MEXICO PROFILE

ANIMAL WASTE MANAGEMENT METHANE EMISSIONS

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I SUMMARY OF EMISSIONS AND CHARACTERIZATION OF THE AGRICULTURAL AND LIVESTOCK SECTOR

In 2006, the Agricultural, Forest and Fisheries Gross Domestic Product (GDP) accounted for 5.4% of the national GDP. Agricultural activities accounted for 70% of the GDP by sector, while livestock activities, and forest and fisheries accounted for 23% and 7% respectively. [1]

Livestock activities are carried out in 110 million hectares. 28% of livestock activities are located in the Mexican tropic, 23% in mild areas and 49% in desert or semi-desert areas. Cattle raising has around 430 thousand units of highly competitive production (approximately 13% of the total), which is mainly devoted to poultry farming, swine breeding and production of bovine milk and meat with high quality standards and innocuousness that allows them to meet the needs of 70 to 98% of the national market depending on the product and access to international markets. However, along with these units, there is another large sector of approximately 2.9 million units of livestock production in the backyard or farmers that raise cattle extensively with very low levels of technology and poor access to markets.[2]

Livestock production has shown an accelerated growth in the last two decades. Currently, 26% more livestock is produced in comparison with the average production from 1995 to 2000 and 62% more livestock is produced than in the early 90's.

The value of livestock production for the same year was 188.5 billion pesos. The state of Jalisco stands out among the states because it accounted for 17% of the livestock production. Veracruz, Puebla, Durango, Guanajuato, Sonora, and Coahuila also excelled at the production after Jalisco. These seven states accounted for 52% of the total production value. The main products are bovine milk, bovine, swine and poultry carcass, egg for human consumption, and honey.

I.1 Characterization of the Livestock Sector

According to data from the Food, Agriculture and Fisheries Information and Statistics Service (SIAP) from the Ministry of Agriculture, Livestock, Rural Development, Fisheries and Food Supply (SAGARPA), Mexico had 30.9 million head of beef and dual purpose bovines, 2.1 head of dairy bovines, 15.2 swine, 8.8 goats, 7.2 sheep, 293.6 broilers, 164.5 poultry for egg, 4.4 turkeys, and 1.7 beehives in 2005. Regarding equine, 2.9 million horses, 0.75 mules, and 1.5 donkeys were reported according to the VII Agricultural and Livestock Census conducted in 1991 by INEGI. We expect to bring these figures up to date based on the agricultural and livestock census conducted in 2007. This census is currently being analyzed.

The livestock activity takes place in different ecological, technological, management system and production objective contexts. Consequently, there are different production systems according to species and products. In parallel, there are different species, breeds or genotypes adapted to the production and market conditions.

[1] Sector Program on Agricultural, Livestock and Fisheries from 2007-2012. Secretary of Agriculture, Livestock, Rural Development, Fisheries and Food Supply –SAGARPA. Page 13
[2] Idem, page 18

I.1.1 Beef Bovines[3]

Currently, this sector has one million production units and occupies the largest territory (50% of the national territory) because this activity is carried out extensively.

Beef production has increased at an average annual growth rate (AAGR) of 1.9%, from 1,329 tons to 1,613 in 2006.

I.1.2 Dairy Bovines[4]

Production of milk from bovines is carried out in all the national territory with 789 thousand breeding units. In 2006, more than 10 billion liters of milk were produced. Mexico was fifteenth in the world's production. Milk production in Mexico accounted for 18% of total production.

I.1.3 Broilers[5]

Production of broilers in Mexico was fifth worldwide. It accounted for 24% of livestock production.

Currently, 293.6 million birds in production, 238 million broilers per cycle, and 5.5 cycles per year have been registered. Broiler production has had the highest growth rate (6.9%) in the last years. This can be seen in the following chart:

I.1.4 Swine[6]

By 2006, the stock was 15 million swine; 1,108.9 tons produced by slaughtering 14.3 million animals. Production has grown 2.0% annually, since only 910.3 million tons were produced in 1996.

In Mexico, there are 789 thousand production units of which 114,000 are considered specialized units.

I.1.5 Sheep[7]

Sheep production has 421 thousand units. Production has increased at an average annual growth rate of 5.0%, from 29.4 thousand tons in 1996 to 48 thousand in 2006. However, it is necessary to point out that national supply has grown at a lower rate than demand. This means that there is a high dependence on imports (more than 50% of demand).

I.1.6 Goats[8]

In 2006, approximately 160 million liters of milk and 494 thousand units of meat were produced. This activity has 494 thousand units of goat production under a heterogeneous system of regional production.

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[3] Based on SAGARPA's data reported in the National Livestock Program 2007-2012.
[4] Idem
[5] Idem
[6] Idem
[7] Idem
[8] Idem

I.1.7 Poultry for Egg production[9]

Egg production is sixth place at a national level. Production was 2.3 million tons in 2006 and 121 million laying hen.

I.2 Inventory of Greenhouse Gases in Mexico

I.2.1 Methane Emissions in Mexico

According to the National Inventory of Greenhouse Effect Gases (INEGEI), the total greenhouse effect gas emissions in Mexico (GEI) in 2002 (without taking into consideration Use of Land, Change of Use of Land, and Forest, USCUSS) were 553,329 Gg[10] in CO_2 equivalent. This represents a 30% increase compared to 1990. These emissions include the six main greenhouse effect gases considered in Kyoto's Protocol (CO_2, CH_2, N_2O, HFCs, PFCs y SF_6).

Chart 1 Mexico. Emissions in CO_2 Equivalent (Gg) from 1990-2002

Emission Category	1990	1992	1994	1996	1998	2000	2002
1 Energy	312,027.20	321,835.90	342,899.60	349,430.60	394,128.80	398,627.30	389,496.70
1A. Consumption of fossil fuel	279,863.70	291,045.50	308,931.80	311,197.10	351,760.20	356,796.30	350,414.30
1B Fugitive emissions	32,163.50	30,790.40	33,967.80	38,233.40	42,368.70	41,831.00	39,082.30
2 Industrial Processes	32,456.40	32,878.30	39,247.80	42,744.00	50,973.10	55,851.20	52,102.20
4 Agriculture	47,427.50	46,049.60	45,503.90	44,076.60	45,444.90	45,527.00	46,146.20
6 Waste	33,357.20	36,935.40	46,862.60	52,894.90	62,655.90	63,219.80	65,584.40
Total	**425,268.20**	**437,699.10**	**474,513.80**	**489,146.10**	**553,202.80**	**563,225.20**	**553,329.40**

In the previous chart, we can see that the largest contribution to total emissions came from the energy category [1], which accounted for 72% of total emissions from 1990 to 2002. In the emission category, consumption of fossil fuels was the main source of GHG emissions in the country, since it accounted for 64% on average of the total emissions each year.

The relative significance that each category has with regards to total emissions has varied from 1990 to 2002. By 2002, there was a higher contribution of the categories related to wastes and industrial processes, while total contributions of energy [1] and agriculture tended downwards.

