Greenhouses Gases Emissions from Dairy Cattle in Indonesia

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Abstract

Dairy cow population in Indonesia has currently reached 487,715 head and located mainly on Java Island, (East Central and West Java Provinces). Indonesian dairy cows contributed 3.8% to the Indonesian total greenhouse gas production, while in global level, dairy sector contributed about 4.0% to the total global anthropogenic GHG emissions. This study assesses the greenhouse gases (GHG's) emissions from dairy cattle sector in Indonesia. The objective of this study was to compare GHG's from Indonesian dairy cows using the IPCC (2006) guideline Tier 1 and Tier 2 method. The data was obtained from field observations in KUNAK dairy cattle village, Bogor as well as previous studies. Cow's body weight, milk production, dry matter intake and dry matter digestibility of feed data were used in the model. Manure management system in dairy cattle was also observed. The results showed that total methane emissions calculated using Tier 1 was relatively higher than that calculated using Tier 2. Methane emission from the enteric fermentation and manure management of dairy cows calculated by Tier 1 method were 33.16 and 15.12 Gg year^{-1} respectively, while by Tier 2 method were 25.74 and 0.12 Gg year^{-1} respectively. Direct and indirect N_2O (nitrous oxide) emissions from manure were 256,381, and 2,299 kg year^{-1} respectively. it is concluded that the total greenhouse gas emission from dairy cattle sector in Indonesia were 1,187 (Tier 1) or 671 (Tier 2) Gg CO_2-eq.

Keywords: dairy cattle, greenhouse gases, methane, N_2O emission

Introduction

Dairy farm in Indonesia has an important role in supplying the milk demand. Current dairy cow population reached 487.715 head and produce approximately 827,000 tones of milk production per year or 26.5% of national demand which reached 2.7 million liters per year. Dairy cow population is mainly located on Java island.

Based on Thalib *et al* (2008) report, dairy cow in Indonesia contribute as much as 3.6% of greenhouse gases compared to the total livestock population. This figure is lower compared with the average contribution of the world which reached 4% globally.

Inventory of greenhouse gas emissions (GHG's) for the livestock sector is highly dependent on the determination of emission factor on each animal. IPCC (2006) has provided guidance in calculating the greenhouse gas in the various sectors. However, emission factors in each sector should be developed in each country.

Based on IPCC (2006) methane emission factor for dairy cattle South East Asia region was 68 kg/head/year. The emission factor is relatively high compared with rill conditions. Therefore it is necessary for the calculation of emission factors based on the real conditions in the field.

The objective of this study was to compare greenhouse gases emissions from Indonesian dairy cows using calculated the IPCC (2006) guideline Tier 1 and Tier 2 methods.

Materials and Methods

Data Collection

The study used primary and secondary data. The primary data was obtained from field observations which have done in dairy cattle production area (KUNAK Cibungbulang), Bogor. The data included cow's body weight, milk production, dry matter intake and dry matter digestibility of ration as well as manure management system in dairy cattle was also observed. The dairy population was cited from Directorate General of Livestock and Veterinary (2011) as secondary data.

Methodology

The calculation of methane (CH_4) and nitrous oxide (N_2O) emissions were calculated based on IPCC Guidelines (2006). The methane emissions were calculated based on Tier 1 (default) and Tier 2 (survey based modified) models. The IPCC (2006) defined that the methane conversion factor (Ym) was 6.5 $\pm$ 1%, indicating that Ym is at the high end of the range when digestibility of feed is low and *vice versa*. Considering the wide range in feed digestibility all over the world we incorporated a range of Ym values according to the following formula: Ym = 9.75 – 0.05 x digestibility. In Model 2, Ym is then used in the following formula: CH_4 emission = (annual feed intake * Ym/100) * (18.55/55.65).

Nitrous oxide (N_2O) emissions (direct and indirect emission) were calculated according IPCC Guideline (2006). Conversion CH_4 to CO_2 was 23, while conversion N_2O to CO_2 was 296 (IPCC 2001). The data were analyzed using statistical descriptive.

Results and Discussion

Dairy Cattle Population

Base on the Table 1, dairy cow population in Indonesia was mainly located in Java Island. Province which has the largest dairy population was East Java Province, which was about 47.4% of the total population, followed by Central Java (25.2%) and West Java (24.7%). The population in other provinces are relatively small, less than 1%.

Table 1. Dairy population in Indonesia 2010

Province	Population (head)	%
East Java	231,408	47.4
Central Java	122,489	25.1
West Java	120,475	24.7
DI Yogyakarta	3,466	0.7
DKI Jakarta	2,728	0.6
North Sumatera	2,642	0.5
South Sulawesi	2,198	0.5
West Sumatera	857	0.2
Other Provinces	1,452	0.3
Total	487,715	

Source: Directorate General of Livestock and Veterinary (2011)

Methane Emission

According to IPCC default (Tier 1), methane emission factor from enteric fermentation of dairy cattle in South Asia region is 68 kg/head/day. Based on the survey results the average of cow body weight was 390 kg and dry matter intake was 11.9 kg/head/day, therefore the methane emission factor was 53 kg/head/day. This methane emission factor was smaller than the IPCC default (Tier 1).

