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Research article

Greenhouse gas emissions from dairy farming in Bangladesh

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Livestock is a vital source of methane and nitrous oxide gas which are considered as hazardous greenhouse gas (GHG) causing global warming. This study was conducted to assess GHG emissions from different livestock categories of different (small, medium, large) dairy farming in Bangladesh by using IPCC guideline 2006 and CIGR 2002. The emission rate of CH_4, N_2O (mainly emits from manure) is increasing day by day in dairy farming due to poor manure management systems. The study was estimated maximum 20% CH_4 was emitted from dairy cow and minimum 8% CH_4 was emitted from calf. Least N_2O emission found from a farm 0.015 Kg head^{-1}yr^{-1} where manure was properly utilized by anaerobic digestion. On the other hand, most N_2O emission found 0.25 Kg head^{-1}yr^{-1} from a farm where manure was not properly managed. In this research, it had been observed increasing milk production decreasing CO_2 emission and vice-versa. The *CO_2*-equivalent for dairy cattle, heifer, calf, bull, buffalo male, buffalo female, and buffalo calf found 1720.4, 788.1, 649.4, 1161.1, 1588.2, 1624.2, and 725 kg head^{-1}yr^{-1} respectively. The emission rate can be minimized by handling proper dietary, which can reduce excretion of GHG during ruminant digestion and manure management practices.

Keywords: Livestock, methane, emission, manure, dairy, enteric fermentation.

INTRODUCTION

Climate sensitivity is defined as the equilibrium increase in the global annual average surface temperature from a doubling of the atmospheric CO_2 concentration with respect to pre-industrial levels and its value is likely between 1.5 and 4.5 °C (IPCC, 2013). The main reason for global warming is greenhouse gas (GHG) emissions. The most important greenhouse gases are carbon dioxide (mainly from burning fossil fuels), methane (mainly from ruminant digestion and waste management of animals) and nitrous oxide (mainly from dung, urine and nitrogenous fertilizers). Among them CH_4 and N_2O are directly emitted from livestock sector. About 74% of global livestock emissions have been occurred from beef and dairy cattle and it is the largest source of livestock emissions (Caro et al., 2014). Methane sources include enteric fermentation, manure storage, field application of manure, and feces deposited on pasture or on the barn floor (Rotz et al., 2011).

Manure management is an important source of N_2O emissions, through the processes of nitrification and denitrification accounting for an estimated 5% of global (EPA, 2012). In total, enteric fermentation, feed production, and manure management typically account for 35, 32, and 26% of GHG at the farm scale, respectively. The rest of the emissions come from fuel and electricity consumption (Thoma et al., 2013).

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Methane from manure storage is also an important source of GHG emissions produced in a dairy farm, this value contributing very significantly to the total GHG emissions at high levels of animal confinement (Del Prado et al., 2013).

Agriculture is responsible for 30-35% of the global GHG emissions (Foley et al., 2011). In agriculture, livestock sector has been revealed as one of the main contributors to climate change, representing 18% of anthropogenic greenhouse gas emissions (Steinfeld et al*.,* 2006). CH_4 emissions from enteric fermentation contribute approximately 50% of total GHG emissions in dairy farms (Hörtenhuber et al*.,* 2010). Beef and dairy are the most emissions-intensive livestock products and are responsible for the most emissions, accounting for 65 per cent of the total GHGs emitted by livestock (FAO, 2013). CH_4 emission related to milk yield (g CH_4/kg milk) decline as milk yield per cow increases (Flachowsky and Brade, 2007; Hristov et al., 2015). Higher CH_4 emissions from slurry of dairy cows offered forage supplemented with concentrates in comparison with dairy cows offered a forage-only diet (Hindrichsen et al*.,* 2006).

The assessment of hazardous greenhouse gas such as CO_2, CH_4, and N_2O emissions from milk production, enteric fermentation, and manure management practice of different livestock categories (dairy cattle, non-dairy cattle, and buffaloes) of dairy farming was the main objective of this study. This paper provides estimation of the emission value per head of animal of different livestock categories in Bangladesh.

