Resource Assessment for Livestock and Agro-Industrial Wastes – Philippines

Prepared for:

U.S. EPA
Methane to Markets Program

Prepared by:

International Institute for Energy Conservation (IIEC)

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EXECUTIVE SUMMARY

In 1999, the Philippines reported to the United Nations Framework on Climate Change (UNFCC) that its agricultural and waste sectors accounted for a combined 40 percent of the country's greenhouse gas (GHG) emissions, which were estimated to be 100,864 million metric tons (MT) of carbon dioxide equivalent (CO_2e) per year.

Capturing methane from livestock and agro-industrial wastes for combustion is a proven and effective GHG abatement strategy. If combined with utilization, methane capture can result in additional financial returns, with or without the clean development mechanism (CDM). This assessment is intended for livestock and agro-industrial sectors deemed to have the greatest potential for methane emission capture. Major agro-industrial sectors that generate significant wastewater volume with a high concentration of organic matter and geographical concentration are the focus of this assessment. In the Philippines, these sectors include swine farming, slaughterhouses, sugar cane distilleries, and coconut and fruit processing—specifically, pineapple processing.

Swine farming is the major sub-sector in the agricultural livestock industry. As of January 2008, the country had 13.7 million pigs and hogs. Twenty-nine percent are located on commercial farms, and 71 percent are located in backyard farms. The majority of the swine population is found in Region III (Central Luzon) and Region IV-A Calamba Laguna Batangas Rizal and Quezon (CALABARZON), where large commercial farms are located, although large commercial farms have been established in provinces near Metro Manila to meet that area's growing demand. Another top producing region is Region VI (Western Visayas), where swine are mostly located in backyard farms. Wastewater from swine farms have five-day biochemical oxygen demand (BOD_5) and chemical oxygen demand (COD) concentrations ranging from 2,000 to 4,400 and 4,000 to 5,400 milligrams per liter (mg/L), respectively. As of 2003, 63 to 65 percent of the medium to large commercial farms use lagoon systems; for small commercial farms, 49 percent use lagoon systems, and 47 percent use settling ponds. As of 2003, approximately 6 to 12 percent of medium to large commercial farms have biogas systems.

There are about 1,100 slaughterhouses in the country. Only 11 percent have facilities that passed the standards set by the National Meat Inspection Service (NMIS), with a majority owned by private entrepreneurs. Most of the accredited slaughterhouses are located in Metro Manila and nearby Regions III and IV-A. These three regions combined account for almost 49 percent of the total swine slaughtered in the country. Slaughterhouses generate an average of 30 to 40 gallons (0.113 to 0.151 cubic meters [m^3]) per hog processed. Due to limited space, most of the slaughterhouses in Metro Manila use physical and chemical waste treatment systems. A number of slaughterhouses outside Metro Manila use either lagoon or a combination of septic tank and lagoon systems. Several slaughterhouses outside Metro Manila have anaerobic digesters, but most are either inefficient or no longer functioning.

Twelve alcohol distilleries operate nationwide. Four are located in Region IV (southern Tagalog). Originally distilleries in the Philippines were concentrated near the source of the raw materials, which is in the Visayas region, the center of the country's sugar cane production. Currently a number of distilleries have plants in Luzon to be near their markets. The wastewaters' BOD_5 concentration ranges from 32,000 to 51,200 mg/L. Several distilleries recover biogas from their wastewater, but only one of the plants is currently equipped with a state-of-the-art wastewater treatment facility that employs a series of anaerobic and aerobic treatment processes with biogas recovery. One distillery reportedly could not attain its expected methane recovery rate while three have insufficient or no facilities for methane recovery.

There are 11 manufacturing plants in the country producing about 147,000 MT/ year of desiccated coconut (DCN). The plants are located in Region IV (Southern Tagalog), Region X (Northern Mindanao) and Region XI (Davao Region). Nearly 23 m^3 of wastewater is generated per MT of DCN produced. Average BOD_5 concentration is 5,800 mg/L. Typical wastewater treatment used by the DCN plants located in Region IV-A consists of activated sludge followed by extended aeration. A DCN plant located in Mindanao uses a series of physical, anaerobic, and aerobic treatment processes, followed by settling prior to discharge. Methane captured is currently not utilized but simply flared. The capture of methane during the anaerobic treatment is reportedly not 100-percent effective as evidenced by the formation of gas bubbles even after the anaerobic treatment.

Potential emission reduction from methane capture is estimated in each sector using the Intergovernmental Panel on Climate Change (IPCC) methodology. The potential emission reduction from fuel oil displacement as a result of methane utilization is estimated for the alcohol distillery and DCN sectors both being thermal energy intensive. The results are summarized in the Table 1:

Table 1 – Summary of Methane and Fossil Fuel Related Carbon Dioxide Emission Reduction Potentials for the Agro-Industrial Sector of the Philippine Economy

Industry/ Sector	Geographical Coverage	Carbon Emission Reduction (MT CO_2e /year)	Emission Reduction From Fossil Fuel Replacement (MT CO_2e /year)	Total Emission Reduction (MT CO_2e /year)
Swine Farming	Regions III, IV-A, VI	1,541,000	247,500	1,788,500
Alcohol Distillery	Nationwide	478,000	84,000	562,000
Coconut processing	Region IV, X, XI	162,500	28,500	191,000
Slaughterhouse	Nationwide	10,500	1,800	12,300
Total		2,192,000	361,800	2,553,800

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List of Abbreviations

ABR	Anaerobic baffled reactor
AD	Anaerobic digestion
AFBBR	Anaerobic filter bed baffled reactor
AMBR	Anaerobic migrating blanket reactor
ANEC	Affiliated Non-Conventional Energy Centers
ANFIL	Anaerobic filter
APDC	Animal Products Development Center
ASBR	Anaerobic sequencing batch reactor
BAS	Bureau of Agricultural Statistics
BAI	Bureau of Animal Industry
BOD_5	Biochemical oxygen demand
CDM	Clean development mechanism
CH_4	Methane
CIGAR	Covered in ground anaerobic reactor
COD	Chemical oxygen demand
CO_2	Carbon dioxide
CO_2e	Equivalent carbon dioxide
CvSU	Cavite State University
DAF	Dissolved air flotation
DA	Department of Agriculture
DATEC	Dingle Agricultural and Technical College
DBP	Development Bank of the Philippines
DCN	Desiccated coconut
DENR	Department of Environment and Natural Resources
DENR- EMB	Department of Environment and Natural Resources – Environment Management Bureau
DNA	Designated National Authority
DOE	Department of Energy
DOST	Department of Science and Technology
DTI	Department of Trade and Industry
FAO	United Nations Food and Agriculture Organization
GHG	Greenhouse gas

GNP	Gross national product
GVA	Gross value added
HPDE	High-density polyethylene
HRT	Hydraulic retention times
IFPRI- LI	International Food Policy Research Institute – Livestock Industrialization
IIEC	International Institute for Energy Conservation
IPCC	International Protocol for Climate Change
kg	Kilogram
kWh	Kilowatt hour
kJ	Kilojoule
L	Liter
LBP	Land Bank of the Philippines
m3	Cubic meter
MCF	Methane conversion factor
mg	Milligram
ml	Milliliter
mm	Millimeter
MT	Metric ton
NGO	Nongovernmental organization
NMIS	National Meat Inspection Service
PCIERD	Philippine Council for Industry & Energy Research and Development
PE	Polyethylene
RE	Renewable energy
RP	Republic of the Philippines
TPED	Tubular polyethylene digester
TS	Total solids
TSS	Total suspended solids
UASB	Upflow anaerobic sludge blanket reactor
UCAP	United Coconut Association of the Philippines
UNFCC	United Nations Framework on Climate Change
UPLB	University of the Philippines, Los Baños
U.S. EPA	U.S. Environmental Protection Agency
VS	Volatile solids

1. INTRODUCTION

The Methane to Markets Program is a multinational program designed to reduce methane emissions from various industrial sectors including livestock and agro-industrial wastes. Among the primary sources of methane emissions from agriculture, livestock waste management and wastewater from agro-industrial activities present the largest opportunity for methane capture and utilization.

The main objective of this resource assessment is to identify the potential for incorporating anaerobic digestion into livestock manure and agro-industrial (agricultural commodity processing) waste management systems to reduce methane emissions and provide a renewable source of energy in the Philippines. This report documents the resource assessment, discusses the most attractive sectors and locations, and prioritizes the sectors in terms of potential methane emission reductions.

While other studies show methane emissions from the sectors covered in this document, these studies usually use total population or production levels as the baseline for calculating emissions. This resource assessment, however, uses a different approach, recognizing that not all waste management operations (e.g., pastures) generate methane. It bases its methane emission reduction estimates on the actual population (or number of industries) that generates methane via their waste management system (e.g., lagoons) using the most accurate and validated data available for each sub-sector. For example, methane emissions from swine and dairy sub-sectors only comprise a fraction of the total population and number of operations in the country. These assumptions provide a better basis for policy development and capital investments.

Finally, it is important to note that this resource assessment limits its scope to the technical potential of emission reduction. It does not address the economic potential, which still must be determined based on sub-sector specific feasibility studies.

1.1 METHANE EMISSIONS FROM LIVESTOCK AND AGRO-INDUSTRIAL WASTES

In 1999, the Philippines submitted to the United Nations Framework on Climate Change (UNFCC) its national inventory of greenhouse gas (GHG) emissions. It reported that as of 1994, the country was estimated to have an annual emission level of 100.864 million metric tons (MT) of equivalent carbon dioxide (CO_2e), of which 33 percent is attributed to the agriculture sector and 7 percent accounted for by waste,[1] as illustrated in Figure 1.1.

In the agricultural sector, rice cultivation and domestic livestock are the major GHG sources. Emissions from rice paddies due to anaerobic decomposition total 40 percent, while emissions from livestock due to enteric fermentation and manure management contributed 32 percent. The major GHG gases emitted from these sectors are methane (CH_4) and nitrous oxide (N_2O). Figures 1-2 and 1-3 show the methane emissions (except for grassland burning) in terms of CO_2e attributed to the agricultural sector and wastes sector, respectively.

[1] This excludes the net uptake of GHG from the land-use change/forestry sector.

Figure 1.1[2] – Philippine 1994 CO_2 Emission Profile

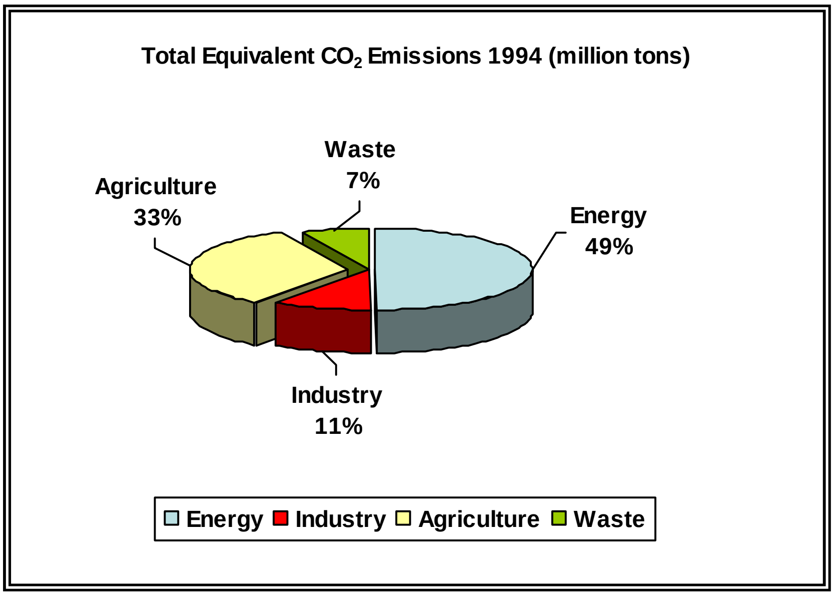
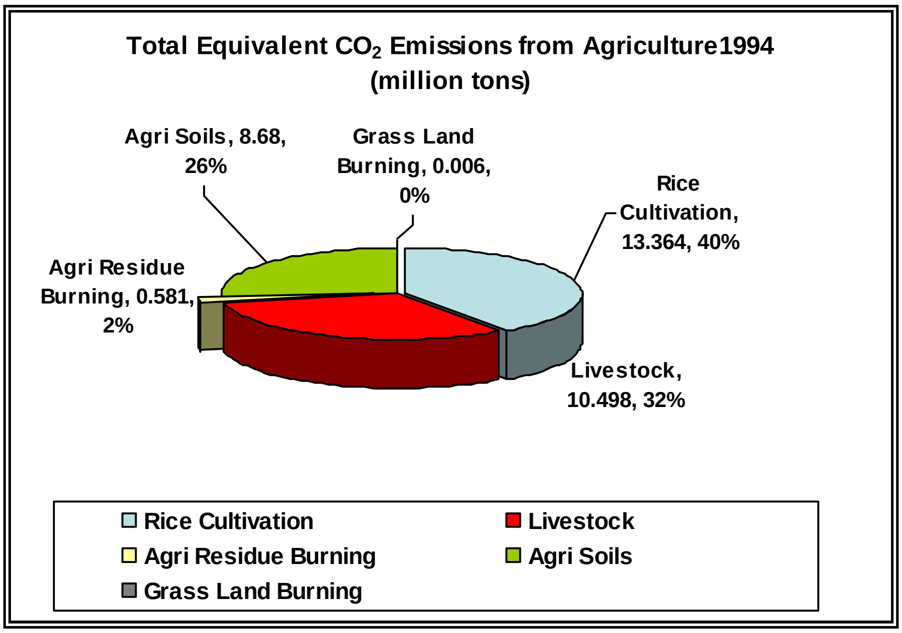
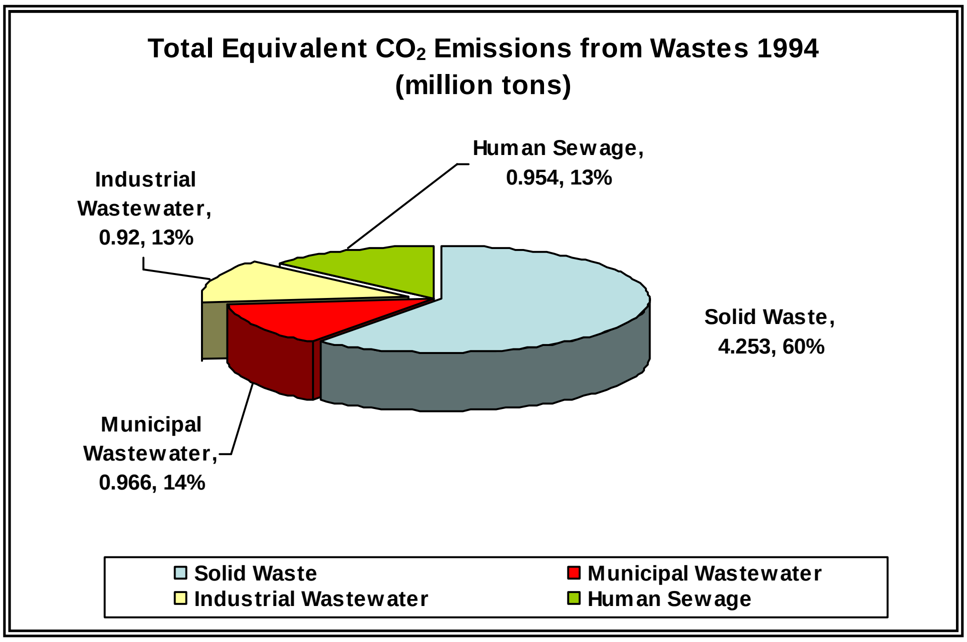


Figure 1-2. Philippine 1994 CO_2 Emission Profile – Agriculture Sector



[2] Source of Basic Data: Ma. Gerarda Asuncion D. Merilo. " Greenhouse Gas Mitigation Strategies: The Philippine Experience", EMB DENR

Figure 1-3. Philippine 1994 CO_2 Emission Profile – Waste Sector



With agriculture including livestock production among the major drivers of the county's economic growth, the Philippines is a good example of an economy with significant resource potential for methane recovery from livestock wastes and wastes from the agro-industrial sector.

2. BACKGROUND AND CRITERIA FOR SELECTION

This report documents the resource assessment of methane emissions of wastes from the Philippines' livestock and agro-industrial sectors. It is focused on livestock and agro-industrial sub-sectors deemed to have the greatest potential for methane emission reduction or methane capture.

2.1 METHODOLOGY USED

The team used a variety of data sources for conducting the resource assessment, including:

- **Field visits** to local sites in various sectors and of scales of operation to characterize the waste management systems used and to verify the information collected through other sources.

- **Interviews** with local experts from pertinent ministries (e.g., ministries of agriculture, environment, and energy), local nongovernmental organizations (NGOs) and engineering/consulting companies working on agriculture and rural development, current users of anaerobic digestion (AD) technologies, and other stakeholders.

- **Secondary data** including national and international data (e.g., United Nations Food and Agriculture Organization animal production data sets); specific sub-sector information from business and technical journals; and other documents, reports and statistics.

The team employed the following approach, which will be replicated in future resource assessments in this series:

Step 1: The first step in the development of the Philippines livestock and agro-industry resource assessment was the construction of general profiles of the individual sub-sectors (or commodity groups, such as dairies, swine, and fruit processing). Each profile includes a list of operations used within the sub-sector and the distribution of facilities by size and geographical location. For the various commodity groups in the livestock sector, the appropriate metric for delineating distribution by size is average annual standing population, (e.g., number of lactating dairy cows, beef cattle, pigs). For the various commodity groups in the agro-industry sector, the metric is the mass or volume of annual processing capacity or the mass or volume of the commodity processed annually.

Step 2: Based on available data, the team then determined the composition of the livestock production and agro-industry sectors at the national level, as well as the relative significance of each of them geographically.

Step 3: With this information, the team focused initially on those commodity groups in each sector with the greatest potential to emit methane from waste management activities. For example, a country's livestock sector might include dairy, beef, swine, and poultry operations, but poultry production might be insignificant due to lack of demand or considerable import of poultry products, with correspondingly low methane emissions. We initially focused on those commodity groups with higher emissions to most effectively utilize available resources. In the best-case scenarios, these livestock production and agro-industry sector profiles were assembled from statistical information published by a government agency. If such information was unavailable or inadequate, the team used a credible secondary source, such as the United Nations Food and Agriculture Organization (FAO).

Step 4: The team characterized the waste management practices utilized by the largest operations in each sector. Typically, only a small percentage of the total number of operations in each commodity group is responsible for the majority of production and thus methane emissions. Additionally, the waste management practices employed by the largest producers in each commodity group should be relatively uniform. Unfortunately, in the Philippines the information about waste management practices, especially in the livestock production sector, is not always collected and compiled or is incomplete or not readily accessible. Thus, it was necessary to identify and directly contact producer associations, local consultants, and business advisors and visit individual operations to obtain this information.

Step 5: The team then assessed the magnitudes of current methane emissions to identify those commodity groups that should initially receive further analysis. For example, large operations in a livestock commodity group, such as beef or dairy, that rely primarily on a pasture-based production system, where manure is distributed continuously by the grazing animals, show only nominal methane emissions because manure decomposition is primarily by aerobic microbial activity. Similarly, an agro-industry sub-sector with large operations that utilize direct discharge of untreated wastewater to a river, lake, or ocean is not the source of significant methane emissions. Thus, the process of estimating current methane emissions is sharply focused to most effectively utilize available resources. This profiling exercise will aid in identifying the more promising candidate sectors and/or operations for technology demonstration.

2.2 ESTIMATION OF METHANE EMISSIONS IN THE LIVESTOCK AND AGRO-INDUSTRIAL SECTOR

This section describes the generally accepted methods for estimating methane emissions from livestock manure and agricultural commodity processing wastes. It also discusses the modification of these methods to estimate the methane production potential with the addition of anaerobic digestion as a waste management system component.

2.2.1 Manure-Related Emissions

We used the 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories Tier 2 method for estimating methane emissions from each commodity group in the livestock production sector. Using the Tier 2 method, methane emissions for each livestock commodity group (M) and existing manure management system (S) and climate (k) combination are estimated as follows using Equation 2.1:

$$CH_{4\,(M)} = \left(VS_{(M)} \times H_{(M)} \times 365 \text{ days/yr}\right) \times \left[B_{o(M)} \times 0.67 \text{ kg } CH_4/m^3\ CH_4 \times MCF_{S,k}\right] \qquad (2.1)$$

where: $CH_{4\,(M)}$ = Estimated methane emissions from manure for livestock category M, kg CH_4 per year

$VS_{(M)}$ = Average daily volatile solids (VS) excretion rate for livestock category M, kilograms (kg) volatile solids per animal-day

$H_{(M)}$ = Average number of animals in livestock category M

$B_{o(M)}$ = Maximum methane production capacity for manure produced by livestock category M, m^3 CH_4 per kg volatile solids excreted

$MCF_{(S,k)}$ = Methane conversion factor for manure management system S for climate k, decimal

As shown, Equation 2.1 requires an estimate of the average daily volatile solids excretion rate for the livestock category under consideration. The default values for dairy cows, breeding swine, and market swine are listed in Table 2.1. Default values for other types of livestock can be found in Tables 10A-4 through 10A-9 in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

Table 2.1 – 2006 IPCC Volatile Solids Excretion Rate Default Values for Dairy Cows, Breeding Swine, and Market Swine (kg/head-day)

Region	Dairy Cows	Breeding Swine	Market Swine
North America	5.4	0.5	0.27
Western Europe	5.1	0.46	0.3
Eastern Europe	4.5	0.5	0.3
Oceania	3.5	0.5	0.28
Latin America	2.9	0.3	0.3
Middle East	1.9	0.3	0.3
Asia	2.8	0.3	0.3
Indian Subcontinent	2.6	0.3	0.3

Realistic estimates of methane emissions using Equation 2.1 also require identification of the appropriate MCF, which is a function of the current manure management system and climate. MCFs for various types of manure management systems for average annual ambient temperatures ranging from ≤ 10 to ≥ 28 ℃ are summarized in Table 2.2, and can be foun d in Table 10.17 of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

Table 2.2 – Default MCF Values for Various Livestock Manure Management Systems

Climate	Manure Management System Default Methane Emission Factor, %								
	Lagoons	Storage Tanks & ponds	Solid storage	Dry lots	Pit >1 month	Pit <1 month	Daily spreading	Anaerobic digestion	Pasture
Cool	66-73	17-25	2	1	3	17-25	0.1	0-100	1
Temperate	74-79	27-65	4	1.5	3	27-65	0.5	0-100	1.5
Warm	79-80	71-80	6	5	30	71-80	1	0-100	2

Finally, use of Equation 2.1 requires specification of the methane production potential (B_o) for the type of manure under consideration. Default values listed in Tables 10A-4 through 10A-9 of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories can be used. The default values for dairy cows, breeding swine, and market swine are listed in Table 2.3.

Table 2.3 – 2006 IPCC Methane Production Potential Default Values for Dairy Cows, Breeding Swine, and Market Swine, m^3 CH_4/kg VS

Region	Dairy Cows	Breeding Swine	Market Swine
North America	0.24	0.48	0.48
Western Europe	0.24	0.45	0.45
Eastern Europe	0.24	0.45	0.45
Oceania	0.24	0.45	0.45
Latin America	0.13	0.29	0.29
Middle East	0.13	0.29	0.29
Asia	0.13	0.29	0.29
Indian Subcontinent	0.13	0.29	0.29

2.2.2 Agricultural Commodity Processing Waste-Related Emissions

Agricultural commodity processing can generate two sources of methane emissions, wastewater and solid organic wastes. The latter can include raw material not processed or discarded after processing due to spoilage, poor quality, or other reasons. One example is the combination of wastewater and solids removed by screening before wastewater treatment or direct disposal. These solid organic wastes might have relatively high moisture content and are commonly referred to as wet wastes. Appendix A illustrates a typical wastewater treatment unit process sequence. The methods for estimating methane emissions from both are presented below.

a. WASTEWATER

For agricultural commodity processing wastewaters, such as meat and poultry processing wastewaters, the 2006 IPPC Guidelines for National Greenhouse Gas Inventories Tier 2 method (Section 6.2.3.1), which utilizes chemical oxygen demand (COD) and wastewater flow data, is an acceptable methodology for estimating methane emissions. Using the Tier 2 method, the gross methane emissions for each waste category (W) and prior treatment system and discharge pathway (S) combination should be estimated using Equation 2.2:

$$CH_{4\,(W)} = [(TOW_{(W)} - S_{(W)}) \times EF_{(W,\,S)}] - R_{(W)})] \qquad (2.2)$$

where: $CH_{4\,(W)}$ = Annual methane emissions from agricultural commodity processing waste W, kg CH_4 per year

$TOW_{(W)}$ = Annual mass of waste W COD generated, kg per year

$S_{(W)}$ = Annual mass of waste W COD removed as settled solids (sludge), kg per year

$EF_{(W,\,S)}$ = Emission factor for waste W and existing treatment system and discharge pathway S, kg CH_4 per kg COD

$R_{(W)}$ = Mass of CH_4 recovered, kg per year

As indicated above, the methane emission factor in Equation 2.2 is a function of the type of waste and the existing treatment system and discharge pathway and is estimated using Equation 2.3:

$$EF_{(W,S)} = B_{o\,(W)} \times MCF_{(S)} \tag{2.3}$$

where: $B_{o\,(W)}$ = Maximum CH_4 production capacity, kg CH_4 per kg COD

$MCF_{(S)}$ = Methane conversion factor for the existing treatment system and discharge pathway, decimal

If country and waste sector specific values for B_o are not available, the 2006 IPCC Guidelines for National Greenhouse Gas Inventories default value of 0.25 kg CH_4 per kg COD, based on stoichiometry, should be used. In the absence of more specific information, the appropriate MCF default value selected from Table 2.4 also should be used.

Table 2.4 – Default MCF Values for Industrial Wastewaters, decimal

Existing Treatment System and Discharge Pathway	Comments	MCF*	Range
Untreated			
Sea, river, or lake discharge	Rivers with high organic loadings may turn anaerobic, which is not considered here	0.1	0—0.2
Treated			
Aerobic treatment plant	Well managed	0	0—0.1
Aerobic treatment plant	Not well managed or overloaded	0.3	0.2—0.4
Anaerobic reactor (e.g. UASB, fixed film)	No methane capture and combustion	0.8	0.8—1.0
Shallow anaerobic lagoon	Less than 2 meters deep	0.2	0—0.3
Deep anaerobic lagoon	More than 2 meters deep	0.8	0.8—1.0

* Based on IPCC expert judgment

If the annual mass of COD generated per year (TOW) is not known and the collection of the necessary data is not possible, the remaining option is estimation using Equation 2.4 with country specific wastewater generation rate and COD concentration data obtained from the literature. In the absence of country-specific data, values listed in Table 2.5 can be used as default values to obtain first order estimates of methane emissions.

$$TOW_{(W)} = P_{(W)} \times W_{(W)} \times COD_{(W)} \tag{2.4}$$

where: $P_{(W)}$ = Product production rate, MT per year

$W_{(W)}$ = Wastewater generation rate, m^3 per MT of product

$COD_{(W)}$ = Wastewater COD concentration, kg per m^3

Table 2.5 – Examples of Industrial Wastewater Data, Doorn et al. (1997)

Industry	Typical Wastewater Generation Rate, m^3/MT	Range of Wastewater Generation Rates, m^3/MT	Typical COD Concentration, kg/m^3	Range of COD Concentrations, kg/m^3
Alcohol	24	16—32	11	5—22
Beer	6.3	5.0—9.0	2.9	2—7
Coffee	NA	NA	9	3—15
Dairy products	7	3—10	2.7	1.5—5.2
Fish processing	NA	8—18	2.5	—
Meat & poultry processing	13	8—18	4.1	2—7
Starch production	9	4—18	10	1.5—42
Sugar refining	NA	4—18	3.2	1—6
Vegetable oils	3.1	1.0—5.0	NA	0.5—1.2
Vegetables, fruits, and juices	20	7—35	5.0	2—10
Wine & vinegar	23	11—46	1.5	0.7—3.0

b. SOLID WASTES

A variety of methods are possible for the disposal of solids wastes generated during the processing of agricultural commodities. Included are: 1) land application, 2) composting, 3) placement in a landfill, and 4) open burning. In addition, solid wastes from meat and poultry processing, such as solids separated from wastewater by screening and dissolved air flotation, can be disposed of by rendering.

If country- and waste-sector-specific values for B_o are not available, the 2006 IPPC Guidelines for National Greenhouse Gas Inventories default value of 0.25 kg CH_4 per kg COD for wastewater, based on stoichiometry, should be used. The use of this default value for the solid wastes from agricultural commodity processing is based in the assumption that the organic compounds in these wastes will degrade as rapidly as the wastewater organic fraction.

Because the mechanisms responsible for the degradation of these wastes are similar to those of livestock manure following land application, the appropriate MCF value for manure disposal by daily spreading listed in Table 10.17 of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories should be used. For composting, the IPCC default value of 4 g CH_4 per kg of wet waste, should be used. When agricultural commodity processing wastes are disposed of in landfills, the applicable MCF depends on the type of landfill, as shown in Table 2.6.

Table 2.6 – Types of Solid Waste Landfills and Methane Conversion Factors

Type of Site	Methane Conversion Factor Default Value
Managed—anaerobic[1]	1.0
Managed—semi-anaerobic[2]	0.5
Unmanaged[3]—deep (>5m waste) and/or high water table	0.8
Unmanaged[4]—shallow (<5m waste)	0.4
Uncategorized solid waste disposal sites[5]	0.6

[1]**Anaerobic managed solid waste disposal sites.** Controlled placement of waste with one or more of the following: cover material, mechanical compacting, leveling

[2]**Semi-anaerobic managed solid waste disposal sites.** Controlled placement of wastes with all of the following structures for introducing air into the waste layer: permeable cover material, leachate drainage system, pondage regulation, and gas ventilation.

[3]**Unmanaged solid waste disposal sites—deep and/or with a high water table.** All sites not meeting the criteria of managed sites with depths greater than 5 m and/or a high water table near ground level.

[4]**Unmanaged solid waste disposal sites.** All sites not meeting the criteria of managed sites with depths less than 5 m.

[5]**Uncategorized solid waste disposal sites.** Uncategorized solid waste disposal sites.

For disposal of agricultural commodity processing solid wastes by open burning, the IPCC default value of 6.5 kg of methane per MT of waste should be used.

For all four disposal options, the commodity specific rate of solid waste generation must be known. In addition, information about the concentration of COD in the solid waste, on a wet weight basis, is necessary for all but the composting disposal option. However, COD concentration generally has not been used as a parameter for agricultural commodity processing solid waste characterization. The alternative is to use published values from studies of methane production potential on a volume or mass of methane produced per unit mass of wet waste, or volatile solids added basis as a first-order estimate for B_o for the waste under consideration. If the COD concentration in the solid waste is known, the methane emissions resulting from land application and landfill disposal with the appropriate MCF is calculated using Equation 2.6:

$$CH_{4\,(SW)} = TOW_{(SW)} \times B_o \times MCF_{(SW,\,D)}] \qquad (2.6)$$

where: $CH_{4(SW)}$ = Annual methane emissions from agricultural commodity processing waste SW, kg CH_4 per year

$TOW_{(SW)}$ = Annual mass of solid waste SW COD generated, kg per year

$MCF_{(SW, D)}$ = Methane conversion factor for solid waste W and existing disposal practice S, decimal

2.3 DESCRIPTION OF SPECIFIC CRITERIA FOR DETERMINING POTENTIAL SECTORS

The specific criteria to determine methane emission reduction potential and feasibility of anaerobic digestion systems are the following:

- Large sector/sub-sector: The category is one of the major livestock production or agro-industries in the country.
- High volumes of wastes going to lagoons: The livestock production or agro-industry generates high volume of wastewater.
- Wastes with high organic content: The wastewater generated has a high organic load as measured in terms of its BOD and COD.
- Geographic distribution: There is a concentration of priority sectors in specific regions of the country, making centralized or co-mingling projects potentially feasible.
- Energy intensive: There is sufficient energy consumption to absorb the generation from recovered methane.

The industries that meet all of the above criteria are swine farming, slaughterhouses, alcohol distillery (a sub-sector of the sugar refinery industry), desiccated coconut (a sub-sector of the coconut industry), and fruit processing plants, specifically pineapple processing.

2.4 HISTORICAL APPROACH FOR METHANE PROJECTS IN THE PHILIPPINES[3]

The country's interest in biogas development started in1965 after officials from the Philippine Coconut Authority learned about the technology during a European tour. Dr. Felix Maramba pioneered the development and demonstration of biogas technology when he set up the Maya Farms Biogas Model on his swine farm. The biogas produced provided for 40 percent of the total power requirement of the farm.

In 1976, a program was initiated aiming to establish biogas systems in every region, province, town and locality in the country. The Bureau of Animal Industry (BAI), through its regional offices, installed one biogas system for each animal breeding center or unit. The demonstration projects at regional and provincial levels installed a total of 340 concrete biogas plants, 321 in Luzon, 18 in Visayas, and one in Mindanao. One regional and one provincial biogas coordinator was assigned to take charge of the technology promotion. These technicians were trained in the basics of biogas, installation, care, and maintenance. This program was titled "Biogas ng Barangay" (Village Biogas Project). Financial Institutions opened lending windows for livestock owners.

The BAI project was not sustained, however. It was developed during a period of political instability in the government leadership, and priority programs changed depending on who was

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[3] Source of data: Department of Science and Technology

in charge. During that time, the Indian design with a floating gas holder was the more popular model, but it did not last long due to maintenance problems.

From 1979 to 1986 the U.S. Peace Corps, in partnership with the Philippine Rural Reconstruction Movement (PRRM) began introducing anaerobic digestion technologies to the Philippines as part of the Rural Energy and Sanitation Program. A critical element of this program was to identify and develop appropriate technologies that were affordable and replicable under the Philippine condition. As such the program initially focused on various low cost digester systems including hydraulic fixed dome digesters, more commonly referred to as Chinese digesters, which were constructed from bricks. Brick construction materials quickly proved problematic due to cost, solids accumulation, and leakage which prompted the application of low cost construction materials, adding other system components, and construction processes to address these problems. As a result a construction process was developed which consisted of Chinese digester fabrication in cottage type industries and completing construction on-site using monolithically cast ferrocement domes. Mixers were also added to reduce problems related to solids accumulation. These innovations resulted in reducing costs and other operational problems identified with this technology.[4]

Also during the 1980s, the Philippine Rural Life Center, an NGO, promoted a culvert biogas model by providing training to government and private sectors. Several units were installed in selected communities. Most of these are now inefficient or no longer functioning. During the same period, the Philippine Department of Energy (DOE) undertook the promotion of renewable energy (RE) and established Affiliated Non-Conventional Energy Centers (ANECs) at different state colleges and universities nationwide to serve as extension centers for rural areas. The Cavite State University – Non Conventional Energy Center (CvSU-ANEC) became very active in the promotion of RE technologies such as wind, hydro, solar, and biomass.

In the 1990s the head of the CvSU-ANEC underwent training in China on biogas technology, while the staff underwent training sponsored by another NGO, prompting another wave of biogas technology promotion. A Chinese Biogas Digester Model was constructed in the main campus of CvSU and served as a template for CvSU-ANEC to design a simple model, which is adaptable to Filipino masonry skills, easy to construct, and readily operational. This gave birth to the DSAC-Biogas Digester Model, which was granted by the Bureau of Patent (registration number: UM 2-1997-15098) on April 9, 2002. In 1996, CvSU-ANEC was designated as the National Biogas Center. Since then, a number of local, regional, and national seminars, hands-on training, and workshops on biogas technology have been conducted.

During the same period, BAI introduced a low-cost biogas technology using polyethylene tubes. The project was partly supported by the Food and Agricultural Organization of the United Nations. It involved the participation of farmers raising 10 to 20 pigs, using sugar cane juice to feed them. The project included the installation of biogas digesters to manage the manure and served as demonstration model for other swine operations. A total of 300 farmers, 25 technicians, and 200 agricultural technicians were trained. The major constraint encountered was the lack of materials and technicians for necessary maintenance and repairs.

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[4] Roos, K.F., Issues in Anaerobic Digestion: Economics, Technology, and Transfer; Thesis presented to the Faculties of the University of Pennsylvania; 1988.

