Greenhouses Gases Emissions from Dairy Cattle in Indonesia

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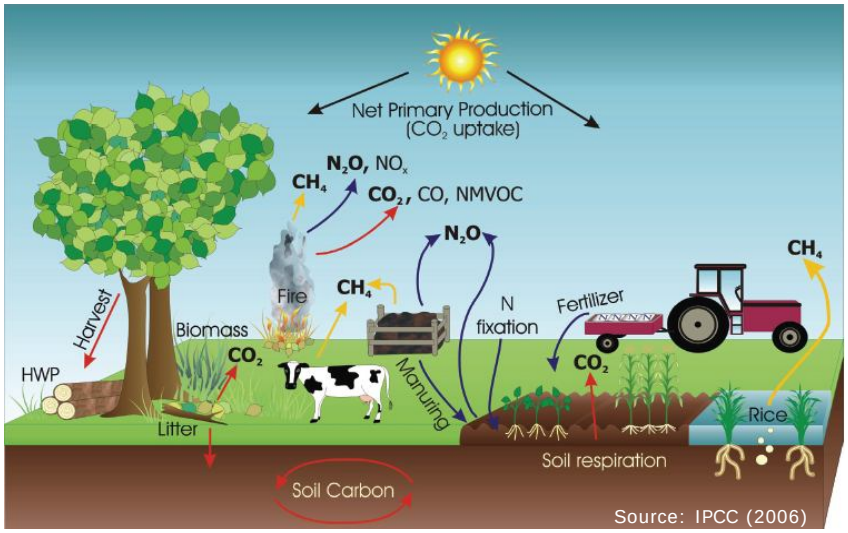
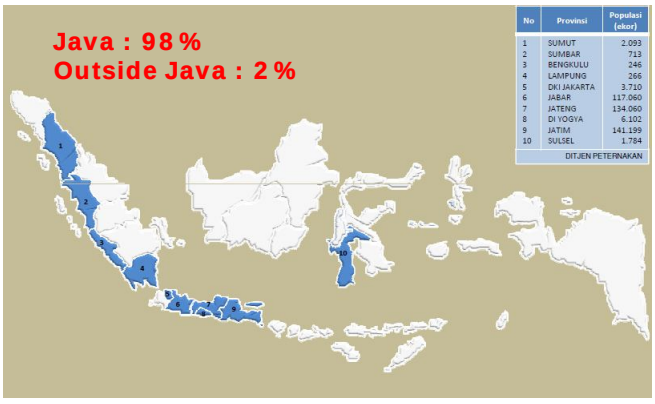
The Main GHG Emission from Agriculture Sector



INTRODUCTION

- Livestock contribute on green house gases (GHG), by methane (CH_4) and nitrous oxid (N_2O) emission.
- Dairy cattle is an important source of CH_4 emission. The methane emission from dairy cattle is higher than beef cattle (IPCC, 2006).
  - Dairy cattle : 68 kg/head/year
  - Beef cattle : 47 kg/head/year
- In Indonesia Livestock Subsector contribute 17.5% of methane emission.

Distribution of Dairy Cattle in Indonesia



No	Provinsi	Populasi (ekor)
1	SUMUT	2.093
2	SUMBAR	713
3	BENGKULU	246
4	LAMPUNG	266
5	DKI JAKARTA	3.710
6	JABAR	117.060
7	JATENG	134.060
8	DI YOGYA	6.102
9	JATIM	141.199
10	SULSEL	1.784

DITJEN PETERNAKAN

Dairy cattle population in Indonesia has currently reached 487,715 head and located mainly on Java Island.

Dairy Cattle Population in 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**	

GHG Emission from Livestock

- Green House Gasses (HGH) from livestock are **Methane** and **Nitrous oxid**.
- Methane (CH_4) is produced as part of the normal digestion process of ruminant:
  - enteric fermentation,
  - livestock manure management system

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N_2O Emission from Livestock

- Nitrous oxide (N_2O) emissions produce from manure, during the storage and treatment of manure (direct and indirect).
- Direct N_2O emissions occur via combined nitrification and denitrification of nitrogen contained in the manure, depend on:
  - N-content, duration of storage and treatment
- Indirect N_2O emissions result from volatile nitrogen losses that occur primarily in the forms of ammonia and NO_x

Methane Emission Factor

- 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.
- Emission factors in each sector should be developed in each country.

Objective

- Objective this study is to estimate greenhouse gases emissions from Indonesian dairy cows using the IPCC (2006) Guideline Tier 1 (default) and Tier 2 (modified) methods.

MATERIALS AND METHODS

Data Collection

- Dairy population data was collected from Statistic Center Buro - Directorate General of Livestock Services and Animal Health (2011)
- The primary data was obtained from field observations in dairy cattle production area (KUNAK Cibungbulang), Bogor.
  - *Cow's body weight, milk production, dry matter intake and dry matter digestibility of ration as well as manure management system.*

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.