MATERIALS AND METHODS

Different greenhouse gas (GHG) such as methane, nitrous oxide which are emitted from dairy waste and ruminant digestion of cattle, buffalo were calculated following the guideline of IPCC (2006) Tier 1 methodology and CIGR (2002). Livestock contributes in CH_4 emissions from enteric fermentation and both CH_4 and N_2O emissions from livestock manure management systems. Methane emissions from manure management tend to be smaller than enteric emissions and emissions of nitrous oxide is less than compared to methane emissions from ruminant digestion and manure management system. But practically the potentiality of hazardous effect of nitrous oxide is more than methane. This research was mainly survey basis. Emissions were estimated in different types (small, large, medium, mechanized, non-mechanized) of dairy farm. The selected areas of this study were Bangladesh Agricultural University (BAU) dairy farm, Mymensingh, Rural Development Academy (RDA) dairy farm, Bogra and four small, four medium and two large farms in Sirajganj district. In this study BAU and RDA dairy farms are considered modernized farms and rest of the farms are non- modernized farms.

Before calculating GHG it is essential to categorize livestock population. The livestock populations were divided into subcategories according to age, type of production, and sex. Cattle and buffalo populations were classified three main subcategories: mature dairy, other mature and growing cattle (IPCC 2006). The emissions of different categories are not same; they are varied mainly for their species, body weight, feeding amount, average excretion rate of dung and urine. So it was needed to divide livestock into different subcategories to assess greenhouse gas emissions precisely.

Methane emissions from enteric fermentation

Enteric CH_4 emission is produced as a result of microbial fermentation of feed components. Methane, a colorless, odorless gas, is produced predominantly in the rumen (87%) and to a small extent (13%) in the large intestines (Murray et al., 1976; Torrent and Johnson, 1994). Methane is produced in herbivores as a by-product of enteric fermentation, a digestive process by which carbohydrates are broken down by micro-organisms into simple molecules for absorption into the bloodstream (IPCC 2006). The methane emissions rate depends on the type of digestive tract, age, and weight of the animal, and the quality and quantity of the feed consumed. Ruminant livestock (e.g., cattle, sheep) are major sources of methane with moderate amounts produced from non-ruminant livestock (e.g., pigs, horses). The ruminant gut structure fosters extensive enteric fermentation of their diet. The emission (Kg yr^{-1}) was calculated by using equation 1.

$$\textbf{Total } \mathbf{CH_{4Enteric}} = \textstyle\sum_i \mathbf{EF_{(T)}} \times \mathbf{N_{(T)}} \qquad (1)$$

Where, $EF_{(T)}$ represents emission factor for the defined livestock population (KgCH_4 $head^{-1}$ yr^{-1}); $N_{(T)}$ represents the number of head of livestock species / category T; T represents species / category of livestock. Enteric fermentation CH_4 emission factors for dairy cow, heifer, bull, calf, adult buffalo male, adult buffalo female, and buffalo calf in Indian subcontinent region are 58, 28, 42, 23, 55, 57, 23 kg CH_4 $head^{-1}$ yr^{-1} respectively (IPCC 2006).

Methane emissions from manure management

Amount of CH_4 emissions from manure is mainly varied from different management system during the storage and treatment of manure, and deposited on pasture. The term ‘manure’ is used here collectively to include both dung and urine (i.e., the solids and the liquids) produced by livestock (IPCC 2006). Each head daily secretes 27.5 kg feces and 13.5 kg urine for 500 kg body weight of cattle (Yang et al., 2003). When manure is stored or treated as a liquid (e.g., in lagoons, ponds, tanks, or pits), it decomposes an-aerobically and can produce a significant quantity of CH_4. The temperature and the retention time of the storage unit greatly affect the amount of methane produced. When manure is handled as a solid (e.g., in stacks or piles) or when it is deposited on pastures and rangelands, it tends to decompose under more aerobic conditions and less CH_4 is produced (IPCC 2006). CH_4 (Kg yr^{-1}) emission from manure was calculated by using equation 2.

$$CH_{4Manure} = \sum_{(T)} EF_{(T)} \times N_{(T)} \quad (2)$$

Manure Management Methane Emission Factors have been taken from IPCC guideline 2006 based on annual average temperature of the farm area. The values are considered for Indian subcontinent condition as there are no separate values supplied in Bangladesh conditions. Manure management methane emission factors were used for dairy cattle, other cattle (heifer, bull, calf etc), and buffalo 6, 2, and 5 Kg CH_4 $head^{-1}$ yr^{-1}(IPCC 2006). These emission factors represent the range in manure volatile solids content and in manure management practices used in Indian subcontinent region, as well as the difference in emissions due to temperature.