For slaughterhouse operations, BAI—through the Animal Products Development Center (APDC)—established a pilot integrated waste management scheme to serve as a model for small to medium-scale slaughterhouses. It includes a wastewater treatment system consisting of a Chinese fixed-dome biogas digester, six chambers of an anaerobic baffle reactor, one chamber of anaerobic filter, and a planted gravel filter.

2.4.1 Available Technical Options

The Philippines has a total of approximately 300 operational biogas systems with varying capacities, ranging from small-scale operation designed for households to large-scale process for commercial/industrial facilities.[5] A list of biodigesters installed in certain regions in the country is attached as Appendix B.

The use of cylindrical-reinforced concrete tanks is the most common biogas digester design. To collect methane, the digester is covered with a fixed, floating, or membrane cover. The fixed or fixed-domes are the most common types. The gas storage, fermentation chambers, hydraulic tank, and inlet tanks are integrated into one structure. With fixed covers, there is space between the roof of the digester and the liquid surface. Gas storage is provided to prevent air from entering when the volume of the liquid changes. With floating covers, the volume of the digester changes as biogas is produced inside the tank without allowing air to enter. With covers using membranes, there is a support structure for a small center gas dome and flexible air and gas membranes. To increase air pressure between the two membranes and vary the air space volume, an air blower is provided. The liquid waste is in contact only with the center gas dome and the gas membrane.

The next sections discuss the types of biogas digesters that have been installed in the country, based on a literature search.

a. CONCRETE ANAEROBIC DIGESTER

The concrete anaerobic digester has been pioneered in the country by Maya Farms (no longer in operation). According to reports, the biogas yield was 0.85 cubic meters (m^3) per sow per day. The high methane yield is attributed to the use of stirrers.

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[5] Promotion of RE EE and GHG Abatement (PREGA) .2006 Biogas Recovery from Swine Waste Treatment Plant Facility Feasibility Study. Geosphere Technologies Inc.

b. TUBULAR POLYETHYLENE DIGESTER (TPED)

Developed by BAI, TPED is a low-cost system based on a model developed in Colombia and modified after a pilot application in Vietnam.[6] It uses a polyethylene (PE) tube as the reactor to produce the methane. It is installed in a well-drained area measuring about 10 m x 2 m. The 10-meter PE tube can process manure from six to eight head of swine. The manure is poured into the container and left to decompose and in the process produces methane. It is suitable for backyard application to supply enough cooking gas for a family of six. The tube sits horizontally and has a very small slope to help move the contents.

BAI spearheaded the promotion of the TPED to backyard swine farms. A total of 99 biodigesters were installed nationwide, of which eight units are utilized for demonstration purposes in government stations or pilot barangays.[7] [8]

c. COVERED LAGOON OR COVERED IN GROUND ANAEROBIC REACTOR (CIGAR)

The covered lagoon, or what is commercially called a “covered in ground anaerobic reactor” (CIGAR) anaerobic digester, uses a high-density polyethylene (HDPE) material as a liner and cover to completely seal and contain the wastewater. The liner is ¾ millimeters (mm) thick, while the cover is 1 mm thick. Philippine Bio-Sciences Co., Inc. (PHILBIO) is the project developer and installer of this technology in the Philippines. HPDE has a 10-year guarantee for manufacturer’s defects, and PHILBIO has a two-year guarantee for workmanship, which includes welding, seaming, and installation. Several swine farms have implemented and registered under the clean development mechanism (CDM) methane recovery and utilization projects using this type of anaerobic digester. As of August 2008, there were a total of 33 farms using the CIGAR anaerobic digester, the list of which is presented in Appendix C. Out of this 33, 10 have been approved and registered under the CDM.

d. ANAEROBIC FILTER BED BAFFLED REACTOR (AFBBR) [9]

The Anaerobic Filter Bed Baffled Reactor (AFBBR) was recently developed by the Environmental Division of DOST’s Industrial Technology Development Institute (ITDI). AFBBR is a hybrid of an anaerobic filter (ANFIL) and an anaerobic baffled reactor (ABR). It consists of multiple compartments with standing and hanging baffles using polyurethane foam as packing materials. The packing materials act as a filter media and as attachment for the growth and development of anaerobic micro-organisms.[10]

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[6] http://www.engormix.com/e_news1384.htm

[7] Livestock Research for Rural Development.1997, Volume 9, Number 2. *Promotion and utilization of polyethylene biodigester in small household farming systems in the Philippines.* F A Moog, H F Avilla, E V Agpaoa, F G Valenzuela and F C Concepcion.

[8] A barangay, also known by its former Spanish adopted name, the barrio, is the smallest administrative division in the Philippines.

[9] Dr. Christopher Silverio, Philippine Biogas Technology Models, ITDI - DOST

[10] http://www.warmphilippines.com/services/afbbr

This type of system was constructed in Trese Martirez Cavite to treat waste from the food processing industry and other industries generating highly polluted wastewater.

e. UPFLOW ANAEROBIC SLUDGE BLANKET REACTOR (UASB)[11]

A UASB pilot plant is installed at the Container Corporation Philippines.

f. SUMMARY

Although a number of small-scale biogas digesters have been installed for small farms and household scale operations, many of them are no longer functional. Among the problems cited by key industry contacts are faulty designs, construction faults, operational problems due to incorrect feeding or poor maintenance, and lack of interest by owners to continue operating the system.[12] A list of technology suppliers in the Philippines is shown in Appendix D.

It is also important to note that the team conducted field visits to small/medium size facilities to observe performance of biogas and wastewater treatment systems and to verify the information collected through other sources. During these visits the team observed a wide range of operational performance of the systems, regardless of the sector. Some of the most common issues observed were solids accumulation in the system, biogas leakage resulting in marginal biogas production, and biogas line and digester blockages.

The Renewable Energy Act of 2008, which was signed into law in December 2008, is expected to further increase the utilization and growth of RE in the country. Among the provisions in the RE law are an "income tax holiday"[13] for the first seven years of commercial operation of RE project; duty-free importation of machinery, equipment, and materials used for RE development; zero percent value-added tax on purchases of local supplies for the development, construction, and installation of plant facilities; tax exemption on carbon emission credits; and tax credit on domestic capital, equipment, and services. Because of this recent development, the advancement and adoption of AD systems in the country is expected to further accelerate. A list of potential partners for a biogas development project is shown as Appendix E. Given these growth expectations, standards and norms will be key in ensuring the reliability of current and future systems and reaching expected levels of performance.

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[11] Dr. Christopher Silverio, Philippine Biogas Technology Models, ITDI - DOST

[12] Dr. Christopher Silverio, Philippine Biogas Technology Models, ITDI- DOST and Ms. Joy Contreras Head APDC

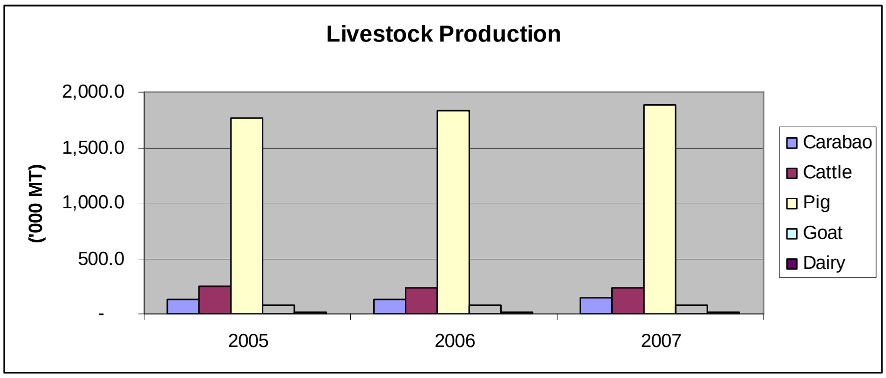
[13] There is no tax on the taxable net income (revenue less expenses) for seven years

3. SECTOR CHARACTERIZATION

3.1 OVERVIEW OF THE PHILIPPINE LIVESTOCK AND AGRO-INDUSTRIAL SECTOR

The livestock sector of Philippines' agriculture has always been dominated by the swine industry both in terms of volume and value of production. Over the past several years, it has accounted for 80 percent of the total livestock production in terms of live weight. Figure 3.1 shows livestock production for the years 2005-2007.

Figure 3.1 – Philippine Livestock Production for 2005-2007



Source of Basic Data: Bureau of Agricultural Statistics

Activities, processes, and downstream industries related to the swine industry are potential methane sources and include manure and slaughterhouse wastes.

The Philippines relies almost totally on imported milk products. In 2007, the Philippines produced just 1 percent of its annual dairy requirement.[14] Total dairy herd registered was 28,395 head, of which only 13,092 were dairy cattle. The rest were dairy carabaos and dairy goats. Approximately 14,347 farm families own dairy animals. These initial data indicate that the dairy industry in the Philippines is relatively small and characterized as a household based sector.[15]

The poultry industry is significant but initial findings indicate that chicken manure is mostly sold as fertilizer and has a higher market value than when it is used to generate biogas.[16] In addition, management of chicken manure does not result in substantial wastewater generation and usually does not necessitate lagoon systems unless poultry and swine production are combined.

The major agricultural crops of the country are rice (palay),[17] corn, coconut, and sugar cane, followed by bananas, pineapple, and mangoes. In addition to these major crops, the country

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[14] Philippine Dairy and Products Annul Report 2007

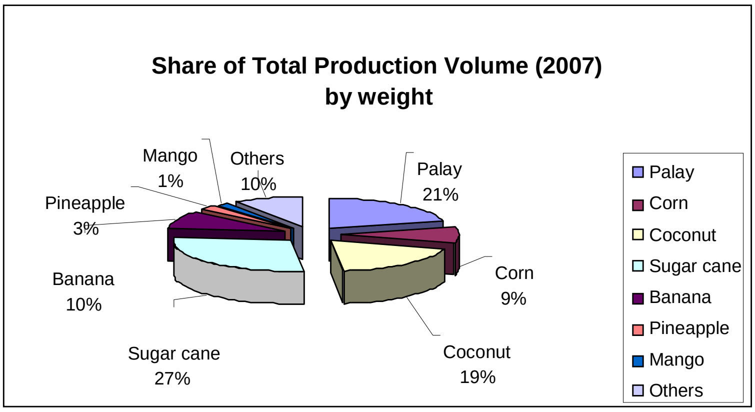
[15] http://www.nda.da.gov.ph/dairysit6b.htm

[16] http://cdmdna.emb.gov.ph/cdm/public/cdm-ph-potential

[17] Palay is unhusked rice or unmilled rice.

produces other minor tropical crops such as coffee tobacco, abaca, peanut, mongo, cassava, camote, tomato, garlic, onion, cabbage, eggplant, and calamansi. Figure 3.2 shows the share of the major agricultural crops to the total crop production of the country by weight.

Figure 3.2 – Distribution of Philippine Crop Production



Source of Basic Data: Bureau of Agricultural Statistics

The production volumes of the major crops are shown in Table 3.1.

Table 3.1 – Major Agricultural Crops Production Volume (thousands of MT)

ITEM	2005	2006	2007
TOTAL CROPS	**73,725.9**	**77,401.1**	**78,214.1**
Palay	14,603.0	15,326.7	16,240.2
Corn	5,253.2	6,082.1	6,736.9
Coconut	14,824.6	14,957.9	14,852.9
Sugarcane	22,917.7	24,345.1	22,235.3
Banana	6,298.2	6,794.6	7,484.1
Pineapple	1,788.2	1,833.9	2,016.5
Mango	984.3	919.0	1,023.9
Others	7,056.7	7,141.8	7,624.3

Source: Bureau of Agricultural Statistics

The only identified major agricultural crops that have related downstream processing sectors with high wastewater production are sugar cane, coconut, pineapple and mangoes. The rest of the crops such as rice palay and corn undergo milling processes and are not water intensive. Bananas are usually sold fresh to end consumers.

The primary product from coconuts is coconut oil, which is extracted from dried coconut meat known as copra. The basic raw material in the coconut milling process is copra. The production of copra is handled on the farm by several small coconut farmers. Coconut water, which is a byproduct of the copra meal, is converted into coconut vinegar or processed into local wine called “tuba.” Use of process water is very minimal in all these processing steps. Another primary product of coconut is the desiccated coconut. To process coconut into desiccated coconut, 2.8 liters of wastewater per nut processed is generated.

Another related downstream sector of the coconut industry is used fats and cooking oil generated by restaurants and hotels. While there are some small entrepreneurs buying used fats and oil, studies conducted in 2000 revealed that most of the used oil ends up in wastewaters and are eventually discharged to surface waters.[18] However there are recent developments paving the way for used oils to be used in biodiesel production. A leading fast food restaurant has started to donate its used oil for the production of bio-diesel, and other restaurants are expected to follow.

The downstream processing sector of sugar cane is the sugar milling and distilled alcohol from molasses, a byproduct of sugar milling. The downstream processing for pineapple is canning. For mangoes, it is juice extraction and fruit drying. But a literature review indicates that only 4.7 percent of the total mango production is processed. Most mango processors are small to medium enterprises with a mere total combined processing capacity of 47,232 MT per year.[19] The bulk of the country's mango production, which was about 1.0 million MT in 2007, is sold fresh. Processing of potatoes and corn into snack food reportedly generates wastewater, but initial research conducted indicates inadequate data on this sector.

The brewery industry in the Philippines is dominated by only two firms: San Miguel Corporation (SMC) and Asia Brewery Incorporated (ABI). SMC controls 90 percent of the market while ABI and the other imported brands hold the balance of 10 percent. San Miguel reportedly uses the anaerobic process to recover the biogas and use as fuel for its boilers.

The focus of this assessment is on the swine industry, slaughterhouses, sugar cane milling and refinery, alcohol distilleries, coconut industry, and pineapple processing.

3.2 SWINE

3.2.1 Description of Size, Scale of Operations, and Geographic Location

As of January 1, 2008, the swine population was 13.7 million pigs and hogs[20] of which 71 percent are on backyard farms and the remaining 29 percent on commercial farms. For the past decade, the industry has consistently grown by an average of 3.2 percent per year (see Figure 3.3).

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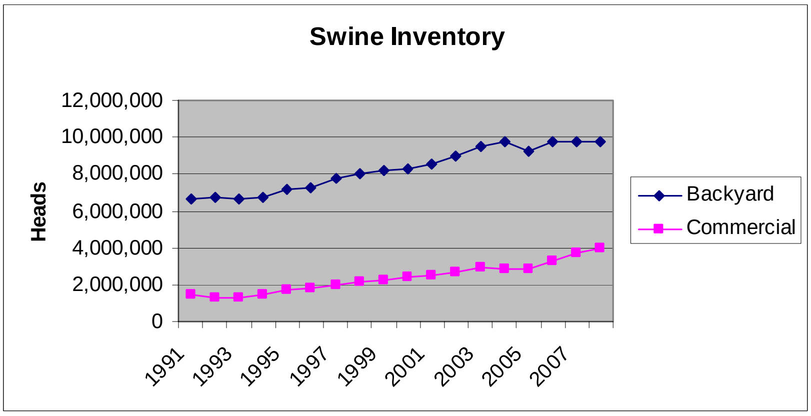
[18] Production of Biodiesel and Oleochemicals from Used Frying Oil, UPLB, Apollo Arquiza, Michael Bayungan and Ronaldo Tan, 2000

[19] Larry N. Dingal, Benefits Diffusion and Linkage Development in the Philippine Tropical Fruit Sector. Paper presented during the conference entitled "Closing the Productivity Gap" sponsored by the World Bank and the National Economic Development Authority" June 2005, Asian Institute of Management Policy Center

[20] Selected Statistics on Agriculture 2008, Bureau of Agricultural Statistics (BAS)

Figure 3.3 – Recent Growth in the Swine Industry in the Philippines.



Source of Basic Data: Bureau of Agricultural Statistics

In a span of 16 years, the number of pigs and hogs on commercial farms has increased from 18 percent to 29 percent of the total population. This change has been brought about by the intensification of swine production in urban and semi-urban areas. Large commercial farms have been established in provinces located near Metro Manila to meet the area's growing demand for pork. The Bureau of Agricultural Statistics (BAS) classifies the swine farms as follows:

- Backyard farms - 20 or less swine
- Commercial farms
  - Small: 21 to 999 swine
  - Medium: 1,000 to 9,999 swine
  - Large: 10,000 swine or more

Over the past five years, the top swine-producing regions are Region III (Central Luzon), Region IVA (CALABARZON), and Region VI (Western Visayas), accounting for 13.8 percent, 13.1 percent, and 10.8 percent, respectively of total combined inventory of backyard and commercial farms as of January 2008. Table 3.2 shows that on a per-province basis, the top producing provinces are Bulacan, Batangas, Leyte, and Iloilo. Details are shown in Appendix F.

Table 3.2 – Top Producing Regions/ Province (Number of Heads)

Location	1-Jan					
	2004	2005	2006	2007	2008	2008
						% of Total
PHILIPPINES	**12,561,690**	**12,139,690**	**13,046,680**	**13,459,330**	**13,701,020**	**100.00%**
BY REGION						
Region III (Central Luzon)	1,862,810	1,666,910	1,805,070	1,955,350	1,893,580	13.82%
Region IV-A (CALABARZON)	1,571,630	1,582,890	1,634,600	1,675,500	1,794,470	13.10%
Region VI (Western Visayas)	1,088,550	1,152,080	1,281,550	1,376,490	1,477,500	10.78%
BY PROVINCE						
Bulacan	1,047,830	928,500	1,078,570	1,257,010	1,246,480	9.10%
Batangas	740,960	747,030	709,650	703,970	718,560	5.24%
Leyte	382,950	358,470	516,550	550,340	653,080	4.77%
Iloilo	449,460	453,920	516,370	514,410	516,360	3.77%

Source of Basic Data: Bureau of Agricultural Statistics

The majority of the commercial farms are located in Region III (Central Luzon), specifically in the Province of Bulacan and in Region IVA (CALABARZON) in the Provinces of Batangas and Rizal. On the other hand, most backyard farms are located in Region VI (Western Visayas), specifically the Provinces of Iloilo and Negros Occidental as well as in Region VIII (Eastern Visayas), specifically the Province of Leyte. Table 3.3 shows the swine inventory of top producing regions.

Table 3.3 – Swine Inventory of Top-Producing Regions/ Provinces by Farm Size

Location	Number of Heads as of Jan 1, 2008			% Share of Total		
	Backyard	Commercial	Total	Backyard	Commercial	Total
PHILIPPINES	**9,726,820**	**3,974,200**	**13,701,020**	**71%**	**29%**	**100%**
BY REGION						
Region III (Central Luzon)	556,390	1,337,190	1,893,580	29%	71%	100%
Region IV-A (CALABARZON)	559,690	1,234,780	1,794,470	31%	69%	100%
Region VI (Western Visayas)	1,281,930	195,570	1,477,500	87%	13%	100%
BY PROVINCE						
Bulacan	85,000	1,161,480	1,246,480	7%	93%	100%
Batangas	204,050	514,510	718,560	28%	72%	100%
Leyte	651,040	2,040	653,080	100%	0%	100%
Iloilo	386,910	129,450	516,360	75%	25%	100%

Source of Basic Data: Bureau of Agricultural Statistics

The commercial farms can be further stratified by number of swine. Based on Bureau of Agricultural Statistics (BAS) records, Table 3.4 shows the stratification of commercial farms by size in the top-producing regions.

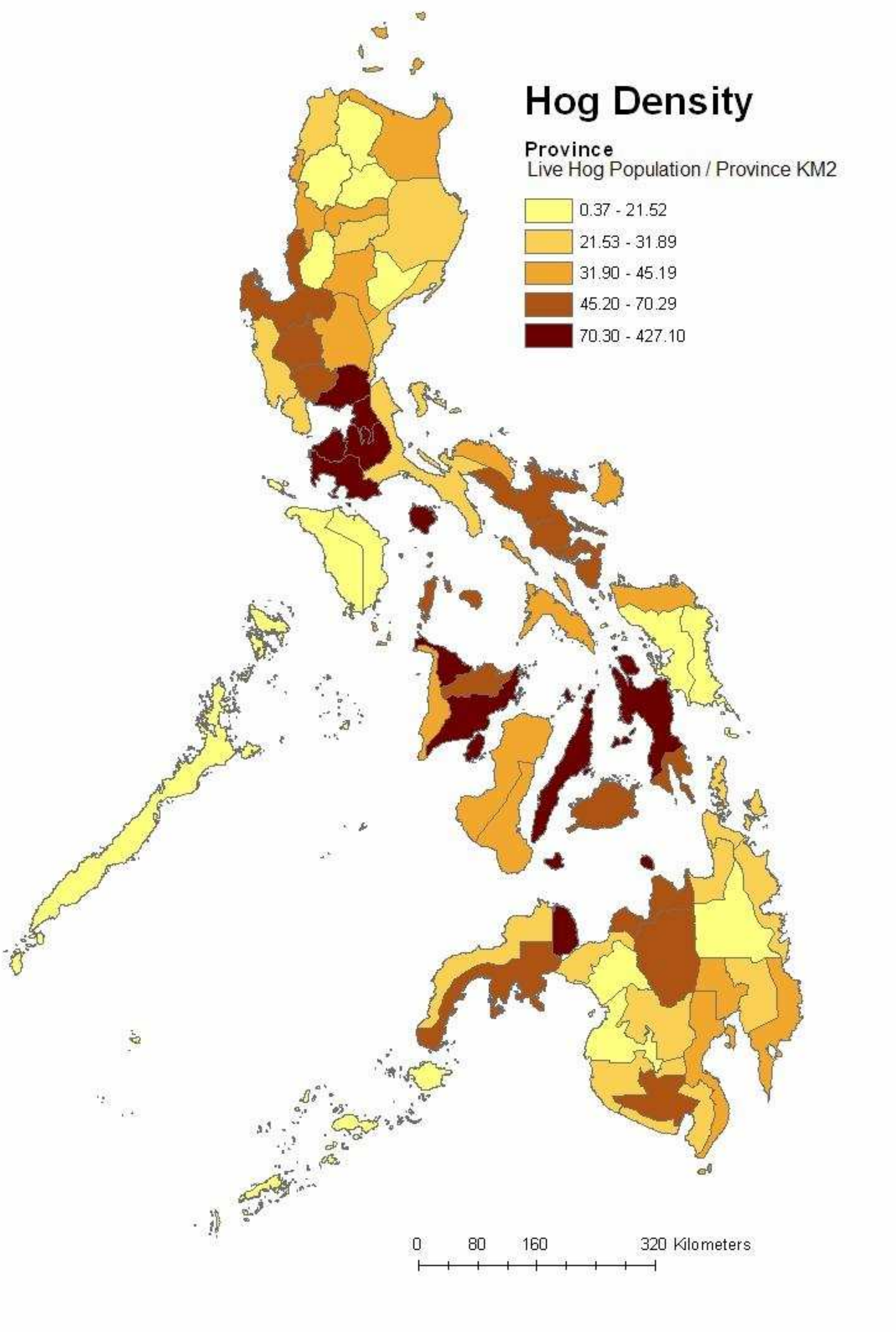
Table 3.4 – Stratification of Commercial Swine Farms by Size

Region/Province	Commercial % of Total			Number of Swine Heads from Commercial Farms
	Small 21-999	Medium 1,000-9,999	Large 10,000>	
Region III-Central Luzon				
Aurora	100%			310
Bataan	100%			20,770
Bulacan	58%		42%	1,161,480
Nueva Ecija	100%			45,650
Pampanga	51%	49%		41,580
Tarlac	52%	48%		63,310
Zambales	26%	74%		4,090
Total				**1,337,190**
Region IV A-Calabarzon				
Batangas	34%	66%		514,510
Cavite	10%		90%	122,350
Laguna	56%	44%		158,780
Quezon	60%	40%		76,160
Rizal	43%		57%	362,980
Total				**1,234,780**
Region VI-Western Visayas				
Aklan	100%			7,260
Antique	100%			3,800
Capiz	100%			3,540
Guimaras	100%			1,400
Iloilo	100%			129,450
Negros Occidental	100%			50,120
Total				**195,570**

Source of Basic Data: Bureau of Agricultural Statistics – Livestock Division

Figure 3.4 shows the swine population density in the country.

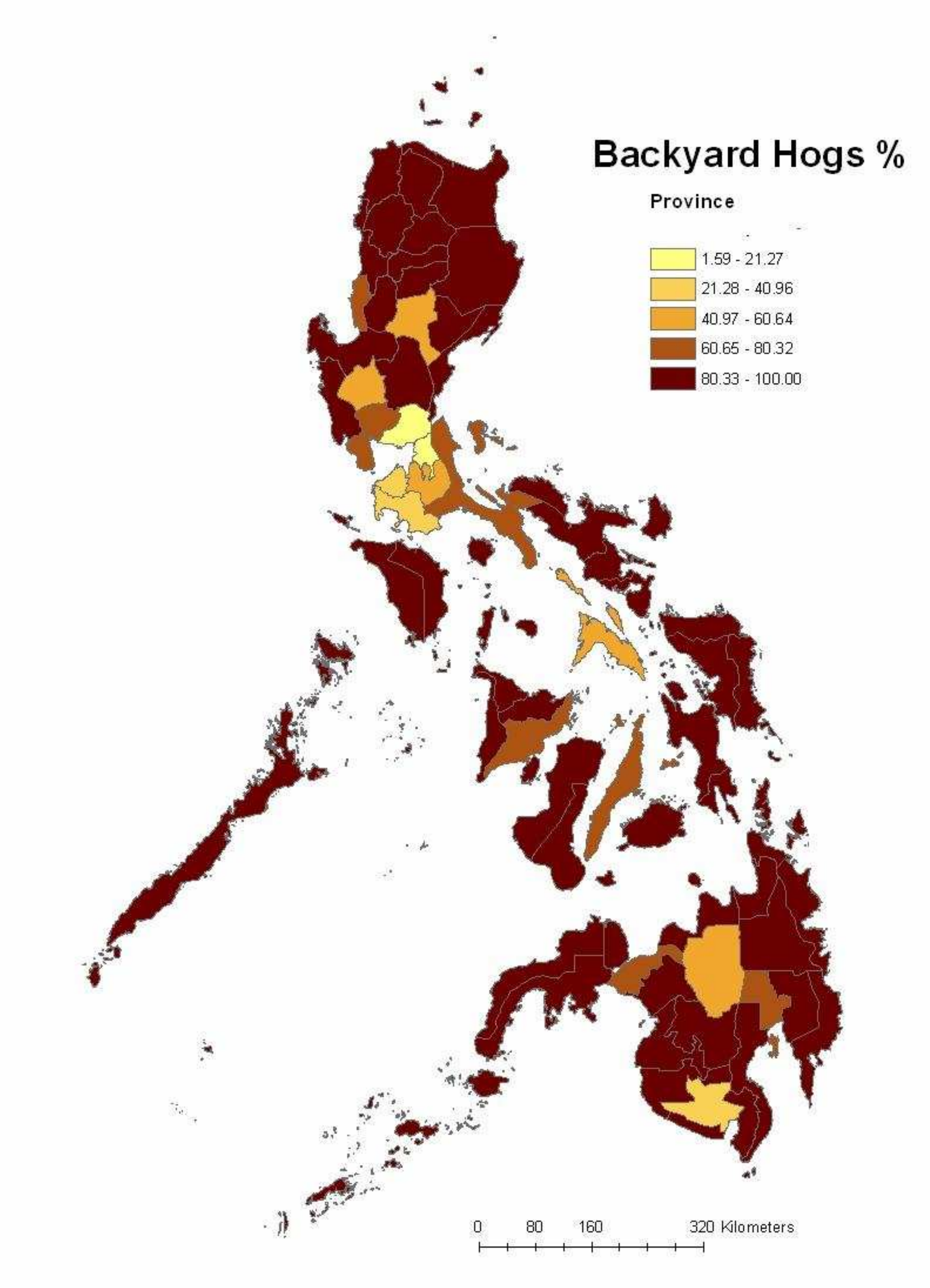
Figure 3.4. Distribution of Swine Production in the Philippines



Source: Bureau of Agricultural Statistics

Figure 3.5 shows the geographical distribution of the backyard farms in the country.

Figure 3.5 – Percentage of Pigs and Hogs Found in Backyard Farms



Source: Bureau of Agricultural Statistics

3.2.2 Description of Waste Characteristics, Handling, and Management

Wastes generated by swine farms are liquid organic wastes consisting of manure, urine, and water used for cleaning, flushing, and cooling. Most commercial swine farms have canals that drain wastewater to a main canal that leads to a wastewater treatment plant. Backyard farms usually drain their wastewater directly to a nearby creek or river.

On most commercial farms, manure is scraped and the area is then manually flushed using a hose. The wastewater drains into a canal that flows into a series of open lagoons. The lagoons have been set up to comply with the effluent requirements. The government monitoring and regulating agency is the Department of Environment and Natural Resources (DENR), particularly the Environmental Management Bureau (EMB).

However, backyard farms and small commercial farms (those with less that 1000 swine), are practically exempt from monitoring and compliance because they generate less than the standard discharge of 30 m^3 per day. The common practice among backyard farms and small commercial farms is to dispose of the manure into the waterways or just leave it on the ground or in an open pit to decompose.

Research reveals that average wastewater generated per head confined on commercial farms range from 17 liters per day to 30 liters per day. If the farm does not practice good housekeeping, wastewater generation could reach 50 liters per day. Typical BOD_5 of effluent wastewater from swine farms ranges from 2,000 to 4,400 mg/L.

Table 3.5 shows results of the literature search on the effluent characteristics of swine farms in the Philippines.

Table 3.5 – Characteristics of Wastewaters from Swine Farms

Parameter	Unit of Measure	A	B	C	D
Biological Oxygen Demand (BOD_5)	mg/L	2,000	4,400	3,800	4,200
Chemical Oxygen Demand (COD)	mg/L	4,000	5,429	n.a.	n.a.
Total Suspended Solids (TSS)	mg/L	1,600	5,380	1,900	3,130
Total Kjeldahl Nitrogen (TKN)	mg/L	1,520	n.a.	n.a.	n.a.
Average Wastewater Production	L/swine	17			
Estimated Swine Population	head	464	6,000		

A- Iloilo State College of Fisheries Dingle Agricultural and Technical College (DATEC) Integrated Agribusiness and Swine Training Center, with a swine population of 464 head consisting of 46 sows, four boars, 230 piglets, and 184 fatteners

B- Sunjin Farm, Antipolo City, with swine population 6,000 head

C- Antelope Muti Ventures Inc. (Region VI EMB Industrial Influent/Effluent Monitoring Report Dec 2002)

D- Nueva Swine Farm (Region VI EMB Industrial Influent/Effluent Monitoring Report Dec 2002)

Table 3.6 summarizes a survey conducted by the University of the Philippines, Los Baños (UPLB) in 2002-2003 on the manure disposal practices of 207 swine farms. The survey is a component for the Livestock Industrialization Project, funded by IFPRI and FAO. The study was conducted on 207 swine farms located in the top swine producing regions: Region III (Central Luzon), Region IV (CALABARZON), and Region X (Northern Mindanao), an emerging major swine producing region. Of the 207 farms, 110 were small scale/backyard farms and 97 were commercial farms.

Table 3.6 – Relationship Between Farm Size and Manure Disposal Practices

Manure Disposal Practice	Small Scale	Commercial	
	Less than 100 Heads	100-1000 Heads Medium	More than 1000 Heads Large
ECONOMIC USE			
On Farm			
Crops	17%	23%	24%
Bio gas	6%	6%	12%
Off-farm			
Sold	1%	4%	0%
Used both on and off farm	1%	4%	0%
NON ECONOMIC USE			
Thrown in canal/river	5%	0%	0%
Laid on ground	15%	0%	0%
Open pit	22%	0%	0%
Septic tank	12%	1%	0%
Lagoon	22%	63%	65%
Total	100%	100%	100%
Number of farms surveyed	110	80	17

Source: UPLB-International Food Policy Research Institute (IFPRI) LI Project Field Survey, 2002-2003 and IFPRI DP 781

The survey shows that as of 2003, about 63 to 65 percent of commercial farms use lagoon systems for manure management and 6 to 12 percent use biogas systems. However, for smaller farms, only 22 percent have lagoon systems, and 6 percent use biogas systems. The others dispose of their waste using either a septic tank or an open pit, or simply by laying it on the ground or allowing it to flow directly to a canal or river.

Note that the UPLB-International Food Policy Research Institute – Livestock Industrialization (IFPRI LI) project used a different classification system to define farm sizes. However, even if the survey report used a different farm size classification, it gives the reader a profile of the waste management practice in the swine industry. To serve as a guide in analyzing the above data, the comparative table of these two classification systems is shown in Table 3.7a.

Table 3.7a – Comparison of the Bureau of Agricultural Statistics and the UPLB- IFPRI LI Project Farm Size Classification Systems

Classification	Bureau of Agricultural Statistics	UPLB-IFPRI LI
Backyard Farms:	20 or less swine	
Commercial:		
Small -	21 to 999 swine	Less than 100 swine
Medium -	1,000 to 9,999 swine	100 to 1,000 swine
Large -	10,000 or more	More than 1,000 swine

In Region VI, a total of 68 swine farms were monitored by the regional office of the Energy Management Bureau (EMB) in 2002. These farms are assumed to be small commercial farms because DENR monitors only entities with discharge rates of 30 m^3/day and above, which is more or less equivalent to 600 heads; backyard swine farms are not monitored. In addition, information obtained from the BAI-Livestock Division shows that most of the farms in Region VI are classified under the small commercial category. The profile of these farms in terms of wastewater management systems are summarized in Table 3.7b.

Table 3.7b – Region VI Wastewater Management System of Small Commercial Swine Farms (21-999 swine)

Province	Total	Lagoon	Biodigester/ Lagoon	Pond	Biodigester/ Pond
Aklan	3	1		1	1
Antique	1	1			
Capiz	0				
Guimaras	1	1			
Iloilo	54	23	2	29	
Negros Occidental	9	7			
Total	68	33	2	32	2
% of Total	100%	49%	3%	47%	1%

Source of Basic Data: Region 6 Industrial Influent/ Effluent Monitoring Report, Dec. 2002

Definitions of waste management and other terms are included in the glossary in Appendix G.

3.3 SLAUGHTERHOUSES

3.3.1 Description of Size, Scale of Operations and Geographic Location

There are reportedly 1,100 slaughterhouses in the country, of which only 121, or 11 percent are accredited.[21] The majority of the accredited facilities are privately owned. Slaughterhouses owned by the local government units are mostly not accredited. Accreditation is obtained from the National Meat Inspection Service (NMIS) of the Department of Agriculture. Accredited facilities are rated according to three major categories. A facility rated "AAA" produces products that can pass export quality and are therefore allowed to sell products to the international market. A facility rated "AA" is allowed to sell and trade products nationwide. A facility rated "A" can sell slaughtered meat only within the municipality. Table 3.8 shows the distribution of slaughterhouses by region and rating.

Table 3.8 – Number of Accredited Slaughterhouses by Location and Classification

Location	No. of Accredited Slaughter Houses	Rating		
		A	AA	AAA
Region I	8	3	5	0
Region II	1	1	0	0
Region III	11	0	11	0
Region IV A	16	1	14	1
Region IV B	4	1	3	0
Region V	6	3	3	0
Region VI	4	1	3	0
Region VII	5	0	4	1
Region VIII	1	1	0	0
Region IX	22	22	0	0
Region X	4	0	4	0
Region XI	4	2	1	1
Region XII	4	0	3	1
CAR	8	6	2	0
CARAGA	4	0	4	0
NATIONAL CAPITAL REGION	19	4	14	1
Total Accredited	**121**	**45**	**71**	**5**

Source of Basic Data: National Meat Inspection Service – Bureau of Animal Industry

The details of the list of registered slaughterhouses are shown in Appendix H.

In terms of slaughterhouse production, Tables 3.9 and 3.10 show that about of 9.8 million swine, 0.57 million cattle, and 0.25 million carabaos (water buffalo) were slaughtered in 2007.