In terms of total contribution, the most marked change was the waste category, since the emissions increased by 97% from 1990 to 2002, as a result of the increase of solid waste disposal in landfills and the boost given in the last decade to industrial and municipality waste water treatment. This increase took place from 1990 to 1996 when the emissions increased by 59%. In the following years, from 1996 to 2002, the growth rate decreased and stabilized: the annual increase was 1 to 4%.

[9] Idem

[10] Unit of measure of mass equivalent to 10^9 grams, used for GHG.

I.2.2 Inventory of Greenhouse Gases in the Agricultural and Livestock Sector

The agriculture category [4], which averaged 10% of total emissions, decreased by 3% in 2002 compared to 1990. This may be the result of a possible stagnation in the livestock sector, an increase in imports, and a decrease in national production of basic grains such as rice.

The average emissions of methane and nitrous oxide estimated in the agriculture sector [4] in CO_2 equivalent were 46,000 Gg from 1990 to 2002.

In Table 2, CO_2 equivalent is shown in Livestock and Crops. Total of CO_2 equivalent in this sector is 46,290.72 Gg and methane in the livestock sector is 38,521.32 Gg, this is, 83% of the total methane emission.

Table 2 Mexico. Methane and Nitrous Oxide Emissions in the Agricultural Sector in CO_2 Equivalent (Gg), 1990-2002.

GHG (CO2 Eq.)	1990	1992	1994	1996	1998	2000	2002	MEAN
Methane	40,622.9	39,698.1	38,946.4	37,397.9	38,255.5	37,936.8	38,804.4	38,808.9
Nitrous Oxide	7,133.9	6,666.4	6,824.5	6,942.3	7,479.3	7,835.2	7,486.4	7,195.4
TOTAL	**47,756.8**	**46,364.5**	**45,770.9**	**44,340.2**	**45,734.8**	**45,772.0**	**46,290.8**	**46,004.3**

GHG (%)	1990	1992	1994	1996	1998	2000	2002	MEAN
Methane	85%	86%	85%	84%	84%	83%	84%	84%
Nitrous Oxide	15%	14%	15%	16%	16%	17%	16%	16%
TOTAL	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

TOTAL IN THE SECTOR (CO2 eq.)	1990	1992	1994	1996	1998	2000	2002	MEAN
Livestock	**39,976.14**	**39,080.54**	**38,424.07**	**36,882.85**	**37,688.41**	**37,458.45**	**38,527.47**	**38,291.1**
Methane	39,969.90	39,074.55	38,417.91	36,876.94	37,682.40	37,452.43	38,521.32	38,285.1
Nitrous Oxide	6.23	6.00	6.16	5.92	6.00	6.02	6.14	6.1
Crops	**7,780.68**	**7,283.89**	**7,346.82**	**7,457.36**	**8,046.40**	**8,313.52**	**7,763.26**	**7,713.1**
Methane	653.01	623.50	528.45	521.01	573.08	484.38	283.04	523.8
Nitrous Oxide	7,127.66	6,660.38	6,818.37	6,936.35	7,473.32	7,829.14	7,480.21	7,189.3
TOTAL	**47,756.82**	**46,364.43**	**45,770.89**	**44,340.21**	**45,734.81**	**45,771.97**	**46,290.73**	**46,004.3**

LIVESTOCK TOTAL (%)	1990	1992	1994	1996	1998	2000	2002	MEAN
Methane	99.984%	99.985%	99.984%	99.984%	99.984%	99.984%	99.984%	99.98%

Nitrous Oxide	0.016%	0.015%	0.016%	0.016%	0.016%	0.016%	0.016%	0.02%
Total	100.000%	100.000%	100.000%	100.000%	100.000%	100.000%	100.000%	100.00%

CROPS TOTAL (%)	1990	1992	1994	1996	1998	2000	2002	MEAN
Methane	8.39%	8.56%	7.19%	6.99%	7.12%	5.83%	3.65%	6.82%
Nitrous Oxide	91.61%	91.44%	92.81%	93.01%	92.88%	94.17%	96.35%	93.18%
Total	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

Source: National Inventory of Greenhouse Effect Gases 2005, Section 4, Agriculture Sector

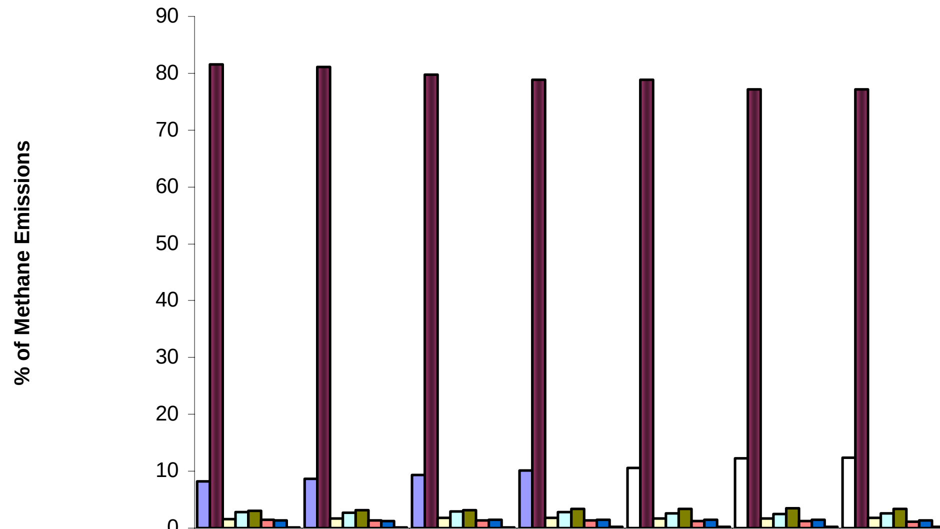
Average methane emissions in the livestock sector over the analyzed period were 1,823 Gg (Table 3), and represent the values of the sum of enteric fermentation and manure management.

Table 3. Mexico. Methane Emissions in the Livestock Sector Expressed in Gg from 1990 to 2002

Methane emissions	1990	1992	1994	1996	1998	2000	2002
Bovines – dairy cow	156.19	161.78	170.01	177.90	190.51	217.92	227.55
Bovines – beef cow	1,551.72	1,508.33	1,459.57	1,384.56	1,415.77	1,377.20	1,414.72
Sheep	30.04	31.44	33.19	31.78	29.83	31.07	32.98
Goats	53.75	50.13	52.83	49.26	46.55	44.82	47.01
Horses	56.81	57.62	58.48	59.39	60.35	61.36	62.41
Mules and donkeys	27.09	26.05	24.95	23.80	22.60	21.35	20.04
Swine	25.76	23.33	27.61	26.10	25.37	26.08	25.62
Poultry	1.97	2.00	2.79	3.24	3.42	3.65	4.01
Total	**1,903.33**	**1,860.69**	**1,829.42**	**1,756.04**	**1,794.40**	**1,783.45**	**1,834.35**

Source: National Inventory of Greenhouse Effect Gases 2005,, Section 4; Agriculture Sector

Illustration 1 Mexico. Methane Emissions Expressed in Percentages by Type of Livestock from 1992-2002



	1990	1992	1994	1996	1998	2000	2002
Dairy Cattle	8.21	8.69	9.29	10.13	10.62	12.22	12.40
Beef Cattle	81.53	81.06	79.78	78.85	78.90	77.22	77.12
Sheep	1.58	1.69	1.81	1.81	1.66	1.74	1.80
Goats	2.82	2.69	2.89	2.81	2.59	2.51	2.56
Horses	2.98	3.10	3.20	3.38	3.36	3.44	3.40
Mules and donkeys	1.42	1.40	1.36	1.36	1.26	1.20	1.09
Swine	1.35	1.25	1.51	1.49	1.41	1.46	1.40
Poultry	0.10	0.11	0.15	0.18	0.19	0.20	0.22

Year

Source: This report was created based on INEGI data 2005
Part IV, Agricultural Sector.

