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The Emissions of CH4 and N2O Gas from Beef Cow In Jambi Province

[1]*Hutwan Syarifuddin, [2]A. Rahman Sy, [3]M. Afdal

ABSTRACT--*Greenhouse gases (GHG) from the livestock sector produced from the enteric fermentation and management of manure in the form of CH_4, CO_2 and N_2O that contributes on the global warming. The contribution of GHG from livestock sector is around 18-51% in the form of anthropogenic GHG. In Indonesia, the contribution of GHG emission from the livestock subsector is around <1.5%, or it is globally around 12% of total world GHG emissions. The aim of this study was to reveal the emission CH_4 and N_2O gas from beef cow in Jambi Province. The GHG emission was estimated using the IPCC Tier-1 method according to IPCC manual book 2006 in which GHG emission factor was calculated based on dairy cow population in Jambi Province from 2014-2018. The cow population data were taken from the Jambi Province handbook year 2019, while the FE value is taken from the IPCC handbook year 2006. The results of this experiment show that the value of gas emission of CH_4 and N_2O from beef cow during year 2014-2018 increased 14.17%. Muaro Bungo Regency was the highest gas emission with the percentage of 21.06% and Jambi City was the lowest gas emission with the percentage of 1.71%.*

Keywords-- *CH_4, N_2O, Emission, GHG, Beef cow.*

I. INTRODUCTION

Livestock business is one of the sectors to fulfill the needs of animal protein and also as a contributor of greenhouse gases (GHGs), such as Methane (CH_4), Carbon dioxide (CO_2) and Nitrous Oxide (N_2O) produced from enteric fermentation and livestock manure management. Most CH_4 and N_2O emission come from ruminants (cows, buffaloes, goats and sheep). According to BPS (2019) the population of ruminant in Jambi Province in 2018 was 159,188 cow, 45,550 buffaloes, 483,889 goats and 74,985 sheeps. In ruminants, the gas produced is the end product from the fermentative digestion of feed by rumen microorganisms, besides volatile fatty acids, ammonia, carbon dioxide, hydrogen and microbial cells. These gases play an important role on the decrease of the environmental quality as the GHGs effect.

GHGs emission from livestock subsector in Indonesia was around <1.5% (Widiawati, 2013) and it was around 12% of total world gas emissions (Dourmad et al., 2008). Livestock manure such as processed feces, stacked feces and feces spread on the land produces GHG that have an impact on global warming (Chadwick et al. 2011). There are several factors that affect GHG emissions from livestock, such as the population of

*[1]*Faculty of Animal Husbandry, Universitas Jambi, Jl. Raya Jambi –Ma Bulian KM 15 Mandalo Indah 36361 ,08127807950 , email: hutwan@yahoo.co.id .*

[2]Faculty of Animal Husbandry, Universitas Jambi, Jl. Raya Jambi –Ma Bulian KM 15 Mandalo Indah 36361 .

[3]Faculty of Animal Husbandry, Universitas Jambi, Jl. Raya Jambi –Ma Bulian KM 15 Mandalo Indah 36361 .

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livestock, types of livestock, feed, manure management, animal digestion, and awareness of farmers on to the environment.

Data on the contribution of CH_4 and N_2O from the livestock subsector has not been widely reported, especially CH_4 and N_2O emissions and mitigation strategies in beef cow for Jambi Province. The CH_4 potential global warming is 21 times higher than CO_2 (UNFCCC 2006). CH_4 gas has a greater effect, because the heat capture power of CH_4 gas is $25 \times CO_2$ (Vlaming 2008). Samiaji (2012) mentioned that N2O could absorb 298 times more heat per weight unit than CO_2 therefore CH_4 and N_2O emissions by livestock activities was the main attention in this study. The CH_4 emission from ruminant was 15% out of the total CH_4 emissions (Moss et al. 2000).

In order to find out the contribution of CH_4 and N2O gas emissions from beef cow farms in Jambi Province, calculations were performed using Tier-1 methods (IPCC, 2006). In this method the data needed is livestock population in one year in one region / country and emission factor (FE) value for each gas (CH_4 and N2O) of each type of livestock.

