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Feeding pattern of dairy animals and enteric methane emission: a study of commercial dairy farms of Haryana

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Abstract
This survey was planned to know the existing feeding pattern and estimate methane emission from the dairy animals of commercial dairy farms of Haryana, India. Structured interview schedule was used to know the feeding pattern of animals and Tier II approach of Intergovernmental Panel on Climate Change (IPCC) was followed to estimate the methane emission from enteric fermentation of the animals. The study revealed that some good quality green fodders like berseem, maize, sorghum etc and dry fodder like paddy and wheat straw were the base of feeding patterns of the dairy animals. Estimated methane emission based on feeding pattern was high in buffalo (98.49 kg methane/animal/year) and crossbred cattle (89.61 kg methane/ animal/ year) as compared to indigenous lactating cattle (81.42 kg methane/ animal/ year). This study recommended that livestock research and extension linkage should focus on quality fodder management. There is also need to make farmers more aware about the use of quality feed and fodder for the dairy animals.

Keywords: Dairy animals, Dry fodder, Feeding pattern, Green fodder, Methane emission

Milk and dairy products are important in the Indian diet and the demand for milk is rising sharply with the time. Livestock has become a key venture for the farmers of rural India as the availability of agricultural land is very less and demand for animal food products are rising owing to population increase, urbanization and sustained rise in per capita income (Birthal and Taneja, 2006). Existence of the dairy farming is mainly accelerated by the availability of good market for animal products. The adequate amount of nutritive feed and fodder given to the dairy animals is a crucial factor impacting the productivity and performance of dairy animals. Indeed, feed cost was the major cost component in the total expenses in commercial dairy farming (Pant and Karanjkar, 1965; Chand *et al.*, 2002).

The country possesses largest livestock population in the world comprising 56.7% of world's buffaloes and 12.5% of cattle population. But livestock population's share to global greenhouse gases (GHGs) emissions is ~14% (Patra, 2014), whereas in Indian context it alone contributes 63.4% of total GHGs emission from Agriculture (INCCA, 2007). But animal feeds and fodders have direct relation with enteric fermentation that takes place in animal's rumen leading to production of methane (CH_4), an important greenhouse gas (Kumari *et al,* 2014; Thoma *et al.*, 2013; Singh *et al.*, 2012). Methane, has about 28 times more global warming potential (GWP) than carbon di-oxide (CO_2) and has atmospheric residence time of about 8 to 11 years. Enteric methane emission (EME) from livestock was accounted ~85% of total greenhouse gases from world livestock for the year 2010 (Patra, 2014), while a major portion of the EME was contributed by cattle (73.8%) and buffalo (11.3%) in the year 2010 (FAOSTAT, 2014). Actually, methane is generated in rumen of the animals (during normal digestive process) by methanogenic bacteria. Baldwin and Allison (1983) reported that about 200 species and strains are present in the digestive system of bovines and about 10 to 20 species, are believed to play an important role in methanogenesis. Indian livestock largely depends on crop residues, which have poor energy efficiency. The animals are often fed on crop residues and grasses from grazing lands in Indian condition and use of concentrated feed is low and limited to productive animals only (Kumar *et al.*, 2008, Mooventhan *et al.*, 2016). In another study, Kumari *et al.* (2014) found that many factors affect the methane emission from livestock like level of feed intake, type of carbohydrate in the diet, quality of the diet etc, and manipulation of these factors can reduce methane emission from livestock. Keeping the above in view, this survey research was designed to know the existing feeding pattern followed for the animals and also to estimate methane emission from enteric fermentation of the dairy animals of commercial dairy farms of Haryana.

The present study was conducted in Haryana, India as the state is known for dairy sector. Five districts (Karnal, Yamunanagar, Sonipat, Hisar and Sirsa) of the state were selected, since more number of commercial dairy farms was present there. Following simple random sampling method from each district 10 commercial dairy farms were selected for primary data collection. Thus total 50 commercial dairy farms were considered for this survey. Dairy farms with 30 milch animals and operational since last 5 years defined as commercial dairy farms for this study.