According to the previous chart, dairy and beef bovines are the type of livestock that generates the largest amount of methane emissions per year. This can be seen over the period of time when this survey was carried out. The rest of livestock contributes very little to methane emissions.

I.3 Livestock Waste Management Practices.

Destination of excreta is closely related to water availability; therefore, it is also correlated to the stockyard cleaning system. This is why the most common system is shoveling. Dung is collected with shovels and piled up in or outside the farm. However, there are always liquid discharged due to liquid excreta.

The second cleaning method most widely used is mixed cleaning. This method consists of shoveling and flushing. Utilization of this method is related with water availability, since the swine breeder has to decide whether he/she uses water for stockyard cleaning or internal use of the farm.

Farms can also be cleaned with water, which is not a frequently used method due to water shortage. After leaving the stockyard, water runs into a solid separation pit and it is later discharged into irrigation channels and/or the farm's own or neighbors' plots.

Due to the great variety of livestock production systems in Mexico, there are no techniques on waste management that could be applied to all of them. However, the most widely used techniques are the following:

- **Application to the soil:** it is the direct application of non-treated slurry to grazing land or arable land
- **Storage and drying:** It consists of storing waste in slurry storage tanks. Subsequently, this waste is used in cultivation areas when the land can best profit from it.
- **Solid and liquid separation:** This system allows a better utilization of nutrients. Most separated solids are dry enough to be piled up, while the separated liquid can be handled as any other fluid. In fact, this liquid may be spread through irrigation sprinklers at rates that can be easily controlled as it happens with crude slurry.
- **Compost:** It consists of degradation of a mix of organic material caused by a series of microbes in a wet, warm and aerobic environment. Compost can later be used as organic fertilizer.
- **Reutilization of excreta as food for livestock species.** One of the techniques used for this purpose is excreta transformation into chicken slurry, pig slurry or silage (depending on the type of animal where it comes from). Nutrients are added to these products and then used to feed cattle.
- **Aerobic-biological treatment of liquid wastes:** Aeration increases the amount of oxygen available for bacteria that naturally appear in slurry. This is the way the metabolic rate is increased and multiplication enhanced. The action of aerobic bacteria is to oxidize biologically the contaminant compounds in the slurry; consequently, it becomes less contaminant.
- **Oxidation lagoons**. It is a deep structure in the soil where the pig slurry is collected. It is left there so that anaerobic bacteria decompose it. In this process, most solids contained in the pig slurry become liquid or gas, consequently, the organic content and the nutrient value of the pig slurry decrease.[11]

I.4 Practices for Methane Recovery and Utilization

In Mexico, recent efforts have been made to strongly encourage capture and burning of methane generated from the oxidation lagoons used by the swine farms to manage excreta.

Oxidation lagoons retain farm effluents (excreta, urine, and cleaning water) in a watery mix. The purpose of these lagoons is to prevent such mix from discharging into rivers, lagoons or other water bodies causing great pollution to the environment. Such lagoons have maximum retention capacity and once these lagoons become "saturated", slurry, which is used for fertilizing cultivation areas) is removed. The lagoon is emptied and the previous cycle starts all over again.

[11] http://www.teorema.com.mx/secciones.php?id_sec=0

Since Kyoto's Protocol and due to the high level of pollution caused by methane emissions (methane has 23 times more power of causing the greenhouse effect in comparison with CO_2), especially those emissions released by the oxidation lagoons in swine farms, the conditions were created in Mexico to develop an anaerobic digester market. The basic objective is to capture and burn biogas (100% of biogas is made up of approximately 68% methane, 30% CO_2, and the rest is mainly water vapor and sulfur traces) to have the possibility to be granted credits (in carbon bonds) for the reduction of CO_2 emissions to the atmosphere.

Illustration 2. Collecting Tank and Anaerobic Digester. Farm Paraíso IV. Abasolo, Guanajuato. Mexico

Illustration 3. Anaerobic digester. Farm Santa Mónica. La Piedad Michoacán. Mexico

There are different types of digesters that respond to the farm characteristics and practices (for example, farm scale, weather conditions, etc), equipment cost-benefit, among others; there may be covered lagoon digesters, bag digesters (for small farms), digesters with modular covers, etc.

In the swine breeding area called La Piedad in Michoacan, Mexico, some digesters were built in the early 80's with the collaboration of the National Council of Science and Technology

(CONACYT) and some swine breeders and developed by the former INIREB (National Institute of Biotic Resources). They were made of masonry and the main restriction was the system cost. Only biogas was burned in tubular collectors made of galvanized steel.

Likewise, in the late 70's and early 80's, some anaerobic digesters were developed on an experimental basis. This was the case of the digesters developed by the Institute of Electric Research (IEE, Cuernavaca, Morelos) from the Federal Commission of Electricity in collaboration with the Latin American Energy Organization (OLADE).

Subsequently, in the late 90's, other digesters were developed in Jalisco and Guanajuato in a more formal way with the support of Fundaciones Produce as part of comprehensive projects to spread technologies of management and utilization of manure from swine farms with medium and small size breeders. In other states like Tabasco and Veracruz, some masonry digesters were developed with the support from agencies such as the German Government Agency, GTZ, and government funds. It was not until the 90's when plastic digesters were built mainly influenced by Cuban and Colombian systems, although geomembrane was not used, since it was not considered useful for this technology at that time.

At a domestic level, from 2000 onward, some Non-Governmental Organizations (NGO's) and some state governments like Guanajuato, Michoacán, Jalisco and Aguascalientes through Mix Funds (funds supporting research) and CONACYT, have promoted this technology in Mexico as an alternative to control pollution in medium and small size swine farms where plastic materials and geomembrane are used.

In general, the digesters that were built in Mexico until the 90's were not really monitored, because the idea that it was cheaper to use domestic gas (propane and butane) persisted and the impact to the environment caused by swine excreta had not really been considered. This criterion has changed and been reoriented to reutilization of excreta to mitigate GHG and biogas generation,

On the other hand, with the impetus to the ratification of Kyoto's Protocol, methane recovery in large scale farms has rapidly gained in importance and many projects have been filed in the Clean Development Mechanism (CDM). 89 swine breeding projects for methane utilization, involving approximately 3,641,596 animals in 487 farms, have been certified. These projects have the approval letter from CDM in Mexico and are going through different stages registration, approval or sell to CER's.

