An overview of the methane emission from ruminant in Jambi Province, Indonesia

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Introduction

Jambi Province is an area situated in the central part of Sumatra Island. Geographically is located between 00 45' to 20 45' Latitude South and 101^0 10' to 104^0 55' Longitude East. Jambi Province is separated by Riau Province in the north, Malacca strait in the east, West Sumatra in the west and South Sumatra in the south. The width of Jambi Province is 53.534 km2 that consists of.

Kerinci Regency	4.200 Km2	(7.86%)
Bungo Tebo Regency	13.500 Km2	(25.26%)
Sarolangun Bangko Regency	14.200 Km2	(26.57%)
Batang Hari Regency	11.130 Km2	(20.83%)
Tanjung Jabung Regency	10.200 Km2	(19.09%)
The Municipality of Jambi	205 Km2	(0.39%)

The agricultural and forestry sector is the main emitter of green house gas (GHG) in this area. A study was done by Prasetyo *et al* (1998) to estimate GHG emission using remote sensing and geographical information system in Jambi. Unfortunately there was not discussion concerning the gas emission from animal. In fact, the emission of GHG also builds up from animal. Machmüller and Clark (2006) reported that methane emissions

comprise 37 % of total greenhouse gas emissions whereas enteric emissions from cow and sheep are the main source.

Methane

Methane, the simplest alkanes, is a chemical compound with the molecular formula of CH4. It is the primary constituent of natural gas. Methane's bond angles are 109.5 degrees. Oxidation of one molecule of methane in the presence of oxygen releases one molecule of carbon dioxide (CO_2) and two molecules of water (H_2O) :

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

The main sources of Anthropogenic methane is from agriculture, waste and energy sector. In agricultural sector, the methane comes from moss soil, paddy field, landfills, enteric fermentation from ruminant, manure and waste. In New Zealand, for example, the enteric emission from ruminant especially cow and sheep is around 37 % (Machmüller and Clark, 2006). CORINAIR (1990) reported that the methane emission in EU is 30 % and 15 % from enteric fermentation and livestock manure respectively.

Methane emission and global warming

Methane is one of the main GHG beside water steam (H_2O), carbon dioxide (CO_2) and nitrous-oxide (N_2O). These gases will absorb the infra red radiation and therefore cause the atmosphere warming which is called GHG effect. Methane, chlorofluoro-carbons (CFCs), nitrous-oxide (N_2O) and ozone (O_3), all together influence around 3% of the global greenhouse gas effect. Although the contribution of the four GHG is relatively small compared to H_2O (67 %) and CO_2 (30%) but the acceleration rate of their concentration in the atmosphere significantly increases the GHG effect in last century

(Lelieveld and Crutzen, 1993). Apart from this the four, GHG is also more reactive than H_2O and CO_2 (Bouwman, 1990). Compared to the carbon dioxide, methane is an important greenhouse gas whose concentration in the atmosphere has more than doubled since pre-industrial time.

Methane and Carbon credit

Carbon credit is a hot issue in the programme of reducing of global warming now a day. Carbon credit arranges a role to mitigate the emission effect of green house gas in the industrial basis by capping of the total annual emission and letting the market to give financial value of gas emission through trading. Principally carbon dioxide caused the enhancement of the global warming that affect to climate changing. Carbon credit is a project to diminish the carbon dioxide emission through the program of clean development mechanism by using new energy.

The emerging of the carbon credit concept is as an outcome of the need for controlling the increase of earth temperature. The IPCC (2001) has studied that:

> *Policies that provide a real or implicit price of carbon could create incentives for producers and consumers to significantly invest in low green house gas product, technologies and processes. Such policies could include economic instruments, government funding and regulation.*

A system for carbon trading is one of the policy mechanisms shown to be environmentally effective in the industrial sector, on condition that there are reasonable levels of predictability over the initial allocation mechanism and long term price. The

formalization of this mechanism was done by an international agreement among more than 170 countries in the Kyoto Protocol, and the market mechanism followed the subsequent Marrakesh Accords (UNFCCC).