[21] As of November 2008

Table 3.9 – Total Livestock Slaughtered by Animal Type

Year	Swine		Cattle		Carabao	
	Heads	% Increase	Heads	% Increase	Heads	% Increase
2002	8,999,518		694,282		289,627	
2003	9,361,768	4.0%	671,828	-3.2%	281,925	-2.7%
2004	9,024,485	-3.6%	625,776	-6.9%	287,103	1.8%
2005	9,415,037	4.3%	607,946	-2.8%	265,345	-7.6%
2006	9,572,217	1.7%	575,977	-5.3%	250,804	-5.5%
2007	9,789,062	2.3%	566,053	-1.7%	245,177	-2.2%
Average		1.7%		-4.0%		-3.2%

Source: Bureau of Agricultural Statistics

Over the past six years, slaughtering of cattle and carabaos has been decreasing, but the slaughtering of swine has been increasing over the same period. Data obtained from NMIS in Table 3.10 indicate that more than half of the total swine slaughtered have been slaughtered in accredited slaughterhouses.

Table 3.10 – Estimated Swine Slaughtered by Type of Abattoir by Region (Jan 2007)

REGION	SWINE	Accredited	Non Accredited	Accredited	Non Accredited
	Head	Head	Head	% Share	% Share
I	56,947	26,146	30,801	46%	54%
II	22,203	4,624	17,579	21%	79%
III*	67,182	26,250	40,932	39%	61%
IV-A	136,841	67,284	69,557	49%	51%
IV-B	16,495	3,872	12,623	23%	77%
V	36,101	3,323	32,778	9%	91%
VI	49,750	3,011	46,739	6%	94%
VII	67,537	19,648	47,889	29%	71%
VIII	18,464	4,686	13,778	25%	75%
IX	10,666	7,812	2,854	73%	27%
X	58,894	48,877	10,017	83%	17%
XI	29,129	26,265	2,864	90%	10%
XII	16,377	14,159	2,218	86%	14%
CAR	11,822	9,200	2,622	78%	22%
CARAGA	9,356	6,171	3,185	66%	34%
NCR	141,853	128,180	13,673	90%	10%
TOTAL	749,617	399,508	350,109	53%	47%
*Production of accredited slaughterhouses in Region III estimated based on data gathered on estimated daily production					

Source of Basic Data: National Meat Inspection Service

Slaughterhouses rated AA and AAA are located mostly in Region III (Central Luzon), IVA (CALABARZON), and the National Capital Region.

The regions with the most number of swine slaughtered are Region IVA (CALABARZON), National Capital Region, followed by Region III (Central Luzon). On a per province basis, excluding Metro Manila, the top-producing provinces are Cebu, Rizal, Cavite, and Bulacan.

As expected, most of the swine are slaughtered in the National Capital Region and nearby provinces. If combined, these areas accounts for 49 percent of the total swine slaughtered in the whole country. This is largely because most of the demand for pork comes from Metro Manila, which accounts for the highest population density and highest per capita income. Most rated AA and AAA slaughterhouses are also in these areas as illustrated in Table 3.11. Detailed statistics on a per province basis are shown in Appendix I.

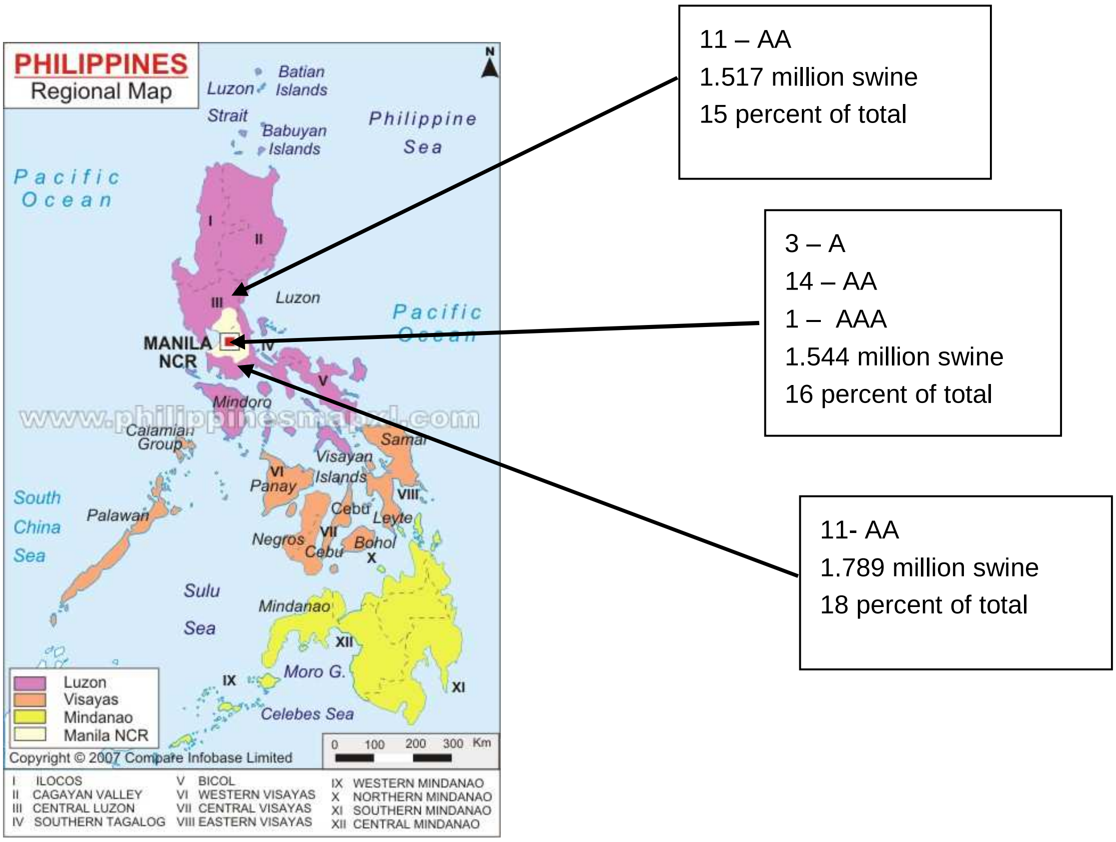
Table 3.11 – Top Regions/ Provinces With the Most Number of Swine Slaughtered

Swine	Annual						2007
	2002	2003	2004	2005	2006	2007	% to Total
PHILIPPINES	**8,999,518**	**9,361,768**	**9,024,485**	**9,415,037**	**9,572,217**	**9,789,062**	**100%**
BY REGION							
Region IV-A (CALABARZON)	1,579,824	1,807,350	1,714,611	1,738,843	1,752,157	1,784,587	18%
National Capital Region	1,727,655	1,527,156	1,459,558	1,768,698	1,631,621	1,544,742	16%
Region III (Central Luzon)	1,447,029	1,450,519	1,391,622	1,417,743	1,530,507	1,517,142	15%
BY PROVINCE							
Cebu	564,483	585,928	498,083	607,764	602,436	618,241	6%
Rizal	372,426	453,346	398,109	476,594	459,518	490,904	5%
Cavite	504,130	593,418	591,753	542,197	484,997	478,965	5%
Bulacan	446,526	420,659	410,490	404,756	425,480	461,516	5%

Source of Basic Data: Bureau of Agricultural Statistics

Figure 3.6 shows the geographical location of provinces with the most number of registered slaughter houses and their production intensity.

Figure 3.6 – Geographical Location of Most Registered Slaughterhouses and Their Production Intensity (2007)



3.3.2 Description of Waste Characteristics, Handling and Management

Wastewater generated by slaughterhouses consists of animal urine, diluted blood, dissolved fats, suspended solids, hair bristles, animal manure, and spent water used in cleaning, scalding vat water, and flushing. Wastewaters from slaughterhouses have high organic load and organic nutrients, adequate alkalinity, and relatively high temperature and are usually free of toxic materials.

Slaughterhouses generate an average of 30 to 40 gallons (0.113 to 0.151 m^3) per hog slaughtered.[22] Raw wastewater BOD_5 concentration reportedly averages 2,500 mg/L.[23] The IPCC 2006 default factor for COD of meat and poultry processing (slaughterhouse) is 4,100 mg/L.

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[22] Gathered from interviews with operators/ owner of Megga Slaughterhouse and Novaliches Slaughterhouse

[23] http://www.borda-sea.org

No data are available from EMB on the characteristic of slaughterhouse wastewater before treatment. Because most slaughterhouses reportedly process an average of 200 to 260 animals per day, discharge rates are lower than the standard discharge of 30 m^3 per day and are exempt from EMB monitoring and compliance. Therefore, these slaughterhouses are not monitored by EMB but are under the jurisdiction of local government units.

Most registered slaughterhouses located in Metro Manila use the physical and chemical treatment process. Even those rated AA do not have lagoon systems due to limited space.[24] Megga Stock Farm Inc., the slaughterhouse located in San Juan City Metro Manila, is considered to have the most advanced wastewater treatment system.[25] It uses physical treatment followed by aeration and chemical treatment. Visual inspections conducted at a number of slaughterhouses located in Metro Manila revealed inefficient operation of biogas digesters, septic tanks, and settling tanks. Inefficiency could be brought about by inadequate facility capacity relative to the wastewater flow. This suggests intermittent disposal of effluents that are not within the standard requirements and possible methane emissions, even in systems that theoretically should be under aerobic conditions.

Slaughterhouses located outside Metro Manila usually have septic tanks followed by lagoon-type wastewater treatment facilities. Small household type slaughterhouses usually do not have wastewater treatment facilities. Wastewaters are discharged directly to common waterways. A number of slaughterhouses outside Metro Manila have biogas digesters installed in combination with septic tanks and lagoons but the digesters are no longer functioning.[26]

Table 3.12 shows the location and type of wastewater treatment process and method of effluent disposal of some slaughterhouses.

Table 3.12 – Slaughterhouse and Their Waste Management System

Slaughterhouse	Location	Wastewater Treatment Process	Effluent Final Disposal
Within Metro Manila			
Megga Stock Farm Inc	San Juan City, MM	*Treatment Processes* - Screening using grease traps - Aeration (activated sludge) - Flocculation using alum and polymers to enhance suspended solids removal - Settling to separate suspended solids - Equalization to even out the wastewater - Chlorination	Creek
Kalookan	Caloocan City,	*Treatment Processes*	Creek

[24] Based on actual site visits and confirmed by Mr. Conde of EMB

[25] Based from two separate interviews with Atty. Bacayo OIC Executive Director of NMIS, Ms. Josefina Contreras Chief of APDC.

[26] EMB key informant Mr. Conde-OIC Director Region IV and NMIS informant Ms. Jane Tapel

Slaughterhouse	Location	Wastewater Treatment Process	Effluent Final Disposal
Slaughterhouse	MM	- Similar to Megga Stock Farm Inc.	
Roblou Meat Products & Abattoir	Cainta, Rizal	*Treatment Processes* - Screening using wire mesh installed at an angle to facilitate flow of wastewater - Aeration (activated sludge) - Flocculation using alum and polymers to enhance suspended solids removal - Filtration to separate sludge	Creek
V& R Abattoir	Antipolo City, MM	Chinese fixed-dome biogas digester, anaerobic baffle reactor, anaerobic filter system :[27] - Influent flows to the fixed-dome digester where the settling and digestion process occur. - Wastewater enters the ABF where suspended and dissolved solids undergo anaerobic degradation through contact with activated sludge in each of the six chambers. The series of chambers is intended to protect the next treatment from any hydraulic and organic shock loads. - This is followed by a further anaerobic treatment where wastewater passes through a fixed-bed media where the solids get in contact with beneficial bacteria. - The wastewater then undergoes a tertiary aerobic treatment though subsurface flow filters in the form of planted gravel filter. -It then flows to the indicator pond,[28] which serves as a facultative pond.	Creek
Novaliches Slaughterhouse	Novaliches, Quezon City, MM	*Physical and Chemical Treatment* Similar to Megga Stock Farm Inc.	City sewer
VST Livestock Corp	Antipolo City	Chinese fixed-dome digester (not functioning) and a series of stabilization tanks	Creek
Outside Metro Manila			
Mother Earth	Region III-Pampanga	Digester followed by lagoon	n.d.
Guimbal	Region VI-	Settling pond	Iloilo Strait

[27] This new treatment facility was under construction at the time of site visit in December 2008.

[28] Its main function is to expose treated water to UV, to remove pathogens and to facilitate the monitoring of treated waste water quality when taking samples for laboratory testing. It may be used for small scale farming.

Slaughterhouse	Location	Wastewater Treatment Process	Effluent Final Disposal
Slaughterhouse,	Guimbal, Iloilo		
Iloilo City Slaughterhouse	Region VI- San Jose St, Molo, Iloilo	Biological Lagoon	Iloilo River
Buenavista Slaughterhouse	Region VI- Buenavista, /Guimaras	Settling Tank	No data
Roxas City Slaughterhouse	Region VI- Roxas City, Capiz	Settling Pond	Panay River

Source of data: For Metro Manila based on actual visits; For those located outside Metro Manila – EMB Monitoring Report for Region VI (2002)

3.4 SUGAR AND DISTILLERIES

3.4.1 Description of Size, Scale of Operations and Geographic Location

The sugar sub-sector is a significant contributor to the Philippine economy. In the 1970s, sugar contributed approximately 7 percent of the agricultural gross value added (GVA).[29] In the 1980s, the share of agricultural GVA of sugar production averaged only 4 percent, and this further declined to 3 percent during the 1990s.[30]

However, measuring the industry's overall contribution to the economy goes beyond sugar production's contribution to agricultural GVA. This indicator is only a partial reflection of sugar's total GVA since processed sugar's contribution is now recorded under manufacturing GVA. One important indicator is the impact, whether direct or indirect, of the amount of investments of the industry to the economy. An estimated 150 billion pesos has been invested all over the country. In 1998 alone, almost 20 billion pesos were invested for modernization and rehabilitation, coming from Board of Investment-registered sugar mills, cane farms, and refineries. The industry also fuels growth in the economy by dispersing the 26 billion pesos generated from sugar cane production to the rural areas, creating centers of economic activity, and to the various sectors.

Almost 25 percent (2 billion pesos) of the milling sector's 30 percent share from the annual total value generated in sugar cane production goes directly to the community as wages and salaries. Following is an industry estimate of how the 30 percent share of the mill is divided among the different sectors: labor (25 percent), suppliers (32 percent), truckers (11 percent), banks (12 percent), stockholders (10 percent), and taxes (10 percent). Figure 3.7 shows how the 7.8 billion pesos, as the 30-percent share of the mills in total production, is distributed in million pesos to different sectors.

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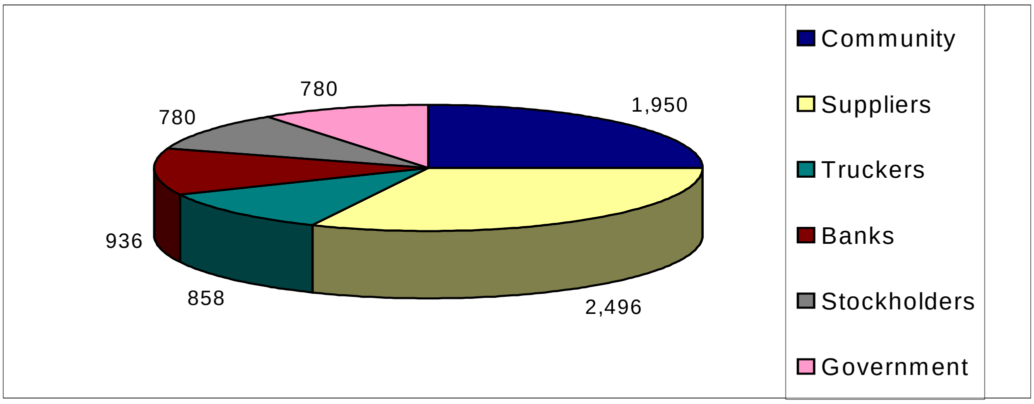
[29] Gross value added (GVA) is a measure of economic activity at basic prices, which includes taxes (less subsidies) on production but excludes taxes (less subsidies) on products.

[30] Philippine Statistical Yearbook, 1999.

Figure 3.7 – Distribution of the 30-Percent Share of the Mill to the Different Sectors
(in million pesos)

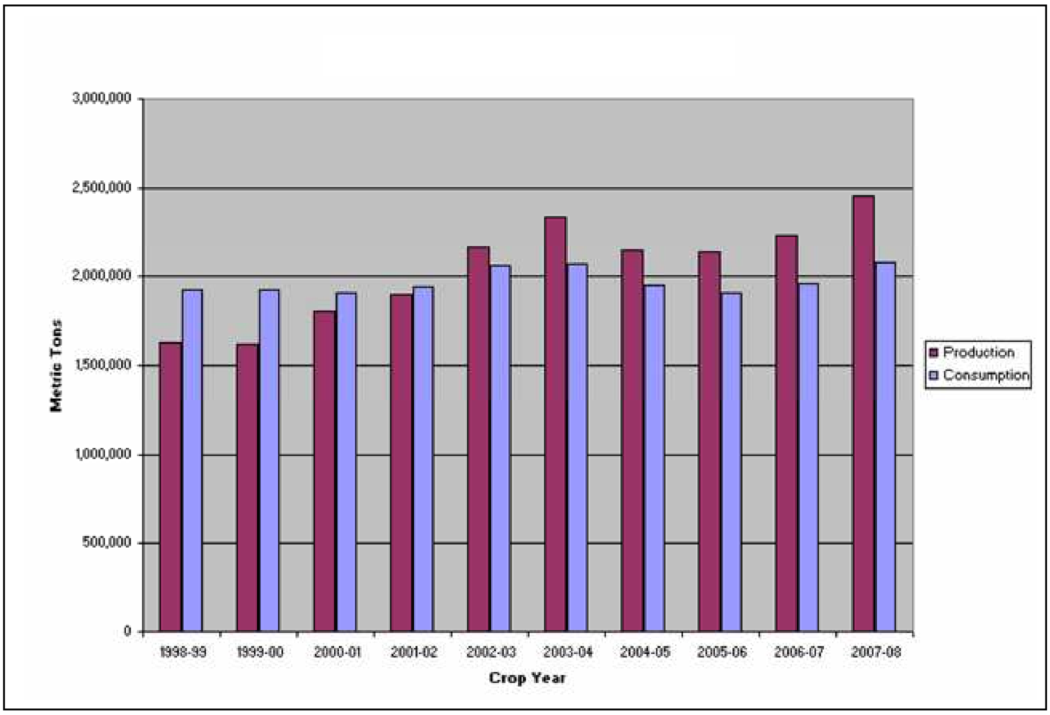


Local sugar production also helps ease the country's foreign exchange requirement. Importing sugar to fill the growing domestic requirement would be a heavy strain on the Philippines' foreign exchange position. For example, if the country did not produce sugar at an annual requirement of 2 million tons of sugar at 10 cents per pound in the world market, then 17.6 billion pesos worth of sugar would be imported every year. In addition, local sugar production ensures self-sufficiency, thereby addressing food security, which the government has declared to be a priority.

Philippine sugar demand mainly comes from the household and industrial sectors. Of the country's annual sugar production, 80 to 85 percent is domestically consumed while the remaining 15 to 20 percent is either sold to the world market or stored as buffer stock or strategic reserve. The strategic reserve is intended to allow sugar prices to attain levels profitable to the planters and millers, and affordable to the consumers.

With estimated annual earnings of about US $70 million from the U.S. market alone, the industry is an important dollar-earner to the Philippines. The U.S. market is a prime market, of which all countries would like to have a share. Export to other destinations in 1998 was valued at about $20 million.

Figure 3.8 – Raw Sugar Production and Consumption (1998-2008)

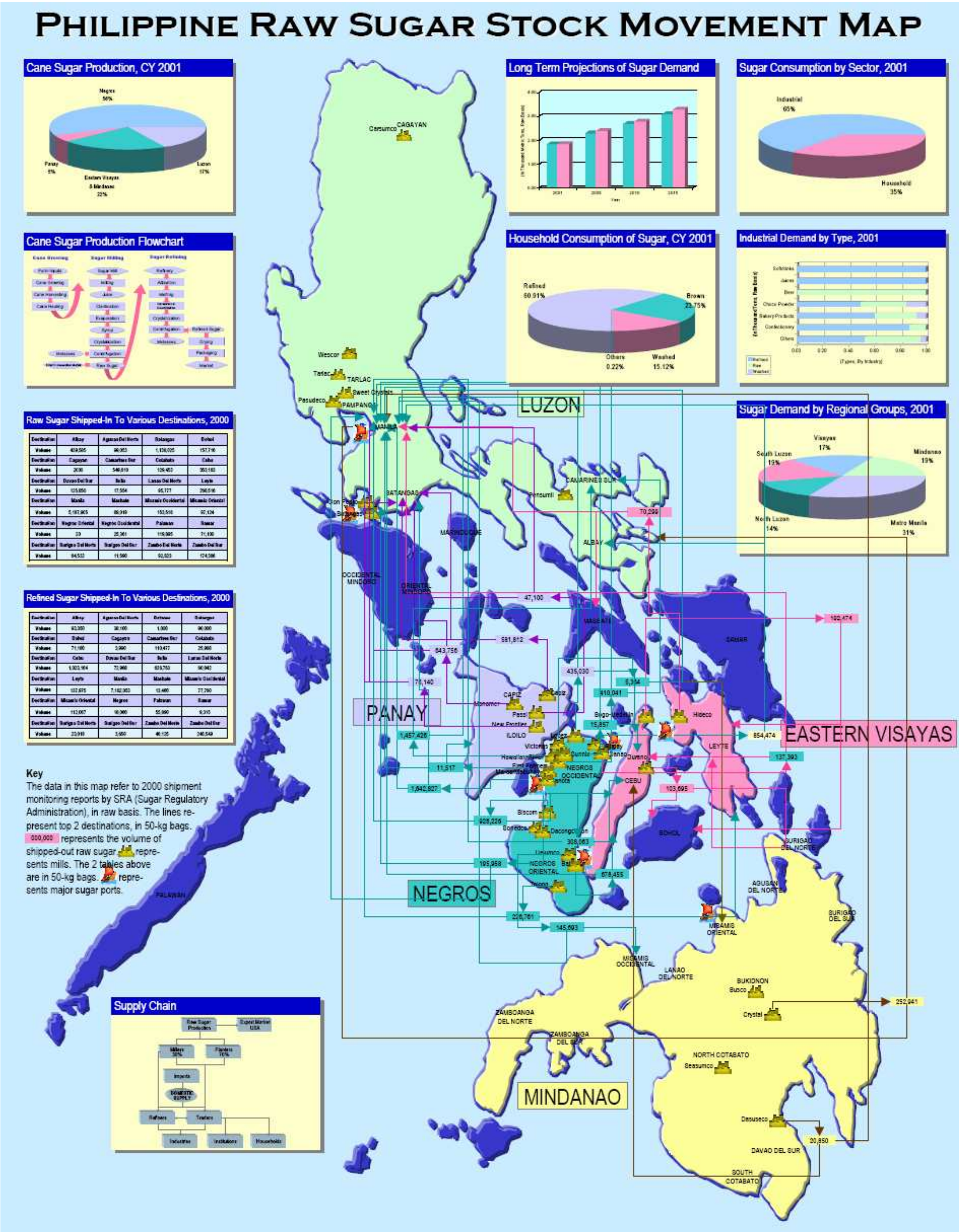


Source of data: Philippine Sugar Millers' Association

Figure 3.8 shows raw sugar production and consumption from 1998 through 2009. Domestic sugar consumption continued to grow at an average of 4.9 percent per year from 1998 to 2008 while consumption only increased at 0.9 percent on average during the same period.

Figure 3.9 shows the geographical distribution of sugar mills in the Philippines.

Figure 3.9 – Geographical Distribution of Sugar Mills



Source: Philippine Sugar Millers' Association

a. ALCOHOL DISTILLERIES

Because the sugar industry is a major agricultural sector in the Philippines, its byproduct, molasses, is the main feedstock for the alcohol distilleries in the country. These distilleries produce ethyl alcohol or ethanol, an ingredient used in the manufacture of alcoholic drinks like gin and rum. There are now about 12 distilleries operating nationally.

Table 3.13 shows the list of distilleries and their production capacities as of 2008.

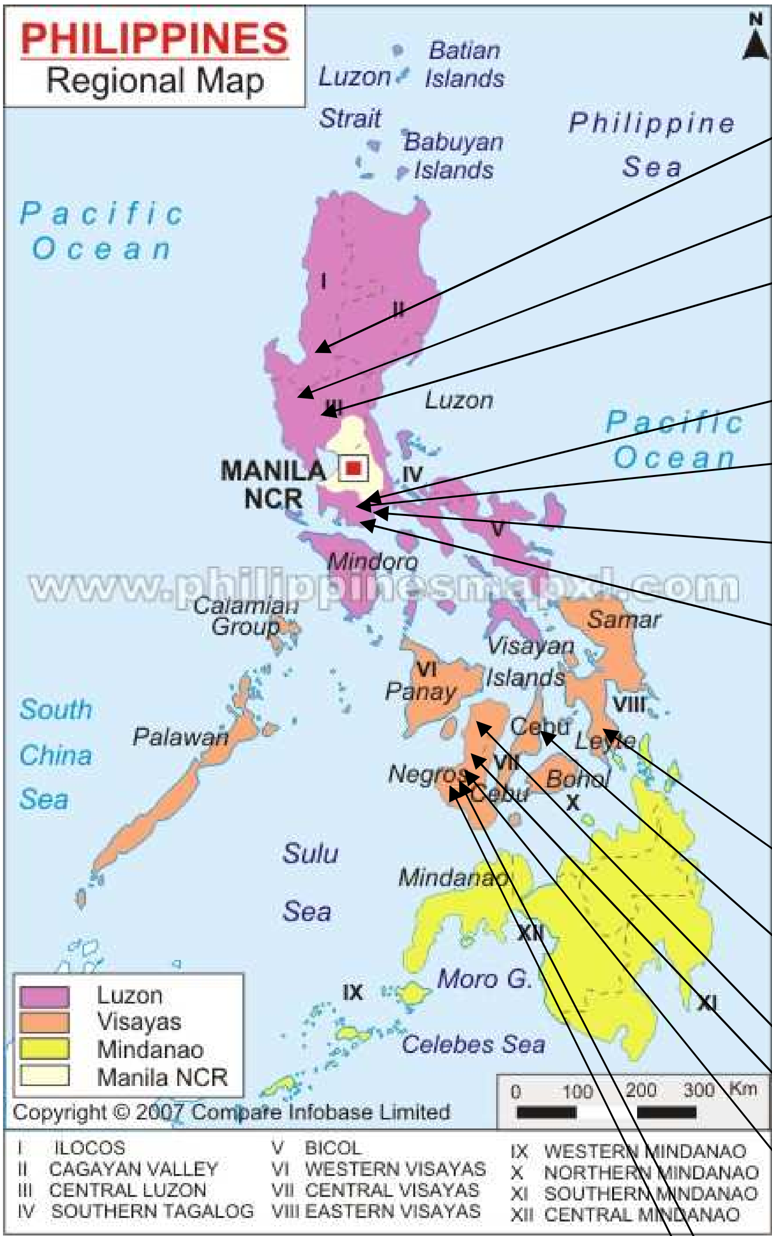
Table 3.13 – Location and Production Capacities of Distilleries

Region	Distillery	Production Capacity - million liters/year
I (Ilocos)	Alko Distillers, Inc.	2.1
III (Central Luzon)	Central Azucarera de Tarlac	18
	Far East Alcohol Corporation	3
IV (Southern Tagalog)	Absolute Chemicals, Inc.(Tanduay Distillery)	12
	Balayan Distillery	22
	Consolidated Distillers of the Far East	7.5
	Dyzum Distillery	15*
VI (Western Visayas)	Asian Alcohol Corporation	45
	Destilleria Bago, Inc.	90
	Kooll Distillery	12
VII (Central Visayas)	International Pharmaceuticals, Inc.	6
VIII (Eastern Visayas)	Leyte Agri-Corp. Ormoc	11
	Total	243.6
New Additional		
To start in 2009	San Carlos BioEnergy Inc.	30
To start in 2010	Roxol Bioenergy Corp.	24

The number of alcohol distilleries is expected to increase as a result of the signing of the Biofuel Act 2006, which calls for the mandatory blending of ethanol with gasoline, initially at 5 percent starting 2009, to be increased to 10 percent after four years following the law's promulgation. Two new distilleries are expected to commence production in the Visayas Region in the near future: San Carlos Bio Energy, with an annual production potential of 30 million liters of ethanol, and Roxol Bioenergy Corp, which will produce about 24 million liters ethanol per year.

Originally, distilleries in the Philippines were concentrated in the center of the country's sugar cane production, in the Visayas region near the source of the raw materials. Currently, a number of distilleries have set up plants in Luzon to be near their markets. Of the 12 distilleries operating nationwide, four are in Batangas, which is in Region IVA (CALBARZON). Figure 3.10 shows the location and production capacities of distilleries.

Figure 3.10 – Geographical Distribution of Alcohol Distilleries



ALCOHOL DISTILLERIES (LUZON)	Production Capacity (Million liters/year)
ALKO DISTILLERIES, INC Bo. Baritao, Manaog, Pangasinan	2.1
CENTRAL AZUCARERA DE TARLAC San Miguel, Tarlac, Tarlac	18.0
FAR EAST ALCOHOL CORP. Alahuli, Apalit, Pampanga	3.0
ABSOLUT CHEMICALS INC. Bo. Malurahatan, Lian, Batangas	12.0
BALAYAN DISTILLERY Balayan, Batangas	22.0
CONSOLIDATED DISTILLERS OF THE FAR EAST Brgy. Lumbangan, Nasugbu, Batangas	7.5
DYZUM DISTILLERY Bo. Baldeo, Lian, Batangas	15.0

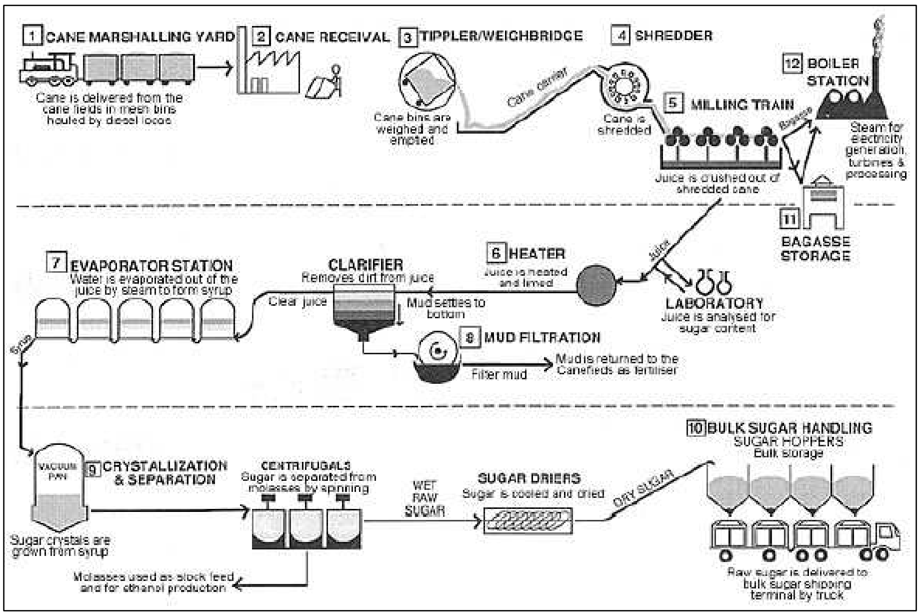
ALCOHOL DISTILLERIES (VISAYAS)	Production Capacity (Million liters/year)
LEYTE AGRI-CORP. Ormoc City, Leyte	11.0
INTERNATIONAL PHARMACEUTICALS INC. Juan Luna Ave., Mabolo, Cebu City	6.0
ASIAN ALCOHOL CORP. Bo. Canjusa, Pulupandan, Negros Occidental	45.0
DESTILLERIA BAGO, INC Bago. Negros Occidental	90.0
KOOLL DISTILLERY Talisay, Negros Occidental	12.0

NEW DISTILLERIES	Production Capacity (Million liters/year)
SAN CARLOS BIO ENERGY INC San Carlos City Negros Occidental	30
ROXOL BIOENERGY Negros Occidental	24

3.4.2 Description of Waste Characteristics, Handling and Management

Sugar production results in three types of wastes: 1) bagasse from milling operations, 2) dirt or mud from juice filtration, and 3) process and floor washings. This process is shown in the process diagram in Figure 3.11.

Figure 3.11. Sugar Process Flow



Bagasse is usually used as boiler fuel, while the dirt or mud is commonly returned to the sugar cane fields as a soil conditioner. Process and floor washings that are low in BOD are treated in lagoons or spray ponds. The historical output of bagasse and mud are presented in Table 3.14. For the crop years 2003-2004 and 2004 2005, there are no data for bagasse and filter cake.

Table 3-14: Philippine Sugar Industry Production Data for 1995-1996 Through 2004-2005

Crop Year	Production				
	Cane Milled (MT)	Raw (MT)	Raw Sugar (piculs[31])	Refined (Lkg)[32]	Molasses (MT)
1995-96	22,898,026.88	1,790,374.97	28,306,323.65	17,771,681.00	852,047.00
1996-97	21,931,186.76	1,829,993.35	28,932,701.22	15,867,415.00	816,927.00
1997-98	20,485,846.56	1,802,744.00	28,501,881.42	17,981,245.00	901,003.00
1998-99	21,720,000.62	1,624,322.00	25,680,980.24	20,632,286.00	872,115.00
1999-00	19,567,363.61	1,619,613.00	25,606,529.64	19,771,840.00	853,329.00

[31] 1 picul = 63.25 kg

[32] Lkg = 50 kg

Crop Year	Production				
	Cane Milled (MT)	Raw (MT)	Raw Sugar (piculs[31])	Refined (Lkg)[32]	Molasses (MT)
2000-01	21,211,490.00	1,805,203.00	28,540,758.89	19,326,208.00	812,724.00
2001-02	21,159,796.00	1,898,501.00	30,015,826.09	20,938,696.00	873,945.00
2002-03	23,676,714.00	2,161,525.00	34,174,308.30	23,251,535.00	1,002,192.00
2003-04	25,864,698.00	2,338,574.00	36,973,501.98	24,258,195.00	998,731.00
2004-05	22,572,028.00	2,150,746.00	34,003,889.33	21,127,485.00	900,426.00

Source: Philippine Sugar Millers' Association

There is no available information on how much wastewater is generated by sugar mills on a national basis since it is not reported to the EMB-DENR. However, an indication of the volume of wastewater that is generated by a sugar mill can be obtained from the data submitted to the EMB Region 6 by one sugar mill in the Visayas; see Table 3.15. This table also shows the characteristic of wastewater from sugar milling operations.

Table 3.15 – Characteristic of Wastewater From Sugar Milling Operations

Parameter	Unit of Measure	A	B	C	D
Biochemical Oxygen Demand (BOD_5)	mg/L	1,960	3,440	85	950
Total Suspended Solids (TSS)	mg/L	1,240	250	20	240
pH		5	5	5	
Temperature	^oC	40	36	30	44
Color	Units	500	500	250	250
Wastewater Generated	m^3/ milling	n.a.	n.a.	n.a.	6,104
Waste Treatment		Biological lagoon, spray pond	Activated sludge, biological lagoon	Biological pond[33]	Biological lagoon, spray pond

A- Passi (Iloilo) Sugar Central, Inc, San Enrique Iloilo

B- First Farmers Holding Corp., Talisay City, Negros Occidental

C- Mabuhay Sugar Central, Inc, Bago City, Negros Occidental

[33] A biological pond is a man-made reservoir above ground with concrete embankments. A biological lagoon is a man-made reservoir underground; lagoons are usually bigger than a pond.