II DESCRIPTION OF KEY STAKEHOLDERS IN METHANE MANAGEMENT AND RECOVERY IN THE LIVESTOCK SECTOR

II.1 Government Sector

The key stakeholders in the government are the following:

- **SEMARNAT** is the agency behind the Methane to Markets (M2M) initiative in Mexico and the main promoter of good practices of environmental management. SEMARNAT promotes methane management and recovery in different sectors, including the agricultural and livestock sector. SEMARNAT's support is provided through promotion, environmental regulations and links with the private sector, donors and other initiatives related to this topic.

- **SAGARPA**, through the General Livestock Coordination, sets and implements policies to Foster Livestock through support programs, regulations, producer organization, research, and technological transfer to increase livestock production competitiveness. In terms of methane management and recovery, the General Livestock Coordination has actively been involved. Due to its links with the production sector, it has promoted this initiative through support mechanisms currently in force and new strategies.

- **Shared Risk Trust (FIRCO),** is an organization from the agricultural and livestock sector. This organization is involved in methane management and recovery through the work area related to Renewable Energy for Rural Development. Currently, FIRCO has projects of methane recovery using anaerobic digesters in swine farms. In addition, it has a program that helps agricultural and livestock producers purchase, install and manage equipment for renewable energy utilization.

- **National Institute of Forest, Agriculture and Livestock Research (INIFAP),** is a public institution focused on technological research and transfer that supports technological innovation demands in the agricultural and livestock sector. Researchers from INIFAP in the states of Jalisco, Michoacan and Guanajuato have carried out research into the swine breeding sector for many years. Some of their line of work has been excreta management, water pollution, methane recovery, and reutilization of solids.

- **Private Sector**: There are international and national project developers, and engineering and consultancy firms within the private sector.

II.2 International Donors / Cooperation

Currently, USAID and EPA, through M2M, are the main donors for methane recovery projects in the livestock sector. M2M was designed and led by the US Environmental Protection Agency (EPA). The main objectives of the initiative are to foster economic growth, promote energy security, reduce greenhouse gas emissions, and improve air quality.

II.3 Private Sector

The private sector has shown an ongoing interest in the methane market in Mexico. Services provided by this type of companies are focused on the elimination of greenhouse gases and subsequent trading of carbon bonds in the international markets. Some examples of this type of companies are AgCert and Ecosecurity (foreign companies with a subsidiary in Mexico). These companies eliminate such gases in swine breeding processes through a scheme in which the company manages the whole process. The company contacts the swine breeder, signs a contract with the breeder, assesses the technology to be used, develops engineering, includes the product in a wider project and files the project in the UN and Mexican government, builds and installs collecting and anaerobic digestion equipment, measurement devices and biogas combustion equipment, operates and maintains the equipment, sells carbon bonds, and carries out negotiations and management.

Projects managed by the private sector are currently registered in the CDM. By February 2008, 162 projects had been registered. These projects involve methane emission abatement in 449 agricultural and livestock farms (including dairy farms and swine breeding farms). It is important to point out that most of these projects are only for burning biogas, because the projects have been neglected by AgCert.

III OVERVIEW OF METHANE RECOVERY AND UTILIZATION POTENTIAL

Estimating the potential of digesters in Mexico is not an easy task, since there may be significant errors due to the quality and reliability of available data. It is important to highlight that data shown is just a first estimation on biogas utilization and capture potential in Mexico. Once there is access to data from the 2007 National Census of Agriculture, we will be in conditions to update the information in this section.

In order to estimate the methane recovery market potential in Mexico, it is necessary to subdivide and break down the total number of digesters into subgroups with slightly controlled variables. Digesters will be broken down in strata based on the following criteria:

1º. Only digesters from swine breeding farms will be considered; digesters that may be installed in other sectors will be set aside such as cattle raising farms and slaughter houses.

2º. Only digesters from semi-modernized and modernized farms will be considered; this is, only medium and large size farms will be considered.

3° The former paragraph does not mean that is not feasible to install digesters in small or backyard-type farms; however, it is more feasible to install anaerobic digesters in large and medium size farms, since it has been seen that this type of farms use cleaning techniques based on water. They normally use water to remove excrement which is later discharged in oxidation lagoons. This practice does not necessarily occur in "small" farms due to the lack of water or because it is more profitable to use dry cleaning methods such as excreta scraping, shoveling or sweeping.

The former points are basic criteria for the current market analysis and the starting point is the total number of swine in Mexico. The number of swine stock was 15,176,822 heads in 2005 according to the Food, Agriculture and Fisheries Information Service (SIAP) from SAGARPA

From the total number of existing swine in Mexico, 50% (7,288,411) are located in semi-modernized and modernized farms (subject of this analysis), and the remaining 50% are swine located in small or backyard-type farms.[12]

On the other hand, CDM has records of 449 digesters in 544 farms with 3,641,596 animals, including sow, piglet, stock breed and boar.

The 449 digesters reported by CDM have contributed to CO_2e emission abatement by 2,566 tons a year.

If we consider the 7,588,411 swine that are located in semi-modernized and modernized farms and deduct the total number of farms that already have digesters (3,641,596 swine heads), the subgroup of swine without digesters is 3,946,815. On the other hand, if the average of swine per farm obtained from the number of projects reported to CDM is acceptable, each farm has approximately 8,110 swine. Based on the swine subgroup that does not have a digester installed and considering the previous average of swine per farm, it may be estimated that the semi-modernized and modernized subgroup that does not have a digester is 487 farms[13].

[12] De acuerdo a la información reportada en el SIAP 2005.

[13] According to data supplied by a digester developer/installer in México, digester potential in México is estimated to be from 600 to 700 digesters, including slaughter houses and bovine farms.

From the information of the projects reported to CDM, we can deduce that the estimated biogas emissions per day per animal averaged 0.134 kg_{biogas}/day/animal. Consequently, if we consider that there are 3,946,815 swine in farms without digesters, the total potential of methane per year is 2,781,068 tons of carbon dioxide produced by swine excreta that is being released to the atmosphere without being utilized.

Based on the former, we can draw the following conclusion: project developers that have traded carbon bonds at CDM or in any other alternative carbon market have addressed approximately 57% of feasible digesters to be installed in Mexico in semi-modernized or modernized swine breeding farms. Therefore, 43% of the remaining farms do not have digesters due to several reasons.

7,588,411 swine are estimated to be located in "small" or backyard-type farms, but only 50% has the right conditions for methane production. Consequently, this results in approximately 127 thousand tons of methane per year or 2.7 million tons of carbon dioxide per year.