Carbon credit is a sequestration of the carbon to the earth. Sequestering of carbon will contribute an opportunity to develop the agricultural production plus benefit the environment. Soil carbon will strengthen the organic matter content of soil thus the establishment of carbon credit will have potential to landowner, farmer and the environment. The points for example no-till and reduced-till farming, cropland retirement, reduce equipment use, reforestation, and livestock manure management practices have the potential to create carbon credits.

Material and Method

The study was presented a case study concerning assessment of methane emission and the carbon credit from ruminant animal in Jambi Province, Indonesia. This study was a literature study and all data were collected from some sources in Jambi Province. Data were the secondary data including land wide, number of ruminant animal and a policy about future plan of Jambi Province.

Calculation of methane, carbon dioxide, faeces and power produced

Based on this data livestock population in Jambi, it was foreseen the methane emission and carbon credit in this area. The CH_4 emission produced from cow, buffalo, goat and sheep was calculated based on an assumption of the average of methane emission calculated by Machmüller and Clark (2006). They reported that the CH_4 emission produced from female cow, male cow, female sheep and male sheep was 308, 144, 36 and 24 g/day respectively. The CH_4 emission produced from cow, buffalo was assumed as those produced from New Zealand cow and the CH_4 emission produced from goat and sheep was assumed as those produced from New Zealand sheep.

The CO_2 produced from the animal was stochiometrically calculated as one mol of methane would synthesize one mol of carbon dioxide and as comparison to one weight unit of methane would produce 2.75 weight unit of carbon dioxide (see formula). Therefore one ton of methane will be equal to 2.75 ton of CO_2.

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

Calculation of faeces produced from animal and power generated was calculated according Amalia (2007). It may be computed that each head of cow would produce 1.41 kg of faeces per day and generate 0.038 kw per day of electric power.

Result and Discussion

Methane Production

Table 1 shows the animal number, methane and carbon dioxide produced from 2002 through 2006. These data only shows the population of cow, buffalo and goat while there is no available data concerning other animals.

Table 1 Cows population and Methane Emission in Jambi Province

Year	Animal number			Methane produced* (ton/day)			CO_2 Produced** (ton/day)
	Male	Female	Total	Male	Female	Total	
	Cow						
2006	11,816	106,344	118,160	3.64	15.31	18.95	52.12
2005	29,011	84,667	113,678	8.94	12.19	21.13	58.10
2004	67,302	80,615	147,917	20.73	11.61	32.34	88.93
2003	66,359	79,486	145,845	20.44	11.45	31.89	87.68
2002	64,428	77,172	141,600	19.84	11.11	30.96	85.13
	Buffalo						
2006	17,212	47,212	64,424	5.30	6.80	12.10	33.28
2005	17,594	55,236	72,830	5.42	7.95	13.37	36.78
2004	19,425	48,734	68,159	5.98	7.02	13.00	35.75
2003	19,994	50,160	70,154	6.16	7.22	13.38	36.80
2002	19,868	49,845	69,713	6.12	7.18	13.30	36.57
	Goat						
2006	13,799	124,189	137,988	0.50	2.98	3.48	9.56
2005	29,914	95,003	124,917	1.08	2.28	3.36	9.23
2004	45,403	86,966	132,369	1.64	2.09	3.72	10.24
2003	45,514	83,349	128,863	1.64	2.00	3.64	10.01
2002	43,491	83,305	126,796	1.57	2.00	3.57	9.80

* Calculated as assumption result from New Zealand ruminant (Machmüller and Clark, 2006)
** Calculated as the stochiometry calculation

In general the total number of animal species in Jambi Province decreased from 2002 through 2006 except goat. This might be due to that animal production system in this area was still in traditional system. Farmers did not raise their animal full time while their main job is in crop, or rubber plant. Animal just left in the field in the morning and collected in the afternoon without paying attention any feed, production, reproduction health etc. As a result Jambi Province is always deficit in animal population.

