Bangladesh Journal of Animal Science
Journal homepage: http://www.banglajol.info/index.php/BJAS

Identification of naturally available forage species and their feeding effect on dairy cows in different climatic vulnerable areas of Bangladesh

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Abstract

An investigation was carried out with the objectives to identify the naturally occurring forage species, seasonal availability, production patterns under different climatic zones and production performance and methane emission from dairy cow under existing feeding systems. For this purpose, three different agro-climatic zones of Bangladesh, namely saline prone area (Satkhira), flood plain/river basin areas (Pabna), semi-arid/drought prone areas (Chapainobabgonj) were selected. To achieve the objectives, three Focus Group Discussions (FGD) were conducted in each location to obtain more information from different age groups of farmers. A total of 9 FDGs were conducted under three selected locations and twelve participants were attended in each FGD. During FDGs, information was collected through participatory discussions through check list and also discussion was recorded to verify the information gathered as per check list. After collection of information in each side, all the data were checked and analyzed. The results indicated that in saline area, farmers reported that different types of local grass e*.g.* Tale Shapna,Durba,Nona Shapna, Khud Gate/ KhudKhachra, Shama, Full Paira, Bass Pata, Math Pora/KhataShak, GhimeeShak and Baksha etc were available round the year but according to their observation Nona Shapna, Tale Shapna and Baksha were more available compared to other species of the natural grasses and these three natural forages are more suitable in this area. In the drought prone area, different types of native grasses e.g. Durba,Shama, Mutha,Katla,Kausha/Kannar, Binna, Datuloka,Shanchi, Shunshue, Bash Batari, Ulo and Binna Pati were identified and utilized by the farmers in different seasons but Durba,Katla and Mutha were found more drought tolerant compared to other species. In flood prone area, Kolmi, Shanti, Baksha, Arail, Dubla, Bokma, Vadail and Bolenga etc were found and Kolmi, Baksha and Arail are more suitable in this area. Farmers were also reported that fodder tree like Dumur/khoksha also is survive in water logging situation and or flood prone area. The study revealed that calculated total DMI (Kg/h/day) was the highest (14.14±1.06) in flood prone followed by drought (13.80±1.30) and saline areas (4.43±0.20), respectively. Similarly, the milk production was also higher (12.06±1.19 litre/h/day) in flood prone area followed by drought (4.47±0.60 litre/h/day) and saline (1.83±0.11 litre/h/day) areas, respectively. The calculated total methane emission (g/h/d) was significantly higher in flood prone (478.31±36.36) and the lowest in saline (153.35±7.14) prone areas. Whereas, methane production per unit of milk yield, was the lowest in flood prone (46.55±6.78) and the highest (110.48±21.69) in drought prone area and the difference was statistically significant ($p<0.05$). Therefore, it may be concluded that farmers' rearing animals under climate vulnerable areas utilizing natural grasses are more prone to higher methane production compared to animals rearing better feed resources though their availability was varied with the seasons and locations. Hence, further research is needed to explore more suitable natural grasses in addition to introduction of high yielding fodder with higher biomass and nutritive values based on the existing cropping systems in those climate vulnerable areas for higher milk production and low enteric methane emission in the country.

Key words: natural forages, saline, drought, flood prone, availability

 Bang. J. Anim. Sci. 2017. 46 (2): 150-158

Introduction

Livestock is an integral component of agricultural economy of Bangladesh. This subsector of agriculture is has multifarious functional aspects as food, nutrition, income generation, savings, foreign currency earning, draft power, manure, fuel, transport, etc. About 36% of the total animal protein comes from the livestock (Sarma, 2014). Most of the animals depend on the agricultural bi-products like straw, green grass and cereal milling by-products. In the country

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animal were supplied with green grass and rice straw. Milking cows were supplemented with concentrate feed in addition to roughage. Some time they cultivate leguminous fodder crops e.g. Khesari (*Lathyrus sativus*), Mastikalai (*Vigna mungo*) , and HYV grass e.g. Napier grass (*Pennisetum purpureum L*) and Jambo (*Sorghum bicolour; Sorghum sudanefe*) grasses.