Since the study intended to know the already existing feeding pattern followed by the farmers, ex-post- facto research design was employed. To know the existing feeding practices followed by the commercial dairy farms structured interview schedule was used and personal interview method was followed to collect the data. Further, Tier II approach of IPCC (2007) was applied to estimate the methane emissions from dairy animals of commercial dairy farms. It uses specific methane conversion factors (MCF) to calculate methane emission from enteric fermentation. For estimating emission factor with Tier II approach, data on average daily feed intake in terms of gross energy [mega joules (MJ) per day], kg dry matter intake (DMI) per day and methane conversion rate (percentage of feed energy converted to methane) were required.

Collected data about daily feed intake on fresh matter basis was converted to dry matter based on the percentage of dry matter available in feed stuffs. Dry matter was calculated separately for each type of feed and fodders, where more than one type of green fodder or concentrate was fed to the animals and percentage of dry matter was referred from 'Nutrient Composition of Indian Feeds and Fodder' by ICAR. Later, DMI was converted into total gross energy in kilo calories. The gross energy of various types of feeds was calculated by the equation-

$$G.E.\ (Kcal/g) = (CF+NFE)\ 4.15 + (CP * 5.65) + (EE * 9.40)$$

Where, CF: percentage of crude fiber expressed in dry matter basis; NFE: percentage of nitrogen free extract present in dry matter basis; CP: percentage of crude protein expressed in dry matter basis; EE: percentage of other ether extract present in dry matter basis (Banerjee, 1998).

The detail of CF, NFE, CP and EE for all types of feeds were referred from the book 'Nutrient composition of Indian feeds and fodder' by ICAR. A conversion factor of 4.184 was multiplied with the total gross energy intake in kcal and divided by 1000 to express the energy intake of feeds in terms of mega joules (Mj). For this study the methane conversion factor for developing countries given by IPCC was referred. All dairy cows were recommended to have a conversion rate of 6.0 percent (± 0.5 percent) and for all non- dairy cattle were recommended to have a conversion rate of 7.0 percent (± 0.5 percent).

In India the condition of feeding practices of the livestock population are comparatively poor. However, the study area is renowned for paddy-wheat cropping system, so usually farmers were depending on paddy and wheat straws for their livestock as dry fodders. Ranjhan (2001) conducted survey in India and based on agro-climatic region, season and stage of the production cycle reported that 15-30 percent of grasses/grazing, 66-70 percent of crop residues, 5-8 percent of cultivated forages and 2-5 percent of concentrates are used for the feeding purpose of the dairy animals. In the selected villages of Haryana there were some good quality forages such as maize, berseem etc, which are used to feed to different categories of dairy animals. In each surveyed dairy farm, stall feeding was practiced for all the animals. None of the dairy farms were engaged in grazing by keeping animals in grazing lands.

Feeding pattern followed for the dairy animals (cattle and buffalo) from the sampled commercial dairy farms were recorded. Customarily animals are fed a mixed ration of green fodder, dry fodder and concentrates on daily basis. This study found that dairy farmers of the eastern Haryana (Karnal, Yamunanagar, Sonipat districts) used to give animals, maize, oat, cowpea/cluster bean, napier grass and sugarcane tops as green fodders. The fodder marketing system is little organized in Karnal and Hisar districts of Haryana. Even Ponnusamy *et al*. (2017) reported that entrepreneurs in fodder marketing are predominantly located in Karnal (96.67%) and Hisar (84.62%). Wheat straw and paddy straw were available as dry fodder throughout the year as this region is popular as traditional rice-wheat growing belt. Tamizhkumaran and Radhakrishnan (2016) also reported paddy straw is the most common dry fodder available for livestock feeding from Puducherry. While concentrates include molasses or jaggery, mustard cake, soybean cake, husk of bengal gram locally called *chunni* etc. Other than these, maize seed husk, wheat bran, rice bran are also included in the food basket of the dairy animals. In western Haryana (Hisar and Sirsa) farmers were using sorghum, bajra, maize, berseem as green fodders; and wheat straw, paddy straw, bajra stover, sorghum stover etc. as dry fodder for the animals. Further, as concentrates, groundnut cake, cotton seed cake, rice bran, and wheat bran were used in daily diet of the animals. In western region of Haryana, especially the farmers of the Sirsa belt used to grow cotton more or less in whole district. Hence, cotton seed cake which is locally known as *binnola* cake was most common concentrate in all the farms of Sirsa district.

