Feed-Milk Conversion Efficiency of Dairy Animals and Methane Emissions across Different Landholding Groups

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Abstract: ***The study delineates the influence of landholding size of the farmers on the feed-milk conversion efficiency of dairy animals. The average milk production of a dairy animal in Andhra Pradesh is 4.40 kg per day and it varies with the breed of the animal. Crossbred cows (6.58 lit) and graded Murrah buffaloes (5.37 lit) produce milk which is more than 50 percent of what their counterparts i.e., local cows and local buffaloes produce. A positive correlation between milk yields and landholding size of the farmers is observed for all the breeds of dairy animals. Further, a positive influence of landholding size is observed in the case of quantity and quality of feeds given to dairy animals. Among all the breeds of dairy animals crossbred cows exhibited higher feed-milk conversion efficiency followed by Murrah buffaloes. The DCP/TDN ratio of the feeds given to dairy animals is 0.083 which is lower than the recommended level of DCP/TDN ratio of 0.10 to 0.12 and it clearly underlines that DCP/TDN ratios of feeds given to the animals of all the breeds are less than the optimum indicating the protein deficiency. The average TDN quantity utilized by the existing dairy animals is 1.55 kg for one kg of milk production as against 1.0 kg of optimum level indicating about 55 percent of excess feeding leading to excessive methane production. If the protein content of the ration is increased optimally the excess amount of TDN could efficiently be converted into milk without leaving the excess TDN for methane production.***

Keywords: Milk production efficiency, landholding size, DCP/TDN ratio, methane emission

1. Introduction

The global demand for food is expected to become double by 2050. The UN estimates that the world population is expected to increase from 7.6 billion today to reach 8.6 billion in the year 2030, 9.8 billion in the year 2050 and 11.2 billion in 2100. This growth will provide opportunities and challenges for the dairy sector. The challenge is to supply the global population the required milk and food which is healthy, nutritious and sustainably produced. About 80 percent of the world's population, or about 6 billion people, regularly consume milk and dairy products. (FAO,2019). Milk and milk products are nutrient- dense foods that supply energy and significant amounts of protein and micro-nutrients including calcium, phosphorous, magnesium, selenium and all types of vitamins. Milk and milk products are fifth largest provider of protein and fat for human beings and an important source of affordable nutrition to meet recommended levels.

The majority of the world's estimated 1.3 billion poor people live in developing countries where they depend directly or indirectly on livestock for their livelihoods (FAO, 2009; UN, 2017). Globally, livestock contributes about 40 percent to the agricultural gross domestic product (GDP) and constitutes about 30 percent of the agricultural GDP in the developing world. Furthermore, estimates show that globally, livestock provide animal traction to almost a quarter of the total area under crop production and also provides traction for about 50% of the world's farmers. Livestock also provide a safety net in times of need in the form of liquid assets and a strategy of diversification for food production (World Bank, 2008).

Indian dairy farming sector is facing some constraints such as feed scarcity, lower milk production ability of cattle and buffalos etc. Milk production depends largely on the availability of natural resources such as grazing lands, fodder, water, breed of the animals etc. Further, livestock rearing is carried out mostly with feed and fodder available from village common lands which would not have been permitted by the individuals having no land and individuals having little own land, especially marginal and small farmers (Jodha, 1986).In the situation of feed scarcity and greater demand for milk, the dairy farmers are going for high yielding crossbred cows and graded Murrah buffaloes in order to reduce the number of animals maintained by them. However, these high yielding animals may not be suitable for all types of farmers because of the resources they have. Further, heat stress due to climate change affects the productivity of the high yielding animals and the effect of thermal stress vary among individuals according to breed, production level, prior experience etc,. *Bos indicus* (Zebuor indigenous) cattle are more thermo-tolerant than *Bos taurus* cattle (European cattle) due to possession of thermo-tolerant gene by zebu cattle (Bajagai, 2011). Landless, marginal and small farmers have little land and thus their animals are underfed due to feed scarcity which leads to decline in the productivity of the animals and also dairy animals release excessive methane gas in to the atmosphere (FAO, 2019). Green- house gases such as carbon dioxide and methane are released by the animals after the intake of feed and subsequent digestion of feed through enteric fermentation in the rumen part of the animal. Enteric fermentation is a natural part of the digestive process of ruminants where bacteria, protozoa, and fungi contained in the fore-stomach of the animal (rumen), ferment and break down the plant biomass eaten by the animal(McAllister and Newbold, 2008). When the feed is not properly balanced with required quantity of protein, the excessive carbohydrate part will be converted in to methane gas which causes global warming. Implementation of existing technologies and management practices in the dairy industry along with continued genetic improvement of the animals in milk yields is expected to result in 10 to 12 percent reductions of methane emissions per unit of milk over the next decade (Knapp et al 2014).