In Bangladesh, there is a requirement of 70 million metric tons of green grass for cattle feed in a year but produced only 24 million metric tons. Thus, there is a deficit of animal feeds for about 60 percent, which are hampering the livestock development to a great extent (ProthomAlo, 2008). The total feed and fodder available for ruminant in the country was estimated to be 3234.14x103 ton in 2012 (BBS, 2012; Huque and Sarker, 2014). Other researchers also reported that the major feed for livestock in Bangladesh is straw. About 2 kg of straw is available per head per day and supplementation is limited to about 1 kg of green fodder plus marginal quantities of cereal and oilseed by-products (Zannat *et al.,* 2012).

The cattle in the small farms are supplied with green grasses mostly grown on fallow lands, crop field boundaries, embankments and side of roads. The situation becomes very worse during dry season and flood. Scarcity of feeds and fodder for livestock production is a major problem in Bangladesh (Rahman, 2011) and the situation is mostly aggravated during the lean period. The lack of fodder is one of the major limiting factors for increasing milk production on small-scale dairy farms (Alam *et.al,* 2006). Bangladesh having about 0.21 acres per capita net cropped area and an annual increase of 1.50 million working age people needs strategic exploration of livestock resources for alleviating rural poverty, ensuring food security and creating employment opportunities (Huque and Huque, 1997). The main constraint to forage production for feeding ruminants is the scarcity of land. Usually farmers do not want to spare cultivable land for fodder production instead of crop production. Recently, fodder production gets momentum as an income generation and employment opportunity in certain areas of Bangladesh, especially milk pocket areas, namely Madaripur, Munshigonj, Rangpur, Sirajgonj and Tangail where small scale dairying, fattening and milk marketing facilities are prevailed (Sayeed *et al.,* 2008). Government, research organization and development agencies have been given priorities for high yielding fodder production due to dairy development.

The major effects of climate change for livestock sector are reduction in grazing area, fodder crisis due to low growth & yield of green grass that decrease the production of milk, egg and meat. All these will lead to loss in rural household income, dietary nutrition and unemployment. Fodder is also a crop/plant having different diversification. While, cultivable cereals fodder, legumes, roughages, perennial grasses and fodder tress, fruit tree required different climatic situation, thus it has immense variation in growth as well as yielding ability of quality green fodder. Loss of habitat, change in habitat conditions, disease outbreak, feed & fodder shortage and obstacle in reproduction & reduced production lead more vulnerable situation for animal husbandry due to climate change. Considering those situation, an investigation was undertaken to know below objectives.

1) To identify the natural forages with their seasonal availability in different climatic vulnerable saline, drought and flood prone areas of Bangladesh.

2) To find out suitable stress tolerant natural forages with higher biomass yield and nutritional values for saline, drought and flood prone areas.

3) To suggest better utilization practices of natural forages and introduction of HYV fodder based on existing cropping systems in saline, drought and flood prone areas of Bangladesh.

Materials and Methods

To achieve the above objectives several studies were done. Focus Group Discussion (FGD) and Key Informant Interview (KII) were followed to find out suitable stress tolerant fodder cultivars for flood, drought and salinity conditions. The study was conducted in different agro-climatic zones of Bangladesh, namely Flood Plain/River basin areas (Pabna), Semi- arid/Drought Prone areas (Chapainobabgonj), Saline Prone area (Sathkhira). Farmers having livestock were selected for the FGDs that who were utilizing natural grasses to livestock by cut & carry from natural habitats.

