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Financial Evaluation of the Technology Used for Waste Management in Swine Farms in Mexico

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Abstract

The purpose of this research was to conduct a financial assessment to determine the actual technology cost of CDM projects in swine farms in el Bajio, Central and Northern Mexico. For this research, the data provided in the Project Design Document (PDD) available in the framework of the United Nations Convention on Climate Change UNFCCC was used. Of the total number of (44) projects and a subset of 3 projects (Bajio, north and center) on pig farms, each project consists of several farms in the states of Guanajuato, Queretaro, Aguascalientes, Nuevo Leon, San Luis Potosí, Jalisco and Sonora that were registered with UNFCCC in 2005. The net present value was used to determine -in a 10-year period- the feasibility of the project through sale of the reduction of emission carbon credits (CERs). The variables used were: the cost of reducing a ton of CO^2, the number of reduced emissions (CERs) and the selling price of emissions. The results of projects comprising 1) Guanajuato, Aguascalientes and Queretaro and 2) Jalisco and San Luis Potosi, show a negative present value, this means that this is not possible with just the sale of carbon credits. Instead Jalisco, Sonora and Nuevo Leon have a positive value, they are viable if the market price is not less than 15 €/ton. These results allow, in more formal terms, that the presences of CDM projects are suitable for encouraging different agroindustry groups to investment in projects wich tend to reduce greenhouse gases. Taking steps to prevent pollution, this became an additional income for the farm there by enhances a company economically and sustainably.

Key Words: *Financial Evaluation, Technology, Swine Farms.*

Introduction

Food and Agriculture of the United Nations (FAO) studied, in January 2000, the effects on the environment caused by pork production operations in central Mexico. The results of these studies showed that certain procedures require a restructuring to mitigate the effects of pollution caused by waste, as they are discharged into land or water without treatment.

The National Institute for Forestry, Agriculture and Livestock (INIFAP), the National Autonomous University of Mexico (UNAM) and the Swiss College of Agriculture created a report for the FAO in 2002, stating that when manure is applied to land properly, it increases soil fertility, improves its structure and does not cause pollution. However, when manure is uncontrollably spread on the land, this results in a major environmental risk to air, soil, and water (surface and groundwater) quality. They also mentioned that methane, nitrous oxide, and nitric acid are produced there for increasing the greenhouse effect which contributes to increased temperatures then transcends to climate change.

Nowadays, there is great concern about human activities that contribute to the increase of gases that cause the greenhouse effect, therefore, the Mexican government implemented projects using clean technology to help the environment and contribute to regional development. Sierra (2009) states that more projects of Clean Development Mechanism (CDM) are waste management in pig farms, making this an option for sustainable and regional development.

The proposed mitigation of greenhouse gas (GHG) emissions from pig farms have a local impact, which includes the creation of jobs and economic benefits for the region via alternative energy generation and sale of carbon credits, both situations promote the profitability of the company and encourage investment. Sutter (2003) and Olsen (2007) argue that profitability is the main idea in CDM projects; Wara (2006) concurred stating that projects are profitable because they dominate the market and some generate huge economic benefit in sale of credits. The same way Ezcurra and Gaioli (2007) mention that one advantage of these projects is the ability to sustain itself through revenues generated from the sale of certified emission reductions (CERs); therefore facilitating a project that could not be implemented because it was not economically viable, or facing technical and high financial risk, can finally be implemented, thereby reduce GHG emissions.

Background of the Problem

Globally, Mexico ranks in 15th place in pork production. In 2008, the number of cattle was 15,230,631 and meat production was around 1,160,677 tons of which 67,800 tons were exported and the rest consumed domestically. In this same year (2008) the rate of consumption increased by 3% and estimated that the per capita consumption was about 14 kg. Of the total meat production, pork has 21% nationwide (SAGARPA. 2009).

This increase in production has led to an increase in the size and number of pig farms, the results of the Census of Agriculture - Livestock INEGI (2007) indicates that there were 979,348 units (pigs) in the country. This resulted in an increase in pollutant capacity of pig farms, especially in regions where pig population density is high.

The decomposition of manure causes serious environmental consequences from the production of gases such as methane and nitrous oxide, in the vast majority of farm this is not collected; instead it is released into the atmosphere. These gases are released through fermentation of animal manure, as well as nitrification and denitrification, the latter as the process associated with nitrogen volatilization also unpleasant odors and the pollution of land and water resources occur.