Only 50% of the swine bred in backyard-type farms has the potential to use excreta for methane production, primarily, because it has been estimated that this percentage only includes the farms in urban areas. In addition, it has to be taken into consideration that sometimes excreta are removed or discharged into the sewage, channels, rivers, lakes, lagoons or any other water bodies: mix of water with the swine excreta and room temperature provide the right conditions for methane production.

Even though a program of methane potential for the swine breeding sector has already been submitted, it will be important, for future purposes, to include in this estimation the dairy farms and slaughter houses, since they also have an animal waste management system that allows obtaining biogas. In addition, it is necessary to include them to avoid environmental impact. Modernized swine breeding farms and specialized production system farms are production units that have foreseen a demand on the implementation of comprehensive biogas systems and that can actually afford carrying out this type of projects.

It is important to point out that previous data only represent a prior estimation on the biogas utilization and capture potential in Mexico. Once we have access to the 2007 National Census of Agriculture, we will be able to update the information from this section.

IV IDENTIFIED BARRIERS TO IMPLEMENTATION OF METHANE CAPTURE AND UTILIZATION PROJECTS IN LIVESTOCK PRODUCTION IN MEXICO

Due to the fact that in Mexico the activity of methane capture and utilization is an incipient market, there are still some barriers that have to be overcome so that there can actually be an increase on the number of projects to abate methane emissions and that the current capture projects can actually include technologies that can help utilize biogas. There is still a lot to do, but the overlook is optimistic as a consequence of the general interest in implanting this technology.

IV.1 Institutional Barriers

- There is not enough research on methane capture and utilization methods.
- Environmental laws are not enforced. This has increased pollution caused by livestock waste.
- Weak national capabilities to design and manage projects to reduce methane emissions stemmed from the livestock activity.
- There are not many projects regarding renewable energy.
- Power generation with biogas is not an appealing choice due to regulations and costs involved to incorporate this method into the distribution network and sell it to the users.

IV.2 Technological Barriers

- Too much heterogeneity among the livestock production units in relation to their size and use of technology.
- Few developers of anaerobic digester technologies.
- Lack of guidelines to design and build anaerobic digesters.
- High operation and maintenance costs of the anaerobic digestion systems.
- Lack of comprehensive schemes to address the issue of livestock waste.
- Little experience in (thermal and electric) methane utilization.
- Lack of co-generation equipment for all types of farm sizes and variable methane production.
- There is no industry currently producing biogas systems on regular basis at a national level.

IV.3 Economic Barriers

- Uncertainty with regards to profitability levels for the livestock producers.
- There are not enough public and private funding schemes.
- Critical economic situation of national breeders due to international prices. This makes it difficult for them to invest in waste treatment.
- Producers are not aware of the emission markets.

V METHANE CAPTURE AND/OR UTILIZATION PROJECTS

As part of the Mexico's current policies to reduce pollution in the agricultural and livestock sector, the Mexican government has been supporting the following programs:

V.1 M2M Initiative in Mexico

Mexico is part of the Methane to Market Initiative led by the US Environmental Protection Agency (EPA). This initiative has already been implemented in other countries such as Germany, Argentina, Australia, Brazil, China, Colombia, European Union, Ecuador, USA, India, England, Italy, Japan, Nigeria, Poland, United Kingdom, Republic of Korea, Russia, Ukraine, and Vietnam.[14]

As part of this initiative, different pilot studies have been developed in the agricultural and livestock sector, specifically in swine breeding farms from the Lerma-Chapala region. The purpose of these projects is to test the existing technology and its performance in traditional Mexican farms. New policies are expected to be developed based on the results that will allow to carry out this type of projects. SEMARNAT and SAGARPA (Secretary of Agriculture, Livestock, Rural Development, Fisheries, and Food Supply) are working together to promote and develop these projects.

The M2M Agriculture and Livestock Sub-Committee in Mexico selected 14 projects and developed basic information, which was shown in M2M Expo in Beijing, China in November 2007.

[14] http://www.methanetomarkets.org/

Illustration 4. Example of a Project under M2M Initiative.

OVERVIEW OF AGRICULTURE PROJECT OPPORTUNITY:

The "La Victoria" swine operation in the Lerma-Chapala watershed area of Mexico is a grower-finish farm with a livestock population comprised of approximately 4030 pigs. The current manure management method is a flush barn where the liquid/slurry waste is stored in a basin or pond. The existing manure disposal method is land application and discharge to surface waters.

The proposed methane recovery system is a covered lagoon digester and the resulting biogas will be utilized for light and heating; unused methane will be flared to reduce greenhouse gas emissions.

The estimated emissions reductions = 738 metric tons CO_2 Equivalent/year

V.2 Clean Development Mechanism (CDM):

Mexico is one of the countries that have ratified the Kyoto Protocol; therefore, it has actively participated in the Clean Development Mechanism (CDM). Mexico has filed 156 projects in the Executive Board of the Climate Change Inter-secretariat Commission[15]. A contribution to reduction of almost 6 million tons of CO_2 Equivalent has been estimated with these projects. This means that Mexico is 5th according to the reduction volume and number of projects registered worldwide[16]

From all registered projects (at different stages), 162 projects are related to methane emission abatement in 449 agriculture and livestock farms (including dairy farms and swine breeding farms) located in the main swine breeding areas in the country in the states of Sonora, Jalisco, Puebla, Tamaulipas, Veracruz, etc. (See table and figure 5). 1.8 million tons of CO_2 equivalent have been reduced in this sector (data by February 29th, 2008).

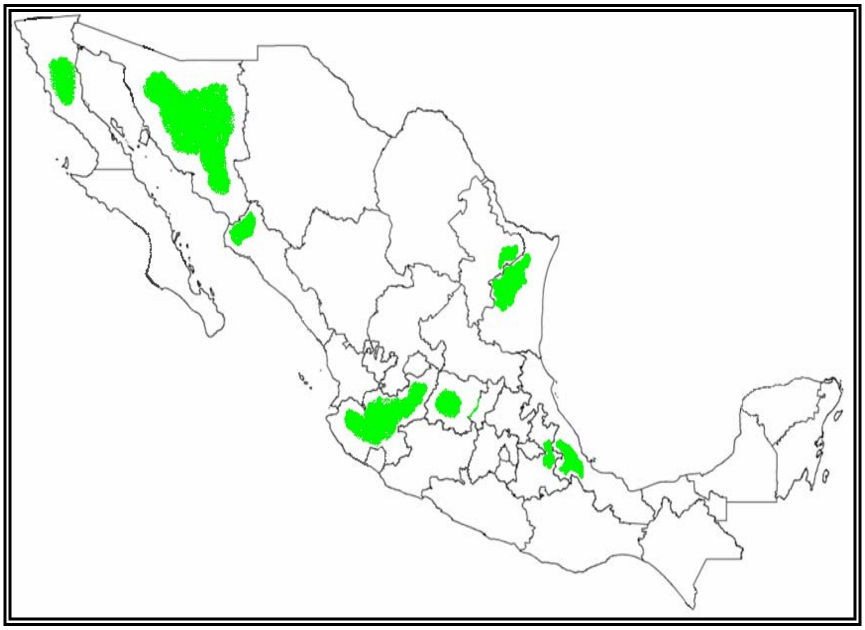
15 http://www.semarnat.gob.mx/queessemarnat/cambioclimatico/Pages/CDM.aspx