Nitrous Oxide emissions from manure management

Nitrous Oxide is mainly produced from manure which is managed in different form such as daily spread, solid storage, dry lot, liquid/slurry, pit storage, aerobic treatment, anaerobic digestion, paddock/range/pasture, burnt for fuel etc management system. Combined nitrification and de-nitrification of nitrogen contained in the manure are the main reasons for N_2O emissions. The emission of N_2O from manure during storage and treatment depends on the nitrogen and carbon content of manure, and on the duration of the storage and type of treatment (IPCC 2006). The emission of N_2O is varied in different management practice. The amount of N_2O emissions is increased in case of paddock/range/pasture, burnt for fuel etc compared to daily spread, dry lot, and solid storage system in Bangladeshi condition. In this study direct N_2O emission from manure management formula (equation 3) was used to calculate N_2O from IPCC 2006.

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

Where, $N_2O_{D(mm)}$ = direct N_2O emissions from Manure Management in the farm, kg N_2O yr^{-1}; $Nex_{(T)}$ = annual average N excretion per head of species/category *T* in the farm, 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 farm, dimensionless; $EF_{3(S)}$=emission factor for direct N_2O emissions from manure management system *S*, kg N_2O-N/kg N in manure management system *S;* S = manure management system; 44/28 = conversion of $(N_2O\text{-}N)_{(mm)}$ emissions to $N_2O_{(mm)}$ emissions. Nex values in Bangladeshi condition found 47.18, 15.51, 9.93, 24.82, 34.46, 40.88, and 11.68 kg N $animal^{-1}$ yr^{-1} for dairy cow, heifer, calf, bull, female buffalo, male buffalo, and buffalo calf respectively. EF_3 values for Solid storage, Dry lot, Liquid/Slurry, and Pasture/Range/Paddock are 0.005, 0.02, 0.005, and 0.02 respectively (IPCC 2006). Fraction of Manure in Management System (MS %) describes the portion of each livestock group's manure that is handled by a specific manure management technique. The portions of manure managed in each manure management system are collected for different livestock category. In some cases, manure may be managed in several types of manure management systems. Then all management system should be considered to calculate N_2O emissions individually in each category of livestock and at last the calculated amount of all systems to be summed. In sub-continent region, there are shown mainly daily spread, pasture/range/paddock and burned for fuel manure management system. Anaerobic digestion system is practiced very little amount as biogas plant is not available an all place throughout the country.

Calculation of CO_2 excretion

The excretion rate of CO_2 was derived based on bodyweight and milk production and temperature inside the building. The CO_2 excretion rate can be calculated as follows (CIGR, 2002):

$$q_t = 5.6(m)^{0.75} + 1.6 \times 10^{-5}(p)^3 + 22y \quad (4)$$

$$CF = 4 \times 10^{-5}\,(20 - T_i)^3 + 1 \quad (5)$$

$$q_{cor} = q_t . CF \quad (6)$$

$$P_{CO_2} = 0.339 \times q_{cor} \quad (7)$$

Where P_{CO2} represents the excretion rate of CO_2 from one cow (g cow^{-1} h^{-1}); q_t represents the total heat production (W); q_{cor} is the corrected value of the total heat production (W); m represents the average mass of the animals (kg cow^{-1}); p is days after insemination (d); y designates the milk yield (kg d^{-1}); T_i represents the temperature inside the barn (°C); and CF is the temperature correction factor.