A total of twelve (12) FGDs were conducted in different locations during the project periods to achieve the above stated objectives (Table 1). A total of 3 FGDs were carried out for each agro-climatic zone to find out suitable stress tolerant forages. Twelve participants were attended in each FGD, having 2 age groups i.e. older people (more than<50) and young people (not less than>40 year age). Relatively, older people were selected due to know the climate change effect on crop-livestock interaction, especially the availability of forages in the respective area. Older people were asked according to prescribed check list. Therefore, through this process all the participants had the opportunity to share real climate change in their specific location what was the situation in three decade ago and what are the present practices related to forages and livestock production systems. Farmers were asked collected the available local or cultivated grasses in the respective area before gathered in the discussions for FGD. It is noted that specific quantitative data on feeds and fodder, milk production and body weight were also collected at end of the participatory discussions of each FGD. Feed intake was determined by weighing the feeds of supplied to individual animal for period seven days minus residual of individual in each location from each FGD.

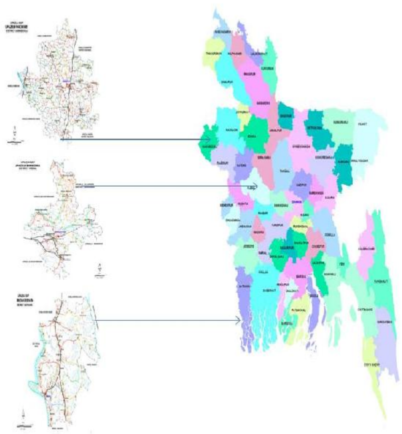

Figure 1. FGD location under climate vulnerable areas

The feed intake was calculated by taking the average of five animals in each location. Calculation of enteric methane emission was determined by following equation considering based on dry matter intake of available feedbase of cattle according to the equation developed by Purnomoadi,(2015). The equation is $Y=0.034X+3.439$; where, Y=methane production (g/d); and X= Dry matter intake (g/d). The total dry matter intake (DMI) was estimated based on dry matter contents of the individual feedstaff according to the book value. Local name of the grasses were identified by the participatory discussion among the farmers'. Matrix of different types of grasses and intensity of its availability were established by the participants based on production in local climatic situation during FGD. The data collected from FGD was cross checked by a interviewing from the farmers.

Statistical analyses were carried out through SPSS version 16 computer package and analysis of variance of treatment means was done by ANOVA. Duncan Multiple Range Test (DMRT) was used to the level of significance the treatment means.

Table 1. Locations of FGDs and number of participants.

Number of FGD	Name of the location	Number of participants	Nature of FGD
	Flood prone area (Pabna)		
1	Bhabanee pur,Bhangura	12	Male group
2	Bowalmare, Bhangura	12	Male group
3	Par Bhangura	12	Mix group
	Drought area (Chapainobabgonj)		
1	West Mirzapur,Fatahpur, Nachol	12	Male group
2	Srirampur,Nachol	11	Male group
3	Bandra ,Nachol	10	Mix group
	Saline area (Satkhira)		
1	Zaowakhalee, Shamnagar	11	Mix group
2	Norarchok ,Debhata	12	Male group
3	Purbapara , Debhata	12	Female group

Results and Discussion

After investigation, the availability of natural forages and their seasonal utilization patterns in different climatic vulnerable areas of Bangladesh are discussed below.

Availability of natural forages in saline area

Farmers' usually collected local grass from bank of the bill & cannel, fellow land. They did not cultivate fodder crop but a few farmers grown *Doincha* (*seasbania spp*.) in their field for improving soil health as well as using for fuel. Cowpea also grown in the homestead land and they did not use *Sesbania and* Cowpea leaf to their cattle. Islam *et al.,* (2013) suggested that adequate amount of fodder crops namely cowpea and barley can be obtained from a maximum salinity by using hosepipe irrigation with fresh water. All participants participated in FGDs mentioned that they were facing shortage of green grasses/ forages. Farmers' reported that shortage of forages almost round the year but the acute scarcity was faced by farmers' in the month of August to September. Farmers' also reported that forages were not properly grown in these areas due to high salinity in the soil but they also noted that duration of rainy season was reduced due to climate chance effect in these areas which further leads to increase the soil salinity and reduced the availability of native grasses day by day.

