have a guaranteed and precise process, agitators must be inserted into the biodigester in order to correctly agitate the substances necessary for transforming waste. It is also important to maintain the biomass at a heated temperature within the biodigester, for as Nogueira (1986) further points out, the biodigester has to be constructed and set up below ground-level, since this depth serves as a thermal insulator. Temperature plays an important part and it is advisable to ensure internal or external heat (of course depending on the agricultural needs of the producer) because bacteria can reproduce in this way, thereby transforming waste into biogas.



Figure 1. The biodigester set up on the property where research findings were collated.

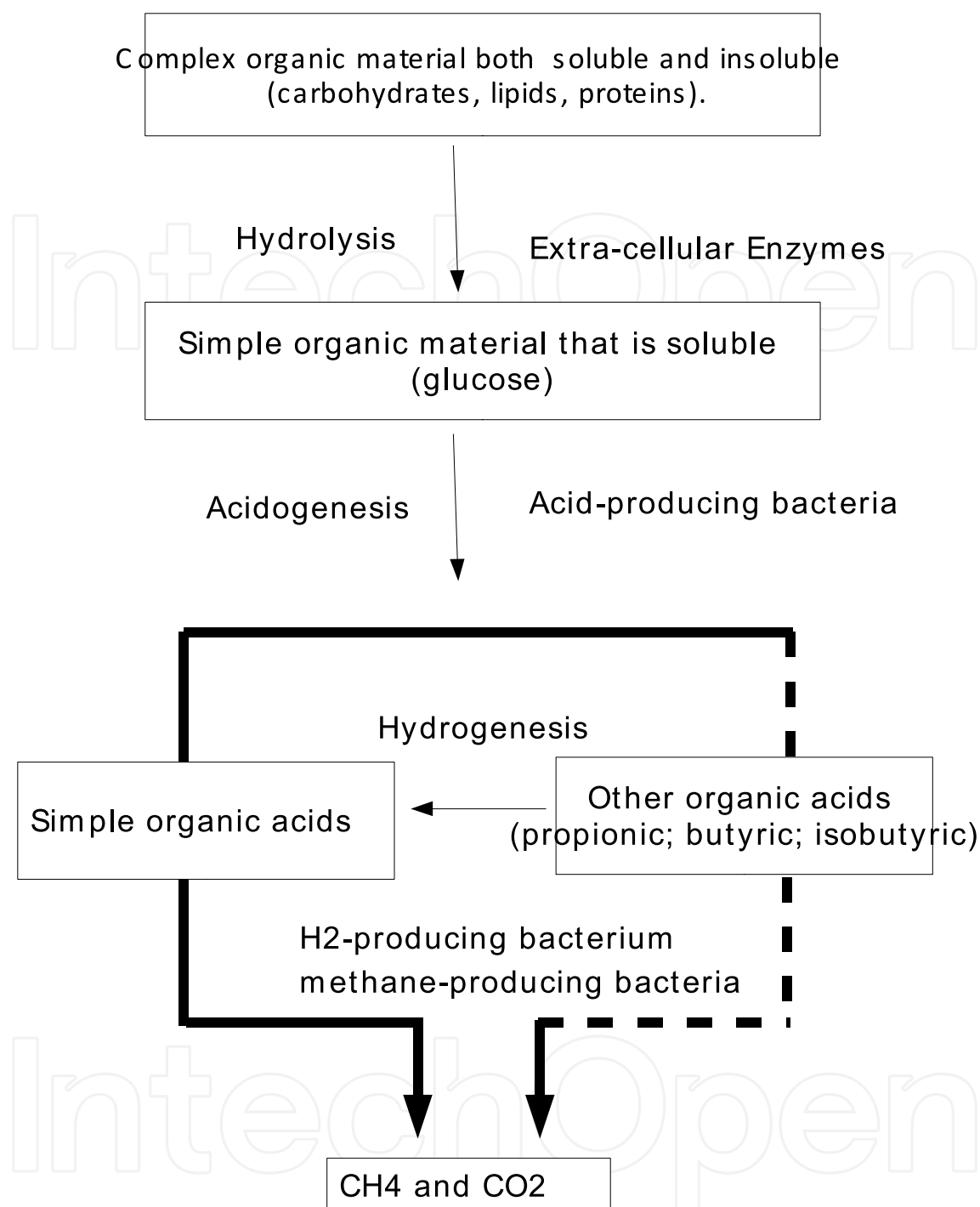


Figure 2. Biogas storage balloon



Source: Gter Energias Renováveis.