RESULTS AND DISCUSSION

Methane emission from enteric fermentation

Maximum CH_4 emission for enteric fermentation of different livestock category found 41.13 Kg CH_4 $head^{-1}yr^{-1}$

Table 1. Methane (CH_4) emissions from enteric fermentation of different dairy farms

Livestock Category		Modernized Farm: BAU* Farm	Modernized Farm: RDA** Farm	Non-Modernized Farm: Smallholder farm	Non-Modernized Farm: Medium Farm	Non-Modernized Farm: Large Farm
Cow	Dairy cow	3016	2088	232	812	8120
	Heifer	364	840	28	168	1400
	Calf	2070	552	69	253	2438
	Bull	42	294	-	168	252
Buffalo	Adult male	220	-	-	-	-
	Adult Female	342	228	-	-	-
	Calf	161	-	-	-	-
Total Emissions Kg CH_4 yr^{-1}		6215	4002	329	1401	12210
Average Emissions Kg CH_4 $head^{-1}yr^{-1}$		35.92	39.62	41.13	40.03	40.43

*BAU means Bangladesh Agricultural University
** RDA means Rural Development Academy

(Table 1) from a smallholder dairy farm which is an indigenous farm and minimum emission found 35.92 Kg CH_4 $head^{-1}yr^{-1}$ from BAU dairy farm which is considered as a modernized farm. Globally, about 80 million tons of CH_4 is produced annually from enteric fermentation mainly from ruminants (Patra, 2012). Singh et al. (1996, 2001) predicted the average methane emission rate to be at 35, 27.5, and 35.5 kg/animal/yr for cattle (crossbred), cattle (indigenous), and buffalo respectively in Indian dairy farm. This result has a little variation with research result due to variation of crossbred and concentration feed ingredient. Yang et al. (2003) found the average annual methane emission from enteric fermentation in Holstein lactation (body weight 611±56 kg) cow, Holstein dry cow (average body weight 425 kg) and growing heifer (average body weight 275 kg) with three feeds of corn silage, napier grass silage, pangola grass haylage was 150.1, 116.6 and 63.8 kg/head, respectively.

Emissions from all non-modernized or indigenous farms are almost same. Emission from a modernized or mechanized farm is lower than non-mechanized indigenous dairy farm. The main reason for varying these values is dietary practice of these farms. The upgrade diet can reduce CH_4 emission from enteric fermentation. Increasing the digestibility of pasture for grazing ruminants is the most practical means of reducing their CH_4 emissions (Hegarty, 1999; Hanson et al., 2013). A feed additive or ingredient that reduces CH_4 emissions from cattle fed high-forage diets could have an important impact on reducing the emissions from the livestock sector (Beauchemin and McGinn, 2006). Garnsworthy et al. (2012) found for 82 cows, methane emission rate during milking increased with daily milk yield but varied between individuals with the same milk yield and fed the same diet. For 42 cows, the methane emission rate during milking was greater on a feeding regimen designed to produce high methane emissions, and the increase compared with a control regimen was similar to that observed for cows in respiration chambers. An understanding of production systems and information on animal populations has enabled global inventories of ruminant GHG emissions, and dietary strategies are being developed to reduce GHG emissions from ruminants (Pacheco et al., 2014).

Methane emission from manure management systems

Annual average CH_4 emissions from different farms are almost same, varies between 3.50 to 4.00 kg (Table 2). Maximum average emission found 4 kg CH_4 $head^{-1}yr^{-1}$ from smallholder dairy farm and minimum emission found 3.50 kg CH_4 $head^{-1}yr^{-1}$ from BAU dairy farm. Su et al. (2003) found average methane emission from anaerobic wastewater treatment systems of dairy farms was 4.898 kg CH_4 per head per year in Taiwan. For variation of waste management practice emission rate is little differed. In our study we have found several management practices. Other reason is annual average temperature difference. Annual average temperature in Taiwan is lower than Bangladesh. Regular removal of manure from buildings and storage would result in lower CH_4 emission (de Boer et al., 2011). The pie chat (Figure 1) is showing CH_4 emission of different livestock categories from enteric fermentation and manure management along. CH_4 emissions of non-dairy cattle are the highest (32%) than dairy cattle (20%). Emissions from dairy buffalo found 19% and non-dairy buffalo found 29% of dairy farms. The non-dairy sector contributed more methane in cattle and buffalo than dairy sector. Yamazi et al. (2003, 2004) found 0.9 $TgCH_4yr^{-1}$ from enteric fermentation and waste management system in Bangladesh. We found the non-dairy sector contributed more methane in cattle while the dairy sector was the highest in buffalo. Swamy and