This situation has prompted the Mexican government in coordination with FAO, have implemented a series of actions to support the reduction of greenhouse gases, including the collection, burning or exploiting biogas is one of them, this will mitigate environmental impacts including odors.

While it is noted that the greenhouse effect is a normal earth process and is produced by gases (water vapor, carbon dioxide, methane, nitrous oxide, ozone, chlorofluorocarbons and Freon) found in the atmosphere and will impart to the world an average temperature of 33 ° C., some authors (Tahoria, Olcina and Rico, 1998) mentioned that human activities alter the chemical composition of the atmosphere causing changes in temperature and hence a change in global climate.

Theoretical Basis

Any economic activity should be considered within the framework of sustainable development. Sustainable development Fuenmayor & López, 2006 state that is assumed to be a strategy that integrates three dimensions: economic, ecological, and social. So the three basic conditions to be achieved under this principle are: (I) increase the social aspect, (2) reduce and/or mitigate the environmental impact and 3) contribute to economic development.

The term sustainable or sustainable development was first formalized in the document known as the Brundtland Report (1987), a result of the United Nations conference on Environment and Development, established in the United Nations Assembly in 1983. This definition is implicit in the 3rd. Principle of the Rio Declaration (1992). "Meeting the needs of the present generation without compromising the ability of future generations to meet their own needs."

As noted above, sustainability implies that the productive entities help the country to move towards sustainable development while they improve their own competitiveness. This concept means adding more and more value to the products and less anthropogenic pollution. This type of pollution resulting from human activities as a result of economic activities, such as production of carbon dioxide from fossil fuels that harm the environment contributing to increased greenhouse gases that affect climate disruption.

In regards to this, it is also important to note that the climate is modified by internal processes such as volcanic emissions or methane produced by farm animals, the main theory behind this approach that the climate is modified by internal processes was established in Svaante 1896 by A. Arrehenius. In his theory, Arrehenius states that the natural greenhouse effect of the planet is increased in the range of 2-4 degrees when the CO^2 concentration in the atmosphere increases (Weart, 2008) and 1958 the first continuous monitoring revealed a rapid increase in CO^2 levels in the atmosphere. These changes affect the present generation and also transcend to future generations.

Kyoto Protocol and the Mechanisms for Reducing the Concentration of GHG

For more than a decade, a large number of countries joined an international treaty, the Kyoto Protocol, with the main objective of stabilizing greenhouse gas concentrations in the atmosphere, caused by the human activities. The Kyoto Protocol introduced three mechanisms to reduce the concentration of gases that produce the greenhouse effect: 1) Emissions Trading, 2) Joint Implementation (JI) and 3) The Clean Development Mechanism (CDM). The Clean Development Mechanism (CDM) was established in Article 12 of the Kyoto Protocol which states that to be considered eligible under the CDM, they need to satisfy two basic conditions described in the protocol: 1) real, measureable and long term 2) Emission reductions from CDM project activities are required to be 'additional' - that is, the greenhouse gas emissions after implementation of a CDM project activity must be lower than those that would have occurred in the most plausible alternative scenario to the implementation of the CDM project activity (that is, the baseline scenario).

Regarding 'additional' this can be: environmental and financial. The Subsidiary Body for Scientific and Technological Advice (SBSTA) has affirmed that "environmental *additionality* is demonstrating that the environmental benefits associated with GHG would not have otherwise occurred, if it weren't for the CDM project". Rodriguez and Gonzalez (2000) state that the CDM project produces a financial *additionality*, if the project's current conditions are viable because of the economic advantages. However, a CDM project must meet the sustainable development of the country, as established in Article 12 of the Kyoto Protocol. The project must comply with the CDM cycle established by the Board of the CDM prior to receiving the economic benefits resulting from such participation.

Therefore, drafted animal waste management projects to mitigate greenhouse gases (GHG Mitigation Project AWMS), as stated in the context of CDM projects, become a viable option to reduce pollution (from this sector) and contribute to sustainable development. The main action behind these projects is to improve current practices applied to waste; these changes mitigate anthropogenic emissions by controlling the processes of decomposition and combustion of landfill gas collection and provide additional economic benefit. The actions proposed in the projects are economically sustainable and are designed to make the most of animal waste from pig farms, by installing bio-digesters to produce biogas which can be used in the generation of electricity and/or heat to cover the farm's needs and simultaneously reduce GHG emissions, improve water quality, and reduce odors. In simple terms, the proposal is to change the practices of waste treatment performed in outdoor lagoons where anaerobic digesters capture and burn biogas.