Participants reported that different types of native green grasses e.g. Shabna,Vadla/Ful-ghas, Durba, Shama,Khuda-shama, Adha-boron, Brammi (Grown in saline water), and Chacho were available in the Zaowakhale village under Shamnagar upazilla of Sathkira district. They also noted that the production of that native green grass was not similar round the year. The year round calendar for forages availability was gathered through FGD is shown in Table 2.

Similar availability of different types of local grasses were also observed in Norarchok and Purbapara villages of Debhata upazilla. The major local grasses such as Tale Shapna, Durba, Nona Shapn, Khud Gate/Khud Khachra, Shama, Full Paira, Bass Pata, Math Pora/Khata Shak, Ghimee Shak and Baksha etc. were identified in these areas and farmers were collected those grasses to fed their animals. Based on matrix , Nona Shapna, Tale Shapna and Baksha were available compared to other species of the natural grasses and these three natural forages are more suitable in this area. *Sarker,NR et. al.* (2016) mentioned the best 10 local green grasses in different agro ecological zones available in different seasons those were Durba (*Cynodon dactylon*),Dal(*Saccrolepsis indica*), Jangra (*Hemarthria protensa*), Botol (*Phragmites Karka),*Swapna (*Panicum sp*.), Beju (*Leersia hexanta*) Kolmi (*Murdania nodilflo*) Lona (*Guazuma ulmifolia*), Chiringa , and Shama (*Panicum paludosum*).

Table 2. Matrix of Green grass production time and intensity in saline areas

Name of the different local grass	Intensity of production	Duration /Season of production
Tale Shapna	++	March-December
Durba *(Cynodom doctylon)*	++	Whole year
Nona Shapna*(Panicum sp.)*	+++	Whole year
Khud Gate/Khud Khachra	++	January–August
Shama*(Panicum paludosum*),	+	June –August
Full Paira	++	July-September
Bass Pata	+	July November
Math Pora/Khata Shak	+++	Whole year
Ghimee Shak	+++	January –July
Baksha	+++	Whole year

+++= More production, ++= Medium production, += Small amount

Availability of natural forages in drought area

The hard red soil of these areas is very significant in comparison to that of the other parts of the country. Matrix of different types of native grasses and its production time were drowned as below by the participants of FGD (Table 3). Participants of FGD were identified different type of local grasses, among those 2-3 types grasses were known as drought tolerant. Seasonal calendar of natural grass were drown by the participants in order to know the amount of grass production and seasonal variation. Farmers' usually harvested more natural grasses from different types of orchard from May to October. Acute fodder scarcity depends on seasonality which exists from December to February. There was no improved fodder cultivar in these areas. BLRI started on station trail of different HYV grass to find out drought tolerant verity. Besides of this research program, BLRI distributed three types of HYV Napier cuttings to five farmers for on-farm research. Different types of pulse produced in this area which it is used for human consumption but not as fodder crops. Chickpea, Doincha, Cowpea, and lentil (mushur) were cultivated in the areas. Fodder tree e.g. Moringa was found in this area but people didn't use it as fodder. Different type of native grasses e.g. Durba, Shama,Mutha, Katla Kausha/Kannar , Binna, Datuloka ,Shanchi ,Shunshue ,Bash Batari , Ulo ,Chikon Durba and Binna Pati were found in drought areas. Durba, Katla and Mutha were found as more drought tolerant as opined by the farmers' during FGD.