Table 2. Methane (CH_4) emissions from manure of different dairy farms

Livestock Category	Modernized Farm		Non-Modernized Farm		
	BAU Farm	RDA Farm	Smallholder farm	Medium Farm	Large Farm
Dairy cow	312	216	24	84	840
Other cattle	208	122	8	42	324
Buffalo	85	20	-	-	-
Total Emissions Kg CH_4 yr^{-1}	605	358	32	126	1164
Average Emissions Kg CH_4 $head^{-1}yr^{-1}$	3.50	3.54	4.00	3.6	3.85

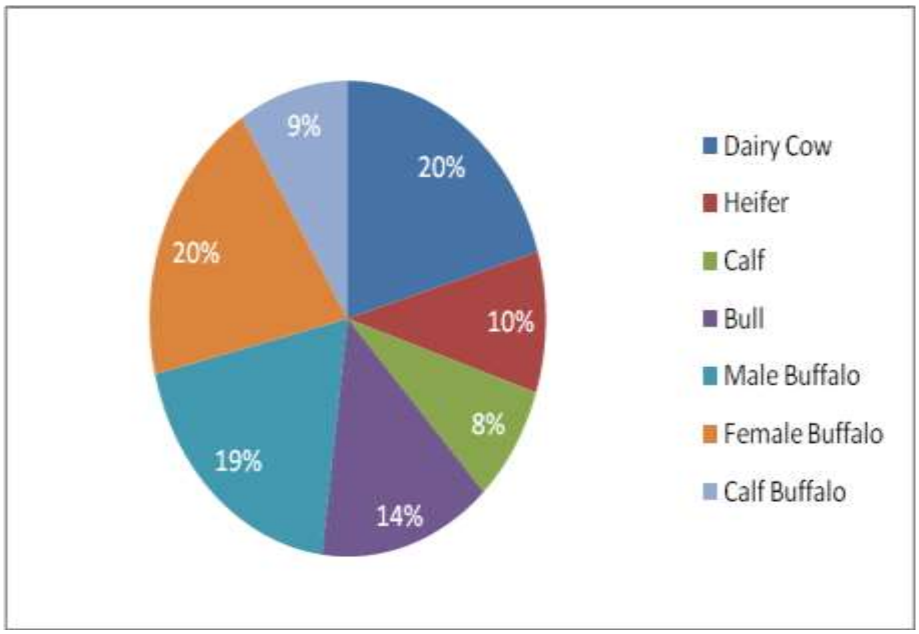

Figure 1. Methane (CH_4) emissions from different livestock categories

Bhattacharya (2006) found CH_4 emission of non-dairy cattle are the highest (35.9%) followed by dairy buffalo (20.8%), dairy cattle (19.9%) and non-dairy buffalo (14.1%) from all Indian dairy farms. Least amount of CH_4 emission can be possible for proper manure management. Avoiding storage of manure in warmer periods would also contribute to reduce emissions further, especially emissions of NH_3, CO_2 and CH_4 (Pereira et al., 2012). In our study we found Maximum 91% methane is emitted from enteric fermentation, 8% methane and 1% nitrous oxide is emitted from manure. Caro et al. (2014) found CH_4 emissions due to livestock represented by 28.3 % of global CH_4 emissions whereas N_2O emissions due to livestock represented by 29.7 % of global N_2O emissions. The addition of dried grass to dairy manure composting piles had a mitigating effect on the GHG emissions (Maeda et al., 2013).