The benefits obtained from these projects are to encourage and participate in them and to contribute to economic growth (PENUMA y RISOE, 2002). However, some obstacles are present, mainly the producers -to encourage such practices because of the high cost involved, in addition, the economic situation of farmers has been affected by lower profit margins due to the increase production of this type of meat worldwide. Given this scenario, producers only focus on the essential functions and are hesitant to implement new waste treatment systems, unless the activity provide the means to balance the cost of changing practice. These projects offer the producer the financial resources to compensate the cost involved in the renewed practice, through these proceeds derived from the sale of emission reduction of greenhouse gases (CERs).

Table 1 Carbon Market at a Glance, Volumes &values in 2007-2008

	2007		2008	
	Volume *($MtCO_2e$)*	Value *(MUS$)*	Volume *$MtCO_2e$*	Value
Project-based Transactions				
Primary CDM	552	7,433	389	6,519
JI	41	499	20	294
Voluntary Market	43	263	54	397
Subtotal	636	8,195	463	7,210
Secondary CDM				
SUB Total	240	5,451	1,072	26,277
Allowances Markets				
EU ETS	2,060	49,065	3,093	91,910
New South Whales	25	224	31	183
Chicago Climates Exchange	23	72	69	309
RGGI	na	na	65	246
AAUs	na	na	18	211
Subtotal	2,108	49,361	3,276	92,859
Total	2,984	63,007	4,811	12,6345

Source: Work Bank (2009)

The transactions of these emissions are defined as sale contracts by which one party pays the other by way of reducing GHG emissions, or the right to release a certain amount of GHG emissions to the atmosphere. These contracts are used by the buyer to fulfill their objectives related to the mitigation of climate change (World Bank, 2007) and are available in a new market known as Carbon Market (MC). Table 1 shows that in 2008, the market reached a total transaction value of $126 billion (€ 86 billion). Approximately $ 92 billion (€ 63 billion) of this overall value is accounted for by transactions of allowances arising under the Emissions Trading Scheme of the European Union (EU.ETS) 4. The second largest segment of the carbon market was the secondary market for Certified Emission Reductions (CERs).

González (2008) states that emissions reductions (CERs) are the second largest segment in the carbon market and the CDM is presented as a useful instrument in the progress towards national goals in economic growth, and are also a good financial source (income) for companies because at the end of the investment. The amount received by the carbon is proportional to the price; and the price of a ton of emissions can reach an amount of $15dls. (Point Carbon, 2010).

Although the international carbon market has generated over 30,000 transactions per billion in 2007, the market is very volatile. At current prices, the price of a ton of CO_2 has decreased (Figure 1).

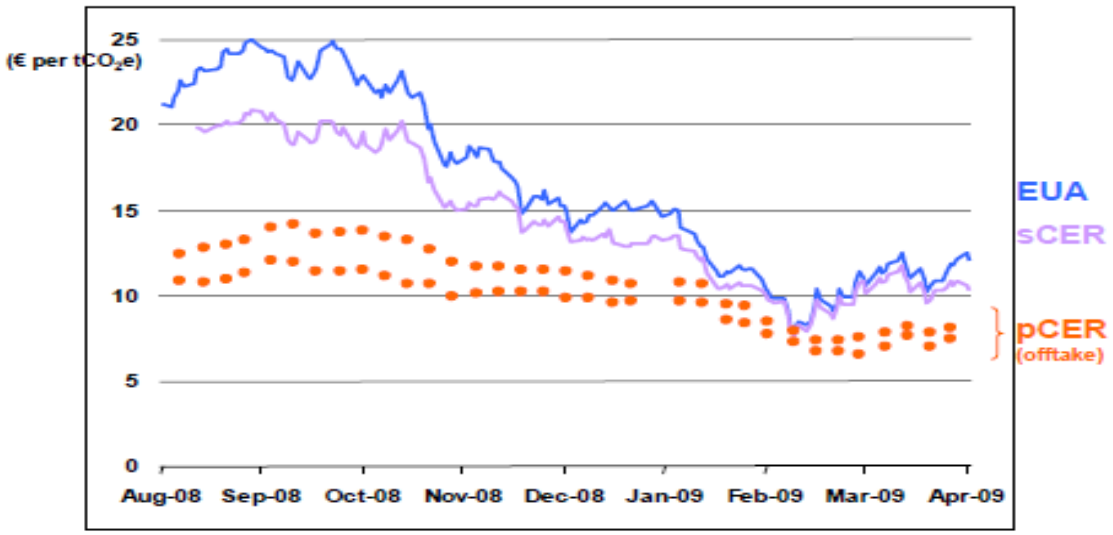

Figure 1 price of a ton of CO_2
Source: Work Bank (2009).