Table 2 showed that methane emissions from enteric fermentation and manure management calculated using Tier 1 model were 33.165 and 15.119 Gg/year respectively, whereas, the calculation of the respective emission using Tier 2 model were 25.738 and 0.120 Gg/year. Methane emission calculation using Tier 2 was lower than Tier 1 model. Enteric fermentation contributed 68.7% to total methane emission from dairy cattle sector.

Methane emissions from livestock sector depend on the number of livestock population. Compared to other livestock, dairy cows contributed only 3.6% to total methane emission. Beef cattle were the major contributor (53.8%) followed

Table 2. Methane emission from enteric fermentation and manure management calculated by Tier 1 and Tier 2

Province	Tier 1			Tier 2		
	Enteric fermentation (Gg/year)	Manure management (Gg/year)	Total (Gg/year)	Enteric fermentation (Gg/year)	Manure management* (Gg/year)	Total (Gg/ year)
East Java	15.74	7.17	22.91	12.21	0.06	12.27
Central Java	8.34	3.80	12.13	6.46	0.03	6.49
West Java	8.19	3.74	11.93	6.36	0.03	6.39
DI Yogyakarta	0.24	0.11	0.34	0.18	0.00	0.18
DKI Jakarta	0.19	0.09	0.27	0.14	0.00	0.15
North Sumatera	0.18	0.08	0.26	0.14	0.00	0.14
South Sulawesi	0.15	0.07	0.22	0.12	0.00	0.12
West Sumatera	0.06	0.03	0.09	0.05	0.00	0.05
Other Provinces	0.10	0.05	0.14	0.08	0.00	0.08
Total	33.17	15.12	48.28	25.74	0.12	25.89

* Calculated using Qurimanasari (2011).

Table 3. Nitrous oxide emission from enteric fermentation and manure management calculated by Tier 1 and Tier 2

Province	Direct N_2O emission (kg/year)	Indirect N_2O emission (kg/year)	Total N_2O emission (kg/year)	Total CO2-Eq (Gg/year)
East Java	121,646	1,091	122,737	36.33
Central Java	64,390	577	64,967	19.23
West Java	63,331	568	63,899	18.91
DI Yogyakarta	1,822	16	1,838	0.54
DKI Jakarta	1,434	13	1,447	0.43
North Sumatera	1,389	12	1,401	0.41
South Sulawesi	1,155	10	1,166	0.35
West Sumatera	451	4	455	0.13
Other Provinces	763	7	770	0.23
Total	256,381	2,299	258,680	76.57

by buffaloes (12.6%), goats (10.6%), pigs (7.4%), and sheep (7.0%) (Thalib *et al*., 2008). During 2003-2007 period, Indonesian methane emission ha increased by 1.9% per year.

Table 3 showed that the N_2O emission from dairy cattle in Indonesia. The N_2O emissions mostly come from direct emissions of N_2O. The direct and indirect N_2O

emission were 256,381 and 2,299 kg/year respectively. The total N_2O emission was 258,680 or equivalent to 76.57 Gg CO_2 per year.

Conclusions

Total methane emissions from dairy sector in Indonesia was 48,28 Gg/year (1,111 Gg CO_{2-} eq) while N_2O emissions were 258,680 kg/year or 76.57 Gg CO_2-eq. Thus the total GHG's emission from dairy sector in Indonesia were 1,187 Gg/year. Methane emissions calculations based on survey results was lower than the IPCC default.

References

Directorate General of Livestock and Veterinary. 2011. Livestock Statistics. Directorate General of Livestock and Veterinary. Jakarta

IPCC. 2001. Mitigation of Climate Change. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press. Cambridge and New York.

IPCC. 2006. Guidelines for National Greenhouse Gas Inventory. Vol. 4: Agriculture, Forestry and Other Land Use. The Institute for Global Environmental Strategies (IGES), Hayama, Japan.

Thalib, A., Suryahadi, A. Unadi, I. Amien, B. Haryanto, E. Noor, I. G. Permana, T. Herawati and W. Estiningtyas. 2008. Verification of Gashouse Gas Emission in Livestock Sector. Agency for Agriculture Research and Development. Department of Agriculture. Bogor.

Qurimanasari, E. 2011. Estimation of Greenhouse Gasses from Livestock Sector in West Java Province. Faculty of Animal Scince, Bogor Agricultural University, Bogor.