In fact the need of animal for meat in Jambi Province increases from time to time. Base on the observation in Muara Bulian animal market, the only one animal market in Jambi Province, it could be seen the increase of animals imported from neighbour area like Lampung and South Sumatra. On the other hand, there is no valid data of imported animal at this market. The government of Jambi Province realized the case of animal deficit and has already made a plan for future development of animal especially for cow population. According to the road map of the animal development especially cow, this province would be a surplus area of cow production in year 2015. It would be foreseen that the number of cow population in that year would be 1.637 million (Anonymous, 2008).

In relation to the methane and CO_2, emission of methane and CO_2 in Jambi Province also decreases as the decrease of animal number. Cow was the main sources of methane emission compared to buffalo and goat. The total emission of methane from cow, buffalo and goat was 47.83 and 34.54 ton per day in 2002 and 2006 respectively and the total emission of CO_2 from cow, buffalo and goat was 131.5 and 94.96 ton per day in 2002 and

2006 respectively (see Table 1). It might be a good sound for reducing of GHG emission. The distribution of the methane emissions follows largely the livestock number allocation to production systems used in this study. Most of the emissions come, and will continue to come, from ruminants in mixed livestock systems.

Back to the road map of the development of cow population in Jambi Province, the population of cow in this area in 2015 would be 1.637 million head. If one cow produced 200 g methane per day it could be predicted the methane and CO_2 produced of 327.4 and 900.35 ton per day respectively.

Increase of animal number will also have a potency to increase the GHG emission that affect to the global warming. In contras development of animal farm will also create the animal pasture that catches CO_2 emission to the earth. This will also reduce the effect of GHG emission that diminishes the global warming. Unfortunately it is needed the study concerning this matter.

Power produced from faeces

Faeces produced from ruminant animal conversely has other effect as a source of biogas that might be used as electric power and other uses. Table 2 shows the estimation of faeces produced, power generated and number of houses got power.

Table 2. Estimation of Faeces Produced, Power Generated and number of house powered in Jambi Province

Year	Number of ruminant	Faeces (ton)	Power(Mw)	Number of House
2006	196,383	276.90	7.46	8292
2005	199,000	280.59	7.56	8402
2004	229,313	323.33	8.71	9682
2003	228,885	322.73	8.70	9664
2002	223,993	315.83	8.51	9458

* Calculated as assumption of a study by Amalia (2007)

Faeces produced from animal is a good potency of energy but it is not used until now yet. Base on the study done by Amalia 2007, Amalia (2007) studied in Lampung that a number of 18,000 cows will produce approximately 25,400 kg of faeces and the biogas produced from manure can generate around 0.68 MW per day of electrical power. It may be calculate that each head of cow will produce 1.41 kg of faeces per day and generate 0.038 kw per day of electric power. It might be calculated that faeces produced in Jambi might power more than 8000 houses since 2002. It might be imagined that in year 2015 Jambi Province could have power energy from animal around 69,118 houses. It is based on the assumption of 900 w per house.

It is a good source of power energy to substitute or assist the lack of electric power in this area as mainly the electric power is still imported from West Sumatra. Nevertheless all number shown could not completely be applied yet as the livestock production system was the small holder farmer and most animals were not distributed evenly. It had to be prepare some pools for collecting faeces before going to the reactor. Then this might be required a group of farmer to prepare a reactor for processing of faeces. It is especially suitable to be applied in the country side.

Conclusion

It might be concluded that ruminant animal has potency as GHG emission like methane and CO_2 from their enteric fermentation. However it might also have potency of biogas that can generate and be applied in the country side that is plenty of animals.

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.[1] The Third assessment report of the IPCC stated that when averaged over 100 years each kg of CH4 warms the Earth 25 times as much as the same mass of CO2. The Fourth assessment report has updated this number to include indirect effects and states that the relative impact of CH4 to CO2 averaged over 20 years is 72.[2]. The reason for this discrepancy is that methane in the atmosphere is eventually oxidized, producing carbon

dioxide and water. As a result, methane in the atmosphere has a half life of seven years (every seven years, the amount of methane halves).