The main advantage that brings the development of projects within the CDM framework is the fact that it enables the realization of using revenue generated from the sale of the reductions (CERS), and turning a failed project –because it was not economically viable or too risky, into a viable one. Thus, Green (2006) mentioned that if some effective strategies are implemented to increase the profitability of these projects, this could increase the participation of developed countries. There by reducing emissions that produce greenhouse gases and also said that the benefit can be achieved when the marginal benefit from the sale of emissions equals the abatement costs of reducing these emissions.

Instead Wu and Babcock cited by Grenn (2006) indicate that profitability is obtained from the difference between the cost of having implemented the technology and payment made for doing this. This fee is paid through the reduction achieved with the new technology. So looking for profitability is an important factor to attract investment for these projects, however the policies proposed such as the price of CERs in the carbon market is not stable, there for the economic benefit cannot contribute to the goal of GHG reduction.

Problem and Objective of the Study

With the background of the observed phenomenon and its theoretical and empirical reality, the following questions arise: What are the actual cost of the pig farms projects in *el Bajio*, Central and Northern Mexico? Similarly: Investing in CDM projects in pig farms in the regions: *el Bajio*, central and northern Mexico will be sustained with just selling Carbon Credits? Such questions lead to a set the objectives: Conduct an assessment of the costs of CDM projects in pig farms of *el Bajio*, Central and Northern Mexico in order to establish a timeframe of when the initial investment can be settled only with the sale of carbon credits (CERs). For this purpose, it was necessary to study the financial 'additionality' of these projects.

Justification

The study would aid, from the beginning, in knowing more profoundly the economic and financial impact of the projects that are currently licensed and are viable to expand to other pig farms. Furthermore, determining the actual cost of these projects will drive to identify opportunities, in specific sectors, that could help economic development.

This work will also allow to understand the importance of promoting and increasing the development of CDM projects in the public and private sectors so that Mexican companies can successfully engage in the CDM, because Mexico's participation in Certified Emission Reductions (CERs) has not been significant due to cultural beliefs and a non-present financial viability. Finally the results obtained, seek to promote among pig farmers to incorporate these projects to generate additional revenue and improve the quality of life.

Methodology

Data for this research was provided by Project Design Document (PDD) available in the framework of the United Nations Convention on Climate Change UNFCCC. Of the total number of projects (44) a subset of 3 projects (*el bajio*, north and center) on pig farms, each project consists of several farms in the states of Guanajuato, Queretaro, Aguascalientes, Nuevo Leon, San Luis Potosí, Jalisco and Sonora that were registered with UNFCCC in 2005. The criteria for sample selection were based on the owners disposition to provide valid information. The selected farms are located in *el Bajio* (7 farms in Jalisco), North (31 farms: 9 in Nuevo León and 22 in Sonora) and center (6 farms: 5 in Aguascalientes, Queretaro, and Guanajuato, and 1 in San Luis Potosi).

The projects can be viewed in the United Nations Framework Convention on Climate Change (UNFCCC) web page. All projects comply with the format (CDM-PDD) of the Clean Development Mechanism proposed by the UNFCCC and contain the following items: an overview of the project activity, application of the baseline methodology, project duration/period, credit application of the monitoring methodology, estimation of GHG emissions and sources, impact on the environment and feedback from shareholders.

In each of the selected projects was investigated on the hypothetical reduction estimate (metric tons CO_2 from the methane and dioxide Nitrous) for the project and reduced emissions obtained from the activities of the clean development mechanism implemented on the farms. It is assumed, in this study, that the financial feasibility in each project comes from the sale of emissions to achieve a return on investment.

The methods used to assess the actual cost of the selected projects are: a) annual amounts of emissions produced in each project and b) the net present value. Theoretically, it is said that if the NPV is greater than zero investment is profitable (Garcia, 2006). Two elements are required for data analysis: the cost of reducing a ton of CO_2 and the number of emissions generated. All pig farms projects in the CDM have chosen duration of 10 years and a discount rate of 17.46%.

Results

From the data provided in CDM pig farm projects, the first consideration, the time period and the number of reduced emissions of each project. The table 2 shows the emissions and the time period in which they were produced.