Animal population was classified as lactating animals, dry animals, calves, heifers and bulls based on age, sex and condition of the animal. Feed intakes of these categories of animals were recorded (Table 1). Study revealed that feed intakes in crossbred cattle and buffalo were more compared to indigenous cattle for each category of animals (lactating, dry, calf, heifer and bull). When dry matter intake (DMI) was calculated based on dry matter content of feeds and fodders collected, on an average total DMI for indigenous lactating cattle was 12.31 kg/day. The corresponding values for dry animals, calves, heifers and bulls were 8.70, 3.51, 5.40 and 10.50 kg/day, respectively. In case of crossbred cattle, lactating animals had intake of 13.49 kg and it was 9.38, 3.99, 6.25 and 11.89 kg/day in dry, calves, heifers and bulls, respectively. For lactating buffalo, it was 14.79 kg/day and the corresponding values for dry animals, calves, heifers and bulls were 10.58, 5.02, 6.89 and 12.25 kg/day, respectively.

Enteric fermentation has a major share in GHGs emission from dairy animals. To calculate the emission factor (EF) in case of enteric fermentation of the animals dry matter intake approach was followed, where total gross energy consumed was worked out for each categories of animals and then with the use of methane conversion rate (MCR), emission factor (EF) was calculated, expressed as kg methane (CH_4) per animal per year. The estimated emission of methane by lactating indigenous cattle was 81.42 kg methane/animal/year (Fig 1), and dry animals emitted 67.7 kg methane/animal/year. Calves and heifers emitted 24.89 and 39.66 kg/animal/year methane, respectively. Generally, the average productivity of indigenous cattle is low and feed energy conversion is an important factor of enteric fermentation in ruminants. In crossbred cattle, lactating animals emitted 89.61 kg methane/animal/year whereas the corresponding values for dry crossbred cattle, calves and

Table 1. Feed Intake of the dairy animals on fresh basis

Animal Category	**Green fodder (kg/day/animal)**		**Dry fodder (kg/day/animal)**		**Concentrate (kg/day/animal)**	
	Mean	***Range***	***Mean***	***Range***	***Mean***	***Range***
Indigenous cattle						
Lactating animals	15.18	12.11-18.05	5.86	4.21-7.55	2.61	2.01-3.82
Dry animals	13.27	10.25-16.21	3.36	2.76-4.76	1.54	1.27-3.01
Calves	3.20	2.29-4.09	2.22	2.00-3.98	0.46	0.22-0.76
Heifers	4.84	3.32-5.82	3.70	2.98-4.63	0.88	0.48-1.21
Bulls	15.88	14.79-18.21	6.22	4.02-8.14	2.01	1.76-2.55
Crossbred cattle						
Lactating animals	18.64	15.72-21.32	5.97	4.25-6.21	3.93	2.24-4.21
Dry animals	13.64	11.91-16.11	4.30	3.32-5.85	2.01	1.42-2.78
Calves	3.81	2.29-4.81	2.89	2.01-4.10	0.55	0.32-0.84
Heifers	6.78	5.14-8.42	4.46	3.51-6.32	1.01	0.89-1.51
Bulls	17.56	16.36-20.41	5.95	4.39-7.23	3.15	2.76-3.72
Buffalo						
Lactating animals	20.65	17.64-22.85	6.21	4.99-7.32	4.03	2.54-5.31
Dry animals	15.73	14.25-18.03	4.68	3.13-6.89	2.27	2.11-2.84
Calves	4.07	2.93-5.31	3.73	2.68-5.90	0.49	0.32-0.65
Heifers	6.92	5.02-8.12	4.89	4.22-6.12	1.28	0.87-1.98
Bulls	18.05	17.99-21.01	5.22	4.89-7.32	3.25	2.78-3.89

and heifers were 72.93, 27.90 and 43.53 kg methane/animal/year, respectively in Haryana.

