CONTROL OF METHANE EMISSION IN LIVESTOCK PRODUCTION
AND MANURE MANAGEMENT IN THAILAND

K. Boonyanuwat1 and W. Champarat2
2Nakornratchasima Livestock Research and Breeding Center. Nakornratchasima, Pakchong, 30130. Thailand

ABSTRACT

Livestock manure management systems should account for the fate of excreted nutrients that may be of environmental concern. The aims of this research was to study the approaching of climate change on animal production in Thailand as controlling of the country’s methane emission in livestock production and manure management. Data collecting was separated into 2 parts: 1) primary data, and 2) secondary data. Greenhouse gas (GHG) emission from the agriculture sector was 55.71 MtCO2e (15.89%) in 2012. Emission from livestock production was 4.08 MtCO2e (1.31%) in 2012 (enteric methane = 0.81%, manure = 0.50%). Manure management is practical to reduce GHG emission. There are 3 major manure management types, 1) pasture, 2) fertilizer, and 3) biogas. From total livestock production, there are 12, 79, and 9 % of pasture, fertilizer, and biogas respectively. In swine production, there are 60% fertilizer and 40% biogas. There are 50% pasture, 40% fertilizer, and 10% biogas in beef cattle. For fertilizer management, there are 4 types, namely 1) dry manure fertilizer, 2) compost fertilizer, 3) pellet fertilizer, and liquid fertilizer. For biogas production, they conducted in 3 parts, 1) CDM project, 2) compressed bio-methane gas, 3) community biogas production. In the CDM project, there are big companies engaged in swine production. They produce biogas, sell electricity, and carbon credits. In medium size farms, they produce biogas to use as power sources in farms. For compressed bio-methane gas, it is the new project for new alternative energy. For community biogas production, small size farms produce biogas for energy use in houses. One hundred m³ from one farm can provide biogas for 100 houses in a community. Manure management of pasture, fertilizer, and biogas, can reduce GHG emission and reduce other gas production for good ventilation of animal houses. A reduction in emissions is therefore necessary not only for environmental protection but also to minimize economic loss.

Keywords: Climate change, Manure, Fertilizers, Biogas, Emission

INTRODUCTION

Carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O) are the major greenhouse gas that are found in livestock production (Moss et al., 2000). Methane was found in various locations in the environment and released from agriculture production around 205-245 Mt (Duxbury and Mosier, 1993) in the world. Animals may be 18% of all greenhouse emissions (FAOSTAT 2006). Methane emission is less than 2% of all the factors that lead to global warming (Johnson and Johnson, 1995) However methane
played an important role because it is 21 times more powerful than CO₂ (Johnson et al., 1996).

Methane emissions are a direct result of fermentation by the microbes in the rumen, especially methanogens archael which are dismissed. Hydrogen is used to produce methane gas. It refers to the power loss between 2% and 15% of primary energy ingested (Van Nevel and Demeyer, 1996). To reduce their greenhouse gas emissions would benefit both livestock production and the environment (Moss et al., 2000). In theory, the methane can be reduced electron sink metabolic pathways at the disposal of the reducing power (Lo'pez et al, 1999, Ungerfeld et al, 2003). Therefore, it is desirable to reduce methane production by enhancing the electron reaction other than creating options for controlling methane in rumen by using inhibitors against methanogens (Mathison et al., 1998).

The other part of methane production in livestock sector is methane from manure management. Methane from manure management is solved to benefit as fertilizer and biogas production (Fulhage et al., 1993). A portion of the organic solids such as proteins, carbohydrates and fats are food and energy.

In addition to using manure for biogas production, there are other benefits of using manure for fertilizers. Integrating manure as a fertilizer for crop production is the primary accepted mechanism for disposal of manure from animal feeding operations. Successfully in using manure as fertilizer, the nutrients contained in the fertilizer rate must be evaluated appropriately to provide essential nutrients to the crop and the fertilizers evenly across the field in the target rate. Efficient use of manure as a fertilizer is complicated because of the imbalance of nutrients in manure, variability in many sources of manure, difficulties in estimating nutrient availability, and the relatively low nutrient concentration limiting the distances which the manure can profitably be transported for use as a fertilizer. Manure management is most likely to be profitable on a farm with concentrated sources of nutrients rather high fertilizer use near field operations and plant or crop rotation which can fully utilize all the nutrients applied.