D- Sonedco, Kabankalan City, Negros Occidental

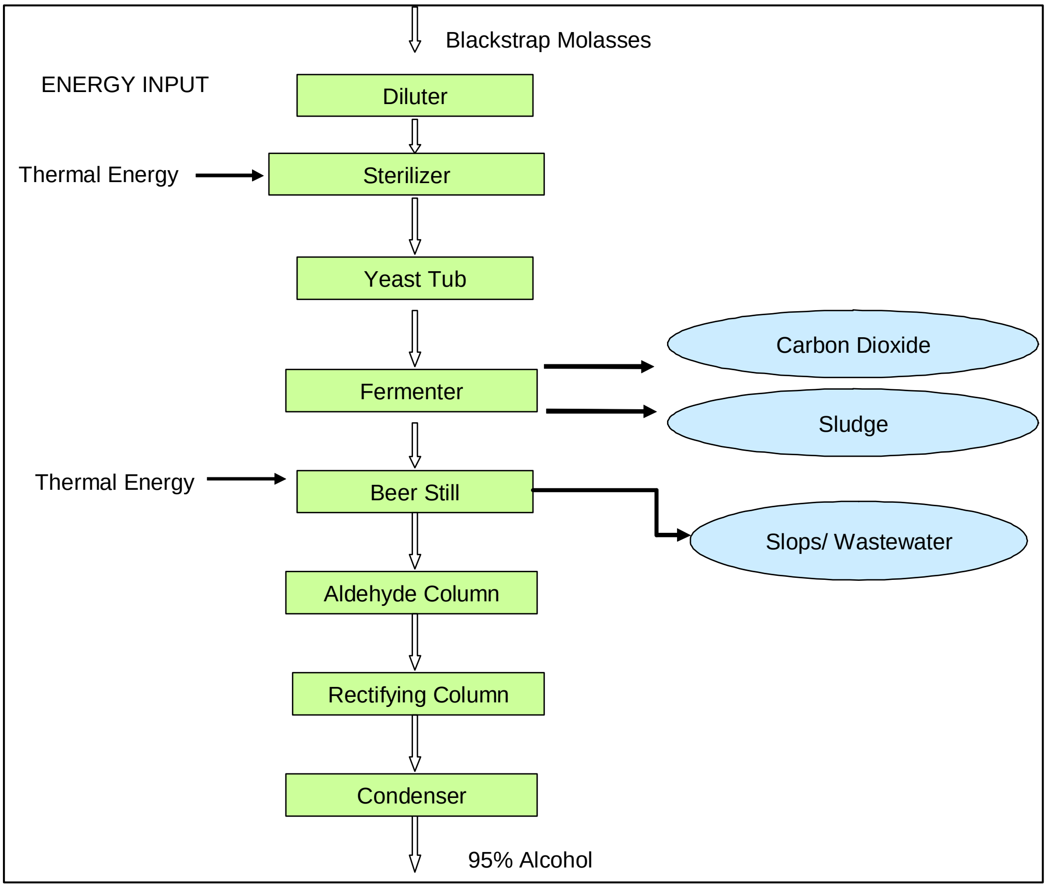
Source of Data: DENR- EMB Region VI Industrial Influent/ Effluent Monitoring Report 2002

DENR-EMB defines a lagoon as an excavated earthen structure, and a pond is lined with concrete.

a. ALCOHOL DISTILLERIES

The alcohol distilleries generate significant volume of wastewater (also called distillery slops) from the fermentation step of the overall process with very high BOD_5 concentrations. One liter of alcohol produced generates 10 to 15 liters of wastewater.[34] Figure 3.12 shows the wastewater generation point in the alcohol distillation process.

Figure 3.12 – Wastewater Generation Point in the Alcohol Distillation Process



The estimated slops production of Philippine distilleries is shown in Table 3.16.

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[34] Philip Balicud – Biogas Specialist in the local distillery sector and validated from the PID for the proposed "Ethanol Plant Wastewater Biogas Project for Central Azucarera de Don Pedro" dated October 2007 and from http://www.pcarrd.dost.gov.ph/news/s&t percent20highlights/jan/snt0206-03.htm

Table 3.16 – Estimated Slops Production

Region	Distillery	Alcohol Production Capacity - million (liters/year)	Estimated Slops Output - million (liters/year)
I (Ilocos)	Alko Distillers, Inc.	2.1	25.2
III (Central Luzon)	Central Azucarera de Tarlac	18	216
	Far East Alcohol Corporation	3	36
IV (Southern Tagalog)	Absolute Chemicals, Inc.	12	144
	Balayan Distillery	22	264
	Consolidated Distillers of the Far East	7.5	90
	Dyzum Distillery*	15	180
VI (Western Visayas)	Asian Alcohol Corporation	45	540
	Destilleria Bago, Inc.	90	1080
	Kooll Distillery	12	144
VII (Central Visayas)	International Pharmaceuticals, Inc.	6	72
VIII (Eastern Visayas)	Leyte Agri-Corp. Ormoc	11	132
	Total	243.6	2923.2
New Addition			
To start in 2009	San Carlos BioEnergy, Inc.	30	360
To start in 2010	Roxol Bioenergy	24	288

***Stopped operating in 2002 but has reportedly resumed operations recently.**

Representative data on the characteristic of alcohol distillery wastewater are provided in Table 3.17.

Table 3.17 – Wastewater Characteristics of Alcohol Distillery Plants

Parameter	Unit of Measure	A	B	C
Biochemical Oxygen Demand (BOD_5)	mg/L	51,260	32,080	54,000
Total Suspended Solids (TSS)	mg/L	4500	7,060	-
pH		4.2	4.3	
Temperature	^oC	58	48	
Color	Units	125,000	125,000	
Wastewater Generated	Liter wastewater/ liter product			12
Waste Treatment		Activated Sludge	Activated sludge * biological lagoon	Lagoon

A- Asian Alcohol, Inc, Palupanan, Negros Occidental

B- Distileria Bago, Inc; Bago City, Negros Occidental

C- Central Azucarera de Tarlac, Hacienda Luisita, Tarlac

Source of Data: DENR- EMB Region VI Industrial Influent/ Effluent Monitoring Report 2002 for A and B. C was obtained from interview with plant personnel

There are no available data on the COD concentrations in Philippine alcohol distillery wastewaters but they are reported to range from 45,000 to 75,000 mg/L in India.[35]

In 2002, most distilleries in Region VI used activated sludge to treat their wastewater, but recent reports indicate that most distilleries are now equipped with biogas digesters.[36] Alcohol distilleries located in Region IVA (CALABARZON) typically employ a biogas digester followed by lagoon treatment system.[37] Absolut Chemicals, Inc., a subsidiary of Tanduay Distillers Inc., has recently installed a waste treatment facility using an advanced, thermophilic anaerobic digester operating between 49 and 57℃ (120 to 135℉). One d istillery has a custom-made mesophilic digester operating between 29 and 38℃ (85 to 100℉) designed by Engineer Philip Balicud and built by a local tank fabricator. A few other distilleries have in-house digesters operating at mesophilic temperatures that were developed through trial and error.[38] Other distillery digesters operate in the thermophilic temperatures. No artificial heating is required.

Slops generated from distillery plants are already hot as a result of the distillation process. This, together with the heat generated from the anaerobic process and the high ambient temperature, creates a condition where the process temperature is maintained at thermophilic range. No data are available on whether or not they operate efficiently. Details of the operating condition of digesters in the alcohol distillery industry are shown in Appendix J.

As of January 2009, the list of distilleries with insufficient or no facilities for methane generation are:

- Central Azucarera de Tarlac—converts only 1/6 of its slops into methane
- Kooll Distillery—converts only 30 percent of its slops into methane
- Leyte Agri-Corp—no facility for methane generation
- Destilleria Bago Inc.—digester not operating to its maximum expected level

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35 http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6TGF-4R5F1WG-2&_user=1

36 Key informant interview Prof. Rex Dimafelis, Department of Chemical Engineering, UP Los Baños.

37 Key informant interview Mr. Conde – OIC Director Region IV.

38 Det Norske Veritas, Validation Report entitled, " Wastewater Treatment Using Thermophilic Anaerobic Digester at an Ethanol Plant in the Philippines, July 2006

The two new alcohol distilleries, San Carlos BioEnergy Inc. and Roxol BioEnergy, will reportedly have biogas methane capture facilities followed by lagoons to further treat wastewaters before disposal.

Wastewater Flow of a Sugar Mill With an Alcohol Distillery

The flow of wastewater at the Central Azucarera de Tarlac, which is a sugar mill and an alcohol distillery, is described as follows and shown in Figure 3.13.

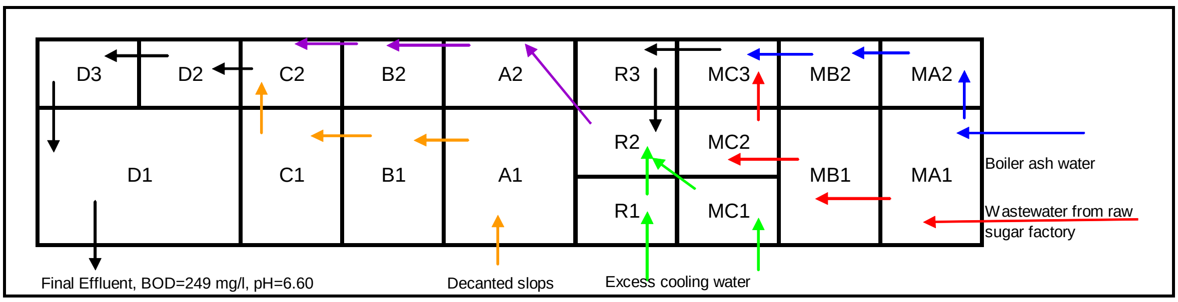
- **Raw Sugar:** The wastewater stream from the raw sugar factory enters a corner of lagoon MA1, which overflows to MB1 and eventually transfers to MC2. The contents of MC2 overflow to MC3 where they are mixed with boiler ash water from MB2. These combined wastewater streams overflow to lagoon R3, then to lagoon R2 where they are mixed with excess cooling water.

- **Excess Cooling Water:** The wastewater stream enters lagoons R1 and MC1, which both overflow to lagoon R2 where they mix with the combined wastewater from the raw sugar factory and boiler ash water coming from lagoon R3.

- **Boiler Ash Water:** Boiler ash water enters lagoon MA1 at a separate point. Its flow within this lagoon is confined to the west periphery as it travels to lagoon MA2 and eventually overflows to MB2. From here, it goes to MC3 where it mixes with the wastewater from the raw sugar factory. The resulting combined wastewater stream overflows to lagoon R3, then to lagoon R2 where it is mixed with the excess cooling water from R1 and MC1. The discharge from lagoon R2 is a combination of the following three streams: 1) wastewater from the raw sugar factory, 2) boiler ash water, and 3) excess cooling water. This discharge stream from R2 travels along the north edge of lagoons A2, B2, and C2 (which are not in use). At C2, the stream mixes with the slops that overflow from lagoon C1.

- **Decanted Slops:** The decanted slops enter lagoon A1 and overflows to lagoon B1. From a pH of about 5.20 and BOD_5 of 12, a quantity of 460 mg/L from A1 is reduced to a BOD_5 of 1,760 mg/L at a pH of 6.65 upon leaving B1 on its way to C1. Here, the slops are further reduced to a BOD_5 of 1,110 mg/L with a pH of 5.38. The slops then overflow to the edge of lagoon C2 where they mix with the combined wastewater from B2. This final combination of four wastewater streams travels along the western edge of C2 before entering D2, then overflows to D3 and finally to D1, the final lagoon. The resulting final effluent from D1 has an average BOD_5 of 249 mg/l and a pH of 6.60.

Figure 3.13 – Wastewater Flow at the Central Azucarera de Tarlac



3.4.3 Seasonality

The sugar industry year starts on September 1 and ends on August 31 of the following year. Peak season is from December to April. This schedule is reflected in the pattern of molasses production shown in Table 3.18.

Table 3.18 – Monthly Production of Molasses (MT)

Crop Year	2003-2004	2004-2005	2005-2006	2006-2007	2007-2008
Sep	10,365	4,122	8,916	15,234	14,385
Oct	45,518	63,052	56,880	67,918	45,854
Nov	115,933	99,543	83,770	102,586	71,604
Dec	124,997	125,479	128,252	177,814	163,872
Jan	141,387	166,587	167,500	143,567	140,228
Feb	199,124	154,777	151,841	166,943	165,371
Mar	140,296	129,500	142,981	154,062	176,146
Apr	101,507	112,515	119,643	100,717	133,968
May	79,207	39,009	32,647	22,280	79,224
Jun	32,619	4,575	10,699	2,438	51,022
Jul	7,776	-	828	124	-
Aug	-	1,259	156	155	-
Total	**998,731**	**900,426**	**904,113**	**953,837**	**1,041,674**

Source of basic data: June 2008, SRA Bulletin
Assumption: 1 MT of raw sugar generates 0.42 MT of molasses based on historical production yield

Although sugar milling has a peak season, molasses is traded and available after the milling season.[39] Alcohol distilleries that use continuous distillation process can operate throughout the year. Alcohol distilleries using the batch distillation process stop after the milling season, however, because they use three times more thermal energy than distilleries using continuous distillation process. The only reason the former remains viable is through the use of bagasse to generate thermal energy. After the milling season when bagasse is not available, distilleries using batch distillation process stop operation. Finding another source of cheap or free energy would address this situation.

3.5 COCONUT PROCESSING

3.5.1 Description of Size, Scale of Operations, and Geographic Location

The coconut industry is an important sector of Philippine agriculture. About 3.1 million of 12 million hectares of farmland in the Philippines are devoted to coconut production. The crop is grown in 68 of the country's 79 provinces. It is estimated that there are 3.5 million coconut farmers and about 25 million Filipinos are either directly or indirectly dependent on the industry. The industry is among the Philippines' top five net foreign exchange earners, averaging US $760 million annually. The industry accounts for a 59 percent share in world coconut exports.

[39] Mr. Philip Balicud,- biogas expert from the alcohol distillery industry currently trading molasses; and Engr. Romy Ecraela- pollution control officer of CAT

Coconut farms are widely distributed, but can be found largely in regions of Southern Luzon in the North and Mindanao in the South. There are approximately 324 million coconut trees in the country, about 85 percent of which are considered productive. The coconut industry provides an annual average of 5.97 percent contribution to the GVA and 1.14 percent to the gross national product (GNP).

The industry's primary products are: coconut oil, desiccated coconut, fresh coconut, and copra. Byproducts include copra meal, activated carbon, coconut shell charcoal, and coconut coir and coir dust. Other products derived from coconut include detergents, soaps, shampoo, cosmetics, margarine, cooking oil, confectionery, vinegar, and nata de coco. In addition, there are coconut intermediates such as oleo-chemicals like fatty acids, fatty alcohols, and coco diesels.

a. COCONUT MILLS

The United Coconut Association of the Philippines (UCAP) in 1999 listed about 90 coconut oil mills scattered all over the country with a total milling capacity of 16,477 MT per day. Most of the mills are located in the Laguna/Quezon and Mindanao areas. The larger mills include Lu Do and Lu Ym Corporation in Cebu City; and Legaspi Oil Company, San Miguel Corporation-Iligan Oil Mill, and Granexport Manufacturing Corporation in Iligan City.

Table 3.19 shows historical production and average utilization of mills.

Table 3.19 – RP Coconut Oil Mills; Capacity Utilization (In 1,000 MT, Copra Term)

Year	Annual Rated Capacity	Estimated Copra Crushed*	Estimated Capacity Utilized
1998	4,943	2,369	47.9 percent
1999	5,065	1,176	23.2 percent
2000	5,187	2,122	40.9 percent
2001	5,185	2,721	52.5 percent
2002	4,837	2,000	41.3 percent
2003	4,990	2,406	48.2 percent
2004	4,543	2,145	47.2 percent
2005	4,562	2,323	50.9 percent
2006	4,618	2,205	47.7 percent
2007	4,687	1,983	42.3 percent

*Based on calculated oil production.

Sources of Basic Data: Trade Information & Relations Division, PCA and Industry Reports to UCAPP Research

b. COCONUT OIL REFINERIES

As of June 2008, there were 57 coconut oil refineries with a total production capacity of 4,848 MT per day. The oil refineries are spread almost evenly throughout the country. Countryside Millers, Incorporated owns the largest number of refineries located in San Pablo City, Iligan City, and Zamboanga del Norte, with a capacity of 350 MT per day for each of the sites. Lu Do and Lu Ym Corporation in Cebu City has a capacity of 600 MT per day while International Copra Export Corporation in Davao City has a capacity of 400 MT per day (see Table 3.20).

Table 3.20 – Production Capacities of RP Coconut Oil Refineries By Regional Distribution (As of June 2008)

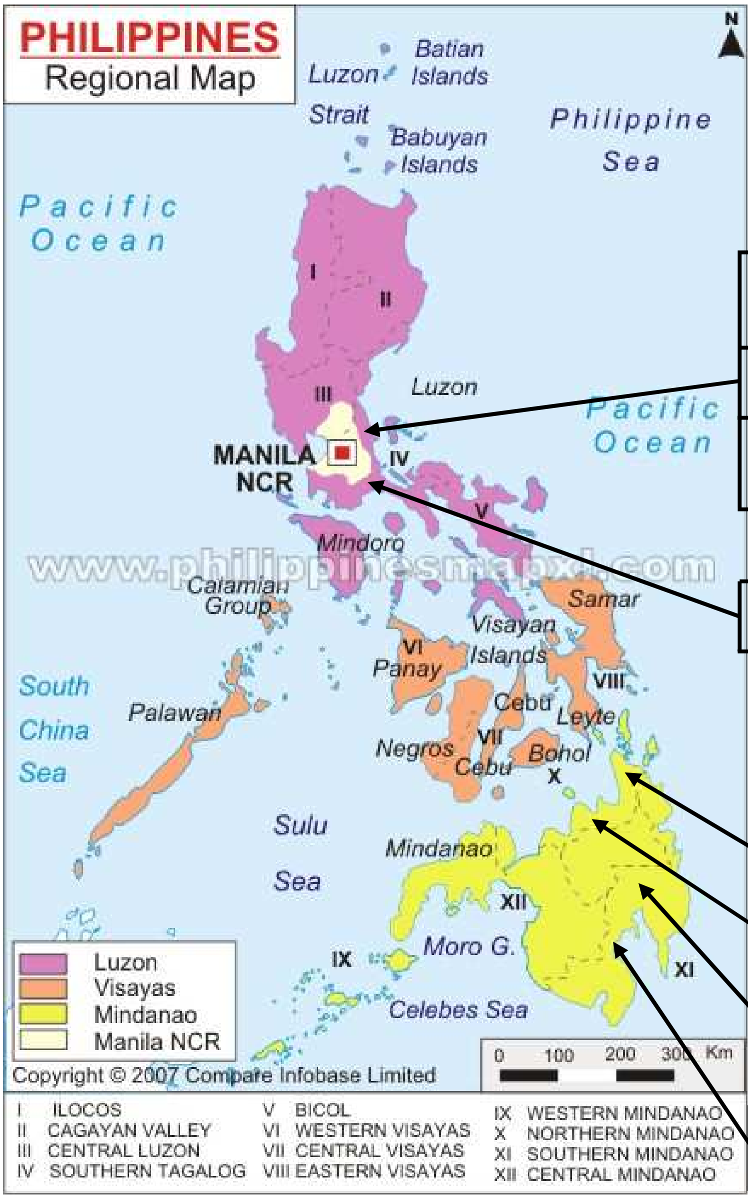
Region	Rated Refining Capacity	
	(MT/day)	(MT/Year)
National Capital Region	**270**	**81,000**
Metro Manila	270	81,000
Region IV (Southern Tagalog)	**952**	**285,450**
Quezon	500	150,000
Laguna	150	45,000
Batangas	300	90,000
Palawan	1.5	450
Region V (Bicol)	**40**	**12,000**
Camarines Sur	40	12,000
Region VI (Western Visayas)	**50**	**15,000**
Iloilo	50	15,000
Region VII (Central Visayas)	**1,130**	**339,000**
Cebu	980	294,000
Negros Oriental	150	45,000
Region VIII (Eastern Visayas)	**228**	**68,400**
Leyte	210	63,000
Northern Samar	18	5,400
Region IX (Western Mindanao)	**630**	**189,000**
Zamboanga City	280	84,000
Zamboanga del Norte	350	105,000
Region X (Northern Mindanao)	**270**	**81,000**
Misamis Oriental	150	45,000
Misamis Occidental	120	36,000
Region XI (Southern Mindanao)	**1,013**	**303,900**
Davao City	1,013	303,900
Region XII (Central Mindanao)	**240**	**72,000**
Lanao del Norte	240	72,000

Region	Rated Refining Capacity	
	(MT/day)	(MT/Year)
Region XIII (CARAGA)	**25**	**7,500**
Agusan del Norte	25	7,500
Total production Capacity - Philippines	**4,848**	**1,454,250**

c. DESICCATED COCONUT PLANTS

Desiccated coconut (DCN), also called coconut powder, is dried shredded coconut kernel. It is used extensively in confectionaries, puddings, and other food preparations as substitute for raw grated coconut. The production capacities of DCN plants in the Philippines and the geographical location are shown in Figure 3.14.

Figure 3.14 – Geographical Distribution of Desiccated Coconut Plants (June 2008)



DESICCATORS (LUZON)	Production Capacity (MTPY)
PETER PAUL PHILIPPINE CORP Candelaria, Quezon	24,480
PRIMEX COC PRODUCTS INC. Candelaria, Quezon	19,040
PACIFIC ROYAL BASIC FOO INC Candelaria, Quezon	13,600
SUPERSTAR COCONUT PRODS INC. Candelaria, Quezon	10,880
FRANKLIN BAKER CO. OF THE PHILS San Pablo City, Laguna	16,592
TROPICANA FOOD PRODUCTS San Pablo City, Laguna	2,720

DESICCATORS (MINDANAO)	Production Capacity (MTPY)
CELEBES COCONUT CORP Butuan City Agusan del Norte	4,325
FIESTA BRANDS INC. Medina, Misamis Oriental	20,400
SUPERSTAR COCONUT PRODS INC. Davao City, Davao del Norte	6,800
FRANKLIN BAKER CO. OF THE PHILS Sta. Cruz, Davao del Sur	16,048
COCO DAVAO, INC Sta. Cruz, Davao del Sur	12,240

Source of Basic Data: Philippine Coconut Authority

d. ACTIVATED CARBON PLANTS, CHARCOAL PLANTS AND OLEO-CHEMICAL PLANTS

Activated carbon is produced by eight plants with a total capacity of 165 MT per day. The biggest producer is the Pacific Activated Carbon Company, which has plants in Cavite and Misamis Oriental, followed by Phil-Japan Active Carbon Corporation in Davao City.

There are six coconut charcoal plants in the country, with a total capacity of 115 MT per day. The largest is Cenapro, Incorporated in Mandaue City, followed by Dacebu Traders & Exporters Corporation in Cebu.

Oleo-chemicals are produced by 20 companies. Table 3.21 shows more prominent ones are United Coconut Chemicals, Incorporated; Pilipinas Kao, Incorporated; Proctor & Gamble Philippines, Incorporated; Primo Oleo-chemicals, Incorporated; and Unilever Philippines, Incorporated.

Table 3.21 – List of Oleochemical Companies

Name of Company	Plant Location	Oleochemical Production Capacity (MT/year)
NATIONAL CAPITAL REGION		**61,800**
1. Chemrez Inc.	Libis, Quezon City, Metro Manila	61,800
REGION IV (Southern Tagalog)		**159,515**
1. Lipi Tech, Inc.	Carmona, Cavite	2,640
2. Stepan Phils., Inc.	Bauan, Batangas	40,000
3. Sakamoto Orient Chemicals Corp.	Bauan, Batangas	8,000
4. United Coconut Chemicals, Inc.	Bauan, Batangas	96,175
5. Senbel Fine Chemicals, Inc.	Lucena City, Quezon	12,400
6. Romtron CME Plant	Odiongan, Romblon	300
REGION V (Bicol)		**30,000**
1. Pan Century Surfactants, Inc.	Jose Panganiban, Bicol	30,000
REGION IX (Western Mindanao)		**35,000**
1. Philippine Int'l Dev't Inc.	Zamboanga City	35,000
REGION X (Northern Mindanao)		**115,485**
1. Pilipinas Kao	Jasaan, Misamis Oriental	115,485
TOTAL PRODUCTION CAPACITY		**401,800**

Source: Trade Information & Relations Division, PCA, as of June 2008

3.5.2 Description of Waste Characteristics, Handling and Management

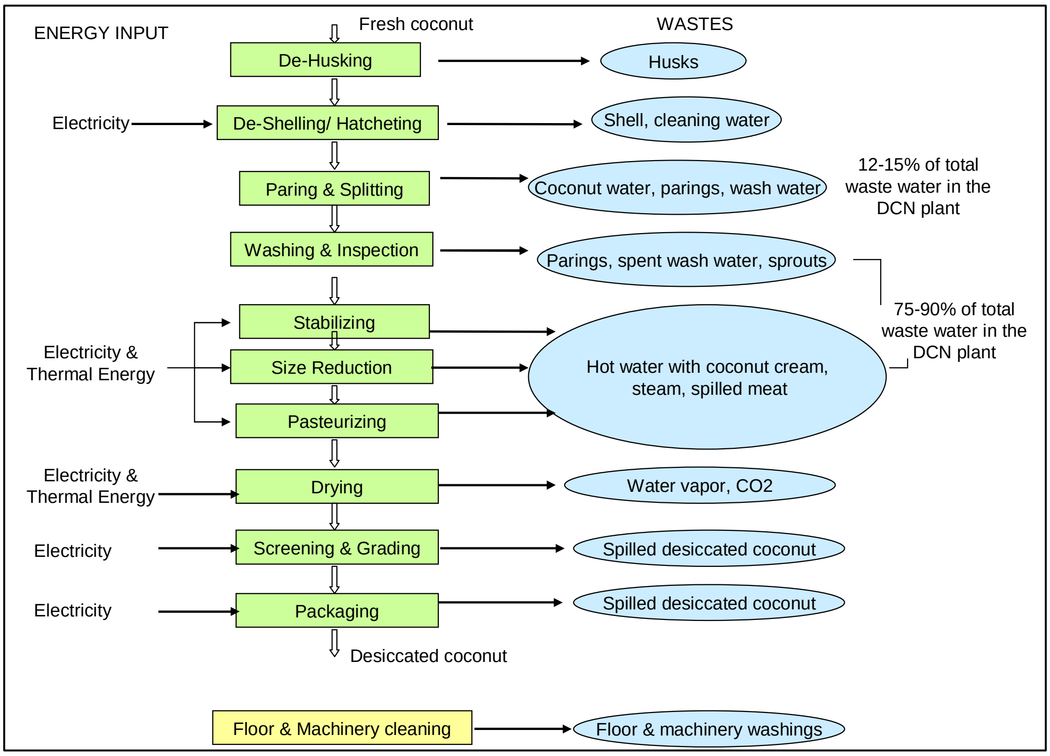
a. COCONUT OIL

Oil wastes produced from coconut oil extraction and refining processes are normally neutralized and converted to soap. Copra meal from crushing operations are usually recovered and sold.

b. DESICCATED COCONUT

Each nut processed in a desiccated coconut (DCN) factory contains approximately 300 milliliters (ml) of coconut water. About 2.5 liters of washwater are used per nut processed. This results in an overall total of 2.8 liters of wastewater per nut. Industry production data indicate that approximately 8,064 nuts are processed to produce 1 MT of DCN, which effectively translates to 22.58 m^3 wastewater per MT of DCN produced. Figure 3.15 shows the major wastewater generation points in DCN process.

Figure 3.15 – Wastewater Generation Point in DCN Process



Source: Small and Medium Scale Industries in Asia: Energy and Environment- Desiccated Coconut Sector, Asia Institute of Technology 2002, Regional Energy Resources Information Center

High strength wastewater is generated in the splitting operation and accounts for about 12 to 15 percent of the total wastewater generated from a DCN factory. Washing and inspection, stabilizing, size reduction, and pasteurization processes account for 75 to 90 percent. Wastewater is also generated from steam leakage and condensates that form during the drying process as well as from cleaning of floors and machinery and equipment. All the wastewater generated in each processing step is usually discharged into a common collection pit.

Characterization of wastewater from DCN factories is shown in Table 3.22.

Table 3.22 – Characteristics of Wastewater From DCN Factories

Parameter	Unit of Measure	Approximate Value
Biochemical Oxygen Demand (BOD_5)	mg/L	6,000 – 10,000
Chemical Oxygen Demand (COD)	mg/L	17,000- 20,000

Parameter	Unit of Measure	Approximate Value
Total Suspended Solids (TSS)	mg/L	2,000 – 4,000
pH		5.0 – 6.3
Oil and grease	mg/L	400 – 600
Average wastewater production	L / coconut processed	2.8

Source of Data: Small and Medium Scale Industries in Asia: Energy and Environment- Desiccated Coconut Sector, Asia Institute of Technology 2003, Regional Energy Resources Information Center

Estimated wastewater generated by the different desiccated coconut operations are shown in Table 3.23.

Table 3.23 – Estimated Wastewater Generated by Philippine Desiccated Coconut Operations

Name of Company	1,000 Whole Nuts/day	Coconut Water, L/day	Wastewater, L/day
Region IV-A (Southern Tagalog)	**2,345.40**	**703,620.97**	**6,567,129.03**
Quezon	**1,826.61**	**547,983.87**	**5,114,516.13**
Peter Paul Philippine Corporation	657.58	197,274.19	1,841,225.81
Primex Coco Products, Inc.	511.45	153,435.48	1,432,064.52
Pacific Royal Basic Food, Inc.	365.32	109,596.77	1,022,903.23
Superstar Coconut Prods., Inc.	292.26	87,677.42	818,322.58
Laguna	**518.79**	**155,637.10**	**1,452,612.90**
Franklin Baker Co. of the Phils. [40]	445.73	133,717.74	1,248,032.26
Tropicana Food Products	73.06	21,919.35	204,580.65
Region X (Northern Mindanao)	**547.98**	**164,395.16**	**1,534,354.84**
Misamis Oriental	**547.98**	**164,395.16**	**1,534,354.84**
Fiesta Brands, Inc.	547.98	164,395.16	1,534,354.84
Region XI (Southern Mindanao)	**942.50**	**282,750.00**	**2,639,000.00**
Davao del Sur	**759.84**	**227,951.61**	**2,127,548.39**
Franklin Baker Co. of the Phils.	431.05	129,314.52	1,206,935.48

[40] Manufacturing facilities will soon be transferred to its other plant in Davao.

Name of Company	1,000 Whole Nuts/day	Coconut Water, L/day	Wastewater, L/day
Coco Davao, Inc.	328.79	98,637.10	920,612.90
Davao City	182.66	54,798.39	511,451.61
Superstar Coconut Prods., Inc.	182.66	54,798.39	511,451.61
Region XIII (Caraga)	**116.29**	**34,887.10**	**325,612.90**
Agusan del Norte	**116.29**	**34,887.10**	**325,612.90**
Celebes Coconut Corp.	116.29	34,887.10	325,612.90
Total RP Production Capacity (11 mills)	**3,952.18**	**1,185,653.23**	**11,066,096.77**

Like all factories in the country, all DCN factories are required by law to have waste treatment facilities. Some industries have developed ways avoid waste treatment, however, while others have developed innovative approaches.

Industry initiatives towards environmental protection and productivity improvement in recent years have yielded positive results. For example, Peter Paul, a DCN manufacturer located in Candelaria, Quezon, entered into a coconut water recovery and recycling joint venture with The Chai Meei plant, also located in the Philippines. Peter Paul provides collects the coconut water, and Chai Meei freezes and processes it as a refreshing drink. The drink is then shipped to Taiwan and sold commercially. Chai Meei requires about 40,000 liters of coconut water per day from Peter Paul.

This joint venture enabled Peter Paul to save 10 percent (approximately $3,700 annually) from its usual expenditure for the operation of its water treatment facility. The estimated BOD level of its wastewater was also reduced by 50 percent. Both companies benefit from using what were formerly waste materials. The venture also resulted in more carefully pared whole coconuts, thus increasing DCN weight by 13.6 kilograms for every MT. Overall, Peter Paul saves an estimated $370,000 annually through the adoption of clean technology.

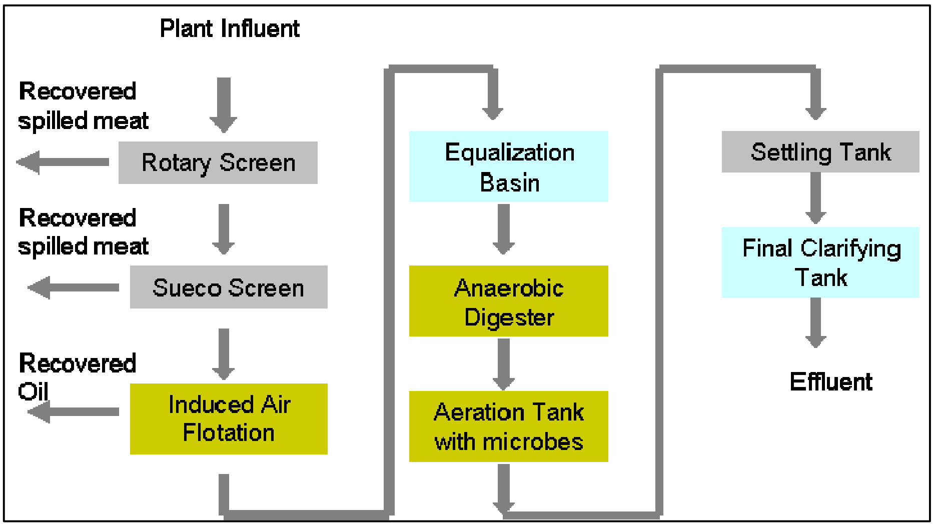
Franklin Baker Company, a DCN factory with plants in San Pablo City, Laguna and Santa Cruz, Davao del Sur, implemented a waste minimization program in its facilities. By monitoring and repairing leaking pipes, valves and faucets, coupled with a comprehensive information campaign on water conservation, the company saved 53,000 pesos per year. It also reduced wastewater generation by 32,110 m^3, and water usage by 40,144 m^3.

Typical wastewater treatment used by the DCN plants located in Region IV-A consists of activated sludge followed by extended aeration of about four hours.[41] The wastewater treatment facility of Franklin Baker Company employs a series of physical, anaerobic, and aerobic treatment process followed by a settling tank prior to discharge. Methane captured is not currently utilized but simply flared to avoid methane emission. The additional capital investment requirement for a boiler to use the methane remains the main reason why it is not being utilized

[41] DENR key informant Mr. Conde

as a thermal source. The capture of methane during the anaerobic treatment used is reportedly not 100 percent due to observed appearance of bubbles in the waste after treatment.[42] The waste treatment process flow of Franklin Baker is described in Figure 3.16.

Figure 3.16 – Waste Treatment Process Flow of a DCN Plant



Source: Key informant from Franklin Baker

3.5.3 Seasonality

In practice, the coconut harvesting cycle varies from 45- to 60- to 90-day periods. The recommended cycle is every 45 days, however, for practical and economic reasons. Two to three bunches of coconuts could be harvested from each palm using this cycle, and this harvesting practice has been found to yield a good number of mature nuts with high copra and oil recovery. Thus coconut processing occurs throughout the year and seasonality is not an issue.

3.6 FRUIT PROCESSING

3.6.1 Description of Size, Scale of Operations, and Geographic Location

The major companies in the processed fruit business in the Philippines are Del Monte Philippines, Inc.; Dole Philippines, Inc; Diamond Star Agro Products, Inc.; Eden Crop., KLT Fruits, Inc.; and San Miguel Corporation. About 150 small and medium-sized fruit processing firms also operate in the Philippines. Due to limited data, it is difficult to estimate the total capacity of the Philippine fruit processing companies, particularly the small and medium sized firms. Local companies hesitate to provide information to government agencies, and capacity varies depending on the availability of raw material fruits and market demand.[43]

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[42] Key informant from Franklin Baker

[43] http://hvcc.da.gov.ph/pineapple.html

The two multinational companies, Del Monte and Dole, are the major players of the country's fruit processing sector. When combined, Del Monte and Dole capabilities can process half of country's annual pineapple harvest. Together they produce almost 85 percent of the total processed pineapple, the majority of which is exported. The Philippines is second only to Thailand in terms of total pineapple processed in the world.[44] It is the third largest producer of pineapple, after Brazil and Thailand.[45]

Del Monte operates one of the world's largest pineapple processing and canning facilities in the Philippines. It has a current annual capacity of 700,000 MT of pineapples, representing 20 percent of the world's processed pineapple production.[46]

Dole's Worldwide Packaged Food Division operates two canneries in Thailand and one cannery in the Philippines. These three canneries supply Dole's world market for processed pineapple fruits. The processing facility includes a 750,000-square-foot cannery plant, a juice concentrate plant, a freezer, a box forming plant, and a can manufacturing plant. Approximately 30 percent of Dole's Fruit Bowl products sold in the international market are processed in the Philippines.[47] In 2006-2007, Dole acquired the pineapple processing plant of T'boli Agricultural Development Inc., also located in Mindanao. Prior to Dole's acquisition, T'boli was the only remaining key player in pineapple processing in the country aside from the multinational companies of Del Monte and Dole.