Table 2: Quantity and period of reduced emissions in swine farms

State	Period	CERs (tons of CO_2 equivalent)
Sonora	1 June 2005 – 31 Dicember 2005	5,984
	1 January 2006 – 31 May 2006	19,586
	1 June 2006 – 31 October 2006	19,615
	1 November 2006 – 30 September 2007	43,433
	1 October 2007 – 31 March 2008	20,179
	1 April 2008 – 31 March 2009	43,663
	1 April 2009 – 31 October 2009	23,027
Total		**175,487**
Nuevo León	1 Octuber 2005 – 28 Febuary 2006	2,345
	1 March 2006 – 31 October 2006	7,650
	1 November 2006 – 31 August 2007	9,481
	1 September 2007 – 31 May 2008	8,124
Total		**27, 600**
Aguascalientes, Querétaro y Guanajuato	1 April 2006 – 30 September 2007	4,174
Total		**4,174**
Jalisco y SLP	17 September 2006 – 30 September 2007	8,636
	1 October 2007 – 31 August 2008	14,759
	1 September 2008 – 31 July 2009	16,854
Total		**40,249**

Source: Authors' calculations based on UNFCCC projects

As observed above, the project that produces more CERs is Sonora with a total of 175,487 in 4 yrs. 5 month period. The annuity of emissions in each project is presented in Table 3.

Table 3: Amount of annuity CERS

STATE	ANUALY AMOUNT
Sonora	31,107.16 $US
Nuevo León	28,359.67 $US
Aguascalientes, Querétaro y Guanajuato	12,628.00 $US
Jalisco y SLP	17,708.19 $US
Jalisco	38,507.63 $US

Source: own

Creating an analysis of the net present value of the income obtained from the sale of CERs considering a price of $15 per ton, the period to pay off the investment in each project varies. The table shows the present value of each Project.

The table 4 shows that two projects: 1) Guanajuato, Aguascalientes, Querétaro and 2) Jalisco, San Luis Potosi, its present value is negative; instead Jalisco, Sonora and Nuevo Leon have a positive value. However, the only project that can be paid off in the project's lifetime is Jalisco (7 years); Sonora and Nuevo Leon require longer than 10 years. However, the project can be considered cost-effective because the life of a digester is between 15 and 20 years.

Table 4: Emissions Reductions (CO2e) in metric tons

State	CERs	Time period	*Price per CER* ($USD)	Discount percentile %	Inicial investment (1 digester a pop. Of 1000 pigs)	VPN
Jalisco	4,425	2 yrs	15	17.46	150, 257.37	7 yrs
Sonora	175,487	4 yrs, 5 months	*15*	17.46	150, 257.37	11.5 yrs
Guanajuato, Aguascalientes Querétaro	4,174	1 yrs. 6 months	15	17.46	150, 257.37	Negative
Nuevo León	27,600	2 yrs. 8 months	15	17.46	150, 257.37	16 yrs
Jalisco, SLP	40,249	2 yrs. 10 months	15	17.46	150, 257.37	Negative

Source: own.

In addition, the project itself is not profitable. When analysis was found to support the project investment ($ 150,257.37 USD) is required to have 32 US $ 794.99 / year, they are not derived from the CDM benefits.

Conclusions

In general the objective posed in this study was fulfilled as it provided empirical evidence to indicate that the investment of CDM projects in swine farms in the regions: *el Bajío*, Central and Northern Mexico are paid off with just the sale of carbon credits. While two subgroups, that have been studied, are not profitable in the period stipulated by the CDM (10 years). It is important to note, however, that the lifetime of the digester is between 15 to 20 years and possibly the projects achieve profitability within that time.

In addition, pig farms that were investigated receive revenue from the sale of their product and the CDM project will contribute to their profitability via the sale of carbon credits, even though the price per ton of CO_2 is €1, at least they are taking actions to prevent contamination and this became an additional income that enhances a company economically and sustainably

With regard to the actual cost of the projects in the pig farms of *el Bajio*, Central and Northern Mexico, this research points out that even if the cost of the initial investment (150,257.37) is the same for each of the projects, even though, the cost effective depends on the amount of reduced emissions which in turn is a function of the amount of exerts produced and these depend primarily on the quality of the food, feeding program, the number of adult pigs from a farm. It is also important to note that the carbon price is critical. The international price of carbon has varied (€1 to €5 per ton of CO_2), and it is expected to recovery after the Summit on Climate Change in Copenhagen.

The results of this study concur with the research of some authors (Sutter, 2003 Mara, 2006 and Olsen, 2007) stating that the central element of such projects is the profitability generated by the sale of carbon credits.

The limitation in this study is that no other costs beyond those generated by the project itself were considered.

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