The aims of this research are to review scientific papers and action plans about manure management for GHG reduction in the livestock sector in Thailand.

MATERIALS AND METHODS

Data collection

1. Primary data  They are collected from
   - Investigation through questionnaire
   - Investigation from interviews with farmers

2. Secondary data
   - The results from national action plan
   - DLD livestock statistics
   - Research paper

RESULTS AND DISCUSSIONS

Greenhouse gas (GHG) emission from agriculture sector was 55.71 MtCO₂e (15.89%) in 2012. Emission from livestock production was 4.08 MtCO₂e (1.31%) in 2012 (enteric methane = 0.81%, manure = 0.50%). Manure management is practical method to reduce GHG emission (TGO, 2016).
Manure management for fertilizer production

Normally, manure from livestock has many benefits when used as a fertilizer in agriculture. They are used directly to pasture, fertilize for flower, vegetables, fruit orchard, paddy rice, and croplands. This method can eliminate pollution from the environment. In 2015, the major sources for manure fertilizers were from chicken, swine, and beef cattle (DLD, 2015). Seventy nine percent (79%) of those mentioned were used as fertilizers.

Table 1. Livestock population and manure management in Thailand.

<table>
<thead>
<tr>
<th>Species</th>
<th>Population</th>
<th>Manure (ton/year)</th>
<th>Manure Management (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Pasture</td>
</tr>
<tr>
<td>Beef cattle</td>
<td>4,407,108</td>
<td>2,380,720</td>
<td>50</td>
</tr>
<tr>
<td>Dairy cattle</td>
<td>509,524</td>
<td>215,732</td>
<td>85</td>
</tr>
<tr>
<td>Buffalo</td>
<td>888,431</td>
<td>778,266</td>
<td>85</td>
</tr>
<tr>
<td>Swine</td>
<td>9,886,897</td>
<td>4,546,984</td>
<td>0</td>
</tr>
<tr>
<td>Goat</td>
<td>539,583</td>
<td>70,901</td>
<td>99</td>
</tr>
<tr>
<td>Sheep</td>
<td>49,448</td>
<td>6,497</td>
<td>100</td>
</tr>
<tr>
<td>Chicken</td>
<td>418,330,613</td>
<td>15,269,067</td>
<td>0</td>
</tr>
<tr>
<td>Duck</td>
<td>28,762,259</td>
<td>1,679,716</td>
<td>50</td>
</tr>
<tr>
<td>Total manures</td>
<td>24,947,884</td>
<td></td>
<td>12</td>
</tr>
</tbody>
</table>

Source: DLD (2015)

The nutrients in the manure are carbon, nitrogen, phosphorous, and potassium. The amount of nutrients varies according to the area, species, farm management, and storage. The following are the benefits of manure:

1. Plant nutrients. The nutrients in feed are digested and released. They will be taken out in the form as manure. In chicken, there are 2.59% N, 1.96% P, and 2.29% K. In swine, there are 2.69% N, 3.24% P, and 1.12% K. In cattle, they are ruminants, so their manure have lower nutrients to their monogastric counterparts. There are 1.36% N, 0.51% P, and 1.71% K. The manure is an important source of nutrients for plants.

2. Provide plant nutrients in a continuous manner. The manure release plant nutrients in the long run compared to chemical fertilizers. There are more organic matter in the manure than there are in chemical fertilizers. It is better to improve soil structure during a long time.

3. Improve soil structure. The manures have a consecutive period of time to improve the physical properties of the soil. They can increase the stability of the soil, as well as its water holding capacity. They reduce the density of the soil. They improve soil chemistry and plant nutrients which are both macronutrients and secondary nutrients. They are beneficial to increase plant growth.

Types of manure management as fertilizers

1. Directly to pasture
   They are used directly to pasture for 12% of the total fertilizer application. They are only used to pasture ruminants. Livestock are raised in pasture during day time. They release manure directly. By this method, manures are plant nutrients and improve soil structure continuously (Thai Youth
Encyclopedia, 1994). They can be used in the area of 1,197,498 rai. It is composed of pasture and the area of animals.

2. They are used as fresh manure for paddy rice, vegetables, fruit orchards, and croplands. But using this model, it takes into account the type of soil and plants. It is not practical for some plants especially the flowering types. Its temperature is high, it should take nitrogen from the soil to use and then there will be lack of nitrogen in the soil area. Plants will turn yellow and die.