The main purpose of this study was to reveal the amount of GHG emissions (CH4 and N2O) originating from the livestock sector in Jambi Province. The specific objectives of these study as below;

(1) To identify the determinant factor of GHG emissions from the beef cow in Jambi Province,

(2) To evaluate the amount of GHG emission from the beef cow sector in supporting the development and development of livestock in Jambi Province using the IPCC Tier-1 method

II. MATERIAL AND METHODS

Place and materials

The study was conducted in 9 regencies and 2 cities in Jambi Province from 1st May to 31st July 2019. Equipment needed such as tally sheet, GPS, camera, capture chamber, thermometer, syringe, dry battery, computer, stop watch, Gas Chromatography and stationery.

Method of collecting data

Data was collected following survey method and field observation method. The data collected included the primary data and the secondary data in accordance with the purpose of the study. Primary data was collected from responder by spreading questionnaire. Secondary data was collected from the statistics of the Jambi Province (BPS 2019). Purposive sampling method was applied in collecting the data of the population of beef cow in each area of regency and City in Jambi Province.

Data Analysis

Tier-1 method of IPCC was applied in calculating GHG emissions from animal samples. There were two data recorded in this experiment including animal population and FE gas values of CH_4 and N_2O for each type of animal. Calculation and use of FE from each type of animal were done as each type of animal emits different

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types and amounts of GHGs. The data collected in this experiment included the quantitative and qualitative data of CH_4 and N_2O gas mitigation from beef cow.

Calculating greenhouse gas emissions

The IPCC method (2006) was applied to calculate GHG emission relating to climate change with the aim to collect an objective information concerning climate change (Ministry of Environment, 2012).

CH_4 and N_2O gas emissions were calculate as following formula:

Emission of enteric fermentation of CH_4:

Enteric of CH_4 gas emission (CO_2-e tons/head) = animal population (head) × FEe (kg/eq) × 21/1000

CH4 emission from manure management:

CH_4 emission from manure (CO2-e tons/head) = animal population (head) × FEm (kg/eq) × 21/1000

N_2O emission from manure management:

N_2O (CO_2-e tons/year) = animal population × (0,05 × FEn)/(1000/BB) × 365 × 44/28 × 293/1000

Note :

FEe	=	Emission factor from enteric (kg CH_4/head/day)
FEm	=	Emission factor from manure (kg CH4/head/day)
21/1000	=	constant for onvertion for CH_4 to CO_2 and from kg to ton
FEn	=	Emission factor N_2O from manure (kg N_2O/kg manure /day)
293/1000	=	Convertion for N_2O to CO_2 and from kg to ton
44/28	=	Convertion from N_2O-N become N_2O
0,05	=	Average N excretion (kg N/head/year)

Emission factors (FE) for enteric and manure management

Based on the Tier-1 method, the IPCC has determined the default factor for the FE of each type animal. For the Indonesian region, the default FE factor follows the Asian region. The FE values for CH4 gas from enteric and livestock manure are presented in Table 1 and the FE values for N_2O gas from livestock manure and livestock body weight are presented in Table 2.

Table 1: Emission factors (FE) of CH_4 gas from enteric fermentation and livestock manure management

Type of Livestock	Digestion process (kg/head/year)	Manure management (kg/head/year)
Beef cow	47	1,00
Dairy cow	61	31,00
Buffalo	55	2,00
Goat	5	0,22
Sheep	5	0,20

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Pig	1	7,00
Horse	18	2,19
Native chicken		0,02
Laying hens		0,02
Broilers		0,02
Duck		0,02

Source: IPCC (2006)

Calculation of GHG emissions from the animal sector conducted using the IPCC Tier-1 method is presented in 3 parts, namely CH_4 gas emissions from enteric fermentation, CH_4 gas emissions from livestock manure, N_2O gas emissions from animal manure. From these three calculations, it can be seen the total GHG emissions generated from the livestock sector.

Table 2: Emission factors (FE) of N_2O gas from manure management

Type of Livestock	Emission factor kg N2O/head/days	Body weight (kg)	Long maintenance (days)
Beef cow	0.34	250.0	365
Dairy cow	0.47	300.0	365
Sheep	1.17	45.0	365
Goat	1.37	45.0	365
Buffalo	0.32	300.0	365
Horse	0.46	550.0	365
Pig	0.82	24.5	365
Poultry	0.05	1.5	365

Source: IPCC (2006)