The top-producing regions in the country are shown Table 3.24, and Figure 3.17 shows the spatial distribution of pineapple production and processing. Region X Northern Mindanao and Region XII SOCCSKSARGEN are the cannery sites of the two largest multinational fruit processing plants for Del Monte and Dole. Del Monte's fruit processing facility is located Bukidon, a province in the northern part of Mindanao. Dole's processing facilities are located in Polomok, Mindanao.

Table 3.24: Top Pineapple Producing Regions in the Philippines (MT)

	2003	2004	2005	2006	2007	2007 % of Total
Philippines	**1,697,952**	**1,759,813**	**1,788,218**	**1,833,908**	**2,016,462**	**100%**
Region X (Northern Mindanao)	840,134	889,593	891,581	911,160	924,505	46%
Region XII (SOCCSKSARGEN)	611,073	619,177	636,450	649,301	803,761	40%
Region V (Bicol Region)	91,740	94,642	104,995	112,210	116,816	6%

[44] http://hvcc.da.gov.ph/pineapple.html

[45] FAOSTAT2006

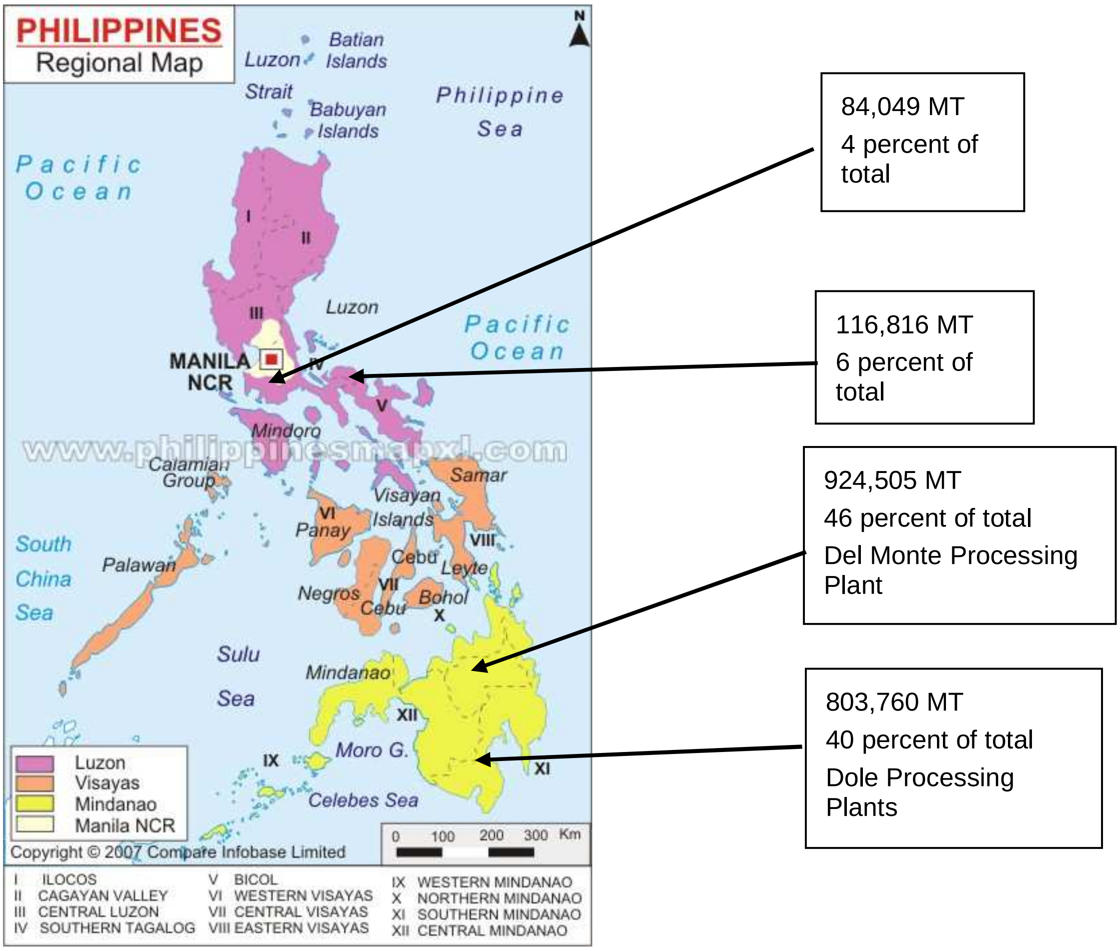
[46] Larry N. Dangil, *Benefit Diffusion and Linkage Development in the Philippine Tropical Fruits Sector*. Paper presented during the conference entitled " Closing Productivity Gap" sponsored by the World Bank and the National Economic and Development Authority, June 2005, Asian Institute of Management Policy Center

[47] dole.com/CompanyInfo/AllAboutDole/pdfs/dole-anniversary-book.pdf

	2003	2004	2005	2006	2007	2007 % of Total
Region IV-A (CALABARZON)	84,884	81,578	80,871	82,459	84,049	4%

Source: Bureau of Agricultural Statistics

Figure 3.17: Geographical Location of Pineapple Production & Processing (as of 2007)



3.6.2 Description of Waste Characteristics, Handling, and Management

Most of the wastewater from a pineapple processing plant is from fruit washing, preparation, and packaging areas. Data on the characteristics of the wastewater effluent from Dole are shown in Table 3.25.[48]

[48] Waste to Energy Project: Pineapple Processing Waste Biomethanation and Treatment Plant- A Pre Feasibility Study Report, ADB PREGA Project, July 2006. Raw data provided by DOLE Technical Staff

Table 3.25 – Characteristic of Wastewater From a Pineapple Processing Plant

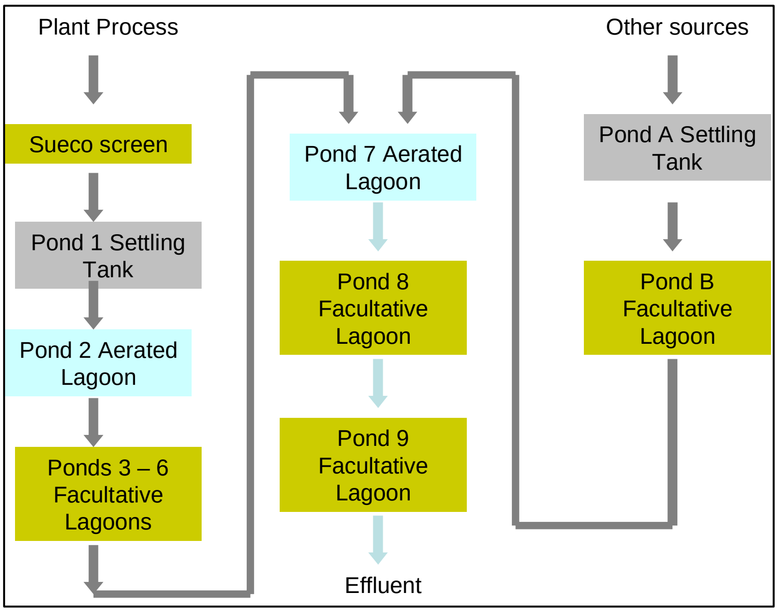
Parameter	Unit of Measure	Influent Values
BOD_5	mg/L	10,200
COD	mg/L	20,000
TSS	mg/L	585
Temperature	° C	40 -50
Oil and grease	mg/L	50
Color	PCU	> 2,000
pH	Units	4.5 – 6.5
Average wastewater production	m^3/day	6,540

Dole's production level in 2006 required a raw material feed of 2,082 MT per day, producing solid waste of 417 MT per day. The combined solid waste and wastewater liquor has a COD of 10,000 mg/L at a flow rate of 6,875 L/ day.

Dole's treatment system consists of filtration followed by two aerated lagoons and seven facultative lagoons. Aeration is economically possible because electricity is cheaper in Mindanao. Carbon dioxide (CO_2) emission reduction potential is insignificant because electricity used in aerating is currently sourced from hydropower. Dole can afford to have several facultative lagoons covering a large land area with lagoon depth lower than 3 meters because of large tracts of available land. Del Monte uses aeration for its wastewater treatment systems.[49] The flow diagram of Dole's waste treatment system is shown in Figure 3.18.

[49] Interviews with Dr. Cindy Tiangco Managing Director of CPI Energy and Ms. Ellen May Zanoria, CDM Manager of Philippine Bio-Sciences Co., Inc.

Figure 3.18[50] – Dole's Wastewater Treatment Process Flow



3.6.3 Seasonality

Tropical fruits are usually seasonal, but most large plantations have learned how to schedule pineapple planting and harvesting season to ensure more or less constant production volume throughout the year. Thus seasonality is not an issue for the large fruit processing plants like Dole and Del Monte.

[50] Waste to Energy Project: Pineapple Processing Waste Biomethanation and Treatment Plant- A Prefeasibility Study Report, July 2006 for PREGA by CPI Energy Philippines, Inc.

4. POTENTIAL FOR METHANE EMISSIONS REDUCTION

This section explains the potential for reducing GHGs though the use of anaerobic digesters. Anaerobic digesters reduce GHG emissions in two ways. First, capturing and burning biogas that otherwise would escape into the atmosphere from the waste management system directly reduces methane emissions. Second, using biogas to displace fossil fuels that would otherwise be used to provide thermal energy or electricity to the agricultural operation indirectly reduces CO_2, methane, and nitrous oxides. Section 4.1 explains the potential methane emission reduction from manure management systems and agricultural commodity processing waste.

The feasibility of modifying existing livestock manure and agricultural commodity processing waste management systems by incorporating anaerobic digestion depends on the ability to invest the necessary capital and generate adequate revenue to at least offset operating and management costs as well as provide a reasonable return to the invested capital.

There are a number of options for anaerobically digesting wastes and utilizing the captured methane. For a specific enterprise, waste characteristics will determine which digestion technology options are applicable. Of the technically feasible options, the optimal approach will be determined by financial feasibility, subject to possible physical and regulatory constraints. For example, the optimal approach might not be feasible physically due to the lack of the necessary land. Section 4.2 of this chapter briefly describes the types of anaerobic digestion technology, methane utilization options, costs and benefits, and centralized projects. Appendix K provides more information regarding emissions avoided when wet wastes are sent to landfills, as well as emissions from leakages and waste transportation in co-substrate projects.

4.1 METHANE EMISSIONS REDUCTION

Anaerobic digestion projects for both manure and agricultural commodity processing wastes might produce more methane than is currently being emitted from the existing waste management system because anaerobic digesters are designed to optimize methane production. For example, the addition of anaerobic digestion to a manure management operation where manure was applied daily to cropland or pasture would produce significantly more methane than the baseline system. As such, the direct methane emission reduction from a digester corresponds not to the total methane generated but rather the baseline methane emissions from the waste management system prior to installation of the digester. The indirect emission reduction, as explained in section 4.1.3, is based on the maximum methane production potential of the digester and how the biogas is used.

4.1.1 Direct Emission Reductions From Digestion of Manure

The methane production potential from manure is estimated using Equation 2.1, and the methane conversion factor for the baseline manure management system used at the operation as show in Equation 4.1:

$$CH_{4\,(M,\,P)} = \left(VS_{(M)} \times H_{(M)} \times 365 \text{ days/yr}\right) \times \left[B_{o(M)} \times 0.67 \text{ kg } CH_4/m^3\ CH_4 \times MCF_{AD}\right] \qquad (4.1)$$

where: $CH_{4\,(M,\,P)}$ = Estimated methane production potential from manure, kg/year

$VS_{(M)}$	=	Daily volatile solids excretion rate for livestock category M, kg dry matter per animal-day
$H_{(M)}$	=	Average daily number of animals in livestock category M
$B_{o(M)}$	=	Maximum methane-production capacity for manure produced by livestock category M, m^3 CH_4 per kg volatile solids excreted
MCF_{AD}	=	Methane conversion factor for anaerobic digestion, decimal

Table 4.1 shows the estimated GHG emission reduction potential for pig operations in the Philippines. In both sectors, when the indirect emissions reductions are considered, the potential reductions are more than 1,000,000 MT equivalent carbon dioxide (CO_2e) per year.

The assumed distribution of the type of manure systems and methane conversion factors used in the computation are as follows. The assumptions are based on the 2002-2003 UPLB – IFPRI Survey, interviews with key industry resource contacts, and the 2006 IPCC default values.

Table 4.1 – Methane Emission Potential From Swine Industry - Regions III, IVA & VI (CH_4 MT/yr)

Region/ Province	Backyard Farms					Commercial													
	(< 20 heads)				Sub Total from Backyard	Small (21 to 999 heads)				Medium (1,000 – 9,999 heads)				Large (10,000 > heads)				Sub Total Commerical	Total
	Lagoon	Open Pit	Septic Tank	Bio Digester		Lagoon	Open Pit	Septic Tank	Bio Digester	Lagoon	Open Pit	Septic Tank	Bio Digester	Lagoon	Open Pit	Septic Tank	Bio Digester		
Region III-Central Luzon																			
Aurora	-	281	631	105	1,017	2	1	1	0	-	-	-	-	-	-	-	-	4	1,021
Bataan	-	141	317	53	511	106	88	35	27	-	-	-	-	-	-	-	-	256	768
Bulacan	-	289	651	109	1,049	3,440	2,867	1,147	860	-	-	-	-	7,473	-	-	623	16,408	17,457
Nueva Ecija	-	417	937	156	1,510	233	194	78	58	-	-	-	-	-	-	-	-	563	2,073
Pampanga	-	353	793	132	1,278	109	91	36	27	214	-	3	26	-	-	-	-	506	1,784
Tarlac	-	187	420	70	677	168	140	56	42	321	-	5	39	-	-	-	-	771	1,447
Zambales	-	227	511	85	824	5	5	2	1	32	-	1	4	-	-	-	-	49	873
Total	0	1,894	4,262	710	6,866	4,062	3,385	1,354	1,016	567	0	9	69	7,473	0	0	623	18,558	25,424
Region IV A - CALABARZON																			
Batangas	-	695	1,563	260	2,518	893	744	298	223	3,583	-	58	433	-	-	-	-	6,233	8,751
Cavite	-	133	299	50	482	62	52	21	16	-	-	-	-	1,687	-	-	141	1,978	2,460
Laguna	-	526	1,185	197	1,909	454	378	151	114	737	-	12	89	-	-	-	-	1,936	3,844
Quezon	-	512	1,152	192	1,856	233	194	78	58	321	-	5	39	-	-	-	-	929	2,785
Rizal	-	39	88	15	142	797	664	266	199	-	-	-	-	3,169	-	-	264	5,360	5,502
Total	0	1,905	4,287	714	6,907	2,440	2,033	813	610	4,642	0	75	562	4,856	0	0	405	16,436	23,343
Region VI Western Visayas																			
Aklan	-	435	979	163	1,578	37	31	12	9	-	-	-	-	-	-	-	-	90	1,667
Antique	-	390	877	146	1,414	19	16	6	5	-	-	-	-	-	-	-	-	47	1,460
Capiz	-	540	1,215	203	1,958	18	15	6	5	-	-	-	-	-	-	-	-	44	2,002
Guimaras	-	286	644	107	1,037	7	6	2	2	-	-	-	-	-	-	-	-	17	1,054
Iloilo	-	1,317	2,963	494	4,774	661	551	220	165	-	-	-	-	-	-	-	-	1,597	6,372
Negros Occidental	-	1,396	3,140	523	5,059	256	213	85	64	-	-	-	-	-	-	-	-	618	5,677

Region/ Province	Backyard Farms					Commercial													
	(< 20 heads)				Sub Total from Backyard	Small (21 to 999 heads)				Medium (1,000 – 9,999 heads)				Large (10,000 > heads)				Sub Total Commerical	Total
	Lagoon	Open Pit	Septic Tank	Bio Digester		Lagoon	Open Pit	Septic Tank	Bio Digester	Lagoon	Open Pit	Septic Tank	Bio Digester	Lagoon	Open Pit	Septic Tank	Bio Digester		
Total	0	4,364	9,819	1,636	15,819	999	832	333	250	0	0	0	0	0	0	0	0	2,413	18,232
GRAND TOTAL																			67,000

4.1.2 Direct Emission Reduction From Digestion of Agricultural Commodity Processing Wastes

The methane production potential from agricultural commodity wastes is estimated using Equation 2.2 and the methane conversion factor for the baseline waste management system used at the operation as shown in Equations 4.2 and 4.3:

$$CH_{4\,(W)} = (TOW_{(W)} - S_{(W)}) \times EF_{(W,S)} \qquad (4.2)$$

where: $CH_{4\,(W)}$ = Annual methane emissions from agricultural commodity processing waste W, kg CH_4 per year

$TOW_{(W)}$ = Annual mass of waste W COD generated, kg per year

$S_{(W)}$ = Annual mass of waste W COD removed as settled solids (sludge), kg per year

$EF_{(W,\,S)}$ = Emission factor for waste W and existing treatment system and discharge pathway S, kg CH_4 per kg COD

The methane emission rate is a function of the type of waste and the existing treatment system and discharge pathway, as follows:

$$EF_{(W,\,S)} = B_{o\,(W)} \times MCF_{(S)} \qquad (4.3)$$

where: $B_{o\,(W)}$ = Maximum CH_4 production capacity, kg CH_4 per kg COD

$MCF_{(S)}$ = Methane conversion factor for the existing treatment system and discharge pathway, decimal.

a. SLAUGHTERHOUSE

Based on the site visits conducted and key interviews, the profile of the wastewater management system application in this sector is presented in Table 4.2. The methane conversion factor (MCF) for lagoons is based on 2006 default values. The MCF of anaerobic digester is 60 percent since it is assumed that most anaerobic digester systems installed are not well managed. The estimated methane emission reduction potential from slaughterhouses is presented in Table 4.3.

Table 4.2 – Waste Management System per Type of Slaughterhouse

Type of Slaughterhouse	% Wastewater Management System Used				
	Lagoon	Anaerobic digester/ Septic Tank/ Lagoon	Anaerobic digester	Chemical Treatment/ Physical	Direct Discharge to waterways
NCR- Accredited			10 percent	90 percent	
Accredited	65 percent	30 percent	5 percent		
Non Accredited		60 percent			40 percent
Methane Conversion Factor	0.90	0.50	0.60	-	0.01

Table 4.3 – Methane Emission Potential From Slaughterhouse Sector (CH_4 MT/yr)

REGION	ACCREDITED SLAUGHTERHOUSES						NON ACCREDITED SLAUGHTERHOUSES						GRAND TOTAL
	Lagoon	Bio Digester Septic Tank/Lagoon	Bio Digester	Chemical Treatment/ Physical	Direct discharge to waterways	TOTAL FROM ACCREDITED	Lagoon	Septic Tank	Bio Digester	Chemical Treatment/ Physical	Direct discharge to waterways	TOTAL FROM NON ACCREDITED	
I (Ilocos)	19.13	5.52	1.10	0.00	0.00	**25.75**	0.00	13.00	0.00	0.00	0.17	**13.17**	**38.93**
II (Cagayan Valley)	4.71	1.36	0.27	0.00	0.00	**6.34**	0.00	10.32	0.00	0.00	0.14	**10.46**	**16.79**
III (Central Luzon)	35.03	10.11	2.02	0.00	0.00	**47.16**	0.00	31.52	0.00	0.00	0.42	**31.94**	**79.10**
IV-A (CALABARZON)	51.86	14.96	2.99	0.00	0.00	**69.81**	0.00	30.93	0.00	0.00	0.41	**31.34**	**101.15**
IV-B	3.05	0.88	0.18	0.00	0.00	**4.10**	0.00	5.73	0.00	0.00	0.08	**5.81**	**9.91**
V (Bicol)	2.17	0.62	0.12	0.00	0.00	**2.91**	0.00	12.32	0.00	0.00	0.16	**12.49**	**15.40**
VI (Western Visayas)	2.16	0.62	0.12	0.00	0.00	**2.91**	0.00	19.34	0.00	0.00	0.26	**19.60**	**22.50**
VII (Central Visayas)	13.77	3.97	0.79	0.00	0.00	**18.54**	0.00	19.36	0.00	0.00	0.26	**19.62**	**38.16**
VIII (Eastern Visayas)	3.44	0.99	0.20	0.00	0.00	**4.63**	0.00	5.84	0.00	0.00	0.08	**5.92**	**10.55**
IX (Western Mindanao)	8.26	2.38	0.48	0.00	0.00	**11.12**	0.00	1.74	0.00	0.00	0.02	**1.76**	**12.89**
X (Northern Mindanao)	17.52	5.05	1.01	0.00	0.00	**23.58**	0.00	2.07	0.00	0.00	0.03	**2.10**	**25.68**
XI (Southern Mindanao)	25.26	7.29	1.46	0.00	0.00	**34.01**	0.00	1.59	0.00	0.00	0.02	**1.61**	**35.62**
XII (Central Mindanao)	13.56	3.91	0.78	0.00	0.00	**18.25**	0.00	1.23	0.00	0.00	0.02	**1.24**	**19.49**
CAR	6.56	1.89	0.38	0.00	0.00	**8.84**	0.00	1.08	0.00	0.00	0.01	**1.09**	**9.93**
CARAGA	6.21	1.79	0.36	0.00	0.00	**8.36**	0.00	1.85	0.00	0.00	0.02	**1.87**	**10.24**
ARMM	0.00	0.00	0.00	0.00	0.00	**0.00**	0.00	0.47	0.00	0.00	0.01	**0.47**	**0.47**
NCR	0.00	0.00	9.48	42.66	0.00	**52.14**	0.00	5.27	0.00	0.00	0.07	**5.34**	**57.48**
TOTAL	212.69	61.35	21.75	42.66	0.00	**338.46**	0.00	163.66	0.00	0.00	2.18	**165.84**	**504.29**

b. SUGAR ALCOHOL DISTILLERY INDUSTRY

Most of the alcohol distilleries now convert their slops into methane gas, although not all gas is being captured. The distilleries with insufficient or no facilities for methane generation are as follows:

- Central Azucarera de Tarlac—converts only 1/6 of its slops into methane
- Kooll Distillery—converts only 30 percent of its slops into methane
- Leyte Agri-Corp—no facility for methane generation

Using the above information, additional methane can still be generated from the slops of these distilleries, as described in Table 4.4.

Table 4.4 – Additional Potential Methane Emission Reduction From Alcohol Distilleries

Region	Distillery	Alcohol Production Capacity - (1000 m^3/yr)	Assumed Percent of Methane Currently Captured	Methane Potential (MT/yr)
I (Ilocos)	Alko Distillers, Inc.	2.1	0.50	170
III (Central Luzon)	Central Azucarera de Tarlac	18	0.17	2,430
	Far East Alcohol Corporation	3	0.50	243
IV (Southern Tagalog)	Absolute Chemicals, Inc.	12	0.70	583
	Balayan Distillery	22	0.50	1,782
	Consolidated Distillers of the Far East	7.5	0.50	608
	Dyzum Distillery *	15	0.50	1,215
VI (Western Visayas)	Asian Alcohol Corporation	45	0.70	2,187
	Destilleria Bago, Inc.	90	0.50	7,290
	Kooll Distillery	12	0.30	1,361
VII (Central Visayas)	International Pharmaceuticals, Inc.	6	0.50	486
VIII (Eastern Visayas)	Leyte Agri-Corp. Ormoc	11	0.00	1,782
	Total	243.6		20,137
New Additional				
To start in 2009	San Carlos BioEnergy Inc.	30	0.70	1,458
To start in 2010	Roxol Bioenergy	24	0.70	1,166
Total Industry including new plants		**297.6**		**22,761**

c. DESICCATED COCONUT INDUSTRY

The methane emission potential of the desiccated coconut factories' wastewater is estimated using the declared production capacity of each factory and the 2006 IPCC methodology. Table 4.5 shows the potential methane emissions reduction in the sector.

Table 4.5 – Methane Emissions Reduction Potential From Desiccated Coconut Processing

Name of Company	Rated Production Capacity* MT/year	Effluent** m^3/MT product	TOW	EF	Methane MT/year
Region IV-A (Southern Tagalog)	**87,312.00**	**22.58**	**36,472.84**	**0.126**	**4,595.58**
Quezon	**68,000.00**	**22.58**	**28,405.64**	**0.126**	**3,579.11**
Peter Paul Philippine Corporation	24,480.00	22.58	10,226.03	0.126	1,288.48
Primex Coco Products, Inc.	19,040.00	22.58	7,953.58	0.126	1,002.15
Pacific Royal Basic Food, Inc.	13,600.00	22.58	5,681.13	0.126	715.82
Superstar Coconut Prods., Inc.	10,880.00	22.58	4,544.90	0.126	572.66
Laguna	**19,312.00**	**22.58**	**8,067.20**	**0.126**	**1,016.47**
Franklin Baker Co. of the Phils.	16,592.00	22.58	6,930.98	0.126	873.30
Tropicana Food Products	2,720.00	22.58	1,136.23	0.126	143.16
Region X (Northern Mindanao)	**20,400.00**	**22.58**	**8,521.69**	**0.126**	**1,073.73**
Misamis Oriental	**20,400.00**	**22.58**	**8,521.69**	**0.126**	**1,073.73**
Fiesta Brands, Inc.	20,400.00	22.58	8,521.69	0.126	1,073.73
Region XI (Southern Mindanao)	**35,088.00**	**22.58**	**14,657.31**	**0.126**	**1,846.82**
Davao del Sur	**28,288.00**	**22.58**	**11,816.75**	**0.126**	**1,488.91**
Franklin Baker Co. of the Phils.	16,048.00	22.58	6,703.73	0.126	844.67
Coco Davao, Inc.	12,240.00	22.58	5,113.02	0.126	644.24
Davao City	**6,800.00**	**22.58**	**2,840.56**	**0.126**	**357.91**
Superstar Coconut Prods., Inc.	6,800.00	22.58	2,840.56	0.126	357.91
Region XIII (Caraga)	**4,324.80**	**22.58**	**1,806.60**	**0.126**	**227.63**
Agusan del Norte	**4,324.80**	**22.58**	**1,806.60**	**0.126**	**227.63**
Celebes Coconut Corp.	4,324.80	22.58	1,806.60	0.126	227.63
Total RP Production Capacity	**147,124.00**	**22.58**	**61,458.44**	**0.126**	**7,743.76**

4.1.3 Indirect GHG Emissions Reductions

The use of anaerobic digestion systems has the financial advantage of offsetting energy costs at the production facility. Biogas can be used to generate electricity or to supplant the use of thermal fuels. Using biogas energy also reduces carbon emissions from the fossil fuels that are displaced by use of the recovered biogas. The degree of emission reduction depends on how the biogas is used; see Table 4.6.

Table 4.6 – Carbon Emissions by Type of Fuel

Fuel Replaced	CO_2 Emissions Factors
Generating electricity - depends on fuel mix 100 percent coal 100 percent hydro or nuclear	 1.02 kg/kWh from CH_4 0 kg/kWh from CH_4
Natural gas	2.01 kg/m³ CH_4
Liquefied petroleum gas	2.26 kg/m³ CH_4
Distillate fuel oil	2.65 kg/m³ CH_4

Source: Hall Associates, Georgetown, Delaware USA.

Indirect emissions are estimated by first estimating the maximum production potential for methane from the digester and then determining the emissions associated with the energy that was offset from biogas use. For the estimation of fuel replacement emissions, it was assumed that the collected biogas would be used to generate electricity, replacing fuel oil.

4.1.4 Summary

As illustrated by the equations presented previously, the principal factor responsible for determining the magnitude of methane emissions from livestock manures and agricultural commodity processing wastes is the waste management practice employed, which determines the methane conversion factor (MCF). As shown in Table 10.17 of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories and in Tables 2.2 and 2.6 of this document, anaerobic lagoons and landfills have the highest potential for emitting methane from these wastes. Thus, replacing these waste management practices with anaerobic digestion has the greatest potential for reducing methane emissions. While the reduction in methane emissions realized by replacing other waste management practices with anaerobic digestion will not be as significant, the methane captured will be a source of renewable energy with the ability to reduce fossil fuel consumption and the associated greenhouse gas emissions from sequestered carbon.

Table 4.7 summarizes the findings of the resource assessment in terms of potential methane emission reductions and carbon offsets in the Philippines. The sector with the highest potential for methane reduction and carbon offsets is the swine sector, followed by alcohol distillery, coconut processing, and finally slaughterhouses.

Swine farming is responsible for the majority of the emissions in the livestock sector. Emissions from swine production largely come from manure management on commercial farms (~29% of total farms), particularly those with lagoons and ponds. Methane emission related to enteric fermentation in the sector is considered to be low. The estimated 1.5 MMT CO_2e/year in this sector represent over 70% of current emissions from commercial farms with lagoons or ponds, as reported on The Philippines Initial National Communication on Climate Change. Total emissions from the livestock sector in 1994 were estimated to be ~10.5 MMT CO_2e/year.

Alcohol distillery, coconut processing, and slaughterhouses are responsible for the majority of the emissions in the agricultural commodity processing sector. The estimated 650,000 MT CO_2e/year in these industries represent over 6% of current emissions from the industrial sector, as reported on The Philippines Initial National Communication on Climate Change. Total emissions from the industrial sector in 1994 were estimated to be ~10.6 MMT CO_2e/year; the majority of emissions come from the cement, metal, halocarbons and chemical industries.

Table 4.7. Summary of Methane and Fossil Fuel Related Carbon Dioxide Emission Reduction Potentials for the Agro-Industrial Sector of the Philippine Economy

Industry/ Sector	Geographical Coverage	Carbon Emission Reduction (MT CO_2e /year)	Emission Reduction from Fossil Fuel Replacement (MT CO_2e /year)	Total Emission Reduction (MT CO_2e /year)
Swine Farming	Regions III, IV-A, VI	1,541,000	247,500	1,788,500
Alcohol Distillery	Nationwide	478,000	84,000	562,000
Coconut processing	Region IV, X, XI	162,500	28,500	191,000
Slaughterhouse	Nationwide	10,500	1,800	12,300
Total		**2,192,000**	**361,800**	**2,553,800**

4.2 TECHNOLOGY OPTIONS

4.2.1 Methane Production

There are a variety of anaerobic digestion processes, which can be broadly categorized as either suspended or attached growth processes. The applicability of any specific process is determined primarily by physical characteristics of the waste or mixture of wastes that will be anaerobically digested. Attached growth processes are suitable for wastes with low concentrations of particulate matter. For wastes with higher concentrations of particulate matter, suspended growth processes generally are more suitable. The anaerobic digestion process options that are applicable to the various types of livestock manures and agricultural commodity processing wastes are discussed in the following sections.

Livestock Manure. For livestock manure, there are four anaerobic digestion reactor options: 1) plug-flow, 2) mixed, 3) covered lagoon, and 4) attached growth. The appropriate option or options are determined by the concentration of particulate matter, generally measured as total solids (TS) concentration in the collected manure; type of manure; and climate, as shown in Table 4.8. The TS concentration in the collected manure is determined by the method of collection, mechanical (scraping) or hydraulic (flushing), and the volume of water used for hydraulically collected manures.

Table 4.8 – Overview of Anaerobic Digestion Options for Livestock Manures

Paramater	Plug-flow	Mixed	Covered Lagoon	Attached Growth
Influent total solids concentration	11—13 percent	3—10	0.5—3	<3
Manure type	Only dairy cattle	Dairy & swine	Dairy & swine	Dairy & swine
Required pretreatment	None	None	Removal of coarse fiber from dairy cattle manure	Removal of coarse fiber from dairy cattle manure
Climate	All	All	Temperate & warm	Temperate & warm

U.S. Environmental Protection Agency. 2004. AgSTAR Handbook, 2nd ed., K.F. Roos, J.H. Martin, Jr. and M.A. Moser eds. EPA-430-B-97-015. Office of Air and Radiation, Washington, DC.

As indicated in Table 4.8, use of covered lagoons and attached growth reactors for methane production from dairy cattle manure requires removal of coarse fiber, usually by screening, before anaerobic digestion. For the attached growth option, screening of swine manure to remove hair and foreign matter, such as ear tags, is advisable. Covered lagoons and attached growth reactors operate at ambient temperature and thus are only suitable for temperate and warm climates. In temperate climates, there may be seasonal variation in the rate of methane production.

Agricultural Commodity Processing Wastewater. As discussed previously, agricultural commodity processing operations generate either liquid wastewater, solid waste, or both. No single treatment process is suitable for all of these wastewaters, except the covered anaerobic lagoon, due to wide variation in physical and chemical characteristics. Even the physical and chemical characteristics of wastewater from the processing of a single commodity can vary widely, reflecting differences in processing and sanitation practices. For example, some processing plants prevent solid wastes, to the extent possible, from entering the wastewater generated, whereas others do not.

In addition, some plants employ wastewater pretreatment processes such as screening, gravitational settling, or dissolved air flotation (DAF) to remove particulate matter, whereas others do not. Although the covered anaerobic lagoon has the advantages of universal applicability and simplicity of operation and maintenance, adequate land area must be available. If the volume of wastewater generated is low, co-digestion with livestock manure or wastewater treatment residuals may be a possibility. Other options for the anaerobic treatment of these wastewaters are briefly described below.

For wastewaters with high concentrations of particulate matter (TSS) or extremely high concentrations of dissolved organic matter (BOD or COD), the complete mix, anaerobic contact, or anaerobic sequencing batch reactor (ASBR) processes are alternatives. These are typically operated at mesophilic (30 to 35 ℃) or thermophili c (50 to 55 ℃) temperatures.

As shown in Table 4.9, the anaerobic contact and ASBR processes operate at significantly shorter hydraulic retention times (HRTs) than the complete mix process. A shorter required HRT translates directly into a smaller required reactor volume and system footprint. Operation of the anaerobic contact and ASBR processes is progressively more complex, however.

Table 4.9 – Typical Organic Loading Rates for Anaerobic Suspended Growth Processes at 30℃

Process	Volumetric Organic Loading, kg COD/m^3-day	Hydraulic Retention Time, days
Complete mix	1.0—5.0	15—30
Anaerobic contact	1.0—8.0	0.5—5
Anaerobic sequencing batch reactor	1.2—2.4	0.25—0.50

Source: Metcalf and Eddy, Inc., 2003

For wastewaters with low TSS concentrations or wastewaters with low TSS concentrations after screening or some other form of TSS reduction, such as dissolved air floatation, one of the anaerobic sludge blanket processes could be applicable. Included are the: 1) basic up-flow anaerobic sludge blanket [USAB], 2) the anaerobic baffled reactor, and 3) anaerobic migrating blanket reactor [AMBR®] processes. The anaerobic sludge blanket processes allow for high volumetric COD loading rates due to the retention of a high microbial density in the granulated sludge blanket. Wastewaters that contain substances such as proteins and fats that adversely affect sludge granulation, cause foaming, or cause scum formation are problematic. Thus, use of anaerobic sludge blanket processes generally is limited to high carbohydrate wastewaters.

Attached growth anaerobic processes represent another option for agricultural commodity processing wastewaters with low TSS concentrations. Included are the:1) up-flow packed-bed attached growth, 2) up-flow attached growth anaerobic expanded bed, 3) attached growth anaerobic fluidized-bed, and 4) down-flow attached growth reactor processes. All have been used successfully in the anaerobic treatment of a variety of food and other agricultural commodity processing wastewaters, but are more operationally complex than the suspended growth and sludge blanket processes.

Agricultural Commodity Processing Solid Wastes. Generally, solid wastes from agricultural commodity processing are most amenable to co-digestion with livestock manure or wastewater treatment residuals in a mixed digester. Although it may be possible to anaerobically digest some of these wastes independently, the addition of nutrients, such as nitrogen or phosphorus, and a buffering compound to provide alkalinity and control pH, might be necessary.

4.2.2 Methane Use Options

In addition to methane, CO_2 is also a significant product of the anaerobic microbial decomposition of organic matter. Collectively, the mixture of these two gases is commonly known as biogas. Typically, biogas also contains trace amounts of hydrogen sulfide, ammonia, and water vapor. The energy content of biogas depends on the relative volumetric fractions of methane and CO_2. Assuming the lower heating value of methane, 35,755 kilojoule (kJ) per m^3, a typical biogas composition of 60 percent methane and 40 percent CO_2 has a lower heating value of 21,453 kJ per m^3. Thus, biogas has a low energy density in comparison to conventional fuels.