Nitrous Oxide emission from manure management systems

For calculating N_2O, different manure management systems were considered which were practiced in different dairy farm. N_2O emission from manure management vary significantly between the types of management system used and can also result in indirect emissions due to other forms of nitrogen loss from the system. Minimum N_2O found (Table 3) 0.015 Kg N_2O $head^{-1}yr^{-1}$ in RDA dairy farm. Houghton et al. (1997) calculated nitrous oxide emissions from animal waste management system in Asia for non-dairy cattle, Dairy cattle, and Buffaloes were 0.34, 0.29, 0.34 kg N_2O–N $head^{-1}yr^{-1}$ respectively. Yamazi et al. (2003, 2004) found N_2O emissions from animal wastes management system in Bangladesh was 15 kg N_2O–Nyr^{-1}. The reason to get

Table 3. Nitrous oxide (N_2O) emissions from different dairy farms (Kg N_2O yr^{-1})

Types of Farms		Manure Management System			Total Emissions	Average Emissions Kg N_2O $head^{-1}yr^{-1}$
		Liquid/ slurry	Pasture/ Range/ Paddock	Dry lot		
Modernized Farm	BAU Farm	0.2808	31.26	1.98	33.53	0.194
	RDA Farm	0.202	-	1.28	1.48	0.015
Non-Modernized Farm	Smallholder farm	0.0184	1.91	0.0569	1.99	0.249
	Medium Farm	0.0756	7.84	0.379	8.29	0.237
	Large Farm	0.674	69.72	2.49	72.88	0.241

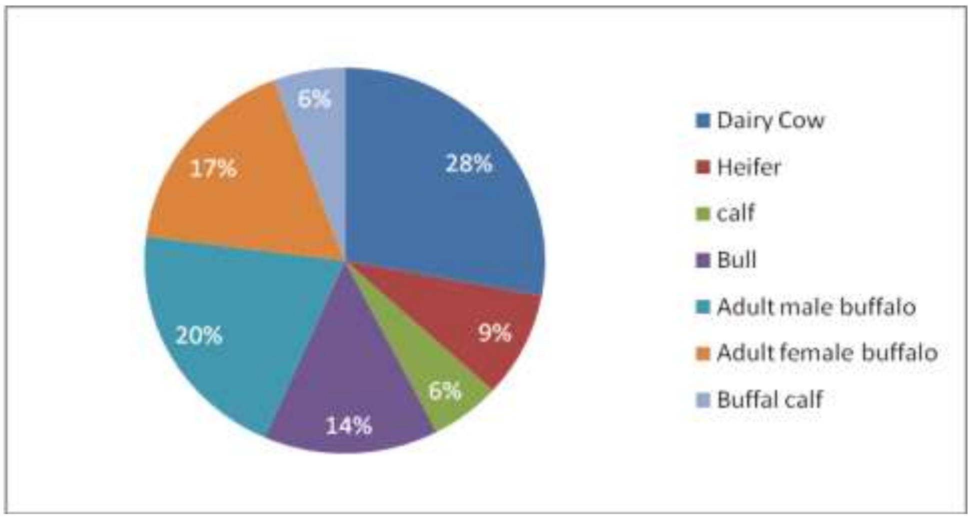

Figure 2. Nitrous oxide (N_2O) emissions from different livestock categories

minimum amount was having anaerobic digester which interrupted to emit hazardous N_2O gas. Pasture-based systems have higher emissions from forage because of a doubled rate of N_2O from N excreted during grazing (IPCC, 2006), as compared to N spread as manure. For achieving low greenhouse gas emissions from manure management, it is need to manage the nitrogen, by utilizing the nitrogen contained in the manure and by decreasing the nitrogen content of animal faeces and urine. High nitrogen losses can cause to raise greenhouse gas emissions. Avoiding overfeeding of protein is an important measure to decrease the nitrogen content in the faeces and urine leaving the animal (Sonesson et al., 2009). Battini et al. (2014) concluded on-farm manure anaerobic digestion with the production of electricity is an effective technology to significantly reduce global environmental impacts of dairy farms (GHG emissions and non-renewable energy consumption). Mitigation of manure emissions is arguably most effectively done by using either anaerobic digester or coverage and flaring of methane in slurry systems. Both options reduce CH_4 and N_2O by around 70 % (Montes et al., 2013). Dairy cow contributes maximum N_2O emission from manure about 28% (Figure 2) and minimum contribution found 6% from cattle and buffalo calf. Sufficient manure management practice can interrupt GHG emission. Su et al. (2003) revealed average emission levels of GHG from anaerobic wastewater treatment systems of dairy farms 0.011 kg N_2O per head per year in Taiwan which is much less value than other management systems. Leytem et al. (2013) estimated average emissions per cow per day from the open-freestall source area were 0.41 kg CH_4, and 0.02 kg N_2O from an open freestall dairy in USA. Anaerobic digester (biogas plant) interrupts to emit N_2O emission from manure. Hence CH_4 is properly utilized and reducing the hazardous gas emissions to environment.