The high proportion of methane emission associated with dairy herd is because of consumption of higher proportion of feed having conserved forage, pasture and crop residues rather than concentrates (Allen et al 1992, Basarab et al 2013).Further, feed is one of the critical components in ensuring good milk yield and also constitutes approximately 60 to 70 percent of the production cost of milk. With rapidly shrinking of pasture land and other natural resources, availability of good quality feed and fodder is increasingly becoming a challenge (Mallikarjuna and Vijaya, 2007). While some level of emissions is expected there are many opportunities to reduce green-house gas emissions to achieve feed efficiency and profitability in dairy farming. Feed is the largest single cost to dairy producers and its efficient use will improve net income and reduce potentially negative inputs on the environment. Further, as the global population surpasses nine billion by 2050, improving the feed efficiency becomes even more urgent to meet the increasing demand for milk and food grains for human food (FAO, 2019).Therefore, it is hypothesized that the farmers are unable to feed their animals adequately thus leading to lower milk production efficiency and excessive methane emission by the dairy animals. To test this hypothesis, an attempt is made in this paper to analyse the milk production, feed-milk conversion efficiency of dairy animals per unit of feed intake with reference to landholding size of the farmers and agro-climatic zones.

2. Methodology

The study is intended to estimate the feed- milk conversion efficiency of cows and buffaloes belonging to farmers of different landholding groups. The study uses primary datacollected from selected households spread over three districts of Andhra Pradesh, India. A structured schedule was used for the data collection from 210 households spread over three agro-climatic zones namely, low irrigation, medium irrigation and high irrigation during the year 2019-20. Data regarding the species and breed of the animals maintained, milk yield, feeds given, feeding practices, farmer type, etc., are collected. Focus is also made on the nutritive value of the feed given to the animals in terms of total digestible nutrients (TDN) and digestible crude protein (DCP). The nutritive value of feed ingredients is estimated through the standard methods in terms of Digestible Crude Protein (DCP) and Total Digestible Nutrients (TDN). The formulae needed to estimate these feed components are as follows:

$TDN = (D \times 0.9 \times 0.45) + (G \times 0.3 \times 0.70) + (C \times 0.9 \times 0.72)$.

$DCP = (D \times 0.9 \times 0.005) + (G \times 0.3 \times 0.06) + (C \times 0.9 \times 0.12)$.

Here, D stands for quantity of dry fodder fed to the animal, G for quantity of green fodder and C for quantity of concentrates. The dry matter of the feed is taken as 90 percent for dry fodder and concentrates and 30 percent for green fodder. TDN of the dry fodder is taken as 45 percent for dry fodder, 70 percent for green fodder and 72 percent for concentrate feeds. Further, DCP of dry fodder is estimated as 0.5 percent for dry fodder, 6 percent for green fodder and 12 percent for concentrates. The nutritive values of different feeds are adopted from the ICAR publications (ICAR, 1998).

3. Results and Discussion

It is a common scenario in India to observe that farmers feed their animals with crop residues as dry fodder, collected green fodder from their land or common property resources as green fodder and purchased feeds like rice bran, wheat bran, gram chunni, oil cakes, grains like jowar, maize tec., as concentrate feeds. Crop residues have very poor nutritive value while the green fodder has fairly high nutritive value. On the other hand, concentrate feeds have very higher nutritive value compared to dry fodder and green fodder. However, major part of these concentrate feeds have to be purchased from the market and thus farmers tend to use them judiciously whereas dry fodder and green fodders are available with no or less cost and thus farmers feed these fodders liberally.