CH_4 Emission from **Enteric Fermentation**

- **CH_4 emission = $N_{(D)}$ x $EF_{(T)}$ x 10^6**
  - $N_{(D)}$ = dairy population (head)
  - $EF_{(T)}$ = emission factor (kg CH_4/head/year)
    - $EF_{(Tier\ 1)}$ = 68 kg/head/year (IPCC, 2006)
    - $EF_{(Tier\ 2)}$ = modified model

CH_4 Emission from **Manure Management**

- **CH_4 emission = $N_{(D)}$ x $EF_{(T)}$ x 10^6**
  - $N_{(D)}$ = dairy population (head)
  - $EF_{(T)}$ = emission factor (kg CH_4/head/year)
    - $EF_{(Tier\ 1)}$ = 31 kg/head/year (IPCC, 2006)
    - $EF_{(Tier\ 2)}$ = modified model

N_2O Emission from **Manure Management**

- **CH_4 emission = $N_{(D)}$ x $EF_{(T)}$ x 10^6**
  - $N_{(D)}$ = dairy population (head)
  - $EF_{(T)}$ = emission factor (kg CH_4/head/year)
    - $EF_{(Tier\ 1)}$ = 0.01 kg/head/year (IPCC, 2006)

N_2O Emission from **Manure Management**

- Using IPCC Gudeline (2006)
- Direct N_2O emission:

$$N_2O_{D(mm)} = \left[\sum_S \left[\sum_T \left(N_{(T)} \bullet Nex_{(T)} \bullet MS_{(T,S)}\right)\right] \bullet EF_{3(S)}\right] \bullet \frac{44}{28} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(4)$$

Where:

$N_2O_{D(mm)}$ = Direct N_2O emissions from Manure Management in the country, kg N_2O yr^{-1}
$N_{(T)}$ = Number of head of livestock species/category T in their country
$Nex_{(T)}$ = Annual average N excretion per head of species/category T in the country, kg N $animal^{-1}$ yr^{-1}
$MS_{(T,S)}$ = Fraction of total annual nitrogen excretion for each livestock species/category T that is managed in manure management system S in the country, dimensionless
$EF_{3(S)}$ = Emission factor for direct N_2O emissions from manure management system S in the country, kg N_2O-N/kg N in manure management system S
S = Manure management system
T = Species/category of livestock
44/28 = conversion of (N_2O)-$N)_{(mm)}$ emissions to $N_2O_{(mm)}$ emissions

N_2O Emission from **Manure Management**

- Indirect N_2O emission:

$$N_2O_{G(mm)} = \left(N_{volatilization-MMS} \bullet EF_4\right) \bullet \frac{44}{28} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

Where:

$N_2O_{G(mm)}$ = Indirect N_2O emissions due the volatilization of N from Manure Management in the country, kg N_2O yr^{-1}

EF_4 = emission factor for N_2O emissions from atmospheric deposition of nitrogen on soils and water surfaces, kg N_2O-N (kg NH_3-N + No_x-N volatilized)$^{-1}$; default value is 0.01 kg N_2O-N (kg NH_3-N + NO_x-N volatilized)$^{-1}$

RESULT AND DISCUSSION

CH_4 Emission Factor

- Survey results:
  - Average BW : 390 kg
  - DM intake :11.9 kg/head/day
  - Milk production 11.3 liter/head/day
  - Ration digestibility 60%
- Methane emission factor was **53 kg/head/day**.
- This methane emission factor was smaller than the IPCC default (**68 kg/head/year)**.

Total CH_4 and N_2O Emission

- Total CH_4 emission calculated using Tier 2 (modified) was lower than calculated by Tier 1 (default), 25.89 vs 48.28 Gg/year.
- N_2O emissions from dairy cattle were
  - Direct N_2O emissions : 256,381 kg/year
  - Indirect N_2O emissions : 2,299 kg/year
  - Total N_2O emissions : 258,680 kg/year

CH_4 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**

N_2O emission from 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)
East Java	121,646	1,091	122,737
Central Java	64,390	577	64,967
West Java	63,331	568	63,899
DI Yogyakarta	1,822	16	1,838
DKI Jakarta	1,434	13	1,447
North Sumatera	1,389	12	1,401
South Sulawesi	1,155	10	1,166
West Sumatera	451	4	455
Other Provinces	763	7	770
Total	256,381	2,299	258,680

CONCLUSION

- Methane emissions calculations based on survey results was lower than the IPCC default.
- Indonesia should develop a new Emission Factor for methane and nitrous oxid from livestock sector.

Thank You