CO_2 emissions from milk production and body weight

GHG emissions from milk production is mainly depends on body weight and feeding arrangement. Higher the milk

Table 4. Carbon dioxide (CO_2) emissions from milk production and body weight

Types of Farms		Average milk production (kg/day)	CO_2/kg milk	CO_2/kg body weight
Modernized Farm	BAU	10	174.13	6.33
	RDA	7	221.32	5.63
Non-Modernized Farm	Smallholder	6	247.54	5.40
	Medium	6	247.54	5.40
	Large	6	247.54	5.40

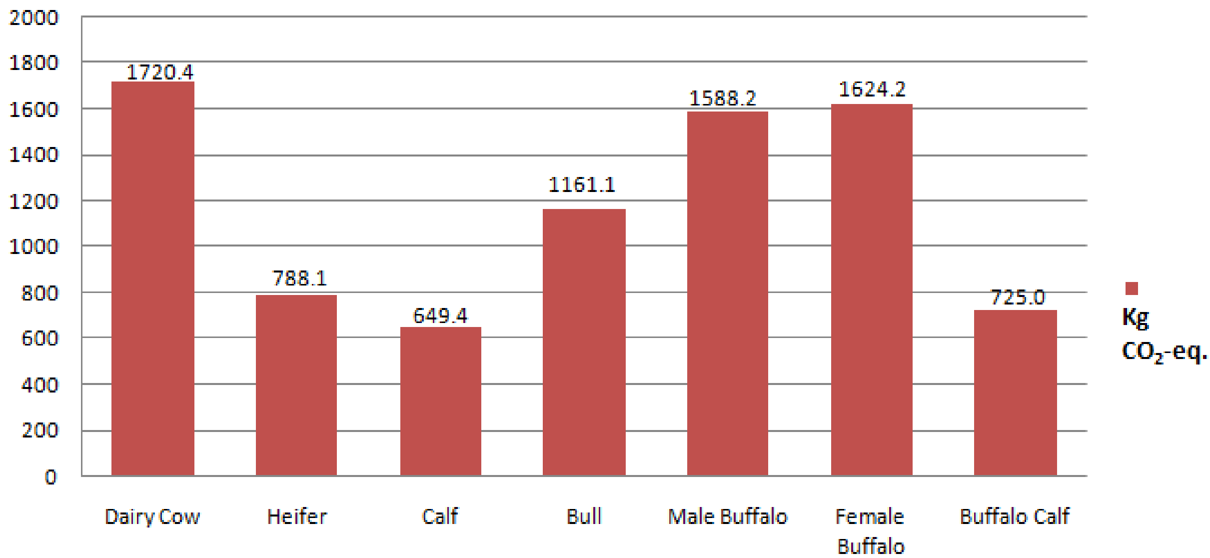

Figure 3. CO_2-eq. value of different livestock categories per head per year

yield, higher is CH_4/kg body weight and lower is CH_4/kg milk animal with better nutritional status. Lower the milk yield, lower is CH_4/kg body weight and higher is CH_4/kg milk animal with nutritional status not good (Swamy and Bhattacharya, 2006; Dutreuil et al., 2014). Diet was the strongest factor explaining differences in GHG emissions from milk production. For average 10 kg head^{-1}day^{-1} milk production CO_2 emission found 174.13 kg/ kg milk production and 6.33 kg/kg body weight (Table 4). On the other hand for 6 kg milk production per head per day CO_2 emission found 247.54 kg/kg milk production and 5.40 kg/kg body weight. So, with increasing milk production decreasing GHG emission and with increasing body weight GHG emission is also increasing and vice versa. Swamy and Bhattacharya (2006) found CH_4 emission from Indian dairy farm average methane production per kg of milk is 41, 21 and 31 g/kg respectively, for indigenous cattle, crossbred cattle and buffalo. Increasing milk production by improving dietary of livestock can reduce emission (Audsley and Wilkinson, 2014). Dutreuil et al. (2014) observed for the grazing and organic farms, decreasing the forage-to-concentrate ratio in the diet decreased GHG emissions when milk production was increased by 5 or 10%. Methane from the rumen and manures, and N_2O emissions from soils comprised most of the GHG emissions for milk production.