1. Feeding patterns of different breeds of dairy animals: The feeds given to different breeds of dairy animals are analyzed with reference to quantity, quality (nutritive value), sufficiency to the animal, utilization of nutrients and the possibility of methane emission (Table-1). A close perusal of these feeding practices clearly states that indigenous/ local cows and local buffaloes are underfed, while crossbred cows and graded-Murrah buffaloes are well fed. For instance, the quantity of concentrates given to local cows, 0.05kg/day/animal, and local buffaloes, 1.26 kg/animal/day, is negligible whereas crossbred cows and graded buffaloes are fed with about 3.5 kg of concentrates per day per animal. Among all the feeds, concentrate feeds are more digestible and have higher nutritive values compared to green fodder and dry fodder. The total feed in terms of dry matter is low for local animals compared to improved varieties. Crossbred cows and graded-Murrah buffaloes are the high yielding improved verities of indigenous cows and local buffaloes developed with the intension of improving milk production and they require more feed.

To analyze the sufficiency of feed given to dairy animals, dry matter of the feed is taken into consideration. Dry matter is the quantity of feed excluding its water content. Green fodder has higher water content (70%) and lower dry matter (30%) while dry fodder and concentrates have as high as 90 percent of dry matter and 10 percent of water. As per the feeding standards, every cow or buffalo requires about 2.5 kg of dry matter for every 100 kg body weight. Lactating animals consume more feed and hence their dry matter requirement is still higher (Banerji, 1982; NRC, 2001). The energy and protein requirements of the animal such as body maintenance, growth, milk production and pregnancy requirements have to be met from the feed given to the animals. The first requirement of the animal is body maintenance and after meeting this the animal would satisfy the needs of milk production, pregnancy etc.

Table 1: Feeding of different breeds of dairy animals and their feed-milk conversion efficiency

Item	Indigenous cow	Crossbred cow	Local buffalo	Murrah buffalo	Average per animal
Green fodder (kg/day/animal)	12.64	24.24	15.42	22.40	18.67
Dry fodder(kg/day/animal)	3.21	3.52	2.76	3.45	3.23
Concentrates (kg/day/animal)	0.051	3.66	1.26	3.65	2.15
Total dry matter (kg)	6.68	13.83	8.28	13.11	10.47
TDN (kg)	3.98	8.89	5.18	8.46	6.63
DCP (kg)	0.24	0.85	0.42	0.81	0.58
Milk yield (kg)	2.21	6.58	3.44	5.37	4.40
DM/ kg milk (kg)	3.02	2.10	2.40	2.44	2.49
TDN/kg milk (kg)	1.80	1.35	1.50	1.57	1.55
DCP/kg milk (kg)	0.11	0.13	0.12	0.15	0.13
Recommended level of TDN/kg milk (kg)	1.08	1.08	1.08	1.08	1.08
DCP/TDN ratio	0.06	0.096	0.081	0.096	0.083
Recommended DCP/TDN ratio	0.10-0.12	0.10-0.12	0.10-0.12	0.10-0.12	0.10-0.12
% deficiency of DCP	50.0	20.0	32.5	20.0	30.62

Note: Recommended level is calculated as per NRC guidelines.

The average body weight of cow or buffalo is about 300 kg for local varieties and 400 kg for crossbred cow and graded Murrah buffaloes. Thus, the dry matter requirement of local cow and local buffaloes under study would be 7.5 kg for 300 kg of body weight @2.5 kg for every 100 kg body weight. Similarly, the dry matter requirement of crossbred cows and Murrah buffaloes is about 10 kg per day per animal (another 2 kg for higher milk production). The feeds given in terms of dry matter to indigenous cow is 6.68 kg, 13.83 kg for crossbred cow, 8.28 kg to local buffalo and 13.11 kg to Murrah buffaloes (Table-1). These quantities indicate that the dry matter given to indigenous/local cow is lower than the requirement of 7.5 kg per day while that of all other breeds is more than the required amount. Thus, indigenous cows are underfed while all the other animals are over fed and the milk yields of these indigenous cows could be attributed to lower level of feeding. This excessive quantity of feed given to animals is waste and becomes a cause for excessive methane emissions (Basarab et al 2013).