Although the principal objective of the anaerobic digestion of livestock manure and agricultural commodity processing wastes is to reduce methane emissions to the atmosphere, biogas has value as a renewable fuel. It can be used in place of a fossil fuel in stationary internal combustion engines or microturbines connected to generator sets or pumps and for water or space heating. Direct use for cooling or refrigeration is also a possibility.

Use of biogas in place of coal, natural gas, liquefied petroleum gas (LPG), or distillate or heavy fuel oil for water or space heating is the most attractive option due to simplicity and the possibility of utilizing existing boilers or furnaces modified to burn a lower energy density fuel. Conversion of a natural gas or LPG fueled boiler or furnace to biogas generally only requires replacement of the existing metal combustion assembly with a ceramic burner assembly with larger orifices. If there is seasonal variation in demand for water or space heating, biogas compression and storage is an option that should be considered if the cost of suitable storage can be justified.

Using biogas to fuel a modified natural gas internal combustion engine or microturbine to generate electricity is more complex. Livestock manures and most agricultural commodity processing wastes contain sulfur compounds, which will be reduced to hydrogen sulfide during anaerobic digestion and partially desorbed. Thus, hydrogen sulfide, in trace amounts, is a common constituent of biogas and can cause serious corrosion problems in biogas fueled internal combustion engines and microturbines. Hydrogen sulfide combines with the water produced during combustion to form sulfuric acid. Consequently, scrubbing to remove hydrogen sulfide may be necessary when biogas is used to generate electricity.

Using biogas to generate electricity also might require interconnection with the local electricity provider for periods when electricity demand exceeds biogas generation capacity, when generation capacity exceeds demand, or when generator shut down for maintenance or repairs is necessary. One of the advantages of using biogas to generate electricity connected to the grid is the ability to use biogas as it is produced and use the local electricity grid to dispose of excess electrical energy when generation capacity exceeds on-site demand. The use of biogas to generate electricity not only will reduce farm operating costs but will also provide a steady revenue stream for the farm.

When avoided methane emissions and associated carbon credits are considered, simply flaring biogas produced from the anaerobic digestion of livestock manures and agricultural commodity processing wastes also can be considered an option. Simply flaring biogas, however, can be considered an option only to the degree that replacing the current methane-emitting waste management practice with anaerobic digestion reduces methane emissions. Although systems utilizing biogas from anaerobic digestion as a boiler or furnace fuel or for generating electricity should have the ability to flare excess biogas, flaring should be considered an option only if biogas production greatly exceeds the opportunity for utilization.

4.3 COSTS AND POTENTIAL BENEFITS

The cost of anaerobically digesting livestock manures and agricultural commodity processing wastes and utilizing the methane captured as a fuel depends on the type of digester constructed and the methane utilization option employed. In addition, these costs will vary geographically reflecting local financing, material, and labor costs. It can be assumed, however, that capital cost will increase as the level of technology employed increases. For digestion, the covered anaerobic lagoon generally requires the lowest capital investment, with anaerobic sludge blanket and attached growth processes requiring the highest. As the complexity of the anaerobic digestion process increases, operating and maintenance costs also increase. For example, only basic management and operating skills are required for covered lagoon operation, whereas a more sophisticated level of understanding of process fundamentals is required for anaerobic sludge blanket and attached growth processes.

For captured methane utilization, the required capital investment for flaring is the lowest and generating electricity is the highest. Based on previous projects developed in the United States, the cost of an engine-generator set is at least 25 percent of the total project cost, including the anaerobic digester. In addition, while the operating and maintenance costs for flaring are minimal, they can be substantial for generating electricity. For example, using captured biogas to generate electricity requires a continuous engine-generator set maintenance program and might include operation and maintenance of a biogas hydrogen sulfide removal process.

4.3.1 Potential Benefits

Anaerobic digestion of livestock manure and agricultural commodity processing wastes can generate revenue to at least offset and ideally exceed capital and operation and maintenance costs. There are three potential sources of revenue. The first is the carbon credits that can be realized from reducing methane emissions by the addition of anaerobic digestion. Methane conversion factors, and therefore reduction in methane emissions and the accompanying carbon credits earned, are determined by the existing waste management system and vary from essentially 0 to 100 percent. Thus, carbon credits will be a significant source of revenue for some projects and nearly nothing for others.

The second potential source of revenue is from the use of the biogas captured as a fuel. The revenue realized depends on the value of the form of energy replaced, however, as well as its local cost. Because biogas has no market-determined monetary value, the revenue realized from its use in place of a conventional source of energy is determined by the cost of the conventional source of energy replaced. If low-cost hydropower-generated electricity is available, the revenue derived from using biogas to generate electricity might not justify the required capital investment and operation and maintenance costs. Another factor that must be considered in evaluating the use of biogas to generate electricity is the ability to sell excess electricity to the local electricity provider and the price that would be paid. There may be a substantial difference between the value of electricity used on site and the value of electricity delivered to the local grid. The latter might not be adequate to justify the use of biogas to generate electricity. Ideally, delivering excess generation to the local grid should be possible during periods of low onsite demand as well as the subsequent ability to reclaim it during periods of high onsite demand under some type of a net metering contract.

The third potential source of revenue is from the carbon credits realized from reducing fossil fuel carbon dioxide emissions when using biogas reduces fossil fuel use. As with the revenue derived directly from using biogas as a fuel, the carbon credits generated depend on the fossil fuel replaced. For using biogas to generate electricity, the magnitude of the reduction in fossil fuel-related carbon dioxide emissions depends on the fuel mix used to generate the electricity replaced. Thus, the fuel mix must be determined to support the validity of the carbon credits claimed.

4.4 CENTRALIZED PROJECTS

Generally, small livestock production and agricultural commodity processing enterprises are not suitable candidates for anaerobic digestion to reduce methane emissions from their waste streams due to high capital and operating costs. The same is true for enterprises that only generate wastes seasonally. If all of the enterprises are located in a reasonably small geographical area, combining compatible wastes from two or more enterprises for anaerobic digestion located at one of the waste sources or a centralized location is a possible option. By increasing project scale, unit capital cost will be reduced. Operating costs will increase, however, and centralized digestion will not always be a viable option if the ability to generate adequate revenue to at least offset the increased operating costs is lacking.

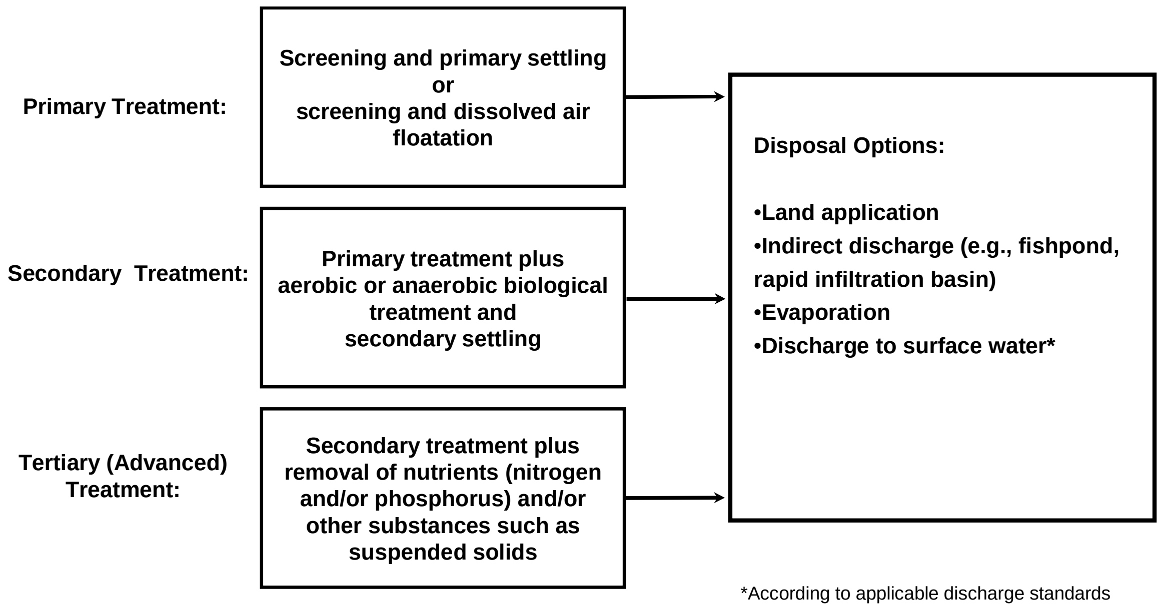
There are two possible models for centralized anaerobic digestion projects; the geographic distribution of waste sources and the options for maximizing revenue from the captured methane should be the basis for determining which model should receive further consideration in the analysis of a specific situation. In the first model, digestion occurs at one of the sources of waste with the waste from the other generators transported to that site. Wastes from one or more agricultural commodity processing operations are co-digested with livestock manure. In the second model, wastes from all sources are transported to a separate site for digestion.

For centralized anaerobic digestion projects, the feasibility analysis should begin with determining a project location that minimizes transportation requirements for the wastes to be anaerobically digested and for the effluent for disposal. The optimal digester location could be determined by trial and error, but constructing and applying a simple transportation model should be a more efficient approach. Although obtaining the optimal solution manually is possible, using linear programming should be considered. With this approach, optimal locations that minimize transportation costs for a number of scenarios can be obtained and compared. For example, the transportation costs associated with locating the anaerobic digester at the largest waste generator versus a geographically central location can be delineated and compared.

Next, the revenue that will be generated from the sale of carbon credits realized from the reduction of methane emissions and from the utilization of the captured methane as a fuel should be estimated. The latter will depend on a number of factors including the location of the digester and opportunities to use the captured methane in place of conventional sources of energy. Generally, captured methane that can be used to meet onsite electricity or heating demand will have the greatest monetary value and produce the most revenue to at least offset and ideally exceed system capital and operation and maintenance costs. Thus, an energy use profile for each source of waste in a possible centralized system should be developed to determine the potential for onsite methane use, the revenue that would be realized, and the allocation of this revenue among the waste sources. .

Ideally, the digester location that minimizes transportation cost will be at the waste source with the highest onsite opportunity for methane utilization. Thus, waste transportation cost will be minimized while revenue will be maximized. The digester location that minimizes transportation costs may not maximize revenue from methane utilization, however, due to low onsite energy demand. Thus, alternative digester locations should be evaluated to identify the location that maximizes the difference between revenue generation from methane utilization and transportation cost. Again, using a simple transportation model to determine the optimal digester location is recommended. If the optimal location is not at one of the waste sources, additional analysis incorporation site acquisition cost will be necessary.

APPENDIX A: ***TYPICAL WASTEWATER TREATMENT UNIT PROCESS SEQUENCE***



*According to applicable discharge standards

APPENDIX B: ***BIOGAS INSTALLATION IN CERTAIN REGIONS***

Source of Data: DOST

REGION V

Albay

	Name of Owner	Location	Capacity (m^3)	Model	Contractor	Year Installed	Cost	Application
1	Biogas Plant	Albay		concrete		1995		For sanitation
2	DA Field Office	Camalig		TPED	DA- R5	1996	10,000	burner

Camarines Norte

	Name of Owner	Location	Capacity (m^3)	Model	Contractor	Year Installed	Cost	Application
1	Cariza, Teodoro	Gahongon, Daet	400	Horizontal Design		1998		
2	Livestock & Poultry Demo F	Basud	500	Vertical Design		1993		
3	Obusan Biogas	Poblacion I, Basud	400	Horizontal Design		1990		
4	Pedro Mancera Biogas	Poblacion 2, Basud	400	Horizontal Design		1998		
5	Sto. Domingo AI Center	Sto, Domingo, Vinzons	400	TPED		1993		
6	Engr. Berlin delos Santos	Calasgasan, Daet	27.21	Floating Type	Owner	1986	15,000	cooking
7	Engr. Berlin delos Santos	Calasgasan, Daet	3.63	Floating Type	Owner	1995	7,000	cooking
8	Herminio Obusan	Rizal St. Basud	3.63	Floating Type	Owner	1994	14,000	cooking/ lighting
9	Armamdo Dando	Minaogan, Vinzons	11	Floating Type	CSSAC-ANEC	1997	50,000	cooking
10	Engr. Jesus Olea	Mantagbak, Daet	4	Fixed Dome	Engr. Ricky Eboña	1999	25,000	cooking/ pollution control
11	Boy de Guzman	Mercedez	6	Floating Type	Engr. Jesus Olea	2001	40,000	cooking

	Name of Owner	Location	Capacity (m^3)	Model	Contractor	Year Installed	Cost	Application
12	Dr. Elmer Jacobo	Poblacion, Sn Vicente	6	Floating Type	Engr. Ricky Eboña	2001	40,000	cooking
13	Teofiso Gareza	Gahonon, Daet	4	Floating Type	Engr. Genie Oliver	1996	50,000	Cooking/ pollution control

Camarines Sur

	Name of Owner	Location	Capacity (m^3)	Model	Contractor	Year Installed	Cost	Application
1	Angeles Asay	San Jose, Pili	5	Floating Type	Owner	2002	45,000	cooking
2	**Antonio Catolico**	San Antonio, Sagñay	1	Floating Type	Michelle Catolico	1995	20,000	cooking
3	Atty. Nelson Legacion	Carolina, Naga City	5	Floating Type	Mr. Angeles Asay	1996	80,000	Cooking/ pollution control
4	CSSAC-ANEC	CSSAC, Swin Project	11	Floating Type	CSSAC-ANEC	1989	66,962	cooking
5	Domiciano Pinta	Conception, Libanan	5	Floating Type	Mr. Angeles Asay	1996	80,000	cooking
6	Engr. Armin Guinto	San Agustin, Pili	6	Floating Type	AG Machineries	1995	20,000	cooking
7	Grace Jordan	San Jose, Pili	6	Floating Type	Mr. Gregorio Ayen	1993	25,000	cooking
8	Gregorio Ayen	La Purisima, Pili	7.5	Floating Type	Owner	1981	6,000	cooking
9	Semplicio Bergantin	San Agustin, Pili	6	Floating Type	Mr. Gregorio Ayen	1993	35,000	cooking

Catanduanes

	Name of Owner	Location	Capacity (m^3)	Model	Contractor	Year Installed	Cost	Application
1	Banzuela, Trso	Sta. Cruz, Bato	10	Rectangular Type				
2	Bernal, Jesus	Tilis, Bato	10	Rectangular Type				

	Name of Owner	Location	Capacity (m^3)	Model	Contractor	Year Installed	Cost	Application
3	Borja, Nora	San Isidro Village, Virac	10	Rectangular Type				
4	Caballero, Freddie	Gigmoto	10	Rectangular Type				
5	Camano, Elmer	San Isidro Village, Virac	10	Rectangular				
6	Gomes, Cesar	Palnab, Virac	10	Rectangular Type				
7	Gonzales, Ruben	District II, San Miguel	10	Circular Type				
8	Guerrero, Ely	Gigmoto	10	Rectangular Type				
9	Olalo, Azucena	Cavinitan, Virac	10	Rectangular Type				
10	Ramirez, Josefina	Palta Big, Virac	10	Rectangular Type				
11	Tablizo, Manuel	Gogon, Virac	10	Rectangular Type				
12	Tapel, Leonida	Bliss site, Virac	10	Rectangular Type				
13	Tatel, Marilyn	District II, San Miguel	10	Rectangular Type				
14	Tejerero, Pedro	Tilis, Bato	10	Rectangular Type				
15	Torregosa, Ceverino	Buenavista, Viga	10	Rectangular Type				
16	Toyado, Cristy	Cavinitan, Virac	10	Rectangular Type				
17	Tubiera, Alcuin	Salvacion, Bato	10	Rectangular Type				
18	Vargas, Felix	Tigbao, Virac	10	Rectangular Type				
19	Vargas, Gloria	West Garde, Bigaa, Virac	10	Rectangular Type				
20	Vargas, Julito	Kilikilihan, San Miguel	10	Rectangular Type				

	Name of Owner	Location	Capacity (m³)	Model	Contractor	Year Installed	Cost	Application
21	Virac Breeding Station	Simamia, Virac	10	Rectangular Type				

BIOGAS INSTALLATION REGION IX

Zamboanga

	Name of Owner	Location	Capacity (m³)	Model	Contractor	Year Installed	Cost	Application
1	Dr. Eduardo Ceraldo (3)	Lapaz, Zamboanga City			private contractor	1997	4,000	cooking
2	Silayan Municipal Piggery	Silayan Zamboanga del Norte			LGU laborers	1999	5,000	coking
3	Robersto Sarao	Ayala, Zamboanga City			private contractor	2005	12,000	cooking
4	Luis Biel III	Labuan, Zamboanga City			private contractor	2006	25,000	cooking/ lighting
5	Nonito Bernardo	Ayala, Zamboanga City			private contractor	2006	20,000	cooking
6	Marvin Macrohon	Talisayan, Zamboanga City			private contractor	2005	50,000	cooking, brooding
7	Cecile Auhero	Upper Calarian, Zamboanga City			private contractor	2006	9,000	cooking
8	Rolly Aquino (2)	Pasonanca, Zamboanga City			private contractor	2002/ 2006	9,000	cooking
9	Orlando Hilario	Tumaga, Zamboanga City			private contractor	2002	12,000	cooking, brooding
10	Dr. Salvador Cabato (2)	Guiwan Highway, Zamboanga City			private contractor	2001	25,000	cooking

	Name of Owner	Location	Capacity (m^3)	Model	Contractor	Year Installed	Cost	Application
11	Adon Aclo	Upper Calarian, Zamboanga City			private contractor	2005	10,000	cooking
12	Tessie Mariano	Cabatangan, Zamboanga City			private contractor	2006	10,000	cooking
13	Katipunan Municipal Piggery	Katipunan, Zamboanga del Norte			private contractor	2005	9,000	cooking
14	Edwin Lagunera	Tumaga, Presa, Zamboanga City			E.L. Contractor	2006	60,000	cooking
15	Tumaga A. I. Center	Tumaga, Zamboanga City			private contractor	2000	20,000	cooking
16	Holy Rosary Trng. Center	Pasobolong, Zamboanga City			private contractor	1999	9,000	cooking
17	Rolando Flores	Culianan, Zamboanga City			private contractor	2005	15,000	cooking
18	Hernane Tupas	Culianan, Zamboanga City			private contractor	2004	10,000	cooking
19	Celestino dela Cruz	Gapuz, Zamboanga City			private contractor	2003	25,000	cooking
20	Holy Rosary Trng. Center	Culianan, Zamboanga City			private contractor	2000	15,000	cooking
21	Antonio Lim	Pasobolong, Zamboanga City			private contractor	2005	60,000	cooking
22	Claritian Novitiate	Bunguaio, Zamboanga City			private contractor	2003	15,000	cooking
23	Jesus Atilano	Curuan, Zamboanga City			private contractor	2001	8,000	cooking

	Name of Owner	Location	Capacity (m^3)	Model	Contractor	Year Installed	Cost	Application
24	Roger Alfaro	Vitali, Zamboanga City			private contractor	2007	9,000	cooking
25	Sirawal Municipal Piggery	Sirawal, Zamboanga del Norte			private contractor	2007	20,000	cooking

BIOGAS INSTALLATION REGION X

Bukidon

	Name of Owner	Location	Capacity (m^3)	Model	Contractor	Year Installed	Cost	Application
1	Abundio Ricablanco	Pinatilan, Valencia City	96	Fixed Dome	Jun Sineca	2007		cooking
2	Cerafin Ungab	Poblacion, Valencia City	8	Floating Type	Owner	1993	45,000	cooking
3	Dante Cantero	P-16 Poblacion, Valencia City	3	Fixed Dome	Owner	2005	10,000	cooking
4	Eliezer Mabao	Poblacion, Valencia City	10	Fixed Horizontal Cylindrical Hanging steel	Sin del Rosario	1998		cooking
5	Ferdinand Esteban	P-16 Poblacion, Valencia City	6	Fixed Dome	CMU-ANEC	2000	55,000	cooking
6	Jaime Gellor, Jr.	Dalwagan, Malaybalay	10	Fixed Dome	CMU- ANEC	2000	85,000	cooking
7	Jose Calipusan	Poblacion, Valencia City	8	Fixed flat rectangular type	Owner	2006	45,000	cooking
8	Juliet Semitara	P- 16 Poblacion, Valencia City	7	Fixed Dome	Norman Esteban	2005	40,000	cooking
9	Nicolas Cajes	Base	9	Fixed Dome	Owner	1994	50,000	cooking

	Name of Owner	Location	Capacity (m^3)	Model	Contractor	Year Installed	Cost	Application
		Camp, Maramag						
10	Patricio Juan	Inawaan, Valencia City	24	Fixed Dome	Jun Sineca	2005	150,000	cooking/ boiling water
11	Roberto Mangubat	Base Camp, Maramag	6	Fixed Dome	CMU-ANEC	1998	40,000	cooking
12	Sixto Magdaraog	Ninoy Aquino, Kalilangan	6	Fixed Dome	CMU-ANEC	2003	60,000	cooking
13	Wilfredo Ganas	Lunocan, Manolo	75	Fixed Dome	Boggy Bajenting	2002		cooking/ boiling water

BIOGAS INSTALLATION REGION XI

Davao del Norte & Davao del Sur

No.	Name of Owner	Location	Capacity (m^3)	Model	Contractor	Year Installed	Cost	Application
1	Ayap, Lito	Poblacion Magsaysay Davao del Sur	9	Fixed Dome	Lito Yap	2001	13,000	cooking & heating
2	Ayap, Lito	Azucena St., Bansalan	9	Septic Tank		2001		
3	Ayap, Lito	Azucena St., Bansalan	9	Septic Tank		2001		
4	Danny & Bening Diokno	Biao, Cogon, Digos Davao del Sur	10	Fixed Dome		Dec-05		
5	Danny & Bening Diokno	Biao, Cogon, Digos Davao del Sur	10	Fixed Dome		Dec-05		

No.	Name of Owner	Location	Capacity (m^3)	Model	Contractor	Year Installed	Cost	Application
6	Diokno, Danny/Bening	Biao, Cogon, Digos Davao del Sur	10	Fixed Dome	Felimon Santander	Dec-05	100,000	cooking & Fertilizer
7	Don Bosco Training Center	Dahican Mati, Davao Oriental	8	Fixed Dome	Dante Delima	Jul-05	80,000	cooking & heating
8	Don Bosco Training Center	Dahican Mati	10	Fixed Dome		2005		
9	Don Bosco Training Center	Dahican Mati		Fixed Dome		Jul-05		
10	Dullasen, Angeles	Poblacion Magsaysay Davao del Sur						
11	Dullasen, Angeles	Poblacion Magsaysay Davao del Sur	10	Fixed Dome		Oct-05		
12	Dullasen, Angeles	Poblacion Magsaysay Davao del Sur	No data					
13	Gutierrez, Al	Poblacion Bansalan Davao del Sur	15	Fixed Dome	Al Gutierrez	Apr-06	10,000	
14	Gutierrez, Al	Poblacion I, Bansalan	15	Septic Tank		Jun-06		
15	Gutierrez, Al	Poblacion I, Bansalan	15	Septic Tank		Jun-06		
16	Janson, Allan	Bonifacio-Bataan, Digos Davao del Sur	6	Fixed Dome	Felimon Santander	Jan-06	65,000	cooking & lighting
17	Janson, Allan	DDF, Mandug	6	Fixed Dome		Jan-06		

No.	Name of Owner	Location	Capacity (m^3)	Model	Contractor	Year Installed	Cost	Application
18	Janson, Allan	DDF, Mandug	6	Fixed Dome		Jan-06		
19	Javeluna, Elmer	Poblacion Matanao Davao del Sur			Elmer Javelin	Apr-03	20,000	For pollution control
20	Javeluna, Elmer	Poblacion, Matanao	10	Septic Tank		Apr-03		
21	Javelluna, Elmer	Poblacion, Matanao		Septic tank		Apr-03		
22	King, Janice	Mintal Davao City, Davao del Sur	8	Fixed Dome	Felimon Santander	1998	50,000 cooking & heating	cooking & heating
23	King, Janice	Catalunan Grade	8	Fixed Dome		1998		
24	King, Janice	King's Farm Catalunan Gran	8	Fixed Dome		1998		
25	LGU Sto. Tomas	Bobungon Sto. Tomas Davao del Norte	6	Fixed Dome	USEP-ANEC	Dec-06	100,000	cooking & heating
26	Lopez, Domingo	Tienda Digos, Davao del Sur	6	Fixed Dome	Felimon Santander	9-May-05	65,000	Cooking & disinfectant
27	Lopez, Domingo	Aplaya Digos Davao del Sur	6	Fixed Dome	Felimon Santander	Mar-06	65,000	Cooking & disinfectant
28	Lopez, Domingo	Tienda, Aplaya, Digos City	12	Fixed Dome		2005		
29	MAPECO	Mandug Davao City, Davao del Sur	6	Fixed Dome	DSAC-ANEC	Dec-07	66,000	Cooking & heating

No.	Name of Owner	Location	Capacity (m^3)	Model	Contractor	Year Installed	Cost	Application
30	Namang, Pablito	Mandug Davao City, Davao del Sur	2	Floating	Tomas Blase	1999	10,000	Cooking & heating
31	Namang, Pablito	Lower San Antonio, Mandug	2	Floating Type		1999		
32	Namang, Pablito	Lower San Antonio, Mandug	2	Floating Type		1999		
33	Pahulas, Jubencio	Purok 7, Km. 88 Bansalan Davao del Sur	13	Fixed Dome	Jubencio Pahulas	Jan-05	10,000	
34	Pahulas, Jubencio	Purok 7, Km. 88 Dulo, Bansa	13	Septic Tank		Jan-05		
35	Pahulas, Jubencio	Purok 7, Km. 88 Dulo, Bansa	13	Septic Tank		2005		
36	Rontal, Danilo	Km. 80 Dolo, Bansalan Davao del Sur	20	Fixed Dome	Danilo Rontal	Apr-03	10,000	Cooking & heating
37	Rontal, Danilo	Bansalan	20	Septic Tank		Apr-03		
38	Rontal, Danilo	Km. 80 Bansalan	20	Septic Tank		Apr-03		
39	San Miguel Corp.	Darong Sta. Cruz, Davao del Sur	2,500	Fixed Dome	Enviro Asia	1995		Sterilization/ regimenta-tion
40	San Miguel Corporation	Darong, Sta. Cruz						
41	San Miguel Corporation	Darong, Sta. Cruz	No data					
42	Santander, Boy (USEP-ANEC)	Lower San Antonio, Mandug	6	Fixed Dome		1997		

No.	Name of Owner	Location	Capacity (m^3)	Model	Contractor	Year Installed	Cost	Application
43	Santander, Boy (USEP-ANEC)	Lower San Antonio, Mandug	6	Fixed Dome		Dec-97		
44	USEP-ANEC Demo	USEP-Apokon, Tagum City	8	Fixed Dome	DSAC-ANEC	1995		cooking/ waste mngt
45	USEP-ANEC Demo	Breeding Center Malalag LGU	8	Fixed Dome	DSAC-ANEC	1996		Cooking/ waste mngt
46	Uzua, Eugene	Biao, Cogon, Digos Davao del Sur	10	Fixed Dome	Felimon Santander	Oct-05	100,000	Cooking
47	Uzua, Eugene	Biao, Cogon, Digos Davao del Sur	10	Fixed Dome		Oct-05		
48	Uzua, Eugene	Biao, Cogon, Digos Davao del Sur	10	Fixed Dome		Oct-05		

BIOGAS INSTALLATION REGION XIII - CARAGA

Surigao del Sur and Surigao del Norte

No	Name of Owner	Location	Capacity (m^3)	Model	Contractor	Year Installed	Cost	Application
1	Arpilleda, Leonila	Madrid, Surigao del Sur	10	TPED		Oct-03		
2	Cuyos, Agustin, Jr	Tago, Surigao Del Sur	6	TPED		Apr-03		
3	Estrada, Rito	Madrid, Surigao del Sur	10	TPED		Oct-03		
4	Gorgod, Lito	Mabua, Surigao City	2.5	TPED	DA-assisted	Sep-05	8,000	

No	Name of Owner	Location	Capacity (m^3)	Model	Contractor	Year Installed	Cost	Application
5	Hendive, Wendive	Tago, Surigao Del Sur	10	TPED		2002		
6	Jamero, Raro	Sta. Cruz, Placer SDN	2.5	TPED	DA-assisted	Nov-05	7,000	
7	La Torre, Margarito, Jr	Tagmalinao, Cagwait Surigao del Sur	10	TPED		2002		
8	LGU- Sta. Joseph	Agusan del Sur	2. 5	TPED	DA-assisted	Nov-01	6,000	household/ stoves
9	Medrano, Gleceria	Magroyong, Surigao del Sur	10	TPED		Jul-04		
10	Montero, Fermin	Tago, Surigao Del Sur	6	TPED		Feb-03		
11	Orberta, Adelito	Marihatag, Surigao del Sur	10	TPED		Jun-04		
12	Pantilo, Adolfo	Sisoy, Surigao del Norte	2. 5	TPED	DA-assisted	Aug-04	7,000	
13	Pedere, Fred	Marihatag, Surigao del Sur	10	TPED		2006		
14	Suarez, Fe	Madrid, Surigao del Sur	10	TPED		Jun-04		
15	Tacogdoy, Ernesto	Puyat, Carmen Surigao del Sur	10	TPED		2002		

APPENDIX C: *LIST OF FARMS WITH COVERED LAGOONS USING CIGAR TECHNOLOGY*

Swine Farm	Sow Level	Gen Set Capacity (kW)
Region III-Bulacan		
Joliza Farm	1,400	100
Sta. Maria Hog Farm (Monterey	1,200	100
Bonview Farm	2,200	100
Vergel de Dios	1,000	100
Filbrid Farms	1.000	100
Region III- Nueva Ecija		
Don Don Farm	1,000	100
Paramount Agri Farm	1,300	300
Region III Pampanga		
Red Dragon Farm	6.000	75
E-Pig San Pablo (Red Dragon 2)	4.000	75
Region III Tarlac		
Gaya Lim Farm	650	60
Superior Farm	850	75
Sto Domingo Farm	1,500	100
Unirich Farm	1200	100
Goldilion Farm	1,000	100
Gold Farm	700	75
Sentra Farm	700	75
Everlasting Farm	1,000	100
RH Farm	2,000	200
Region IVA Batangas		
Lanatan Farm	1,200	100
SIDC Community Project	600	75
Bulihan Community Project		75
Taysan Breeder Farm	1,500	75
Region IVA Cavite		
Cathay Tanza	1,800	100

Swine Farm	Sow Level	Gen Set Capacity (kW)
Cathay Tarnate	1,500	75
Region IVA Quezon		
Bondoc Farm	1,000	100
Rose Industries	350	60
Region IVA-Rizal		
Rocky Farm	900	60
Jhon and Jhon Farm	700	75
Everest Farm	2,500 with 16,000 fatteners	300
Sunjin	1,000	100
Region X Cagayande Oro		
D & C Farm	650	60
Chonas Farm	600	100
Asian Livestock	1,000	100

APPENDIX D: *LIST OF TECHNOLOGY SUPPLIERS*

There are a total of nine biogas technology manufacturers and suppliers in the country. These manufacturers provide the necessary facility and service to biogas system users. Services include sales and installation of turn-key plants, after-sales monitoring, and operation and maintenance services. Concrete digesters are being promoted for backyard to small scale systems because of the availability of local and cheap materials. Environmental concerns are forcing swine farms to adopt a biogas system.

Listed below are some of the existing biogas technology suppliers and biogas project developers in the country:

1. **Solutions Using Renewable Energy Inc. (SURE Inc.)**

   SURE has installed several biogas digesters for swine and poultry farms and poultries. Its biogas project in Tayud, Cebu, won the 2006 Green Energy Award for the non power category from the Department of Energy (DOE). Methane captured from swine and poultry manure is utilized to provide energy needed to manufacture egg trays from recycled newspaper and packaging paper.

   Address: 602 OMM CTIRA BLDG, San Miguel Avenue, Ortigas Center, 1605, Philippine
   Website: www.sure.com.ph
   Fax No.: (632) 634.7945
   General Email: info@sure.com.ph
   Solar: solar@sure.com.ph
   Hydro: hydro@sure.com.ph
   Biogas: biogas@sure.com.ph

2. **Philippine Bio Sciences Company Inc. (PHILBIO)**

   PHILBIO designs and constructs biogas systems. If the facility owner requires funding support, PHILBIO offers a build/operate/transfer (BOT) arrangement. The range of product and services that PHILBIO offers are as follows:[51]

   - Design and build Covered In Ground Anaerobic Reactor (CIGAR) for the livestock industry.
   - Design and build Anaerobic Baffled Reactor (ABR) for food and beverage processing.
   - Develop, design, and implement Clean Development Mechanism (CDM) projects.
   - Provide technologies in the high-recovery of low-material gas through anaerobic digesters at landfill sites.

[51] http://home.philbio.com.ph

- Supply General Motors dual-fuel generator sets designed by Don Hardy with power output of 60 to 200 kW.

- Distribute and install Huitex High Density Polyethylene (HDPE) geo-membrane and geo-tectile liners.

- Install, operate, and maintain local power plants of up to 10 MW capacity.

- Provide technology and financial assistance to facilitate environmental compliance and reduce dependency on costly fuel to electricity

Address: 19th Flr., Unit F, Strata 100 Bldg., Emerald Ave., Ortigas Center, Pasig City
Tel. No.: (632) 632 0277
Fax No.: (632) 631.2044

3. **Bio-Environmental Services and Technologies, Inc (BEST Inc.)**

Address: 19th Flr., Unit F, Strata 100 Bldg., Emerald Ave., Ortigas Center, Pasig City
Tel. No.: (632) 632 0277

4. **CPI Energy**

Address: 39 San Miguel Avenue, 17th Floor, One Magnificent Mile, Ortigas Center, Pasig City, Metro Manila
Tel No: (632) 635 2692
Fax No.: (632) 635 2693

5. **Wastes and Resources Management Inc. (WARM)**

WARM is an all -Filipino company that provides waste management solutions for industries and communities. Its mission is to find and develop way to convert wastes to useful resources so that the volume of residuals is minimized, and the environment is preserved. WARM signed a Memeorandum of Agreement (MOA) with the DOST ITDI on June 6, 2008, for the construction of an anaerobic filter bed baffled reactor. The initiative aims to help address the pollution problem caused by wastewater containing high levels of organic matter generated by food processing plants. WARM is headed by its president Mr. Manuel Alvarez.

Address: Manila Admin Office, 4/F Cargohaus Building, NAIA Complex, Brgy. Vitalez, Parañaque City 1700
Tel No.: (632) 879 43 56
Fax No.: (632) 879 43 23
Website: www.warmphilippines.com
Email: contactus@warmphilippines.com

APPENDIX E: ***LIST OF POTENTIAL PARTNERS***

1. **Government Agencies**

- *Department of Science and Technology (DOST)*

Philippine Council for Agriculture, Forestry and Natural Resources Research and Development (PCARRD) will also be implementing the "Baseline Information and Development of Database on Swine Waste Management Systems" project, which will examine the quality of methane produced by different designs of biogas systems.

- *Energy Management Bureau (EMB) - Department of Environment and Natural Resource (DENR)*

DENR is the government agency that monitors and enforces environmental rules and regulations. DENR is the Designated National Authority (DNA) for the Clean Development Mechanism in the Philippines. As DNA, the DENR facilitates the development and approval of CDM activities. It screens, evaluates, and decides whether a project contributes to the country's sustainable development. As of August 2008, there were already 19 projects registered with the CDM Executive Board, of which 10 are biogas capture projects from animal waste and two are from wastewater treatment. EMB serves as the CDM Secretariat.

DENR is also the government agency that implements the Philippine Clean Water Act of 2004 (R.A. 8749), which sets the water discharge standards by which industries producing wastewater must comply.

- *Bureau of Animal Industry (BAI) - Department of Agriculture (DA)*

BAI is the government agency under the DA that formulates and implements long- and short-term programs to develop and expand the livestock, poultry and dairy industries

- *National Meat Inspection Service (NMIS)*

NMIS is the government agency under the DA that monitors, inspects, and rates the sanitary conditions of public and private slaughterhouses in the country.