CO_2-equivalent emission per animal per year in different farming systems

The global warming potential (GWP) is calculated according to Intergovernmental Panel on Climate Change (IPCC, 2007), set at 25 kg CO_{2eq}/kg of CH_4 and 298 kg CO_{2eq}/ kg of N_2O (100-years horizon). When the emissions of CH_4 and N_2O are multiplied by their GWP, the emissions are expressed as CO_2-equivalents (Janzen et al., 1999; Desjardins et al., 2001). From Table 5 less emission is found from RDA and BAU dairy farm which farms are considered as mechanized and modernized farm. A well mechanized farm can increase production but reduce GHG emissions. This is occurring by perfectly controlled of manure management practice and supplying concentrates for feeding. Maximum CO_2-eq value (Figure 3) 1720.4 kg is found from dairy cow and minimum value is found 649.4 kg for calf. These values are assessed on CH_4 emissions from enteric fermentation and manure management system, and N_2O emissions from manure management systems. Hedenus et al. (2014) estimated

Table 5. CO_2-equivalent emission per animal per year in different farming systems

Dairy Farm	$CH_{4(Enteric)}$ Kg head^{-1}yr^{-1}	$CH_{4(Manure)}$ Kg head^{-1}yr^{-1}	$N_2O_{(Manure)}$ Kg head^{-1}yr^{-1}	*CO_2*-equivalent emission Kg head^{-1}yr^{-1}
BAU	35.92	3.50	0.19	1042.12
RDA	39.62	3.54	0.015	1083.47
Smallholder	41.13	4.00	0.249	1202.45
Medium	40.03	3.60	0.237	1161.38
Large	40.43	3.85	0.241	1178.82

CO_2-equivalent emissions will be approximately 13 Gton CO_{2eq}/year in 2070, compared to 7.1 Gton CO_{2eq}/year 2000. Wiedemann et al. (2015) found that over the three decades since 1981 there has been a decrease in GHG emission intensity (excluding land use change emissions) of 14% from 15.3 to 13.1 kg CO_2-e/kg liveweight (LW). Based on a report by the US Environmental Protection Agency (EPA, 2006) found 523 Mt CO_2-eq/yr from manure storage. Research over the past century in genetics, animal health, microbiology, nutrition, and physiology has led to improvements in dairy production where intensively managed farms have GHG emissions as low as 1 kg of CO_2 equivalents (CO_2e)/kg of energy-corrected milk (ECM), compared with >7 kg of CO_2e/kg of ECM in extensive systems (Knapp et al., 2014).

CONCLUSIONS

In this study maximum GHG emissions have been found from non-modernized farms where indigenous farming has been practiced. Emission from modernized and mechanized farm is comparatively lower than indigenous farms. The main reason for increasing emission from non-mechanized farm is, here manure is not properly managed. As CH_4 and N_2O is emitted from manure, so it can be prevented by utilizing dairy waste to construct biogas plant, where CH_4 is consumed by burning and less scope to emit raw gas to the environment. A well mechanized modern farm RDA dairy farm has emitted less methane only for having proper manure management system of anaerobic digester, it interrupts to produce N_2O and spread out CH_4. Another important source of N_2O emission from dairy farms in grazing area is deposition and spreading manure on pasture land. In Bangladesh, most of the dairy farms deposited manure for long times within farm area. This is a vital reason to emit greenhouse gas emission. By reducing stocking and minimizing grazing periods is resulting in lower emissions.

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