2. Feed-milk conversion efficiency of dairy animals and methane emissions:

Important aspect of feeding dairy animals is the nutritive value of feeds given to the animals. The nutritive value of feed is generally expressed as TDN (Total Digestible Nutrients) and DCP (Digestible Crude Protein). The nutrients like protein (DCP) and energy (TDN) are the factors that determine the health, growth and productivity of the milch animals. If the ration of the animal has higher quantity of protein, then that animal is expected to show higher milk productivity. Table-1 indicates the feeding of nutrients to different breeds of dairy animals in terms of Digestible Crude Protein (DCP) and Total Digestible Nutrients (TDN).The energy or TDN given to produce one kg of milk is 1.80 kg for local cows, 1.35 kg for crossbred cows, 1.50 kg for local buffaloes and 1.57 kg for Murrah buffaloes (Table-1). However, the recommended level (feeding standards) of TDN to produce one kg of milk is 1.08 kg or1.0 kg. In case of protein or DCP, 0.11 kg is required to produce one kg of milk for indigenous cows, 0.13 kg for crossbred cows, 0.12 kg for local buffaloes and 0.15 kg for Murrah buffaloes. On comparison of these amounts with the recommended level of 0.10-0.12 kg of DCP for one kg of milk, it is apparent that the protein content of the feed given to all dairy animals is almost optimum (Table-1). However, the protein content or DCP of the feed is low in relation to the quantity of TDN present in the feed and this could be observed through DCP/TDN ratios.

In order to produce milk efficiently without wastage of nutrients the feed shall have sufficient quantities of protein and energy in the diets of animals. The ratio of protein (DCP) to energy (TDN) shall be about 0.10 to 0.12 for efficient conversion of feed in to milk. In other terms the ration of the animals should have at least 10-12% of DCP. The DCP/ TDN ratio of the ration given to local cow is 0.06, for crossbred cow 0.096, for local buffaloes 0.081 and 0.096 for Murrah buffaloes (Table-1). By juxtaposing the DCP to TDN ratios and recommended levels of all the breeds it is striking to note that the ratios of DCP/TDN are lower than the recommended or optimum levelsof 0.10 to 0.12. In the case of crossbred cows and Murrah buffaloes the ratios are nearly optimum and in the case of local cows and local buffaloes the ratios are far less than the optimum levels. The lower ratios of DCP/TDN indicate that the diets of the animals have lower protein values than the required. The excessive amounts of TDN fed to animals in relation to DCP will be fermented in to methane and released in to the atmosphere. Therefore, it is necessary to increase the protein content of the feed either through feeding good quality green fodder or through protein-rich concentrates and oil cakes. As the cost of protein rich- concentrates such as pulses, oil cakes etc., is higher the farmers might have reduced these feeds in order to reduce the cost of milk production. Once the protein content of the feed is improved the milk production efficiency of the animals will be enhanced with concomitant decline in the rumen methane production. It is evident that the feed conversion efficiency across the regions has improved between 2006 and 2015 i.e., with increasing milk production per cow relatively using lower feed inputs of good quality to produce one kg of milk (fat - protein corrected milk) with consequent decline in GHG emissions (FAO, 2019).

3. Feeding patterns of dairy animals and their feed-conversion efficiency across different landholding groups: The above analysis reveals that the rations of all the animals are observed to be deficient in protein in all landholding groups across all agro-climatic zones. However, it is not clear that which farmer category has lower or higher level of feeding and feed-milk conversion efficiency. Therefore, an attempt is made to analyze the milk productivity, deficiency in nutritive values of feeds with reference to breed and landholding category or production system.

Quantity of feed Vs landholding size: The level of feeding and milk productivity of the animal depends on the size of landholding by the farmers. Land is the important resource in providing green and dry fodder required for the dairy animals. It is hypothesized that increase in the landholding size of the farmers increases the feed and fodder resources and thus farmers are able to feed more fodder to their animals. This hypothesis stands true when the feeding patterns of the dairy animals across different landholding groups, different breeds of dairy animals and different agro-climatic zones are observed (Table-2). It is striking to note that the quantity of green fodder, dry fodder, concentrates, TDN and DCP fed to indigenous cows and crossbred cows increased with the landholding size and the same trend could be observed for buffaloes also (Table-2 and 3).

Milk yield Vs landholding size: A similar trend that of feeding patterns is noticed in the case of milk production of dairy animals with landholding size (Table-2 and Table-3). The milk yield of the indigenous cows, crossbred cows and buffaloes showed a positive correlation with the landholding size. Therefore, it could be inferred that landholding size influences the availability of feed resources and in turn these feed resources influence the milk productivity of the dairy animals. However, there may be variation in the nutritive value of feeds across different landholding farmers.