- *Department of Energy (DOE)*

DOE promotes renewable energy including the capture or methane as an alternative source of energy.

2. Swine Industry and Slaughterhouse Associations

1. Mr. Val Mendoza
Ex-President
Slaughterhouse Operators Assn. of the Phils. (SOAP)
San Juan Slaughterhouse
66 F. Manalo St. San Juan City
Mobile #: 0917 846 0222
Tel # (res): 365 8676

Tel #(slaughterhouse): 722 2514

2. Mr. Menandro Maleon (Chairperson)
Managing Director
Philippine Swine Industry, Research and Devt.
Foundation (PSIRDF)
c/o Jessman Placement Services Incorporated
#12 Doña Consolacion Bldg.
Gen. Santos Avenue, Araneta Center
Cubao, Quezon City
Tel. # 913-5314
912-9017 (Amy)
Fax # 912-9061
Cellphone # (0917)882-2845
e-mail: menen@pacific.net.ph

3. Soledad Agbayani
President
Phil. Association of Hog Raisers, Inc. (PAHRI)
2 Samat St., Sta. Mesa Heights
Quezon City
Tel. # 731-7529 / 731-7854 (Rose) (044)6780205
Fax # 731-1842 / 731-6186
Cellphone # (0917) 8919130

4. Mr. Jeffrey Ileto
President
United Swine Producers Association (USPA)
3rd Floor, Rm. 301, R & G Tirol Building
831 EDSA corner Scout Albano St., Quezon City
Tel. # 924-8884/924-2317 (Nel)
TeleFax # 924-8884
Residence Tel. # 671-4748 to 49
e-mail : usda@mindgate.com.ph

7. Mr. Riel Griengo
Vice-President
Phil. Swine Producers Association (PSPA)
Sto. Domingo, Capas, Tarlac
Tel # (045)925-0505
Fax # (045)925-0506

Alternate:
Mr. Isidro de Guzman

8. Mr. Francisco Wong
Corporate Secretary
National Federation of Hog Farmers, Inc. (NFHFI)
3rd Floor, Room 301, R & G Tirol Bldg.
831 EDSA corner Eugenio Lopez St.
Diliman, Quezon City

Tel. # 927-9621 loc. 108
924-2259/924-2317/637-6526
Fax # 924-2259/687-4672
Cellphone # (0917)529-5780
e-mail: pigfed@yahoo.com
secretariat@nfhfi.org
www.nfhfi.org

9. Mr. Alberto Lim, Jr.
President
National Federation of Hog Farmers, Inc. (NFHFI)
2nd Floor, Reliance House
205 EDSA Cor. Rochester St.
Greenhills, Mandaluyong City
Tel. # 726-3644
Telefax # 744-3500/726-3644
Cellphone # (0917)300-2314/(0919)736-7891
e-mail: nfhfi@skyinet.net
Alternate:
Ms. Olivia Gomez
Manager, LIMCOMA Multi-Purpose Coop.
Sabang, Lipa City, Batangas
Tel. # (043)756-1841-42
Fax # (043)756-2578

10. Dr. Cesar Ballesteros
President
Phil. Colleges of Swine Practitioners (PCSP)
c/o International Training Center of Pig Husbandry
PO Box I, Lipa City
4217 Batangas
Tel. # (043)756-1987
Fax # (043)756-1995/(044)-766-1858

Alternate:
Dr. Romeo Alcasid
#85 Road 13, Pag-Asa
Quezon City
Tel. # 929-1311

11. Mr. Felix Tiukinhoy, Jr.
President
Phil. Association of Meat Processors, Inc. (PAMPI)
Suite 204, Sunrise Condominium
Ortigas Ave., Greenhills, San Juan, MM
Tel. # 631-6617
Fax # 634-4461

Alternate:
Mr. Francisco Buencamino

Executive Director
Unit 104, Delsa Mansion
#44 Scout Borromeo St.
Scout Triangle, Quezon City
Tel. # 928-6865/942-3282 (Josine)
(Makati Off.)881-8071 (Lorna)
Fax # 926-5865
Cellphone # (0917)528-0184
e-mail: privcapital@yahoo.com.ph

12. Slaughterhouse Operators Assn of Rizal (SOAR)

3. Alcohol Distillery Associations

1. Center for Alcohol Research and Development Foundation

2. Philippine Sugar Millers Association

4. Financial Institutions/ Mechanisms

Financial institutions with lending windows are designed to support clean energy projects. The Development Bank of the Philippines (DBP) and the Land Bank of the Philippines (LBP), which are both government development banks, currently offer loan products that can support waste to energy conversion projects. One of the major private banks, the Bank of the Philippine Island, is currently working with the International Finance Corporation (IFC) to develop a financing mechanism in the country that will support sustainable energy projects.

APPENDIX F: *SWINE STATISTICS*

Source: Bureau of Agricultural Statistics

Swine Inventory by Region/Province, Period and Year

TOTAL	1-Jan					
	2004	2005	2006	2007	2008	2008
						% to Total
Philippines	12,561,690	12,139,690	13,046,680	13,459,330	13,701,020	100.00%
Metro Manila	.	.	.	.	.	
CAR (Cordillera	299,270	268,890	247,220	247,040	206,150	1.50%
Abra	57,070	57,890	52,660	52,610	51,500	0.38%
Apayao	19,420	20,510	24,420	27,000	25,090	0.18%
Benguet	33,280	28,710	24,360	32,830	23,000	0.17%
Ifugao	53,820	48,180	49,620	44,210	28,650	0.21%
Kalinga	55,080	48,190	31,910	35,970	39,140	0.29%
Mountain Province	80,600	65,410	64,250	54,420	38,770	0.28%
Region I (Ilocos Region)	533,780	507,140	513,120	515,340	518,030	3.78%
Ilocos Norte	98,440	95,810	95,200	88,300	84,340	0.62%
Ilocos Sur	74,490	74,680	90,870	108,970	116,790	0.85%
La Union	136,640	115,190	80,170	71,920	72,250	0.53%
Pangasinan	224,210	221,460	246,880	246,150	244,650	1.79%
Region II (Cagayan	805,910	713,780	748,930	657,450	539,070	3.93%
Batanes	.	.	.	.	.	
Cagayan	312,560	291,850	310,060	291,290	261,970	1.91%
Isabela	339,620	264,150	254,960	226,290	191,430	1.40%
Nueva Viscaya	103,940	112,490	134,890	98,940	55,000	0.40%
Quirino	49,790	45,290	49,020	40,930	30,670	0.22%
Region III (Central Luzon)	1,862,810	1,666,910	1,805,070	1,955,350	1,893,580	13.82%
Aurora	82,020	82,030	88,430	77,260	82,750	0.60%
Bataan	28,070	27,980	29,930	36,200	62,200	0.45%
Bulacan	1,047,830	928,500	1,078,570	1,257,010	1,246,480	9.10%
Nueva Ecija	292,580	254,560	232,450	235,560	168,010	1.23%
Pampanga	155,020	139,590	130,990	131,440	145,140	1.06%
Tarlac	146,080	134,840	147,230	140,350	118,140	0.86%
Zambales	111,210	99,410	97,470	77,530	70,860	0.52%
Region IV-A	1,571,630	1,582,890	1,634,600	1,675,500	1,794,470	13.10%
Batangas	740,960	747,030	709,650	703,970	718,560	5.24%
Cavite	144,470	150,720	159,570	169,300	161,390	1.18%
Laguna	259,200	260,080	279,030	269,150	313,440	2.29%
Quezon	146,190	146,160	190,900	181,410	226,560	1.65%
Rizal	280,810	278,900	295,450	351,670	374,520	2.73%
Region IV-B (MIMAROPA)	420,910	394,240	398,340	431,330	471,540	3.44%
Marinduque	98,410	82,210	72,840	77,510	82,670	0.60%
Mindoro Occidental	72,820	62,620	68,360	67,880	68,490	0.50%
Mindoro Oriental	63,320	62,910	52,330	62,120	86,180	0.63%
Palawan	124,980	126,540	140,510	154,280	164,310	1.20%
Romblon	61,380	59,960	64,300	69,540	69,890	0.51%
Region V (Bicol Region)	674,620	680,460	826,370	815,670	776,160	5.66%
Albay	117,300	108,300	142,519	116,850	131,220	0.96%
Camarines Norte	72,270	74,910	80,321	91,090	95,960	0.70%
Camarines Sur	246,810	278,530	277,430	279,680	238,560	1.74%
Catanduanes	52,310	48,610	49,310	42,260	51,400	0.38%
Masbate	100,620	84,140	178,850	188,910	191,160	1.40%
Sorsogon	85,310	85,970	97,940	96,880	67,860	0.50%

TOTAL	1-Jan					
	2004	2005	2006	2007	2008	2008
						% to Total
Region VI (Western Visayas)	1,088,550	1,152,080	1,281,550	1,376,490	1,477,500	10.78%
Aklan	112,540	119,130	132,660	126,300	135,100	0.99%
Antique	63,730	63,970	83,070	126,980	118,350	0.86%
Capiz	124,480	141,950	151,830	153,840	162,200	1.18%
Guimaras	22,970	33,770	47,840	67,890	85,420	0.62%
Iloilo	449,460	453,920	516,370	514,410	516,360	3.77%
Negros Occidental	315,370	339,340	349,780	387,070	460,070	3.36%
Region VII (Central Visayas)	927,100	916,890	934,420	1,004,420	971,210	7.09%
Bohol	289,460	301,520	310,020	309,330	285,260	2.08%
Cebu	421,920	404,650	407,420	432,350	423,950	3.09%
Negros Oriental	175,050	171,470	177,490	220,470	219,600	1.60%
Siquijor	40,670	39,250	39,490	42,270	42,400	0.31%
Region VIII (Eastern Visayas)	762,560	745,730	979,630	984,000	988,990	7.22%
Biliran	44,060	44,510	59,910	44,050	26,490	0.19%
Eastern Samar	65,730	73,540	86,090	72,200	72,360	0.53%
Leyte	382,950	358,470	516,550	550,340	653,080	4.77%
Northern Samar	97,200	96,650	121,850	129,330	95,050	0.69%
Samar	86,150	84,630	93,850	71,250	34,680	0.25%
Southern Leyte	86,470	87,930	101,380	116,830	107,330	0.78%
Region IX (Zamboanga Peninsula)	802,370	713,720	799,710	792,110	809,070	5.91%
Zamboanga del Norte	223,270	153,830	164,830	157,850	161,410	1.18%
Zamboanga del Sur	295,380	286,000	356,120	360,830	380,250	2.78%
Zamboanga Sibugay	114,740	113,530	114,900	139,150	166,250	1.21%
Zamboanga City	168,980	160,360	163,860	134,280	101,160	0.74%
Region X (Northern Mindanao)	806,930	768,860	841,140	825,420	798,020	5.82%
Bukidnon	313,100	284,510	373,860	377,430	342,140	2.50%
Camiguin	32,620	34,440	36,210	36,570	34,750	0.25%
Lanao del Norte	62,340	61,950	73,000	75,240	81,720	0.60%
Misamis Occidental	187,830	169,210	155,200	138,660	131,550	0.96%
Misamis Oriental	211,040	218,750	202,870	197,520	207,860	1.52%
Region XI (Davao Region)	873,270	898,160	895,660	947,990	937,640	6.84%
Compostela Valley	127,350	155,670	130,990	130,480	135,730	0.99%
Davao Norte	135,270	138,460	143,910	150,690	147,390	1.08%
Davao del Sur	179,990	186,630	205,820	282,760	288,340	2.10%
Davao Oriental	125,330	125,360	172,040	149,230	135,220	0.99%
Davao City	305,330	292,040	242,900	234,830	230,960	1.69%
Region XII (SOCCSKSARGEN)	674,080	662,880	654,280	673,930	849,140	6.20%
North Cotabato	217,600	215,490	204,620	218,250	233,220	1.70%
Sarangani	91,630	99,030	99,740	101,240	103,730	0.76%
South Cotabato	217,850	209,060	220,290	222,090	386,910	2.82%
Sultan Kudarat	147,000	139,300	129,630	132,350	125,280	0.91%
CARAGA Administrative Reg.	398,960	409,050	408,530	404,070	397,970	2.90%
Agusan del Norte	75,570	81,270	71,090	70,560	71,800	0.52%
Agusan del Sur	118,230	118,080	118,730	113,690	114,250	0.83%
Surigao del Norte	78,240	78,660	84,450	84,640	85,140	0.62%
Surigao del Sur	126,920	131,040	134,260	135,180	126,780	0.93%
ARMM (Autonomous Reg. of Muslim Mind.)	58,940	58,010	78,110	153,220	272,480	1.99%
Basilan	15,900	16,170	20,260	28,260	32,200	0.24%
Lanao del Sur	1,970	2,240	2,670	2,700	2,450	0.02%
Maguindanao	40,240	38,570	53,930	121,140	236,800	1.73%
Sulu	750	620	570	410	380	0.00%
Tawi-Tawi	80	410	680	710	650	0.00%

Swine Inventory Region/Province, Period and Year

Backyard	1-Jan						
	2002	2003	2004	2005	2006	2007	2008
Philippines	**8,935,400**	**9,462,960**	**9,722,030**	**9,257,900**	**9,728,640**	**9,825,510**	**9,726,820**
Metro Manila	.	.	.	.	.	.	.
CAR (Cordillera Administrative	291,720	303,260	296,800	267,170	244,960	244,540	203,650
Abra	58,800	72,000	56,700	57,490	52,040	51,800	50,770
Apayao	18,340	18,330	19,420	20,510	24,420	27,000	25,090
Benguet	41,560	38,440	32,240	28,050	23,370	31,790	22,150
Ifugao	65,520	52,320	53,220	47,820	49,260	43,820	27,960
Kalinga	33,000	49,500	54,890	48,010	31,710	35,730	38,910
Mountain Province	74,500	72,670	80,330	65,290	64,160	54,400	38,770
Region I (Ilocos Region)	414,890	460,780	481,180	455,330	446,820	436,470	434,470
Ilocos Norte	96,000	102,660	95,360	92,250	90,980	80,260	74,240
Ilocos Sur	60,000	75,770	72,340	71,870	85,050	99,340	106,740
La Union	90,070	118,360	130,150	108,510	67,610	54,120	55,000
Pangasinan	168,820	163,990	183,330	182,700	203,180	202,750	198,490
Region II (Cagayan Valley)	632,740	750,940	780,200	682,110	681,110	614,480	503,170
Batanes	.	.	.	.	.	.	.
Cagayan	284,020	300,550	311,740	291,050	307,850	288,410	257,900
Isabela	250,740	310,500	325,940	255,470	238,370	201,730	165,710
Nueva Viscaya	60,900	96,830	93,030	90,490	87,660	85,390	50,700
Quirino	37,080	43,060	49,490	45,100	47,230	38,950	28,860
Region III (Central Luzon)	713,440	808,820	882,240	694,320	697,380	651,300	556,390
Aurora	63,880	85,480	82,020	82,030	88,430	77,260	82,440
Bataan	15,940	15,500	15,470	15,980	17,930	23,400	41,430
Bulacan	225,000	230,860	253,290	138,000	131,660	120,950	85,000
Nueva Ecija	173,270	204,420	250,080	210,260	199,800	190,000	122,360
Pampanga	90,240	105,130	102,200	89,010	96,500	97,510	103,560
Tarlac	42,030	56,530	70,390	62,780	70,490	69,440	54,830
Zambales	103,080	110,900	108,790	96,260	92,570	72,740	66,770
Region IV-A (CALABARZON)	431,270	497,230	511,000	503,330	526,770	498,300	559,690
Batangas	178,660	215,930	219,360	224,460	208,340	201,890	204,050
Cavite	44,300	54,700	50,590	55,080	50,520	44,420	39,040
Laguna	117,290	125,920	128,940	126,560	138,820	140,810	154,660
Quezon	89,160	98,960	110,370	95,300	125,400	104,180	150,400
Rizal	1,860	1,720	1,740	1,930	3,690	7,000	11,540
Region IV-B (MIMAROPA)	365,630	377,130	407,710	380,530	380,490	404,080	423,200
Marinduque	99,450	97,110	98,170	82,000	72,630	77,260	82,350
Mindoro Occidental	57,090	59,840	70,660	60,180	65,860	64,870	66,020
Mindoro Oriental	43,280	44,000	55,330	57,430	47,410	56,370	68,730
Palawan	114,800	120,140	122,760	122,200	132,010	137,860	138,130
Romblon	51,010	56,040	60,790	58,720	62,580	67,720	67,970
Region V (Bicol Region)	691,390	672,470	657,330	659,070	712,690	674,460	599,100
Albay	125,790	121,330	110,840	97,640	122,469	81,590	58,030
Camarines Norte	52,940	66,200	70,340	73,270	79,191	89,780	91,980
Camarines Sur	280,260	247,660	239,660	271,960	268,150	266,700	228,140
Catanduanes	48,950	50,320	52,310	48,610	49,310	42,260	51,400
Masbate	89,660	95,980	100,620	84,140	97,770	100,510	104,190
Sorsogon	93,790	90,980	83,560	83,450	95,800	93,620	65,360

Swine Inventory Region/Province, Period and Year

Backyard	1-Jan						
	2002	2003	2004	2005	2006	2007	2008
Region VI (Western Visayas)	887,090	918,420	976,950	1,029,360	1,110,370	1,200,970	1,281,930
Aklan	104,280	101,280	111,920	118,350	126,700	115,620	127,840
Antique	51,190	57,870	61,990	62,190	79,360	123,100	114,550
Capiz	100,410	112,030	124,120	140,430	149,480	151,780	158,660
Guimaras	24,780	19,580	22,830	33,580	47,590	67,550	84,020
Iloilo	390,930	390,960	374,890	375,170	388,420	386,410	386,910
Negros Occidental	215,500	236,700	281,200	299,640	318,820	356,510	409,950
Region VII (Central Visayas)	738,390	721,080	775,980	779,630	779,490	834,240	794,050
Bohol	261,390	254,430	276,000	286,110	292,290	287,230	254,580
Cebu	255,680	251,060	291,870	290,330	286,030	310,200	305,200
Negros Oriental	185,520	179,250	167,440	163,940	162,040	194,900	192,060
Siquijor	35,800	36,340	40,670	39,250	39,130	41,910	42,210
Region VIII (Eastern Visayas)	710,980	716,470	758,870	741,730	972,930	973,330	978,570
Biliran	45,280	41,260	44,000	44,450	59,860	44,010	26,430
Eastern Samar	64,220	60,290	65,410	73,170	85,560	71,440	71,510
Leyte	370,200	379,100	381,420	356,800	514,480	548,250	651,040
Northern Samar	86,440	89,350	96,990	96,410	121,540	126,190	91,850
Samar	66,750	69,360	85,850	84,400	93,530	70,670	34,400
Southern Leyte	78,090	77,110	85,200	86,500	97,960	112,770	103,340
Region IX (Zamboanga Peninsula)	704,090	790,000	792,310	700,770	776,260	769,210	796,780
Zamboanga del Norte	229,010	220,000	222,180	152,430	161,500	153,550	157,070
Zamboanga del Sur	328,880	282,000	290,290	280,000	341,000	347,020	376,940
Zamboanga Sibugay	.	109,180	112,650	110,340	114,000	138,350	165,180
Zamboanga City	146,200	178,820	167,190	158,000	159,760	130,290	97,590
Region X (Northern Mindanao)	671,630	714,740	712,690	652,260	659,200	645,080	608,370
Bukidnon	216,980	258,210	246,440	199,510	228,560	239,220	200,390
Camiguin	29,310	31,070	32,190	34,160	35,530	35,930	34,020
Lanao del Norte	54,520	51,980	51,390	50,360	59,730	59,400	66,200
Misamis Occidental	172,400	182,260	185,300	166,770	152,180	136,220	128,450
Misamis Oriental	198,420	191,220	197,370	201,460	183,200	174,310	179,310
Region XI (Davao Region)	695,000	713,850	698,480	716,710	744,880	796,270	781,290
Compostela Valley	132,950	141,240	121,130	148,860	123,980	122,750	127,580
Davao Norte	91,940	99,310	102,750	104,500	108,070	111,020	109,660
Davao del Sur	149,710	179,020	172,410	176,820	196,170	271,640	274,840
Davao Oriental	126,810	128,320	123,500	123,320	169,430	146,580	133,990
Davao City	193,590	165,960	178,690	163,210	147,230	144,280	135,220
Region XII (SOCCSKSARGEN)	554,600	552,690	537,130	533,620	513,520	529,830	540,810
North Cotabato	205,500	207,740	213,240	210,130	198,270	213,040	223,800
Sarangani	60,000	80,500	88,550	95,390	95,880	97,750	99,660
South Cotabato	114,670	115,530	94,840	97,300	100,520	100,360	106,130
Sultan Kudarat	174,430	148,920	140,500	130,800	118,850	118,680	111,220
CARAGA Administrative Region	383,130	404,170	394,220	403,950	403,660	399,730	392,870
Agusan del Norte	74,040	75,150	72,680	78,100	67,990	68,540	69,290
Agusan del Sur	109,620	125,820	117,720	117,400	118,020	112,880	113,500
Surigao del Norte	78,850	77,400	77,450	77,750	83,740	83,740	84,080
Surigao del Sur	120,620	125,800	126,370	130,700	133,910	134,570	126,000
ARMM (Autonomous Reg. of Muslim Mind.)	49,410	60,910	58,940	58,010	78,110	153,220	272,480
Basilan	14,140	14,700	15,900	16,170	20,260	28,260	32,200
Lanao del Sur	1,240	1,650	1,970	2,240	2,670	2,700	2,450
Maguindanao	33,110	43,820	40,240	38,570	53,930	121,140	236,800
Sulu	850	680	750	620	570	410	380
Tawi-Tawi	70	60	80	410	680	710	650

Commercial Farms	1-Jan						
	2002	2003	2004	2005	2006	2007	2008
Philippines	**2,717,300**	**2,901,340**	**2,839,660**	**2,881,790**	**3,318,040**	**3,633,820**	**3,974,200**
Metro Manila	.	.	.	.	.	.	.
CAR (Cordillera Administrative Region)	2,780	2,970	2,470	1,720	2,260	2,500	2,500
Abra	520	290	370	400	620	810	730
Apayao	.	.	.	.	.	.	.
Benguet	1,170	1,490	1,040	660	990	1,040	850
Ifugao	550	670	600	360	360	390	690
Kalinga	220	220	190	180	200	240	230
Mountain Province	320	300	270	120	90	20	.
Region I (Ilocos Region)	59,990	60,960	52,600	51,810	66,300	78,870	83,560
Ilocos Norte	2,870	2,850	3,080	3,560	4,220	8,040	10,100
Ilocos Sur	2,270	2,560	2,150	2,810	5,820	9,630	10,050
La Union	7,930	9,980	6,490	6,680	12,560	17,800	17,250
Pangasinan	46,920	45,570	40,880	38,760	43,700	43,400	46,160
Region II (Cagayan Valley)	9,790	16,260	25,710	31,670	67,820	42,970	35,900
Batanes	.	.	.	.	.	.	.
Cagayan	480	700	820	800	2,210	2,880	4,070
Isabela	5,300	9,330	13,680	8,680	16,590	24,560	25,720
Nueva Viscaya	3,550	5,600	10,910	22,000	47,230	13,550	4,300
Quirino	460	630	300	190	1,790	1,980	1,810
Region III (Central Luzon)	1,025,320	1,058,780	980,570	972,590	1,107,690	1,304,050	1,337,190
Aurora	.	.	.	.	.	.	310
Bataan	9,590	13,350	12,600	12,000	12,000	12,800	20,770
Bulacan	846,540	877,910	794,540	790,500	946,910	1,136,060	1,161,480
Nueva Ecija	36,260	41,560	42,500	44,300	32,650	45,560	45,650
Pampanga	59,040	57,980	52,820	50,580	34,490	33,930	41,580
Tarlac	72,110	66,260	75,690	72,060	76,740	70,910	63,310
Zambales	1,780	1,720	2,420	3,150	4,900	4,790	4,090
Region IV-A (CALABARZON)	986,740	1,060,990	1,060,630	1,079,560	1,107,830	1,177,200	1,234,780
Batangas	465,640	528,190	521,600	522,570	501,310	502,080	514,510
Cavite	82,280	92,000	93,880	95,640	109,050	124,880	122,350
Laguna	117,340	125,360	130,260	133,520	140,210	128,340	158,780
Quezon	40,200	36,050	35,820	50,860	65,500	77,230	76,160
Rizal	281,280	279,390	279,070	276,970	291,760	344,670	362,980
Region IV-B (MIMAROPA)	10,370	10,200	13,200	13,710	17,850	27,250	48,340
Marinduque	270	300	240	210	210	250	320
Mindoro Occidental	2,620	2,100	2,160	2,440	2,500	3,010	2,470
Mindoro Oriental	6,780	6,550	7,990	5,480	4,920	5,750	17,450
Palawan	700	1,250	2,220	4,340	8,500	16,420	26,180
Romblon	.	.	590	1,240	1,720	1,820	1,920
Region V (Bicol Region)	14,460	14,580	17,290	21,390	113,680	141,210	177,060
Albay	3,300	4,270	6,460	10,660	20,050	35,260	73,190
Camarines Norte	1,020	1,890	1,930	1,640	1,130	1,310	3,980
Camarines Sur	8,610	7,060	7,150	6,570	9,280	12,980	10,420
Catanduanes	.	.	.	.	.	.	.
Masbate	.	.	.	.	81,080	88,400	86,970
Sorsogon	1,530	1,360	1,750	2,520	2,140	3,260	2,500

Swine Inventory by Farm Type, Region/Province, Period and Year

Commercial Farms	1-Jan						
	2002	2003	2004	2005	2006	2007	2008
Region VI (Western Visayas)	113,670	119,410	111,600	122,720	171,180	175,520	195,570
Aklan	640	510	620	780	5,960	10,680	7,260
Antique	1,630	1,540	1,740	1,780	3,710	3,880	3,800
Capiz	460	270	360	1,520	2,350	2,060	3,540
Guimaras	2,210	1,740	140	190	250	340	1,400
Iloilo	73,160	78,980	74,570	78,750	127,950	128,000	129,450
Negros Occidental	35,570	36,370	34,170	39,700	30,960	30,560	50,120
Region VII (Central Visayas)	123,940	148,000	151,120	137,260	154,930	170,180	177,160
Bohol	12,370	13,990	13,460	15,410	17,730	22,100	30,680
Cebu	106,920	127,780	130,050	114,320	121,390	122,150	118,750
Negros Oriental	4,650	6,230	7,610	7,530	15,450	25,570	27,540
Siquijor	.	.	.	.	360	360	190
Region VIII (Eastern Visayas)	2,610	2,880	3,690	4,000	6,700	10,670	10,420
Biliran	40	60	60	60	50	40	60
Eastern Samar	310	320	320	370	530	760	850
Leyte	850	1,070	1,530	1,670	2,070	2,090	2,040
Northern Samar	30	30	210	240	310	3,140	3,200
Samar	500	530	300	230	320	580	280
Southern Leyte	880	870	1,270	1,430	3,420	4,060	3,990
Region IX (Zamboanga Peninsula)	7,590	10,810	10,060	12,950	23,450	22,900	12,290
Zamboanga del Norte	1,500	780	1,090	1,400	3,330	4,300	4,340
Zamboanga del Sur	3,170	4,380	5,090	6,000	15,120	13,810	3,310
Zamboanga Sibugay	.	2,870	2,090	3,190	900	800	1,070
Zamboanga City	2,920	2,780	1,790	2,360	4,100	3,990	3,570
Region X (Northern Mindanao)	83,150	86,800	94,240	116,600	181,940	180,340	189,650
Bukidnon	62,490	62,800	66,660	85,000	145,300	138,210	141,750
Camiguin	260	380	430	280	680	640	730
Lanao del Norte	8,140	11,120	10,950	11,590	13,270	15,840	15,520
Misamis Occidental	1,380	1,800	2,530	2,440	3,020	2,440	3,100
Misamis Oriental	10,880	10,700	13,670	17,290	19,670	23,210	28,550
Region XI (Davao Region)	149,990	173,470	174,790	181,450	150,780	151,720	156,350
Compostela Valley	3,090	5,600	6,220	6,810	7,010	7,730	8,150
Davao Norte	25,000	33,270	32,520	33,960	35,840	39,670	37,730
Davao del Sur	6,520	7,420	7,580	9,810	9,650	11,120	13,500
Davao Oriental	2,460	2,220	1,830	2,040	2,610	2,650	1,230
Davao City	112,920	124,960	126,640	128,830	95,670	90,550	95,740
Region XII (SOCCSKSARGEN)	123,320	131,230	136,950	129,260	140,760	144,100	308,330
North Cotabato	5,000	3,720	4,360	5,360	6,350	5,210	9,420
Sarangani	1,920	3,710	3,080	3,640	3,860	3,490	4,070
South Cotabato	110,870	117,370	123,010	111,760	119,770	121,730	280,780
Sultan Kudarat	5,530	6,430	6,500	8,500	10,780	13,670	14,060
CARAGA Administrative Region	3,580	4,000	4,740	5,100	4,870	4,340	5,100
Agusan del Norte	2,420	2,370	2,890	3,170	3,100	2,020	2,510
Agusan del Sur	250	410	510	680	710	810	750
Surigao del Norte	700	840	790	910	710	900	1,060
Surigao del Sur	210	380	550	340	350	610	780
ARMM (Autonomous Reg. of Muslim Mind.)	.	.	.	.	.	.	.
Basilan	.	.	.	.	.	.	.

Acetogenesis—The formation of acetate (CH3COOH) from carbon dioxide and hydrogen. Many methanogens grow and form methane from acetate.

Acidogenesis—The formation of primarily short-chain volatile acids such as acetic, proprionic, butyric, valeric, and caproic from simple soluble compounds produced during hydrolysis.

Activated Sludge Process—A biological wastewater treatment process in which a mixture of wastewater and activated sludge (biosolids) is agitated and aerated. The activated sludge is subsequently separated from the treated wastewater by sedimentation and wasted or returned to the process as needed.

Advanced Waste Treatment—Any physical, chemical or biological treatment process used to accomplish a degree of treatment greater than achieved by secondary treatment.

Aerated Pond or Lagoon—A wastewater treatment pond or lagoon in which mechanical or diffused aeration is used to supplement the oxygen supplied by diffusion from the atmosphere.

Aerobic—Requiring the presence of free elemental oxygen.

Aerobic Bacteria—Bacteria that require free elemental oxygen to sustain life.

Aerobic Digestion— The degradation of organic matter including manure by the action of microorganisms in the presence of free elemental oxygen.

Aerobic Waste Treatment—Waste treatment brought about through the action of microorganisms in the presence of air or elemental oxygen. The activated sludge process is an aerobic waste treatment process.

Anaerobic—Requiring the absence of air or free elemental oxygen.

Anaerobic Bacteria—Bacteria that grow only in the absence of free elemental oxygen.

Anaerobic Contact Process—Any anaerobic process in which biomass is separated from the effluent and returned to a complete mix or contact reactor so that the solids retention time (SRT) is longer than the hydraulic retention time (HRT).

Anaerobic Digester—A tank or other vessel for the decomposition of organic matter under anaerobic conditions.

Anaerobic Digestion—The degradation of organic matter including manure by the action of microorganisms in the absence of free elemental oxygen.

Anaerobic Pond or Lagoon—An open treatment or stabilization structure that involves retention under anaerobic conditions.

Anaerobic Sequencing Batch Reactor (ASBR) Process—A batch anaerobic digestion process that consists of the repetition of following four steps: 1) feed, 2) mix, 3) settle, and 4) decant/effluent withdrawal.

Anaerobic Waste Treatment—Waste stabilization brought about through the action of microorganisms in the absence of air or elemental oxygen. Usually refers to waste treatment by methane fermentation. Anaerobic digestion is an anaerobic waste treatment process.

Attached Film Digester—An anaerobic digester in which the microorganisms responsible for waste stabilization and biogas production are attached to inert media.

Bacteria—A group of universally distributed and normally unicellular microorganisms lacking chlorophyll.

Biochemical Oxygen Demand (BOD)—A measure of the quantity of oxygen utilized in the biochemical oxidation of organic matter in a specified time and at a specified temperature. It is not related to the oxygen requirements in chemical combustion, being determined entirely by the availability of the material as biological food and by the amount if oxygen utilized by the microorganisms during oxidation.

Biogas—A mixture of methane and carbon dioxide produced by the bacterial decomposition of organic wastes and used as a fuel.

Biological Treatment Processes—There are two general types of biological waste treatment processes: suspended and attached growth. Suspended growth processes generally involve mixing to enhance contact between the microbial population and the wastewater constituents. Suspended growth processes can be either aerobic or anaerobic. The activated sludge process is an example of suspended growth wastewater treatment process.

Attached growth processes are characterized by the development of a microbial population attached to a natural or artificial media when exposed to wastewater constituents. The trickling filter is an example of an attached growth wastewater treatment process. Attached growth processes also can be either aerobic or anaerobic.

Cesspool—A lined or partially lined underground pit into which wastewater is discharged and from which the liquid seeps into the surrounding soil. Sometimes called a leaching cesspool.

Chemical Oxygen Demand (COD)—A quantitative measure of the amount of oxygen required for the chemical oxidation of carbonaceous (organic) material in wastewater using inorganic dichromate or permanganate salts as oxidants in a two-hour test.

Chemical Unit Processes—Processes that remove dissolved and suspended wastewater constituents by chemically induced coagulation and precipitation or oxidation. An example is the addition of alum or lime to remove phosphorus by precipitation in tertiary treatment.

Clarifier—Any large circular or rectangular sedimentation tank used to remove settleable solids from water or wastewater. A special type of clarifiers, called upflow clarifiers, use floatation rather than sedimentation to remove solids.

Complete Mix Digester—A controlled temperature, constant volume, mechanically or hydraulically mixed vessel operated for the stabilization of organic wastes including manures anaerobically with the capture of biogas generated as a product of waste stabilization.

Compost—The production of the microbial oxidation of organic wastes including livestock manures at an elevated temperature.

Composting—The process of stabilizing organic wastes including livestock manures by microbial oxidation with the conservation of microbial heat production to elevate process temperature.

Covered Lagoon Digester—A pond or lagoon operated for the stabilization of organic wastes including manures anaerobically and fitted with an impermeable cover to capture the biogas generated as the product of waste stabilization.

Digester—A tank or other vessel for the aerobic or anaerobic decomposition of organic matter present in biosolids or other concentrated forms of organic matter including livestock manures.

Dissolved Air Floatation (DAF)—A separation process in which air bubbles emerging from a supersaturated solution become attached to suspended solids in the liquid undergoing treatment and flat them up to the surface for removal by skimming.

Effluent—The discharge from a waste treatment or stabilization unit process.

Evaporation Pond—A pond or lagoon used for the disposal of wastewater by evaporation.

Facultative—Having the ability to live under different conditions; for example with or without free oxygen.

Facultative Bacteria—Bacteria, which can carry out metabolic activities including reproduction in the presence or absence of free elemental oxygen.

Facultative Pond or Lagoon—A natural or constructed pond or lagoon with an aerobic upper section and an anaerobic bottom section so that both aerobic and anaerobic processes occur simultaneously.

Five Day BOD—That part of oxygen demand usually associated with biochemical oxidation of carbonaceous material with in five days at 20 ℃.

Greenhouse Gas—A gas present in the atmosphere, which is transparent to incoming solar radiation but absorbs the infrared radiation reflected form the earth's surface. The principal greenhouse gases are carbon dioxide, methane, and CFCs.

Human Sewage (Domestic Wastewater) – Human sewage is wastewater that contains human urine and feces. It also usually contains wastewater from bathing and washing of dishes, kitchen utensils, clothing, etc. and may include food preparation wastes. It may be discharged directly, treated on-site prior to discharge, or transported by a collection system for direct discharge or treatment in a centralized wastewater treatment plant followed by discharge. Human sewage also is known as domestic wastewater.

Hydraulic Retention Time (HRT)—The volume of a reactor divided by the volumetric flow rate.

Hydrolysis—The reduction of insoluble organic and complex soluble organic compounds to simple soluble organic compounds.