Figure 3. The biogas treatment process prior to intake.



Source:<http://www.biodieselbr.com/i/energia/renovavel/biogas/processo-biodigestor.gif>.
Accessed: 18/5/08.

Figure 4. The metabolic stages of anaerobic digestion occurring in the biodigester: the transformation of organic materials into gases used by farms, means that the environment is benefitted through the reduction of harmful methane gas emission.

The introduction of biodigesters to rural swine production can thus equally benefit producers and the environment, reducing and possibly eliminating risks of environmental degradation whilst ensuring the quality of life required by human being.

5. Methodology

Our present study focuses on a rural farm chiefly producing swine. Research was carried out on a farming property with a herd of 5,362 pigs. All processes and procedures undertaken at the farm are officially approved and licensed by the governing environmental agency. We also investigated whether the implementation of a biodigester is an economically and financially viable alternative: where there is the appropriate treatment of swine waste from production and the financial return of investment for the farmer. Data was solicited by semi-structured interview, with the additional analysis of documentation. The methodology of our study consisted of exploratory (qualitative) research, case studies of site procedures as well as quantitative research. Collated data was then tabled, and calculations / financial projections were made for the economic viability of investment.

For the sake of anonymity, "Business A" is used to designate the slaughterhouse and "Business B" the company which invested funds into the biodigester.

Calculations for the economic and financial viability of investment drew upon data collected in the first half of 2009. These data were tabled and are the basis for projections. In January 2012, we revisited the businesses which had participated in the research study in order to measure the strength and validity of the 2009 projections. We found that the generation of biogas and the financial return were in line with our 2009 forecasting/calculations. Adjustments were made in order to ensure a greater reliability for the return of investment.

6. Interpretation of data

The object of our study is Farm III and its 2 nuclei. The farm provides raw material to Business A. Our study seeks to measure the economic and financial feasibility of installing a digester and the proper treatment of swine waste this promises. All necessary data was therefore collected from Farm III/Nuclei I and II.

Farm III currently has a herd number of 5,362 pigs between nuclei I and II. It has a legally authorized waste treatment system. Each nucleus on the site has six pools and a Geomembrane Biodigester of HDP (High Density Polyethylene) and LLDP (Linear Low Density Polyethylene) of 1.00 mm with a volume capacity of 800m³ in nucleus I and 1400m³ in nucleus II. Each nucleus has a homogenization tank which heats waste prior to it entering the biodigester. This tank has a volume capacity of 75m³ in nucleus I and 150m³ in nucleus II. There is also a homogenization pump in each nucleus with a power of 5 hp.

7. Initial investment in the project

Installing a biodigester requires building a workable structure. Costing included reservoirs of clean biogas; biogas cleaning kits and labor. It was also necessary to purchase equipment such as biogas dryers; piping; compressors. Table 1 presents the total costing of initial investment necessary for installing a biodigester.

Description	Qty	Value (R\$)
Biodigester 1.400 m ³	1 und	131.700,00
Biodigester 900 m ³	1 und	102.426,00
Earthwork/excavation	N/D	37.000,00
Machinery room	2 und	26.000,00
Biogas cleaning kit	2 und	49.640,00
Biogas dryer set	N/D	38.960,00
Reservoirs of clean biogas	3 und	54.000,00
Pipe connections	N/D	12.000,00
Compressor	2 und	24.000,00
High pressure network	N/D	9.600,00
Pipeline	4 km	41.735,00
Pipeline excavation	4 km	22.000,00
Control fittings	N/D	28.716,00
Command table	2 und	24.800,00
Burners / heating equipment	N/D	32.321,00
Unforeseen costs	N/D	15.873,00
Total		650.771,00

Source: data collected from Business B.

Table 1. Initial investment.

7.1. Revenue generated by investment

Business B is responsible for funding the biodigester. It receives a return through the use of biogas consumed in the slaughterhouse and the singeing of swine. Values are invoiced using the following calculation:

$$CBG(R\$) = \frac{m^3 \text{ biogas} \times \text{cost per kg of GLP} \times 0.80}{2.3}$$

KEY: CBG = value of biogas consumed

m³ biogas = quantity of biogas consumed;

cost per kg of GLP (liquefied petroleum gas);

0.80 = eighty percent of the value of LPG (as per the binding contractual clause between investor and slaughterhouse);

2.3 = conversion factor for energy equivalence GLP/biogas.