Feed-milk conversion efficiency Vs landholding size: The quantity of feed dry matter used to produce one kg of milk is lower for landless farmers and it steadily increased with landholding size. For instance, the quantity of feed dry matter used to produce one kg of milk for indigenous cows by landless farmers is 2.18 kg and it increased with the landholding size to 3.78 kg for large farmers (Table-2). Further, the quantity of dry matter required is 1.81 kg per one kg of milk by crossbred cows for landless farmers and it gradually rose to 2.29 kg in the case of large farmers. The similar relationship between quantity of dry matter required to produce unit volume of milk and landholding size is observed for all the breeds of buffalos (Table-3). From this it could be recoded that landless farmers and marginal farmers or farmers with poor resources showed more efficiency in producing the milk with lower feed resources compared to medium and large farmers. As feed resources are scarce for resource-poor farmers they have used them judiciously whereas others with enough land have fed with large quantity of feeds because most of the feeds are of their own.

Protein deficiency or DCP/TDN ratio Vs landholding size
The DCP/TDN ratios represent the balance of nutrients present in the feeds fed to dairy animals. Animal feed could be divided as TDN or energy portion and DCP or protein portion. Protein is important feed nutrient required for body maintenance, milk production, growth and reproduction of the animal in appropriate proportion along with energy. Therefore, scientists recommended that the ration of the all the animals should have at least 10-12% of protein amounting to DCP/TDN ratio of 0.10 to 0.12 (Banerji, 1982, NRC, 2001). By comparing the DCP/TDN ratios of the feeds given to all the breeds of dairy animals across different landholding categories it could be recorded that all the rations of the animals have lower DCP/TDN ratios irrespective of breed, climatic zone and landholding size revealing the protein deficiency in the rations (Table-2 and 3). The protein deficiency is more prominent in the case of indigenous cows to the extent of 54 percent and in local buffaloes 20 to 30 percent compared to minimum value of 0.10. In the case of crossbred cows and Murrah buffaloes the protein deficiency is only less than 10 percent on all the zones and for all land holding categories. Landholding size has shown a negative relation with protein deficiency indicating that well off farmers are feeding their animals properly. It is true in the case of indigenous cows and local buffaloes while in the case of crossbred cows and Murrah buffaloes no distinct pattern is observed. The results indicate that the milk production potential of all the animals including high yielding crossbred cows and Murrah buffaloes could be realized by enhancing the nutritive values of feeds particularly protein content of the feeds (FAO, 2019). The existing lower milk yields of dairy animals in the country could be attributed to the feeding of poor- quality feeds.

Table 2: Feeding of dairy cattle and their feed-milk conversion efficiency across different landholding groups.

Item	Landless	Marginal	Small	Medium	Large
Indigenous or local cow					
Green fodder (kg/day/animal)	7.50	10.20	12.24	14.50	16.10
Dry fodder(kg/day/animal)	2.60	3.00	3.42	4.10	4.50
Concentrates (kg/day/animal)	0.00	0.00	0.05	0.060	0.40
Total dry matter (kg)	4.59	5.76	6.79	8.09	9.24
TDN (kg)	2.63	3.36	3.99	4.74	5.46
DCP (kg)	0.147	0.197	0.241	0.286	0.353
Milk yield (kg)	2.10	2.30	2.34	2.42	2.44
DM/ kg milk (kg)	2.18	2.50	2.90	3.34	3.78
TDN/kg milk (kg)	1.21	1.46	1.70	1.96	2.24
DCP/kg milk (kg)	0.07	0.085	0.103	0.12	0.145
DCP/TDN ratio	0.055	0.059	0.060	0.060	0.065
Recommended minimum level of DCP/TDN ratio	0.10- 0.12	0.10- 0.12	0.10- 0.12	0.10- 0.12	0.10- 0.12
Crossbred cow					