The radiactive forcing effect of methane is about one-third of that of CO2 [1], which means that pound for pound it may trap more heat in the atmosphere than CO2, even though far more CO2 is actually emitted. However, there is a large, but unknown, amount of methane in methane clathrates in the ocean floors. Global warming could release this methane, which could cause a further sharp rise in global temperatures. Such releases of methane may have been a major factor in previous major extinction events. The Earth's crust also contains huge amounts of methane. Large amounts of methane are produced anaerobically by methanogenesis. Other sources include mud volcanoes which are connected with deep geological faults.

Apa Penyebab Pemanasan Global ?

Pemanasan Global terjadi karena peningkatan jumlah Gas Rumah Kaca (GRK) di lapisan udara dekat permukaan bumi (atmosfer). Gas tersebut memperangkap panas dari matahari sehingga menyebabkan suhu bumi lebih panas daripada suhu normal.

Apa Itu Gas Rumah Kaca (GRK)?

Gas Rumah Kaca (GRK) adalah gas di udara pada lapisan permukaan bumi yang memungkinkan sebagian panas dari matahari ditahan di permukaan bumi. Secara alami gas-gas rumah kaca ini juga memancarkan kembali panas matahari agar tidak semuanya

diserap bumi tetapi juga agar sebagian diserap bumi. Dengan demikian gas rumah kaca membuat suhu di bumi pada titik yang layak huni bagi makhluk hidup. GRK secara alami juga menjaga agar iklim menjadi stabil.

Mengapa Emisi Gas Rumah Kaca Meningkat?

Emisi GRK berasal dari kegiatan manusia, terutama yang berhubungan dengan penggunaan bahan bakar fosil (seperti minyak bumi, batu bara, dan gas alam). Pembakaran bahan bakar fosil sebagai sumber energi untuk listrik, transportasi, dan industri akan menghasilkan karbondioksida dan gas rumah kaca lain yang dibuang ke udara. Proses ini meningkatkan efek rumah kaca. Emisi yang dihasilkan dari pembakaran bahan bakar fosil menyumbang 2/3 dari total emisi yang dikeluarkan ke udara. Sedangkan 1/3 lainnya dihasilkan kegiatan manusia dari sektor kehutanan, pertanian, dan sampah.

Pada tahun 2000 buangan total di atmosfer mencapai 42 miliar ton (Gigaton) setara karbondioksida. Satu liter bensin mengeluarkan buangan 2,4 kg setara CO2.

Siapa Penghasil Emisi terbesar?

Negara-negara maju adalah penghasil emisi gas rumah kaca terbesar di dunia. Menurut data dari PBB, urutan beberapa negara penghasil emisi karbondioksida per kepala per tahun sebagai berikut:

- Amerika Serikat 20 ton
- Kanada dan Australia 18 ton
- Jepang dan Jerman 10 ton
- China 3 ton
- India 1 ton
- Afrika >1 ton

Kebakaran hutan dan lahan juga melepaskan karbondioksida dalam jumlah cukup besar, seperti yang terjadi di Indonesia hampir setiap tahun terutama bila kebakaran sangat luas seperti pada tahun 1997.

Gambar 2 menunjukkan bahwa buangan dari sektor energi di negara berkembang jauh lebih kecil daripada di negara maju. Tetapi bila digabungkan dengan sektor non energi (perubahan tata guna lahan dan penggundulan hutan) maka angka buangan di negara berkembang juga cenderung tinggi walaupun tetap tidak setinggi di negara maju. Angka untuk sektor non energi masih jadi perdebatan. Indonesia, misalnya, memang menyumbangkan emisi yang cukup tinggi saat terjadi kebakaran hutan, tapi emisi ini terjadi secara musiman dan perhitungannya belum bisa dipastikan. Walaupun demikian, kebakaran hutan dan lahan tetap harus dicegah demi menjaga kelestarian ekosistem dan mencegah pencemaran udara untuk kepentingan masyarakat Indonesia sendiri.