Table 2 shows the net income accrued over 2006; 2007; 2008; 2009; 2010 and 2011, and the projected income for 2012; 2013; 2014 and 2015. The projections were made by calculating the average between 2009, 2010, 2011 and applying a 5% growth estimate (subsequent years are projected to grow by 5% when compared to previous years).

Year	Revenue
2006	94.922,09
2007	115.993,24
2008	107.239,10
2009	111.354,05
2010	116.921,75
2011	122.767,84
2012	122.865,27
2013	129.008,54
2014	135.458,96
2015	142.231,91

Source: Data collected from Business B.

Table 2. Generated and projected revenue.

In 2006 we see that the investing company had revenues of R \$ 94,922.09 (ninety four thousand, nine hundred and twenty-two Reals, nine cents). This, representing a nominal return of 14.95% from the value invested. The rate of inflation for 2006, using the IPCA index (adopted by the Brazilian government as the official measure of inflation) was 3.14% (according to the Central Bank of Brazil) and stands at 11.45% as the effective rate of return for that year.

In 2007, the investing company achieved a total revenue of R \$ 115,993.24 (one hundred and fifteen thousand nine hundred and ninety-three Reals, twenty-four cents), representing an 18.27% nominal return on the value invested. The IPCA inflation rate for 2007 stood at 4.46% (according to the Central Bank of Brazil), with 13.22% as the effective rate of return on investment for the period.

In 2008, total revenue accrued by the company amounted to R \$ 107,239.10 (one hundred and seven thousand, two hundred and thirty-nine Reals, ten cents), reaching a nominal return of 16.89% on invested capital. IPCA (according to Central Bank of Brazil) registered inflation at 5.90%, thus qualifying 10.38% as the effective return of investment.

In 2009 the total net revenue obtained by the company amounted to R \$ 111,354.05 (one hundred and eleven thousand, three-hundred and fifty-four Reals, five cents), reaching a nominal return of 17.54% on invested capital. Using IPCA as an index (and according to the Central Bank of Brazil) inflation stood at 4.31%, thus qualifying a 12.68% effective return of investment.

2010 had total revenues of R \$ 116,921.75 (one hundred and sixteen thousand, nine hundred and twenty-one Reals, seventy-five cents), reaching a nominal return of 18.42% on invested capital. In 2010 IPCA (according to the Central Bank of Brazil) pegged inflation at 5.91%, this putting the effective return of investment at 11.81%.

In 2011 net revenue was R \$ 122,767.84 (one hundred and twenty-two thousand, seven hundred and sixty-seven Reals, eighty-four cents), reaching a nominal return of 19.34% on invested capital. Inflation stood at 6.50% according to IPCA (and the Central Bank of Brazil), with the effective return of investment at 12.06%.

It appears that the annual return of savings (investment considered low risk and yield equal in all financial institutions in the country) for the years 2006; 2007; 2008; 2009; 2010 and 2011 was 8.41%; 7.80%; 7.74%; 7.09%; 6.81% and 7.50% respectively. The rate of cumulative nominal return on investment in question was higher in all the periods analyzed when compared to the accumulated rate of return of savings. From a purely financial viewpoint, such investment is attractive in terms of yields.

Year	Initial Investment	Net revenue	Return
2006	-650.771,00		-650.771,00
2006		94.922,09	-555.848,91
2007		115.993,24	-439.855,67
2008		107.239,10	-332.616,57
2009		111.354,05	-221.262,52
2010		116.921,75	-104.340,77
2011		122.767,84	18.427,07
2012		122.865,27	141.292,34
2013		129.008,54	270.300,88
2014		135.458,96	405.759,84
2015		142.231,91	547.991,75

Table 3. *Payback and return of investment.* The payback method of analysis presents to shareholders the necessary time to recover the financial resources invested in the project. Source: authors.

One of the weaknesses of payback strategy is the depreciation of monetary value over time. This said, a reversal seems to have occurred between 2010 (negative) and 2011 (positive). In terms of our research and its specific scenario, a recovery of initial investment kicks in at about five years and 11 months. The projection of discount rates for the following years was calculated by using the simple average of yields recorded over the previous three years, this being approximately 7.13%.

Year	Initial investment	Net revenue	Tax deduction	Net income	Deducted return
2006	-650.771,00				-650.771,00
2006		94.922,09	8,41%	87.558,43	-563.212,57
2007		115.993,24	7,80%	99.814,85	-463.397,72
2008		107.239,10	7,74%	85.747,65	-377.650,07
2009		111.354,05	7,09%	84.666,25	-292.983,82
2010		116.921,75	6,81%	84.107,70	-208.876,12
2011		122.767,84	7,50%	79.548,84	-129.327,29
2012		122.865,27	7,13%	75.866,74	-53.460,55
2013		129.008,54	7,13%	74.358,33	20.897,78
2014		135.458,96	7,13%	72.879,90	93.777,68
2015		142.231,91	7,13%	71.430,88	165.208,56

Source: authors.