16 http://www.pointcarbon.com/category.php?categoryID=323&expand=323

Table 4. Mexico, Projects registered in the CDM

State	Number of digestors
Aguascalientes, Guanajuato and Querétaro	4
Sonora	157
Guanajuato and Querétaro	6
Jalisco	101
Aguascalientes and Guanajuato	4
Veracruz	25
Puebla	18
Yucatán	9
Nuevo León	8
Sinaloa	6
Sinaloa and Sonora	20
Nuevo León and Tamaulipas	7
Jalisco and San Luís Potosí	13
Michoacán	2
Jalisco and Michoacán	7
Coahuila, Durango and Nuevo León	4
Guanajuato	4
Guanajuato and San Luís Potosí	4
Guanajuato and Jalisco	3
Chiapas	3
Tamaulipas	9
Guanajuato Michoacán and Querétaro	6
Oaxaca and Puebla	13
Chihuahua and Nuevo León	3
Michoacán and Querétaro	3
Jalisco and Nayarit	2
Guanajuato, San Luís Potosí and Jalisco	8
Total	**449**

Illustration 5. Location of CDM Livestock Projects in Mexico.



Source: This chart was created based on the information from the CDM projects registered in Mexico

V.3 FIRCO-SAGARPA Project

In 2006, FIRCO along with Mexico City's Autonomous University (UACM) developed a project for biogas utilization. In general terms, the project consisted of the construction of 9 demonstration modules with motor generators operated with biogas to generate electric power. In December 2007, FIRCO provided financial support for the acquisition of motor generators for 71 projects that already had an anaerobic digester.

VI SIGNIFICANT ASPECTS OF METHANE MARKET AND REGULATIONS

In the agriculture and livestock sector in Mexico, there is a great amount of productive units that produce different organic waste. This waste has just recently been considered a public health and environmental pollution issue.

With the development of renewable energy technologies, in particular utilization of biogas, the possibility for this waste to be used in the electric and thermal power has opened. Waste from swine breeding farms, pig pens and slaughterhouses have a high potential for biogas generation. The benefit will be that the energy generated with this compound may be used in different production processes inside the facilities in an environmental friendly manner.

Not only that, but, currently, under the Clean Development Mechanism, biogas from animal waste has become an income source if is burned directly or reutilized. In both cases, it would be considered "carbon bonds".[17]

VI.1 Potential of Methan Use In Situ

Methane captured in anaerobic digesters has a high use potential, mainly on direct burning and utilization of heat in different applications where other commercial fuels are currently being used such as LP gas, natural gas, gasoline, diesel, among other. Biogas may be used as follows:

- Sanitary facilities for the employees.
- Caloric energy during direct burning for food cooking processes.
- Lighting systems through biogas lamps.
- Heating source for animals (piglets and sows) through lamp-type heaters.
- Heating source for animals (piglets and sows) through hot water "mats".
- Animal and hogsty cleaning with hot water instead of water at room temperature. The benefit will be better phytosanitary conditions.
- Fuel to run motor generators and generate electric power. The latter may be used in many production units. Electric power production through biogas production systems may be used in machinery and equipment used in production processes.

[17] "Utilization of biogas for electric power generation in the agriculture and livestock sector", Claridades Agropecuarias Magazine .ASERCA-SAGARPA. No. 168, August 2007, page 3

Illustration 6. Production of Electric Power with a Motor Generator.[18]

VI.2 Regulation Aspects

The livestock production units are bound by the Mexican Official Standard 001 which sets forth the maximum limits allowed of pollutants of water discharged to federal water channels or bodies. This Standard has forced them to develop animal waste management systems to meet those maximum limits.

The General Act of Prevention and Comprehensive Waste Management published in 2003 identifies cattle raising activity as a waste generator sector that needs to set up animal waste management plans.

Currently, there are no specific regulations for biogas or methane gas utilization. However, we can refer in general terms to the Bioenergetics Act, Bill for Utilization of Renewable Energy Sources, and National Strategy of Climate Change.

- **Bioenergetics Act.** This act has just recently been passed (February 1st, 2008). This law sets forth the guidelines to promote and develop Bioenergetics to contribute to energetic diversification and sustainable development and create conditions that can guarantee the support to Mexican agriculture. This law establishes the bases for the following activities:
I. Promote input production for Bioenergetics derived from agricultural and livestock activities, forest and algae activities, biotechnological and enzymatic processes in agriculture.
II. Develop production, trading and efficient use of Bioenergetics to contribute to reactivation of the rural sector, employment generation and better quality of life for the population, in particular those individuals living in abject poverty.
III. Seek for reduction of pollutant emissions to the atmosphere and greenhouse gases through the international provisions included in the Treaties signed by Mexico.

According to Article 2 in this act, subsection 4, biogas is considered a biofuel subject to and regulated by this law. [19]

[18] Picture of a FIRCO project.

- **Bill for Utilization of Renewable Energy Sources.** In article 2, subsection II, gas methane is described as a biofuel that is part of the renewable energy sources. In addition, article 23 mentions the creation of a General Energy Fund (in which methane is included, since it has been considered biofuel in accordance with the previous paragraph). It reads as follows:

Article 23.- The "General Renewable Energy Fund" will be created within the Trust for Utilization of Energy Renewable Sources. This Fund will promote the development of applications of Renewable Energy Sources other than biofuel generation and production such as water solar heating and sustainable utilization of biomass for food cooking, among others.

Likewise, the "Fund for Technological Research and Development of Renewable Energy" will be created in accordance with this law. This Fund will be applied to the assessment of national Renewable Energy Source potential and technologies for electric power generation in connection with the National Electric System networks, electric power generation in isolated areas, **biofuel production**, thermal utilization of solar and geothermal energy, pumping with eolian energy, pumping with ram-pumps or **development of technologies for efficient and sustainable use of biomass in domestic and production activities,** among others.[20]

- **2007 National Strategy of Climate Change.** The National Strategy of Climate Change (ENACC) identifies measures and specifies greenhouse gas emission reduction possibilities and range, proposes studies necessary to set more accurate mitigation goals, and outlines the country's needs to make progress in building adapting capacities. Although the ENACC focuses on the Federal Public Administration competence, it contributes to a wide and inclusive national process based on government, corporate and social consensus to identify opportunities to reduce emissions and develop mitigation projects, among others.