Influent—Wastewater flowing into a unit waste treatment or stabilization process.

Lagoon—Any large holding or detention structure, usually with earthen dikes, used to contain wastewater while sedimentation and biological oxidation or reduction occurs.

Liquid Manure—Manure having a total solids (dry matter) content not exceeding five percent.

Manure—The mixture of the fecal and urinary excretions of livestock, which may or may not contain bedding material.

Mesophilic Digestion—Digestion by biological action at 27 C to 38 °C.

Methane—A colorless, odorless, flammable gaseous hydrocarbon that is a production of the anaerobic, microbial decomposition of organic matter.

Methanogenesis—The formation of methane from CO_2-type, methyl, and acetoclastic type substrates.

Municipal Wastewater—Wastewater treated in a municipal (publicly owned) treatment plant and can contain domestic, commercial and industrial wastewaters.

Organic Matter—Chemical substances of animal or vegetable origin, or more correctly, containing carbon and hydrogen.

Oxidation Pond—A relatively shallow body of wastewater contained in an earthen basin of controlled shape, in which biological oxidation of organic matter is effected by the natural or artificially accelerated transfer of oxygen.

Physical Unit Processes—Processes that remove particulate matter in wastewater. Screening and gravity separation to remove particulate matter are examples of physical unit processes. These processes are used for primary treatment and following secondary and tertiary treatment processes. A typical example of the use of physical unit processes in a wastewater treatment system is primary settling followed by the activated sludge treatment process, which is then followed by secondary settling before final effluent discharge.

Plug-Flow—Flow in which fluid particles are discharged from a tank or pipe in the same order in which they entered it. The particles retain their discrete identities and remain in the tank for a time equal to the theoretical retention time.

Plug-Flow Digester—A controlled temperature, constant volume, unmixed vessel operated for the stabilization of organic wastes including manures anaerobically with the capture of biogas generated as a product of waste stabilization.

Primary Treatment*—(1) The first major treatment in a wastewater treatment facility, usually sedimentation but not biological oxidation. (2) The removal of a substantial amount of suspended matter but little or no colloidal and dissolved matter. (3) Wastewater treatment processes usually consisting of clarification with or without chemical treatment to accomplish solid-liquid separation.

Psychrophilic Digestion—Digestion by biological action below 27 °C.

Raw Wastewater—Wastewater before it receives any treatment.

Secondary Treatment*—(1) Generally, a level of treatment that produces removal efficiencies for BOD and suspended solids of at least 85 %. (2) Sometimes used interchangeably with the concept of biological wastewater treatment, particularly the activated sludge process. Commonly applied to treatment that consists chiefly of clarification followed by a biological process, with separate sludge collection and handling.

Solids Retention Time (SRT)—The average time in which solids including the population of active microbial biomass remain in a reactor.

Septic Tank—An underground vessel for treating wastewater by a combination of settling and anaerobic digestion. Effluent usually is disposed of by leaching. Settled solids are removed periodically for further treatment or disposal.

Settling Pond—An earthen basin in which wastewater containing settleable solids is retained to remove a part of suspended matter by gravity. Also called a settling or sedimentation basin and settling tanks or basins perform the same function.

Stabilization—Reduction in the concentration of putrescible material by either an aerobic or anaerobic process. Both aerobic and anaerobic digestion are examples of waste stabilization processes.

Suspended Solids—(1) Insoluble solids that either float on the surface of, are in suspension in, water, wastewater, or other liquids. (2) Solid organic or inorganic particles (colloidal, dispersed, coagulated, flocculated) physically held in suspension by agitation or flow. (3) The quantity of material removed from wastewater in a laboratory test, as prescribed in “Standard methods for the Examination of Water and Wastewater” and referred to as nonfilterable residue.

Tertiary Treatment*—The treatment of wastewater beyond the secondary or biological stage. Term normally implies the removal of nutrients, such as nitrogen and phosphorus, and a high percentage of suspended solids. Term now being replaced by preferable term, advanced waste treatment.

Thermophilic Digestion—Digestion carried on at a temperature approaching or within the thermophilic range, generally between 43 ℃ and 60 ℃.

Total Solids—The sum of dissolved and suspended solid constituents in water or wastewater.

Treatment—The use of physical, chemical, or biological processes to remove one or more undesirable constituents from a waste.

Upflow Anaerobic Sludge Blanket (UASB) Reactor—An upflow anaerobic reactor in which influent flows upward through a blanket of flocculated sludge that has become granulated.

Volatile Solids—Materials, generally organic, which can be driven off by heating, usually to 550 ℃; non-volatile inorganic solids (ash) remain.

Wastewater—The spent or used water of a community or industry, which contains dissolved and suspended matter.

Wastewater Treatment System*—A sequence of unit processes designed to produce a final effluent that satisfies standards for discharge to surface or ground waters. Typically will include the combination of a primary and secondary treatment processes.

*Appendix A illustrates the typical wastewater treatment process.

APPENDIX H: ***LIST OF REGISTERED SLAUGHTERHOUSES***

LIST OF ACCREDITED SLAUGHTER HOUSES
2008 Entry

	Name of Meat establishment	ADDRESS/LOCATION	ESTIMATED VOLUME SLAUGHTERED /DAY	ACCREDITATION RATING	TELEPHONE NO	FAX NO.	CONTACT PERSON	DESIGNATION
	REGION 1							
1	Alaminos City Abattoir	Sabaro, Alaminos City, Pangasinan		AA				
2	Malasiqui Municipal Abattoir	Brgy. Cabatling, Malasiqui, Pangasinan		AA				
3	Mangaldan Municipal Abattoir	Brgy. Bari, Mangaldan, Pangasinan		AA				
4	PGMA-Multiline Food Processing Plant	Brgy. Mabilbila, Santa, Ilocos Sur		AA				
5	Rosario Municipal Abatto	Poblacion East, Rosario, La Union		A				
6	San Carlos City Abattoir	Brgy. San Pedro, San Carlos City, Pangasinan		A				
7	Umingan Municipal Abattoir	Brgy. Lauren, Umingan, Pangasinan		A				
8	Urdaneta City Abattoir	Brgy. Anonas West, Urdaneta City, Pangasinan		AA				
	REGION II							
1	Bayombong Municipal Abattoir	Brgy. Vista Alegre, Bayombong, Nueva Viscaya		A				
	REGION III							
1	Balagtas Municipal Abbatoir	Wawa, Balagtas, Bulacan		AA				
2	Balanga City Abattoir	Access Rd., San Jose, Balanga City, Bataan	75	AA	047 791-4452/ 047 791-3274		Amalio Rusuello / Nerissa B. Mateo	City Market Administrator
3	Clarefelle Abattoir	Navarette St., Obando, Bulacan		AA				
4	Marilao Municipal Abattoir	Sta. Rosa 1, Marilao, Bulacan		AA	044 711-4058/ 0928490-8926		Virginia De La Paz	
5	Meycauayan Market and Abattoir	Zamora St., Meycauayan, Bulacan	120	AA	044 840-6565		Edward A. Cabangon	President
6	Moncada Municipal Abattoir	Public Market Compound, Pob. 1, Moncada, Tarlac	30	AA	045 601-0374			
7	Mother Earth	Maunawa St., Brgy. Duquit, Mabalacat, Pampanga	250	AA	045 892-6621 / 6625/6543	045 332-3371	Renato S. Tayag	President
8	Rombe Philippines, Inc.	Km. 47 Dampol 1st, Pulilan, Bulacan	200	AA	044 676-3700/ 044 676-1461	03 299-8346	Buenaventura M. Peralta	President
9	Samaria Food Corporation	Sitio Pakulis, Brgy. Gaya-Gaya, San Jose del Monte, Bulacan	200	AA	044 433-0237 / 044 433-0144		Roger O. Galicia	President
10	San Jose del Monte Abattoir	Tungkong Mangga, San Jose del Monte, Bulacan		AA			Loreto Roque	
11	San Rafael Municipal Abattoir	Cruz na Daan, San Rafael, Bulacan		AA	044 902-0066			
	Sub Total		**875**					

	Name of Meat establishment	A D D R E S S/ L O C A T I O N	ESTIMATED VOLUME SLAUGHTERED /DAY	ACCREDITATION RATING	TELEPHONE NO	FAX NO.	CONTACT PERSON	DESIGNATION
	REGION IV-A							
1	Bungahan Development Enterprise	66 Bungahan, Cuenca, Batangas	2	AA	043 342-1528		Augusto G. Chavez	
2	Emmanuel Multi-Purpose Cooperative, Inc.	Emmanuel, Cuenca, Batangas	10	AA	043 772-0175 / 342-5220		Teresita M. Malabanan	
3	Fortress Food Manufacturing Corp.	#35 Sto. Nino St., Ma. Corazon Subd., Cupang, Antipolo City		AA	02 682-8272		Amelia R. Coronel	General Manager
4	General Mariano Alvarez Abattoir	Brgy. FVR, Poblacion 5, GMA, Cavite		AA			Mario Villapando	
5	Imus Municipal Abattoir	Buhay na Tubig, Imus, Cavite	80	AA				
6	Jaro Dev't Corp. Abattoir	Buhay na Tubig, Tanzang Luma, Imus, Cavite		AA	046 471-0170	046 471-0252	Roberto A. Jaro	
7	Maria Asuncion Albano Abattoir	San Jose, Pingay, Antipolo City	130	AA	645-1778/645-1771		Mr. Manuel S. Ko	Owner
8	Monterey Foods Corp.	Gov. Dr., Brgy. Langkaan, Dasmarinas, Cavite	1,050	AAA			Cynthia Garcia	QSM Head
9	Kabayan Abattoir, Inc.	Brgy. Natunuan, San Jose, Batangas		AA	0927 468-3750		Leon C. Gonzales	
10	R. Fresno Abattoir	Brgy. Pinugay, Baras, Rizal	50	AA			Reynaldo Z. Fresno	Owner
11	Rocky Farms, Inc. Abattoir	#8 Circumsferential Rd., Dalig, Antipolo City	23	AA	697-0103 / 697-1708		Jeffrey C. Ileto	
12	Rublou Meat Products and Abattoir	131 A. Bonifacio Ave., Cainta, Rizal	300	AA	02 655-4127		Ruby A. Ticman	President
13	San Pedro Abattoir	246 Mendoza St., San Roque, San Pedro, Laguna	75	AA	02 520-1863		Jaime Medina	
14	Virginia J. Cabasaan Abattoir	Brgy. 3, National Highway, Cuenca, Batangas		A	043 342-1138		Virginia J. Cabasaan	Owner
15	VR Abattoir	54 Sumulong Highway, Mayamot, Antipolo City	100	AA	02 681-6727	02 624-2730	Evangeline T. Tapia	Plant Manager
16	VST Livestock Corp.	Km. 13 Marcos Highway, Cupang, Antipolo City		AA	02 647-5165	02 647-5168	Irma S. Abeleda	General Manager
	Sub Total		**1,820**					
	REGION IV-B							
1	Aborlan Municipal Abattoir	Brgy. Mabini, Aborlan, Palawan		A				
2	Puerto Galera Abattoir	Hundura, Poblacion, Puerto Galera		AA				
3	Puerto Princesa City Abattoir	Brgy. Tagburos, Puerto princesa City, Palawan		AA				
4	Victoria Municipal Abattoir	Victoria, Mindoro Oriental		AA				
	REGION V							
1	Baao Municipal Abattoir	Salvacion, Baao, Camarines Sur		A				
2	Gubat Municipal Abattoir	Highway 59, Ariman, Gubat, Sorsogon		AA				
3	Guinobatan Municipal abattoir	Guinobatan Albay		A				
4	Masbate City Abattoir	Brgy. Kinamaligan, Masbate City		AA				
5	Naga City Abattoir	Brgy. Del Rosario, Naga City		AA				
6	San Andres Municipal Abattoir	Belmonte, San Andres, Catanduanes		A				

	Name of Meat establishment	A D D R E S S/ L O C A T I O N	ESTIMATED VOLUME SLAUGHTERED /DAY	ACCREDITATION RATING	TELEPHONE NO	FAX NO.	CONTACT PERSON	DESIGNATION
	REGION VI							
1	Guimbal Municipal Abattoir	Brgy. Bagumbayan, Guimbal, Iloilo		AA				
2	Iloilo City Abattoir	Brgy. Tacas, Jaro		AA				
3	Miag-ao Municipal Abattoir	Baybay Norte, Miag-ao, Iloilo		A				
4	Passi City Abattoir	F. Palmeras St., Poblacion, Ilawod, Passi City		AA				
	REGION VII							
1	Alturas Abattoir	Tabalong, Dauis, Bohol		AA				
2	Bohol Quality Corp. Abattoir	Pandol, Corella, Bohol		AA				
3	Dumaguete City Abattoir	Bajumpandan, Dumaquete City		AA				
4	Sunpride Foods, Inc.	S.E Jaime St., Paknaan, Mandaue City		AAA				
5	Talisay City Livestock and Poultry Center	Lower Mohon, Talisay City		AA				
	REGION VIII							
1	Isabel Municipal Abattoir			A				
	REGION IX							
1	Atilano Abattoir	Curuan, Zambunga City		A				
2	Bayog Municipal Abattoir	Despase, Bayog, Zambuanga del Sur		A				
3	Bonita's Abattoir	Labuan, Zambuanga City		A				
4	Buug Municipal Abattoir	Buug, Zambuanga Sibugay		A				
5	Chiong Abattoir	Vitali Proper, Vitali, Zambuanga City		A				
6	Danilo A. Uy Abattoir	Zone 2, Duncaan, Boalan, Zambuanga City		A				
7	Divisoria Abattoir	Divisoria, Zambuanga City		A				
8	Dumingag Municipal Abattoir	Dumingag, Sambuanga del Sur		A				
9	Falcasantos Abattoir	Curuan, Zambuanga City		A				
10	Guipos Municipal Abattoir	Guipos, Zambuanga del Sur		A				
11	Ipil Municipal Abattoir	Bangkerohan, Ipil, Zambuanga Sibugay		A				
12	Mahayag Municipal Abattoir	Mahayag, Zambuanga City		A				
13	Macrohon Abattoir	Tulungatung, Zambuanga City		A				
14	Margosatubig Municipal Abattoir	Margosatubig, Zambuanga del Sur		A				
15	Molave Municipal Abattoir	Molave, Zambuanga del Norte		A				
16	Pinan Municipal Abattoir	Pinan, Zambuanga del Norte		A				
17	Polanco Municipal Abattoir	Polanco, Sambuanga del Nrte		A				
18	Salug Municipal Abattoir	Poblacion East, Salug, Zambuanga del Norte		A				
19	Sarao Abattoir	Ayala, Zambuanga City		A				
20	Senora Rosa Abattoir	Ayala, Zambuanga City		A				
21	Sindangan Municipal Abattoir	Goleo, Sindangan, Zambuanga del Norte		A				
22	Tropical Meat Haus Abattoir	Tetuan Highway, Zambuanga City		A				
	REGION X							
1	Del Monte Phils., Inc.	San Miguel, Manolo Fortich, Bukidnon		AA				
2	Manolo Fortich Municipal Abattoir	Pol-oton, Poblacion, Manolo Fortich		AA				
3	Mega Integrated Agro-Livestock Farm	Cugman, Cagayan de Oro City		AA				
4	St. Jude Abattoir	Sta. Ana, Tagoloan, Misamis Oriental		AA				
	REGION XI							
1	Banaybanay Municipal Abattoir	San Vicente, Banaybanay, Davao Oriental		A				
2	Davao City Abattoir	Ma-a, Davao City		A				
3	Digos City Abattoir	Tres de Mayo, Digos, Davao del Sur		AA				
4	Nenita Quality Foods Corp.	Marapangi, Toril, Davao City		AAA				
	REGION XII							
1	Ciudad Halal Abattoir	Sadaan, Midsayap, Cotabato		AA				
2	Gen. Santos City Abattoir	Brgy. Mabuhay, Gen. Santos City		AA				
3	Jolisa Agri-Business Corp.	Brgy. Apopong, Sinawal, Gen. Santos City		AA				
4	Matutum Meat Packing Corp. Abattoir	Brgy. Glamang, Polomolok, South Cotabato		AAA				

	Name of Meat establishment	ADDRESS/LOCATION	ESTIMATED VOLUME SLAUGHTERED /DAY	ACCREDITATION RATING	TELEPHONE NO	FAX NO.	CONTACT PERSON	DESIGNATION
	CAR							
1	Alabanza Private Abattoir	Badiwan, Tuba, Benguet		AA				
2	Baguio City Abattoir	Slaughterhouse Compound, Baguio City		A				
3	Bangued Municipal Abattoir	Bangued, Abra		A				
4	Gismundo Abattoir	Taloy Norte, Benguet		AA				
5	Manabo Municipal Abattoir	Manabo, Abra		A				
6	Philex Mines Abattoir	Padcal, Camp 3, Tuba, Benguet		A				
7	Pudtol Municipal Abattoir	Poblacion Pudtol, Apayao		A				
8	Tayum Municipal Abattoir	Tayum, Abra		A				
	CARAGA							
1	Bislig City Abattoir	Brgy. Cumawas, Bislig City		AA				
2	Prosperidad Municipal Abattoir	Poblacion, Prosperidad, Agusan del Sur		AA				
3	San Francisco Municipal Abattoir	San Isidro, San Francisco, Agusan del Sur		AA				
4	Surigao City Abattoir	Poctoy, Surigao City		AA				
	NATIONAL CAPITAL REGION							
1	Batimana Abattoir	77 Batimasa Compound, Marulas, Valenzuela City	130	AA	02 291-7280		Ernesto M. Batimana, Jr.	
2	Hulong-duhat Lechonan	57 Don B. Bautista Ave., Dampalit, Hulong-duhat, Malabon City		A	02 281-6197 / 0922 942-5379		Cesar R. Nunez	
3	Integrated Livestock & Allied Service, Inc. (ILASI) Abattoir	1380 Edang St., Brgy. 154, Pasay City		A	02 833-7226	02 831-9126	Ernesto B. Ochoa, Jr.	Owner
4	J & E Abattoir	62 Don B. Bautista St., Dampalit, Malabon City	100	AA	02 281-0717		Pepito H. Santiago	Owner
5	Jerril's Abattoir	2386 Antipolo St., Guadalupe Nuevo, Makati City	63	AA	02 882-1852		Jerril La Torre	Owner
6	Joe's Native Lechon	73 N. Senora del Rosario St., Pasay City	10	AA	02 524-9948 / 523-7095	02 536-3639	Jose Cabral	
7	Kalookan Abattoir	3772 Sinilyasi cor. Lapu-lapu Ave., Caloocan City	200	AA	02 323-7972	02 323-7972	Dr. Edgardo Dimalanta	In-House Veterinarian
8	Las Pinas Abattoir	11 Santos Dr., Santos Village, Zapote, Las Pinas City	180	AA	02 872-3236	02 874-5181	Jaime Santos	
9	Leonardo's Native Lechon	89 J. Basa St., Brgy. San Pedro Cruz, San Juan, Metro Manila		A	02 724-3068 / 726-9828 / 744-5172	02 725-8618	Mr. Leonard Aquino	Manager
10	Loring's Native Lechon	#6 J. Eustaquio St., San Juan, Metro Manila		A	02 724-2867 / 725-2580		Loreto Galit Bautista	
11	Malabon Abattoir	Interior Luna II, San Agustin, Malabon City	120	AA	02 281-5606 / 281-4693		Clemente Dela Cruz	Owner
12	Max and Benz Abattoir	5079 Darlucio St., Brgy. Ugong, Valenzuela City	50	AA	02 443-2215		Silvino R. Rinosa	
13	Megga Stock Farm, Inc.	66 F. Manalo St., Brgy. Kabayanan, San Juan, Metro Manila	250	AA	02 722-2514 / 726-4160		Val Mendoza	President
14	Muntinlupa Abattoir	743 Purok 5, Sucat, Muntinlupa City	100	AA	02 544-6183 / 0917 803-6818		Hilarion Ramirez	
15	Novaliches Abattoir	Lot 1, Blk 3, Baco St., Brgy. Capri, Nagkaisang Nayon, Novaliches, Quezon City	150	AA	02 938-7303 / 02 937-3292	02 936-0453	Jose A. Visaya	President
16	Presnedi Abattoir	212 San Guillermo St., Brgy. Putatan, Muntinlupa City		AA	02 861-2296 / 862-2772		Daniel Presnedi	
17	Purefoods-Hormel Co., Inc.	Brgy. San Roque, Marikina City		AAA				
18	Yabut Abattoir	Lot 15, Progreso I, Guadalupe Viejo, Makati City	75	AA	02 729-4487		Benigno R. Yabut	
19	Zaraspe Abattoir	3824 Mascardo St., Tejeros, Makati City	110	AA	02 897-0127 / 896-0811	02 890-3509	Lino Zaraspe, Jr.	
	Sub Total		**1,538**					

APPENDIX I: ***SLAUGHTERHOUSE PRODUCTION***

Livestock Slaughtered in Abattoirs by Animal Type, Region/Province, Period and Year							
	Annual						
	2002	2003	2004	2005	2006	2007	2007
Swine							
Philippines	8,999,518	9,361,768	9,024,485	9,415,037	9,572,217	9,789,062	100%
National Capital Region	1,727,655	1,527,156	1,459,558	1,768,698	1,631,621	1,544,742	16%
CAR (Cordillera Administrative Region)	130,563	137,709	123,658	122,791	130,209	142,715	1%
Abra	21,462	21,400	22,636	22,383	22,917	26,684	0%
Apayao	3,219	3,277	3,379	3,462	3,715	4,054	0%
Benguet	84,090	91,096	77,214	77,198	83,649	89,078	1%
Ifugao	6,487	6,664	6,078	5,915	6,713	8,637	0%
Kalinga	9,448	9,458	8,115	8,505	8,316	8,784	0%
Mountain Province	5,857	5,814	6,236	5,328	4,899	5,478	0%
Region I (Ilocos Region)	680,961	725,629	677,905	646,956	651,091	705,019	7%
Ilocos Norte	112,646	122,311	112,806	109,071	106,704	115,826	1%
Ilocos Sur	88,151	92,506	82,403	83,392	88,574	90,260	1%
La Union	137,547	151,546	135,386	128,025	125,241	138,047	1%
Pangasinan	342,617	359,266	347,310	326,468	330,572	360,886	4%
Region II (Cagayan Valley)	378,104	401,624	365,635	358,837	373,086	382,367	4%
Batanes	.	.	.	.	.	.	
Cagayan	131,025	131,411	116,203	126,917	134,283	132,049	1%
Isabela	175,796	190,093	176,750	166,736	170,239	170,774	2%
Nueva Viscaya	57,124	64,370	59,069	52,382	56,023	63,831	1%
Quirino	14,159	15,750	13,613	12,802	12,541	15,713	0%
Region III (Central Luzon)	1,447,029	1,450,519	1,391,622	1,417,743	1,530,507	1,517,142	15%
Aurora	15,801	17,491	15,684	14,599	16,387	18,841	0%
Bataan	89,584	105,495	103,440	99,983	104,184	110,665	1%
Bulacan	446,526	420,659	410,490	404,756	425,480	461,516	5%
Nueva Ecija	270,317	284,245	263,218	271,559	317,092	268,515	3%
Pampanga	356,021	330,632	321,868	366,712	391,736	386,790	4%
Tarlac	158,371	170,499	163,191	146,450	155,505	147,020	2%
Zambales	110,409	121,498	113,731	113,684	120,123	123,795	1%
Region IV-A (CALABARZON)	1,579,824	1,807,350	1,714,611	1,738,843	1,752,157	1,784,587	18%
Batangas	265,998	284,362	270,629	266,242	323,670	310,351	3%
Cavite	504,130	593,418	591,753	542,197	484,997	478,965	5%
Laguna	274,384	300,465	284,064	286,264	311,388	309,590	3%
Quezon	162,886	175,759	170,056	167,546	172,584	194,777	2%
Rizal	372,426	453,346	398,109	476,594	459,518	490,904	5%
Region IV-B (MIMAROPA)	201,134	211,340	204,500	199,464	200,390	219,748	2%
Marinduque	25,309	25,658	26,158	24,278	24,696	27,086	0%
Mindoro Occidental	34,478	32,831	36,172	37,844	37,860	39,735	0%
Mindoro Oriental	66,388	72,517	68,470	65,274	65,793	70,900	1%
Palawan	58,473	61,741	56,588	56,727	55,324	61,331	1%
Romblon	16,486	18,593	17,112	15,341	16,717	20,696	0%
Region V (Bicol Region)	363,769	410,951	401,208	379,543	383,238	398,000	4%
Albay	102,642	124,519	112,499	102,806	109,010	101,206	1%
Camarines Norte	45,176	51,875	48,936	46,055	50,170	57,698	1%
Camarines Sur	127,123	137,867	140,015	132,859	130,916	143,545	1%
Catanduanes	10,311	11,361	10,728	10,265	10,935	7,616	0%
Masbate	23,114	24,534	31,167	30,939	23,397	26,465	0%
Sorsogon	55,403	60,795	57,863	56,619	58,810	61,470	1%
Region VI (Western Visayas)	446,575	494,499	541,112	522,489	565,505	603,766	6%
Aklan	57,947	61,406	64,320	71,379	77,775	83,995	1%
Antique	17,041	20,376	21,889	21,124	22,668	25,526	0%
Capiz	36,100	36,641	36,200	37,656	42,288	48,771	0%
Guimaras	5,621	5,196	5,592	5,180	5,414	5,769	0%
Iloilo	152,113	175,379	194,991	186,018	202,956	215,588	2%
Negros Occidental	177,753	195,501	218,120	201,132	214,404	224,117	2%

Livestock Slaughtered in Abattoirs by Animal Type, Region/Province, Period and Year

	Annual						
	2002	2003	2004	2005	2006	2007	2007
Swine							
Region VII (Central Visayas)	706,208	743,324	669,843	773,436	769,914	800,976	8%
Bohol	66,871	78,968	85,011	78,167	73,332	80,007	1%
Cebu	564,483	585,928	498,083	607,764	602,436	618,241	6%
Negros Oriental	70,545	73,625	82,186	82,600	89,378	98,024	1%
Siquijor	4,309	4,803	4,563	4,905	4,768	4,704	0%
Region VIII (Eastern Visayas)	199,284	214,407	217,000	212,388	221,642	229,492	2%
Biliran	9,587	10,447	12,633	12,486	11,542	10,946	0%
Eastern Samar	9,518	10,365	10,663	13,518	15,913	17,542	0%
Leyte	121,877	132,376	128,768	121,731	128,928	132,423	1%
Northern Samar	9,608	10,059	11,405	11,761	13,473	13,727	0%
Southern Leyte	23,718	24,458	25,827	25,053	24,630	28,650	0%
Western Samar	24,976	26,702	27,704	27,839	27,156	26,204	0%
Region IX (Zamboanga Peninsula)	180,882	195,090	198,284	191,213	182,321	190,912	2%
Zamboanga del Norte	32,167	33,168	35,320	35,251	36,700	37,837	0%
Zamboanga del Sur	75,674	88,109	92,453	90,386	37,357	97,988	1%
Zamboanga Sibugay	16,607	17,189	17,138	15,565	44,637	16,151	0%
Zamboanga City	56,434	56,624	53,373	50,011	63,627	38,936	0%
Region X (Northern Mindanao)	306,181	329,587	327,534	336,867	340,240	357,192	4%
Bukidnon	59,526	71,656	77,064	70,933	80,808	93,862	1%
Camiguin	5,080	4,571	6,295	6,089	6,543	7,195	0%
Lanao del Norte	42,122	43,690	35,269	39,839	35,239	32,805	0%
Misamis Occidental	36,013	38,970	39,031	35,260	35,419	40,322	0%
Misamis Oriental	163,440	170,700	169,875	184,746	182,231	183,008	2%
Region XI (Davao Region)	329,239	368,029	386,060	395,181	474,117	474,067	5%
Compostela Valley	33,534	36,081	35,590	35,984	37,104	39,113	0%
Davao City	169,764	188,266	203,174	220,566	296,788	283,536	3%
Davao Oriental	43,283	50,338	49,784	46,780	43,473	44,167	0%
Davao del Sur	29,768	32,994	34,848	30,938	29,996	53,550	1%
Davao Province	52,890	60,350	62,664	60,913	66,756	53,701	1%
Region XII (SOCCSKSARGEN)	181,665	197,287	198,601	205,015	214,714	265,306	3%
North Cotabato	53,584	59,661	58,408	57,206	48,461	62,762	1%
Sarangani	13,774	15,062	15,075	15,593	15,692	15,483	0%
South Cotabato	88,590	94,002	97,294	106,471	125,474	160,091	2%
Sultan Kudarat	25,717	28,562	27,824	25,745	25,087	26,970	0%
CARAGA Administrative Region	123,487	133,827	132,596	131,104	137,063	159,364	2%
Agusan del Norte	61,605	67,726	63,598	61,311	62,801	68,157	1%
Agusan del Sur	23,396	25,063	26,277	28,674	30,887	33,070	0%
Surigao del Norte	16,383	17,609	17,190	16,681	18,404	30,258	0%
Surigao del Sur	22,103	23,429	25,531	24,438	24,971	27,879	0%
ARMM (Autonomous Reg. of Muslim Mind.)	16,958	13,440	14,758	14,469	14,402	13,667	0%
Basilan	4,618	4,179	4,305	4,274	3,594	3,728	0%
Lanao del Sur	.	.	.	.	.	.	
Maguindanao	11,647	8,540	9,709	9,402	10,145	9,277	0%
Sulu	693	721	744	793	663	662	0%
Tawi-Tawi	.	.	.	.	.	.	

[..] Data not available **Latest update:** 2008-09-18 09:00 **Source:** Bureau of Agricultural Statistics (BAS) **Contact:**

APPENDIX J: ***OPERATING CONDITION OF BIO-DIGESTERS IN ALCOHOL DISTILLERIES***

Region	Distillery	Production Capacity - million (liters/year)	Bio digester Operating Condition	Source of Data
I (Ilocos)	Alko Distillers, Inc.	2.1	No data	
III (Central Luzon)	Central Azucarera de Tarlac	18	Has lagoons but biodogester converts only 1/6	- Philip Balicud (Bio gas specialist distillery sector) use to work with Central Azucarera before becoming an entrepreneur
	Far East Alcohol Corporation	3	Anaerobic digester operates at Mesophilic temperature range	- Philip Balicud (Bio gas specialist distillery sector)
IV (Southern Tagalog)	Absolute Chemicals, Inc.(Tanduay Distillery)	12	Anaerobic digester operates at thermophilic temperature range	- Philip Balicud (Bio gas specialist distillery sector) - CDM –PDD Document (CDM Registered Project
	Balayan Distillery	22	Anaerobic digester operates at thermophilic temperature range	- Philip Balicud (Bio gas specialist distillery sector) - Office of Exec Sec of Balayan Distillery does not want to cooperate nor provide information on contact number of Plant Manager. Company president apparently has not responded to formal letter sent to them.
	Consolidated Distillers of the Far East	7.5	Anaerobic digester operates at thermophilic temperature range	- Philip Balicud (Bio gas specialist distillery sector) - Ferdinand Masi (Plant Manager of Consolidated Distillers)
	Dyzum Distillery	15*		

Region	Distillery	Production Capacity - million (liters/year)	Bio digester Operating Condition	Source of Data
VI (Western Visayas)	Asian Alcohol Corporation	45	Anaerobic digester operates at thermophilic temperature range	- Philip Balicud (Bio gas specialist distillery sector) - Alfredo Aquino (Plant Manager of Destilleria Bago Inc) familiar with operation of Asian Alcohol
	Destilleria Bago, Inc.	90	Operating at mesophilic condition not operating to its maximum level; has leaks	- Philip Balicud (Bio gas specialist distillery sector) - Alfredo Aquino (Plant Manager of Distilleria Bago Inc.)
	Kooll Distillery	12	Operating at thermophilic condition but converts only 30 percent	- Philip Balicud (Bio gas specialist distillery sector) - Eng. Bejamin Masiglat (Plant Manager of Kooll Distillery)
VII (Central Visayas)	International Pharmaceuticals, Inc.	6	No data	
VIII (Eastern Visayas)	Leyte Agri-Corp. Ormoc	11	No facility for CH4 generation	- Philip Balicud (Bio gas specialist distillery sector)
	Total	243.6		

Solid Wastes

Estimating the methane production potential for agricultural commodity processing wastes is confounded by the same issue regarding B_o expressed on a mass or volume of methane per unit COD basis discussed above. If the solid waste COD concentration is known, estimating methane production potential is as follows:

$$CH_{4\,(SW,\,P)} = TOW_{(SW)} \times B_o \times MCF_{(SW,\,P)}]$$

where: $CH_{4(SW,\,P)}$ = estimated methane production potential from agricultural commodity processing waste SW, kg CH_4 per year

$TOW_{(SW)}$ = annual mass of solid waste SW COD generated, kg per year

$MCF_{(AD)}$ = methane conversion factor for anaerobic digestion, decimal

Again based on limited data and best professional judgment, the MCF_{AD} values of 0.90 and 0.80 appear to be reasonable estimates respectively for heated and ambient temperature digesters for first-order estimates of methane production potential.

Leakage and Combustion Related Emissions

The reduction in methane emissions realized when anaerobic digestion is incorporated into an existing livestock manure or agricultural commodity processing waste management system will be somewhat reduced by leakage and combustion related emissions.

There is very little information regarding methane leakage from anaerobic digestion systems although some leakage probably occurs from all systems and should be incorporated into estimates net methane emissions reductions. The 2006 IPCC Guidelines for National Greenhouse Gas Inventories provides no guidance, with an MCF default value of 0-100 percent. Thus, the use of the 2008 California Climate Action Registry (CCAR) default collection efficiency value of 85 percent in the following equation is recommended unless a higher value can be justified by supporting documentation.

$$LK_{(P)} = \left(\frac{CH_{4\,(P)}}{0.85} - CH_{4\,(P)}\right) \times 0.67\ \text{kg/m}^3$$

where: $LK_{(P)}$ = project methane leakage, kg/year

$CH_{4\,(P)}$ = estimated methane production potential from manure or agricultural commodity processing wastes or both, kg/year

0.85 = default methane capture efficiency, decimal

Because no combustion process is 100 percent efficient and all captured methane should be disposed of by combustion, combustion related methane emissions also should be accounted for in estimating a project's net methane emission reduction. Unless higher combustion efficiency values can be justified by supporting documentation, the default values (CCAR, 2008) listed in the table below should be used.

Default Values for Methane Combustion Efficiencies, decimal

Combustion Process	Default Value
Open flare	0.96
Enclosed flare	0.995
Lean burn internal combustion engine	0.936
Rich burn internal combustion engine	0.995
Boiler	0.98

Methane emissions associated with each combustion process utilized should be based on the fraction of estimated methane production that will be captured and calculated as follows:

$$CE_{(P)} = \left[\left(CH_{4\,(P)} - LK_{(P)}\right) \times \left(1 - C_{eff}\right)\right]$$

where: $CE_{(P)}$ = Combustion related emissions, kg CH_4 per year

$CH_{4\,(P)}$ = Estimated production potential, kg CH_4 per year

C_{eff} = Combustion efficiency, decimal

Fossil Fuel Use Related Emissions

An anaerobic digestion project may result in increased fossil fuel use such as use of gasoline or diesel fuel for manure transport to a centralized anaerobic digestion facility or transport of another waste to a facility for co-digestion. The resulting increase in carbon dioxide emissions also should be accounted for using the default values for fossil fuel use related carbon dioxide emission rates, as shown in the table below.

Default Values for Carbon Dioxide Factors for Gasoline and Diesel Fuel Use for Transportation (Regional Greenhouse Gas Initiative, Inc., 2007)

Fuel	CO_2 Emission Factor, kg/L
Gasoline	2.38
Diesel	2.75

Estimate the carbon dioxide emissions resulting from increased fossil fuel use due to transportation as follows.

$$FF_{(P)} = \frac{\left(FF_{(Use)} \times C_{factor}\right)}{21}$$

where: $FF_{(P)}$ = Fossil fuel related carbon dioxide emissions on a methane equivalent basis, kg CH_4 per year

$FF_{(U)}$ = Additional fossil fuel use, L/yr

E_{factor} = Emission factor, kg CO_2/L

21 = GWP of methane as compared to carbon dioxide, kg CO_2/kg CH_4