Table 4. *Deducted return*: this table shows the calculation of discounted payback. The discount rates applied to net annual income were from savings accounts checked for the years 2006, 2007, 2008, 2009, 2010 and 2011.

Considering this data, a sign inversion occurs between the projected years 2012 (negative) and 2013 (positive), pitching the recovery of initial investment at roughly 7 years and 9 months. Using the information in Table 4 as a reference point, that is, the initial investment and net income both generated and projected, it is also possible to calculate the internal rate of return for the project – this being 12.16% per year.

Financial analysis reveals the benefits of investing in a biodigester. The farm reported a total revenue of R \$ 650,771.00, with a net income of R\$ 94.922,09 for 2006; R\$ 115.993,24 for 2007; R\$ 107.239,10 for 2008; R\$ 111.354,05 for 2009; R\$ 116.921,75 for 2010 and R\$ 122.767,84 for 2011. For 2012 net income is projected to be R \$ 122,865.27 with 5% real annual growth applied.

The payback period of investment recovery stands at 5 years and 11 months, and the discounted payback at 7 years and 9 months. Comparing the annual return of investment to the cost of savings, the rate of return on investment yielded higher gain over all periods analyzed, this, confirming the economic and financial viability of such a project. Financial and economic optic thus evidences the viability of financial investment into the project. This, combined with the environmental benefits, marks the entrepreneurial quality of such an enterprise.

8. Conclusion

The goal of our study was to demonstrate the relationship between swine production and the environment – where the former can be developed through new, innovative technologies, the latter is not impervious and remains vulnerable. There is a need to

consider the negative environmental effects of such practices, highlighting the urgency for due care and attention in waste management and business strategy.

The current market calls for fundamental changes in the economic situation and nature of organizations as well as flagging demands for a new benchmark in business management. An innovative approach to the way new realities are both understood and dealt with is a modern requirement.

There is nevertheless a lack of accurate information about the chemical concentration of swine waste. Alternatives remain limited and the rationale underdeveloped. Ongoing research is required into the suitability of different soil types and crops receiving fertilizer. Likewise, both the short and long-term environmental effects of swine waste need to be studied and known. What we do know is that the indiscriminate disposal of swine waste in natural environments, runs the elevated risk of contaminating soil; water supplies; rivers; effluents and the air itself – this, a condonable practice directly affecting the health of rural and urban communities.

Any waste distribution system then, must take into account the cultural and economic realities of farmers and local producers of swine. It is essential to raise the awareness of farmers and society alike, bringing to their attention issues of waste pollutants, as well as the benefits of implementing a technology that combines the agronomic use of manure as fertilizer, providing the economy with greater input and systems which minimize the effects of pollution.

As we previously asserted, our modern scenario is one requiring a social conscientiousness for the ecosystem is on the verge of total collapse. It is where modern man is faced with the urgency to change his world-view through sustainable business practices, igniting a change of values and a new direction in operating systems which engage with sustainable development and environmental preservation.

According to Freitas (2008), a great many experts fear that if emissions of greenhouse gases (mainly carbon dioxide, methane and nitrous oxide) continue to increase, then the planet's temperature will rise and the results will be drastic if not unimaginable. Formidable changes in our climate with extreme cold and elevations of wetland will lead us to experiencing periods of drought; fertile farmland will not too far into the future succumb to desertification; incidences of severely destructive storms, tornadoes, hurricanes or typhoons will be frequent; the dwindling and complete loss of floral species and fauna in different parts of the natural world will be commonplace, as will the melting of ice caps and the consequent increase in global sea levels. With the unbridled increase in global warming, mainly due to high levels of carbon dioxide and methane, serious consequences can already be felt on a global scale, threatening the survival of the earth's inhabitants.

The aim of our study is to demonstrate the benefits generated by installing a biodigester as a financially and economically viable alternative in the management of swine waste. Given this, biodigester technology and its environmental value, is more than a mere hypothesis but a tried and tested means of treating and reusing detrimental waste material – this, important

for both swine producer and society. Besides being an alternative source of renewable gas, such a technology reuses and recycles, improving and maintaining soil without jeopardizing environmental standards and human wellbeing.

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