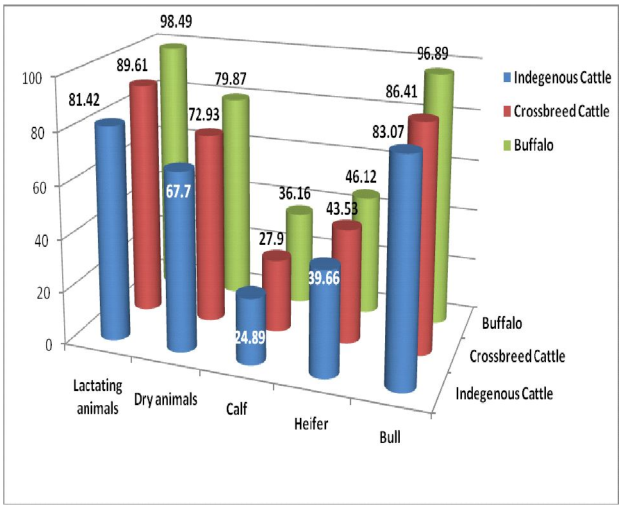

Fig 1. Methane emission (kg/animal/year) from dairy animals of commercial dairy farms of Haryana

Similarly in buffalo also emission factor was calculated and it was found that lactating buffalo were emitting 98.49 kg methane/animal/ year by enteric fermentation. While the corresponding values for dry buffaloes, calves and heifers were 79.87, 36.26 and 46.12 kg methane/animal/year, respectively (Fig 1). Actually Indian livestock depends on low quality of fodders, especially dry fodders are very poor in terms of energy efficiency, which might be the possible reason behind the high emission of methane from these animals. But emission in terms of productivity *i.e.*, in terms of per kg milk, it was high in case of indigenous cattle as their milk production was low compared to crossbred cattle and buffaloes. Chabra *et al.* (2009) reported that the methane (CH_4) emission in terms of milk production was low in exotic cows (23.8 g CH_4 /kg milk) as compared to indigenous cows (44.6 g CH_4/kg milk). Although methane emission is not one factor function and it depends on quality of feed and fodder fed to the animals, age of the animal, sex of the animal, genetic quality of the breed, microorganisms present in the rumen of the animal *etc*. Singh *et al.* (2012) conducted a study on estimation of livestock enteric methane (CH_4) emission based on feeding systems (diets) for different animal functions (maintenance, production and growth) prevailing in different agro ecological regions (AERs) of India using livestock population (2003) and revealed that Indian livestock emitted 9.10 Tera gram (Tg) methane (CH_4) from enteric fermentation annually. Sirohi and Michaeiowa (2007) reported that India has emerged as largest contributor to the livestock methane budget simply because of its population strength, although the rate of emission was much lower than the developed countries. It was observed that methane production was related to the level of intake and digestibility of the feeds.

Existing feeding pattern of dairy animals indicated that some good quality green fodders like berseem, maize, sorghum etc, and dry fodders like paddy and wheat straw are the life line of animals' feeding system in commercial dairy farms of Haryana. Estimation of methane emission from enteric fermentation of the animals revealed that it was high in case of buffalo and crossbred cattle as compared to indigenous cattle. But in terms of productivity (per kg milk) methane emission was high for indigenous cattle as their milk yield was low. It was concluded that our animal research and extension linkage should give more emphasis on growing good quality forages for the dairy animals and making our farmers more aware about the use of good quality green forages and concentrate, which leads to improvement in energy conversion efficiency in animals and reduce methane emission, leading to sustenance of environmental ecosystem relation to animal production and management.

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