Green fodder (kg/day/animal)	16.20	20.50	24.32	29.60	34.40
Dry fodder(kg/day/animal)	2.90	3.20	3.65	3.85	4.10
Concentrates (kg/day/animal)	2.75	3.10	3.45	3.90	4.25
Total dry matter (kg)	9.94	11.82	13.67	15.85	17.84
TDN (kg)	6.34	7.61	8.82	10.30	11.64
DCP (kg)	0.601	0.72	0.83	0.97	1.10
Milk yield (kg)	5.5	5.8	6.3	6.8	7.8
DM/ kg milk (kg)	1.81	2.04	2.17	2.33	2.29
TDN/kg milk (kg)	1.15	1.31	1.40	1.51	1.49
DCP/kg milk (kg)	0.11	0.12	0.13	0.14	0.14
DCP/TDN ratio	0.095	0.095	0.094	0.094	0.094
Recommended minimum level of DCP/TDN ratio	0.10- 0.12	0.10- 0.12	0.10- 0.12	0.10- 0.12	0.10- 0.12

Table 3: Feeding of buffaloes and their feed-milk conversion efficiency across different land holding groups.

Item	Landless	Marginal	Small	Medium	Large
Local buffalo					
Green fodder (kg/day/animal)	8.55	10.50	12.64	14.50	15.80
Dry fodder(kg/day/animal)	2.55	3.10	3.52	3.75	4.25
Concentrates (kg/day/animal)	0.50	0.90	1.10	1.55	2.10
Total dry matter (kg)	5.31	6.75	7.95	9.12	10.45
TDN (kg)	3.15	4.04	4.79	5.57	6.40
DCP (kg)	0.22	0.30	0.36	0.45	0.53
Milk yield (kg)	2.8	2.9	3.0	3.2	3.4
DM/ kg milk (kg)	1.89	2.33	2.65	2.85	3.07
TDN/kg milk (kg)	1.12	1.39	1.60	1.74	1.88
DCP/kg milk (kg)	0.078	0.103	0.12	0.141	0.156
DCP/TDN ratio	0.070	0.074	0.075	0.081	0.083
Recommended minimum level of DCP/TDN ratio	0.10- 0.12	0.10- 0.12	0.10- 0.12	0.10- 0.12	0.10- 0.12
Murrah buffalo					
Green fodder (kg/day/animal)	14.50	18.25	20.20	26.20	30.40
Dry fodder(kg/day/animal)	2.50	2.90	3.70	4.20	4.50
Concentrates (kg/day/animal)	3.25	3.40	3.50	3.80	4.10
Total dry matter (kg)	9.52	11.14	12.54	15.06	16.86
TDN (kg)	6.16	7.21	8.008	9.66	10.86
DCP (kg)	0.623	0.708	0.758	0.901	1.01
Milk yield (kg)	4.3	4.4	4.5	4.8	5.0
DM/ kg milk (kg)	2.21	2.53	2.79	3.14	3.37
TDN/kg milk (kg)	1.43	1.64	1.77	2.01	2.17
DCP/kg milk (kg)	0.145	0.16	0.17	0.19	0.20
DCP/TDN ratio	0.101	0.098	0.095	0.093	0.093
Recommended minimum level of DCP/TDN ratio	0.10- 0.12	0.10- 0.12	0.10- 0.12	0.10- 0.12	0.10- 0.12

Methane emission vs landholding size: Methane is naturally produced during digestion process by cows and buffaloes and is released into the atmosphere daily. TDN portion of the feed fed in excess in relation to protein becomes waste and it will be converted into methane gas. This methane gas is produced in addition to the one produced naturally during the process of digestion. If the ration of the animal is a balanced mix of TDN and DCP then the production of additional amount of methane is prevented. This condition could be obtained if the DCP/TDN ratio of the feed is more than 0.10. In this condition the quantity of TDN utilized to produce one kg of milk will be less,in other words, unit volume of milk can be produced with minimum quantity of feed nutrients. The present study clearly states that the amount of TDN utilized to produce one kg of milk is lower for landless dairy farmers and this quantity increased along with landholding size (Table-2 and 3). In other words, excess methane emission from dairy farming is lower for landless and resource poor farmers whereas it is higher for farmers having more land. This could be due to the availability of crop residues and green fodder in plenty at no cost to the small, medium and large farmers and this results in the production of extra methane.