III. RESULTS AND DISCUSSION

CH_4 and N_2O gas emissions

The target of GHG reduction from the agricultural sector is 0.008 giga tons by 2020. GHG consists of CO2 and CH4 gas produced naturally by living things, both livestock and plants (Rusbiantoro, 2008). The agricultural sector contributed 10-12% of total antrapogenic GHGs, consisting of CH_4 and N_2O, while the livestock sector contributes around 18-51% of antrapogenic GHGs, which was mostly composed of CH_4 gas (Goodland and Anhang, 2009). The increase of GHG relates to the livestock populations, types of livestock, housing, type of feed, manure management, and behavior of farmers in raising livestock. Population of beef cow in Jambi Province is presented in Table 3

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Table 3: Population of beef cow in Jambi Province in 2014-2018 (heads)

Regency/City	Year (heads)				
	2014	2015	2016	2017	2018
Kerinci	12,125	12,700	13,039	13,034	13,244
Merangin	15,431	16,961	16,794	16,703	17,136
Sarolangun	8,772	8,991	9,225	9,419	9,562
Batang Hari	7,563	7,631	7,536	10,946	7,536
Muara Jambi	18,496	21,367	22,412	23,887	21,786
Tanjung Jabung Timur	14,506	16,961	18,517	19,543	20,480
Tanjung Jabung Barat	7,044	7,193	8,306	8,521	8,672
Tebo	18,001	18,505	18,690	17,179	18,276
Muara Bungo	28,553	29,712	31,129	33,457	35,984
Kota Jambi	2,619	2,095	2,957	2,891	2,314
Kota Sungai Penuh	3,527	3,644	4,614	3,966	4,198
Total	136,637	145,760	153,219	159,546	159,188

Note * BPS, 2019

Farming system of beef cow in Jambi Province is generally carried out intensively and semi-intensive, with the average ownership of livestock of around 4-8 animals/farmer. Usually cow was fed with kind of grass such as *Pennisetum purpureum,* Brachiaria *sp, Hymnenachne amplixicualis* and field grass. Mostly the farmer raises cow as a part-time job with the purpose for fattening and as savings. Cow manure in the form of feces and urine is generally collected behind the pen, and spread around grass plants, and some are used as biogas. Then generally there is still a lot of cow urine that has not been processed into biourin for crop fertilizer or for sale. CH_4 gas emissions in Jambi Province can be seen in Figures 1 and 2.

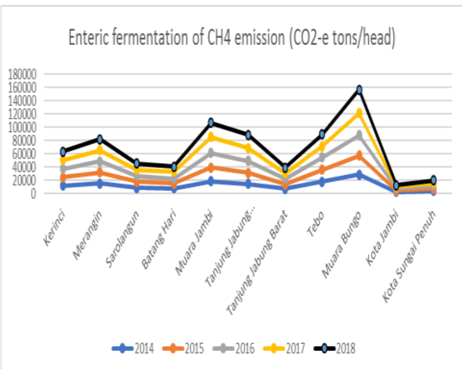

Figure 1: Enteric fermentation of CH_4 emission (CO_2-e tons/head)

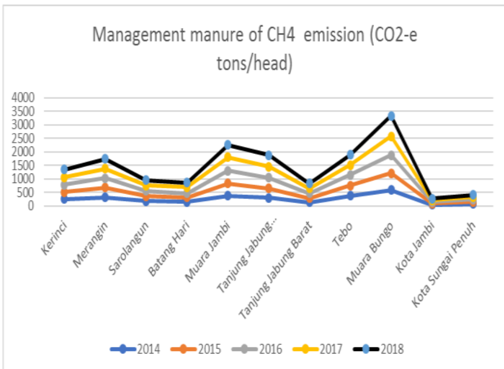

Figure 2: Manure management of CH_4 emission (CO_2-e tons/head)

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The amount of GHG gas emissions, CH_4 from enteric fermentation, increased from 134,860.72, 143,865.12, 151,227.15, 157,471.90, and 157,118.56 (CO_2-e tons/head) for year 2014, 2015, 2016, 2017 and 2018 respectively. Based on the regency, the highest enteric CH4 emissions was in Muara Bungo Regency at 156,770.15 (CO_2-e tons/head) and the lowest in Jambi City was 12,708.61 (CO_2-e tons/head), as related to cow population. The largest number of beef cow population was in Muara Bungo Regency and the least number of beef cow population was in Jambi City.

CH_4 emission from livestock manure management looks the same pattern with CH_4 emission from enteric fermentation. It was 2,869.38, 3,060.96, 3,217.60, 3,350.47, and 3,342.95 (CO_2-e tons/head) for year 2014, 2015, 2016, 2017 and 2018 respectively. Whereas the regency that produced the largest CH_4 emissions from livestock manure management was Muara Bungo Regency at 3,335.54 (CO_2-e tons/head) and the lowest was Jambi City with the emission of 270.40 (CO_2-e tons/head). This was not only due to the large population of cow in Muara Bungo Regency but also the cow manure management system was still not utilized for making biogas or compost. Cow dung is still spread around the cage and under the plant.