Table 3. Matrix of intensity for natural forage production and its production time in drought area

Name of the different local grass	Intensity of production	Duration /Season of production	Ranking of Drought tolerant grass
Durba (*Cynodom doctylon*)	+++	Whole Year	**Durba** +++
Shama (Panicum paludosum)	++	Whole Year	**Mutha** ++ **Katla**++
Mutha (Cyperus rotunda)	+++	Whole Year	
Katla	+++	Whole Year	
Kausha/Kannar	+	Whole Year	
Binna	+	Whole Year	
Datuloka	+	August- October	
Shunshue	+	Whole Year	
Bash Batari	+	Whole Year	
Binna Pati	+	Whole Year	
Jaona	+++	June-August	
Jabra	++	June- August	
Motmota	+	June- August	
Datloka	++	August- October	
Shanchi	+++	Whole Year	
Dudh Kolmi	+	June –August	
Bon Chila	++	Whole Year	
Ulo(*Imparato cylinderica*)	+	June- August	
Jaona	++	June- October	
Katla	+	June- September	
Kaiatuti	+	June-November	
Keshra (*Lathyrus sativus*)	+	June- September	
Nepiar (Pennisetum purpureum L)		Whole Year	
Jambo (*Sorghum bicolour*)		Whole Year	

+++= More production, ++= Medium production, += Small amount

Natural forages available in flood prone area

Different types of natural grass produced in this flood prone area but a few natural green grasses were fed their dairy cattle. Fodder crop e.g. Khesari, Mushur were fed their cattle from December to February. These types of fodder crops were sown just after recedes of flood water from the field. Napier Jumbo and Gama grass were also cultivated to meet up the requirement of green grasses. Different native grass e,g. Kolmi, Shanti. Arail, Dubla, Baksha, Vadail, Bolenga were found in the studied area. MoE&F (2014) also mentioned that Baksha grass was very much suitable for low-lying areas of Bangladesh. Fodder tree like Dumur (khoksha) was found in this area and it can survive in water logging situation. Though its leaf fed to cattle but it was not normally used by farmers as forages. During the flood, farmers' were used this leaf as cattle feed but it could not meet up the demand of green grasses in this period due to availability of little number. Mash Kalai, Jambu and Napier cultivates as fodder for cattle. Matrix of different types of native grasses and its availability were drowned as below by the participants of FGD. Participants of FGD were identified different type of local grasses, among those 2-3 types grasses were known as flood tolerant.

In River basin areas, constriction of embankment reduce the flood situation inters the areas but it creates some time water logging and sudden flood which leads change the cropping pattern. Farmers' cultivated green grass and Khesari (*Lathyrus sativus*) as considering cattle feed as well as own consumption; all of those affect positively on their life & livelihood.

Table 4. Matrix of intensity for green grass production and time of production in flood areas

Name of the different local grass	Intensity of production	Duration /Season of production	Ranking of Flood tolerant grass
Kolmi (*Murdania nodilflo*)	+++	Whole year	+++
Shanti	+++	Whole year	++
Arail(*Leersia hexanta*)	+++	Whole Year	++
Baksha	+++	October- July	+++
Vadail	++	October- July	
Bolenga	+	January-March	
Mash Kalai(*Lathyrus sativus*)	+	Nov-Feb	
Jambu (*Sorghum bicolour*)	+++	Whole year	
Napier *(Pennisetum purpureum L)*	++	Whole year	
Ulo (*Imparato cylinderica*)	+	Whole year	
Khuksha/Dumur *(Ficus racemosa)*	+	Whole year	++
Katla	++	Whole Year	
Gotat	+	Whole year	
Keshto Lota	+	Whole year	
Dudhle	++	Oct-Dec	
Dol *(Sacerotepsis indica)*	+++	Whole year	
Gesha	+++	October-July	
Kesto lota	++	Whole Year	
Vue baula/Vue babla	++	Whole Year	
Durba (*Cynodom doctylon*)	++	Whole year	
Kochuripana (*Eichhornia crassipes)*	+++	Whole year	