The general mitigation objective consists of uncoupling the increase of emissions with economic growth in two major areas: a) Energy generation and utilization, and b) Vegetation and Use of Land. In all cases, these goals have been set for under the Special Program of Climate Change framework which is currently being created.[21]

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[19] Bioenergetics Act. Ministry of Energy. February 1st, 2008.
[20] Bill for Utilization of Renewable Energy Sources. Ministry of Energy (pending of approval by the Senate).
[21] National Strategy of Climate Change (ENCC) Executive Summary.
www.sre.gob.mx/eventos/am_dh/**cambioclimatico**.pdf

VII FUNDING OPTIONS

VII.1 International

- Mexico has participated in the Livestock, Environment and Development initiative (LEAD) coordinated by the FAO, led by a governing committee and funded by different international donors, The initiative has adopted the Area-Wide Integration model as a strategy to face, in the different countries, the issue related to pollution derived from intensive livestock production. So far, Mexico has not filed any funding applications for this initiative.

- In March 2006, the agreement on SEMARNAT-USAID-USEPA cooperation was entered into for the development of methane capture and utilization projects in Mexico. USEPA's funding was used to build two digesters with lagoon-type technology in two swine breeding farms classified as large farms based on the number of animals in those farms, while USAID's funding was used to build three lagoon-type digesters in smaller farms.

VII.2 National

Currently, the main funding sources in Mexico are anaerobic digesters developed by private sector companies that also manage "carbon bonds" for methane emission reduction in accordance with the Clean Development Mechanism. However, there are other types of support provided by government bodies:

- SAGARPA, through FIRCO, supports promotion of renewable energy by means of the "Program of Shared Risk Fund to Foster Agricultural Businesses" (FOMAGRO), which is one of the many programs created to support the agricultural and livestock sector. FOMAGRO is the Federal Government instrument. FIRCO acts as the financial service and public investment supplier and promoter. FOMAGRO identifies, promotes and funds production projects with a high social and economic impact. The types of support provided by FOMAGRO have been categorized as a shared risk and include the following: 1) Direct financial support to cover expenses for new investments such as the business and project plans, technical assistance, infrastructure and equipment, among others. Infrastructure and equipment include renewable energy systems and equipment to improve or start their operation, thus improving the environment; 2) Support to create, set up, establish Liquid Security or Alternative Payment Sources. Some of the subprogram's objectives are to support agricultural businesses that use clean energy in their production processes which contribute to production unit sustainability, reduction of environmental pollution and reduction of production costs.
- National Council of Science and Technology (CONACYT). Currently, CONACYT is funding state and municipality projects for scientific and technological development by means of a Trust created with contributions from the State Government or Municipality and Federal Government. These are two projects that were recently approved under this scheme: "Development of a scalable biodigester prototype to treat half to three tons of manure per day" from the University of Guanajuato and "Creation of standards to manufacture and operate anaerobic digesters to generate electric power".
- Fundación Guanajuato Produce. Since 1994, this Foundation has financed projects to install digesters in communities from the State of Guanajuato with the collaboration of the National Institute of Agricultural and Livestock Research (INIFAP) to implement

and execute the project through the Cattle Raising Group for Technology Validation and Transfer (GGAVATT).

- The Trust of Electric Power Saving (FIDE) has a funding program to purchase motor generators. This Trust covers 100% of the funding necessary to purchase motor generators and carry out the associated works. The projects are submitted to the Trust by farms and/or companies. By 2007, 8 swine breeding farms had been funded.[22]
- FIRA and FINANCIERA RURAL. These are credit institutions focused on the rural sector. They provide financial support for methane capture and utilization projects by means of credits that may or may not be linked to other financial supports.

[22] www.fide.org.mx

VIII COOPERATION AGREEMENTS

By April, 2006, Mexico had entered into 8 Cooperation Agreements related to CDM with the following countries: Austria, Canada, Denmark, Spain, France, Italy, Japan and Netherlands. However, most of the international funds are provided to large projects. This may be considered a restriction for Mexico, since a large percentage of the cattle breeders work on a small scale. Only two of the Spanish Funds, Carbon Fun for Community Development and Biocarbon Fund, consider small scale projects.

The following is a table that lists the cooperation agreements between Mexico and other countries.

Table 5. Mexico. Cooperation Agreements with Other Countries

COUNTRY	PROJECT	OBJECTIVE
Austria	CDM Austrian Program / Joint Implementation	Support development and execution of CDM projects and advise project developers.
Canada	Climate Fund	Promote complete projects to mitigate climate change.
Denmark	KfW Carbon Fund	Facilitate and promote private sector investment and implementation of CDM projects (including forest, energy efficiency, renewable energies and solid waste management) in Mexico.
Spain	Carbon Spanish Fund	Foster technology transfer and promote projects in areas like forest sinks, renewable energies and urban waste emission reduction.
France	Carbon European Fund	Facilitate development and implementation of CDM projects in Mexico and cooperation of other areas involved in climate change, including new emerging actions in the energy sector, promotion of energy efficiency, renewable energies, transport, waste management and emission right trading.
Italy	Carbon Italian Fund	Facilitate development and implementation of CDM projects in Mexico and transfer to Italy of the emission reduction certificates derived from such project in accordance with the agreement.
Japan	Carbon Japanese Fund (Japan GHG Reduction Fund – JGRF)	Explore and create opportunities for CDM projects that may be supported by different JBIC financial instruments.
Netherlands	Several projects	Facilitate development and implementation of projects in Mexico and foster cooperation in other areas of climate change related to training and development of policies and procedures.

IX PRIORITIES TO DEVELOP METHANE CAPTURE AND UTILIZATION IN LIVESTOCK ACTIVITY IN MEXICO.

If the current constraints to disseminate anaerobic digestion technology and biogas use are considered, the following priorities have been identified:

- Foster methane capture and utilization research and increase dissemination of existing data.
- Disseminate anaerobic digestion technological models for farms with different modernization levels and sizes.
- Coordinate the current efforts made by different institutions and organizations.
- Develop technical standards for anaerobic digester design and construction.
- Create a certification scheme of national companies for the design and construction of anaerobic digesters.
- Develop and/or adapt biogas management and utilization techniques (storage, equipment improvement and adjustment, biogas purity and quality, etc.)
- Develop and assess additional systems for final treatment of liquid waste from the anaerobic digester.
- Promote development of a certification system for clean production in farms, including anaerobic digestion.

X OTHER ASPECTS RELATED TO ANIMAL WASTE MANAGEMENT

The use of anaerobic digestion for an appropriate management of animal waste coming from the intensive production units may be a way to address other environmental problems related to this type of waste like water pollution, which is considered a critical problem in some regions in the country.

The possibility for the farmers linked to methane capture and utilization activities of having additional revenues through thermal or electric power provides the opportunity to reinvest in production units to improve water quality.

For some regions in Mexico, anaerobic digestion as a way to manage animal waste may not be the right option due to water shortage. This means that we need to have an array of technologies that may be adapted to different scenarios.

Anaerobic digestion and other types of animal waste management (compost for arable land) need to be assessed from a broader perspective where not only are the methane abatement benefits included, but also contributions to water and air quality, reduction of public health problems and waste recycling.

An essential aspect for adopting anaerobic digestion systems is the development of a methane market that acknowledges mitigation of this gas.

Undoubtedly, general national policies need to be more specific on the technological and economic regulations and incentives to be considered so that biogas capture and utilization may become a widely use technology and benefit from biogas potential.