Further, the protein deficiency of the rations given to dairy animals have to be improved to reduce the wastage of nutrients in the form of TDN in order to reduce methane emissions. The deficiency of protein as indicated by lower DCP/TDN ratios is lower for high yielding crossbred cows and Murrah buffaloes compared to low milk yielding local cows and buffaloes, when the DCP/TDN ratio is taken as optimum of 0.10. If the optimum level of the ratio is taken as 0.12 the deficiency of the rations is further raised. If the nutritive values of the feeds are optimum, the animals will exhibit better health, better reproductive performance, long lactation periods and higher milk production efficiency. The deficiency of protein in the rations of dairy animals will result in the conversion of excessive TDN component in to methane gas by the animals. Though the deficiency of feed ration is lower for landless and marginal farmers compared to others, it is statistically insignificant. Thus, the study reveals that resource poor farmers use the feed resources carefully and produce milk with lower feed inputs and thus causes less amount of methane release from cattle and buffaloes (Graingerand Beauchemin. 2011; Giampiero, 2019).

In fact, methane is a by-product of rumen digestion and needs special mention as a greenhouse gas because emissions from cows/ ruminants contribute substantially to the global greenhouse gases. It is rated as having a global warming potential 21 times that of the equivalent amount of carbon dioxide, based on a 100-year time scale. It has been estimated that, of all the greenhouse gases, methane is second in effect only to carbon dioxide and is responsible for around 10–15 percent of the present greenhouse gas effect in the atmosphere (Mike, 2014). Globally, ruminant livestock produce about 28 percent of methane emissions from human-related activities. A single adult cow is a relatively minor contributor, emitting only 80–110 kg of methane in a year, but, with about 100 million cattle in the United States alone, 535.78 million cattle in Indiaand 1.2 billion large ruminants in the world, ruminants are one of the largest sources of methane. In the United States, cattle emit about 5.5 million tons of methane per annum into the atmosphere, accounting for 20 percent of U.S. methane emissions, with dairy cattle producing around one-quarter of the total (Mike, 2014).An increase in productivity of dairy animal results in a reduction in methane production per kg of product- milk or meat, mainly due to dilution of the methane that is always produced from the feed consumed to fulfil the animal's maintenance requirement (Gerber et al.,2013). Therefore, it is imperative to reduce the methane emissions from cattle and buffaloes through proper feeding and management.

4. Summary and Conclusions

The average milk production of a dairy animal in Andhra Pradesh is 4.40 kg per day and it varies with the breed of the animal. Crossbred cows and graded Murrah buffaloes produce milk more than 50 percent of what their counterparts i.e., local cows and local buffaloes produce. Crossbred cows, Murrah buffaloes and local buffaloes are fed with sufficient quantity of feed in terms of quantity whereas local cows are under fed both in terms of quantity and quality. A positive correlation between milk yields and landholding size of the farmers is observed for all the breeds of dairy animals. Further, a positive influence of landholding size is observed in the case of quantity of feeds given to dairy animals. Among all the breeds of dairy animals crossbred cows are observed to possess higher feed-milk conversion efficiency followed by Murrah buffaloes. The average quantity of feed required to produce one kg of milk with the existing dairy animals is 2.49 kg of feed dry matter. The TDN of the feed required for one kg of milk production is 1.55 kg as against 1.0 kg of optimal level. Further, the DCP/TDN ratio of the feeds given to dairy animals is 0.083 and it varies with the breed of the animal. The recommended level of DCP/TDN ratio ranges from 0.10 to 0.12 and it clearly underlines that DCP/TDN ratios of feeds given to the animals of all the breeds are less than the optimum indicating the protein deficiency of the rations of the dairy animals. The protein deficiency of the ration of the local cows is as high as 50 percent followed by local buffaloes, Murrah buffaloes and crossbred cows. The average TDN quantity of feed utilized by the existing dairy animals is 1.55 kg for one kg of milk production and it is about 55 percent higher compared to optimum level of 1.0 kg. If the DCP content of the ration is increased optimally the excess amount of TDN could efficiently be converted into milk without leaving the excess TDN for methane fermentation. It could be stated that if the protein content of the rations is improved by suitable methods, the milk production of the animals could be enhanced by fifty percent with the existing number of cattle and buffaloes present in the country. Therefore, the study indicates that the proposed hypothesis- the farmers are unable to feed their animals adequately thus leading to lower milk production efficiency and excessive methane emission by the animals – stands true.

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