3. They are used as compost fertilizers. Farmers used manures with more than 40% humidity. They can be fermented and degraded. The decomposition process is completed. The heat from compost fertilizer was decreased. They are suitable to be used.

Types of compost fertilizer

3.1. They are mixed with farm by-products like rice straw, cassava leaf, and enzymes from microorganisms developed by the Department of Land Development (Fig. 1).

![Fig. 1. Compost fertilizer manure and plant](image)

3.2. They are mixed manures and enzymes from microorganisms developed by the Department of Land Development (Fig. 2).

![Fig. 2. Compost fertilizer manure](image)
4. They are compressed as pellet fertilizer. This type comes as both dry manure and as compost fertilizer. They are easy to use (Fig. 3).

Fig. 3. Pellet fertilizer

5. They are used as liquid extraction manure fertilizer from cattle and swine manures. The manures are packed in nylon bags and then soaked in a ratio of 1 kg per 10 liters of manure in tank. They are marinated for 24 hours and then lifted out of the tank. The bag containing manure can be extracted and changed from green to brown. The containers should be stored in tanks. Liquid extraction, fermentation, manure can be stored for a long time. It will allow water to extract more. It can be used more economical than using no treated manures. In Thailand, they are produced from swine, chicken, and dairy cattle manures (Fig. 4).

Fig. 4. Liquid manure extracted fertilizer

**Manure management for biogas production**

In 2015, the total livestock production of produced biogas from manures is recorded at 9%. They are used to produce electricity, farm energy and cooking gas.

There are 3 types of biogas production.

1. **CDM project and carbon credit**
   This project followed the Kyoto protocol, the national environment strategy, and renewable energy strategy. GHG emissions are reduced from biogas production and renewable energy.
There are few big companies which process this project for biogas and carbon credits. They sell electricity from biogas to electricity authority and sell carbon credit to Annex I country. In other big and medium size farms, they are in CDM project of the Department of Livestock Development. They produce biogas to use as energy in farms and produce electricity as well (Fig. 5).

Fig. 5. Biogas and electricity production from manure (ERDI-CMU, 2016)

2. CBG production
CBG is Compressed Biomethane Gas. Energy Institute, ERDI-CMU has developed renewable energy called "CBG gas" by improving the quality of biogas and package. It is removed carbon dioxide (CO₂), hydrogen sulfide (H₂S), and humidity from biogas (Fig. 6). They used water scrubbing technology and membrane technology to compress gas or biomethane gas equivalent. The CBG is similar to NGV (Natural gas for vehicles) can be used for motor vehicles. They contribute to fill the tank for use in the household sector instead of using LPG, which is sold at a high price and tends to be scarce in the future.

Fig. 6. CBG for house and car (ERDI-CMU, 2016)
3. Community biogas production
Pig environmental problem in the Phraekha community, Khuan Khanun district, Phatthalung province has been used as an opportunity for people in the community without support from the government. Small swine farms made biogas and send gas through a pipeline parallel to the village water supply. Every house in the community can bring gas to the households. They can reduce expenses of LPG following the sufficiency economic program.

The eight villages in this community have a problem with the swine house that are closed to water sources. They got the idea to produce biogas from swine manure. They lay the pipeline to all households in six villages. The members of this community used biogas instead of LPG. Savings can be in the village at least 50,000 baht per month in one village (Fig. 7).

Fig. 7. CBG for house and car (Thairat, 2016)

CONCLUSION
There are 3 major manure management types, 1) pasture, 2) fertilizers, and 3) biogas. From total livestock production, there are 12, 79, and 9 % of pasture, fertilizer, and biogas respectively. In swine production, there are 60% fertilizers and 40% biogas. There are 50% pasture, 40% fertilizer, and 10% biogas in beef cattle. For fertilizer management, there are 4 types, 1) dry manure fertilizer, 2) compost fertilizer, 3) pellet fertilizer, and liquid fertilizer. For biogas production, they conducted in 3 parts, 1) CDM project, 2) compressed bio-methane gas, 3) community biogas production. Manure management of pasture, fertilizer, and biogas, can reduce GHG emission and reduce other gas production for good ventilation of animal houses. A reduction in emissions is therefore necessary not only for environmental protection but also to minimize economic loss.

REFERENCES