N_2O emission from beef cow manure management (Figure 3) also seems the same pattern with the CH_4 emissions. It was 97,591.59, 104,107.60, 109,435.11, 113,954.11, and 113,698.41 (CO_2-e tons/year) for year 2014, 2015, 2016, 2017 and 2018 respectively. The highest N_2O emission was found in Muara Bungo Regency at 113,446.28 (CO_2-e tons/year) and the lowest was found in Jambi City 9,196.55 (CO_2-e tons/year). Whereas the percentage of CH_4 and N_2O emissions from 2014 to 2018 (Figure 4) was the highest in Muara Bungo Regency with 21.06% and the lowest in Jambi City at 1.71%. The amount of GHG emissions much depends on the number of cow population and there is a linear relationship between the number of populations and CH_4 and N_2O emissions, type of feed consumed, manure management and awareness of farmers to protect the environment.

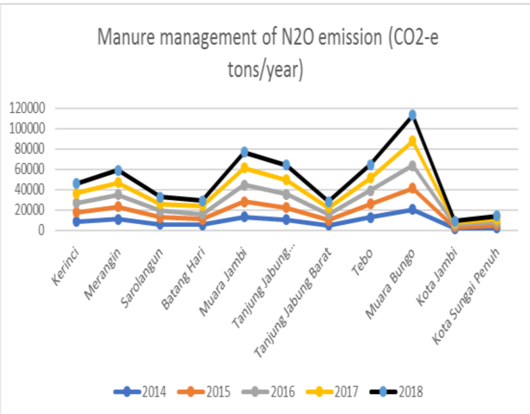

Figure 3: Manure management of N_2O emissions (CO_2-e tons/year)

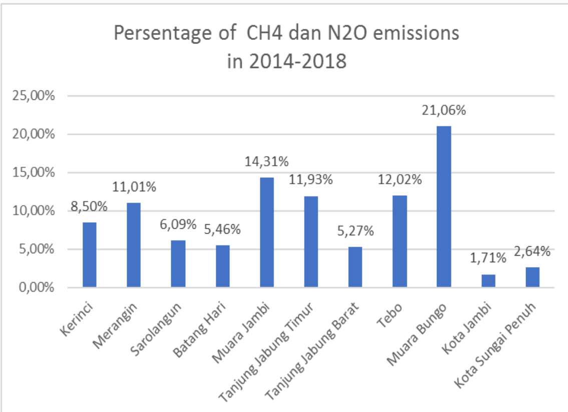

Figure 4: Percentage of CH_4 and N_2O emissions in 2014-2018

N_2O gas emission in Indonesia tends to increase with the largest source coming from agricultural and animal husbandry sector. N_2O gas is only originated from the process of decomposition of livestock manure, both from ruminants and non-ruminants. Chadwick et al. (2011) states that livestock manure in the form of processed feces, stacked feces and feces spread on land produces greenhouse gases.

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Enteric CH_4 production from ruminant contributed 17 - 37% of global anthropogenic CH_4 (Pedreira et al., 2009; Alemu et al., 2011; Cottle et al., 2011; Knapp et al., 2014). Globally, CH_4 gas from the livestock sector contributed around 37% of all human-induced CH_4 emissions, with 89% of emissions from livestock coming from enteric fermentation (Jiao et al., 2014).

CH_4 emission from enteric fermentation was the largest contributor on GHG followed by CH_4 derived from manure management systems and land applications (Klevenhusen et al., 2011; Hristov et al., 2013; Montes et al., 2013). Based on the amount of meat production, broilers contributed 41% of total emissions while emissions from dairy cows make up about 20% of the total emissions of the livestock sector (Gerber et al., 2013).

IV. CONCLUSION AND SUGGESTION

Conclusion

CH_4 and N_2O emissions in Jambi Province increased 14.17% from year 2014 to 2018, Muara Bungo Regency was the highest CH_4 emissions with 21.06% and Jambi City was the lowest CH_4 emissions with 1.71%.

Suggestion

To reduce GHG emission, it is recommended to study more on feed quality, type of feed, physiological status of livestock and environmental conditions

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