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XI.4 Trust Companies

- Trust Fund for Electric Power Saving (FIDE); Mariano Escobedo No. 420, Col. Anzures, C.P. 11590, México D.F.Tel: 01800 3433 835; http://www.fide.org.mx

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- Rural Finance Company; Agrarismo 227 Col. Escandón. C.P. 11800 Del. Miguel Hidalgo México, D.F.
Tel. 01 800 0078725; http://www.financierarural.gob.mx

- Trusts In Relation To Agriculture (FIRA)
Periférico Sur 4300 Col. Jardines del Pedregal. C.P. 04500 México, D.F.
www.fira.gob.mx

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General Manager of Credit
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XI.5 International Agencies

US Environmental Protection Agency (USEPA); Ariel Rios Building 1200 Pennsylvania Avenue, N.W.; Washington, DC 20460; http://www.epa.gov

XI.6 Consultancy Firms and Anaerobic Digestión System Installers

Environmental Fabrics de México S. de R.L. de C.V.; Oaxaca 32, Primer Piso, Col. Jacarandas Tlalnepantla de Baz, C.P. 54050, Estado de México, Tel: +52 (55) 5361.0312 Fax: +52 (55) 5361.0317 Cel: +52 1 55 2727.5694; http://www.environmentalfabrics.com/

GO Sistemas Ambientales / ML Ingeniería; Av. Insurgentes Sur No. 1991 Torre A, Desp. 100A Col Guadalupe Inn C.P. 01020, México D.F.; tel: 1054 6740 / 5661 2324 / 5661 9917; www.geosistemas.net.

XI.7 Geomembrane Suppliers

Membranas Ecológicas de México S.A. de C.V.; Km. 9.5 Carretera Villahermosa-Cárdenas VHSA, Tabasco, C.P. 86280, Tel: 01 (993) 380 2073 / 380 2076; www.membranasecologicas.com; memecol@prodigy.net.mx

Estrategias en Ventas Industriales, S.A. de C.V. (EVI); Córdoba No. 5 Int. 7 Col. Roma, México D.F. C.P. 06700; Tel./Fax: (55) 5511-8422 Tels.: (55) 8596-6097 / 8596-6098; www.evi.com.mx damarisgc@evi.com.mx

Soluciones Ambientales Integrales (GEOSAI); Calvario No. 1, Col. Tlalpan Centro, C.P. 14000, México, D.F.; Tel: 5487 0140 Fax. 1315 1846; www.geosai.com ggarcia@solucionesambientalesintegrales.com.

Embalses y Plásticos de Michoacán, S.A. de C.V.; Camino a la Huerta 501 Fracc. San José de la Huerta C.P. Morelia Mich., Tel: 01 (433) 299 6897 / 299 6898; www.embalses.com.mx ventas2@embalses.com ventas@embalses.com.mx.

Geoliners de México S.A de C.V.; Lincon 3113-B Col. Juárez; Nuevo Laredo, Tamps.; México; Tel: 01 800-570-03-66; Fax: 01 867-715-93-30; contacto@geoliners.com.mx; www.geoliners.com.mx.

Tangeomex; Montemorelos No. 129 Col. Loma Bonita C.P.45086 Zapopan Jalisco; tel01 (333) 5639 921 /22; ventas@tangeomex.com; tangeomex@yahoo.com.mx.

Geomembranas y Geosinteticos S.A. de C.V.; Av. Azcapotzalco No. 340 Esq. Polo Norte, Col. Angel Zimbrón, Del. Azcapotzalco, C.P. 02099, México, D.F.; tel: 5020 6500 al 03 Fax 5347 2926; gygsertec@hotmail.com

Tremesa Comercializadora e Importadora S.A. de C.V.; Montecito No. 38 Piso 20 Ofc. 17. Col. Nápoles, México, D.F. 03810. World Trade Center; tel: 9000 0172 / 74; sojeda@tremesa-tci.com; sanks_3175@hotmail.com

Polilainer de México S.A de C.V.; Eje Central Lázaro Cárdenas No. 630 P.B. C.P.03400 México, D.F; tel: 5590 6217 / 5579 0293 / 6792 / 55 90 61 17; oza@polilainer.com.mx.

Hidrolands S.A de C.V.; tel: 01 (722) 218 3549 / 218 9813. Cel. 045 5521 28 5200; landcom@prodigy.net.mx

Polímeros y Derivados, S.A. de C.V.; Palo Cuarto 213, Colonia Michoacán, León, Guanajuato CP 37240; www.polimeros.com

Promotora Mexicana de Industrias; Calzada de la Naranja 167 1er Piso; Fracc. Ind. Alce Blanco Naucalpan, Edo. México, 53370; Tels. 5020- 7764 al 71 , Fax: 5357- 0482; http://www.promotoramexicana.com

Geo Productos Mexicanos, S.A. de C.V.; Francisco I. Madero no. 13, Col. Barrio San Miguel, C. P. 08650. México, Distrito Federal; geoproductos@prodigy.net.mx, Tel: (55) 8590-6300 al 03.

XII CONCLUSIONS AND OBSERVATIONS

From 1990 to 2002, the agricultural and livestock sector in Mexico contributed 10% to total greenhouse gas (GHG) emissions. However, there was a significant reduction by 2006 when Mexico's contribution to total emissions was 7%. From the agricultural contribution to greenhouse gas emissions, methane associated with enteric fermentation and animal waste management accounted for 83% of total agricultural GHG.

In general, the livestock sector shows great heterogeneity with regards to farm size and modernization level. In Mexico, large scale and modernized bovine and swine breeding farms coexist with small units with poor technology. In all these production units, animal waste management represents a challenge in terms of associated environmental pollution, but it is also an opportunity to get additional benefits from appropriate treatment and energy utilization.

Different animal waste management systems are currently used in Mexico, depending on farm size, modernization level, and water availability. However, anaerobic digestion is the technology with more technical and economic feasibility for methane capture and management.

Besides GHG reduction, animal waste management by means of anaerobic digestion may contribute to address other public issues such as water quality, energy diversification, public health and rural development. Therefore, other sector policies may help support expansion of this technology.

Several policies, regulations and incentives have been developed recently in Mexico to promote GHG mitigation and development of renewable energy. Consequently, methane projects in the livestock sector have increased significantly, although the number of projects is not enough. Therefore, it is necessary to make greater efforts regarding this subject.

Some of the immediate tasks are to strengthen anaerobic digestion research for national conditions and make this information available to farmers, project developers, and support institutions. In the short and medium term, Mexico will have to deal with some subjects such as anaerobic digestion in slaughter houses, utilization of biogas as fuel, development of alternative emission markets and regulations, production costs, trading of electric power generated with biogas.

The country's participation in the Methane to Market Alliance represents a valuable opportunity in terms of technical cooperation and experience sharing with other countries to overcome institutional, technological and economic barriers to successfully establish a policy that can foster methane capture and utilization in the agricultural sector.

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