+++= More production, ++= Medium production, += Small amount

Feed intake, milk production and methane emission

The overall quantitative data collected from the participants during FDGs revealed that the highest dry matter intake (DMI/h/day) from green grasses was reported in flood prone area and the lowest DMI was reported by the participants in saline area and which was statistically significant among the locations (Table 5). Further, it was observed that farmers' in flood prone area, usually reared crossbred dairy cows compared to others two locations, where indigenous/native cows were reared by the farmers'. The availability of concentrate DMI kg/h/day was the highest (5.86±0.68) in flood prone area and the lowest in saline area (0.59±0.05). Khan, *et.al.,*(2008) stated that smallholder farmers of Bangladesh provided maximum limit of 1 kg concentrate daily to local cows but the crossbred cows are supplied with concentrate in amount 2-3 times higher than local cows which composed of rice polish, wheat bran, brans of legumes and oil cakes. The participants also reported that they usually brought some individual ingredients from nearby market and mixed with home produced by-products such as rice polish, broken rice etc. were mixed and fed to the dairy cows. Based on their statement, it was found that the calculated total DMI (Kg/h/day) was the highest (14.14±1.06) in flood prone followed by drought (13.80±1.30) and saline areas (4.43±0.20), respectively (Table 5).

The milk production was higher (12.06±1.19 litre/h/day) in flood prone area followed by drought (4.47±0.60 litre/h/day) and saline (1.83±0.11 litre/h/day) areas, respectively. Milk production of indigenous cows (1.79±0.04 litre/h/day) in saline areas were also similar to the work of Sarker, *et.al.,* (2016).

Table 5. Quantitative information on feed intake, milk production and methane emission in different climate vulnerable areas of Bangladesh

Parameters studied	Flood prone	Saline prone	Drought prone	Overall	Level of significance
Type of Breed	Cross	Native	Native	-	-
Body weight (kg/cattle)	365.87^a±27.02	351.73^a±26.15	261.47^b±22.18	326.36±15.83	*
Green grass Intake (DM kg/h/day)	3.05^a±0.55	0.76^b±0.01	2.17^a±0.45	1.99±0.27	***
Rice straw intake (DM kg/h/day)	5.22^b±0.75	3.07^c±0.18	9.04^a±0.90	5.77±0.53	***
Concentrate intake (DM kg/h/day)	5.86^a±0.68	0.59^c±0.05	2.58^b±0.34	3.01±0.41	***
Total DMI (kg/h/day)	14.14^a±1.06	4.43^b±0.20	13.80^a±1.30	10.79±0.87	***
Milk production (Lt/h/day)	12.06^a±1.19	1.83^c±0.11	4.47^b±0.60	6.12±0.78	***
TotalCH_4 production (g/h/day)	478.31^a±36.36	153.35^b±7.14	418.48^a±59.58	350.05±31.23	***
CH_4 production Per unit of milk yield	46.55^a± 6.78	87.58^b±5.97	110.48^b±21.69	81.53±8.63	*

* = Significant at 5 % ; *** = Significant at 1 % ; ± = standard error

The calculated enteric methane emission in different climatic zones based on dry matter intake and available feed resources of cattle is also shown in Table 5. The results indicated that the total methane emission (g/h/d) was significantly higher in flood prone (478.31±36.36) and the lowest in saline (153.35±7.14) prone areas. Whereas, methane production per unit of milk yield, was the lowest in flood prone (46.55±6.78) and the highest (110.48±21.69) in drought prone area and the difference was statistically significant ($p<0.05$).

The study revealed that though there was no significant difference in total methane production between flood prone and drought prone areas but the methane production per unit of milk production was significant, which may be due to the low milk production compared to flood prone area. It was further indicated that the methane productions varies from region to region. This may be due to the availability of feed resources in different climatic locations & dry matter intake (DMI), breed, and also body size of the animals. Base on methane production drought areas was more vulnerable compared to saline and flood prone areas, it revealed that cattle rearing in drought prone (Chapai) areas were fed low quality roughages compare to saline (Satkhira), and flood prone (Pabna) areas. The study indicated that there were two kinds of roughages in the feeding regimes of cattle, first was based on rice straw and second was based on natural grasses and/or cultivated. Different type of concentrate feeds fed to cattle in three climatic zones e.g. wheat bran, broken maize, broken wheat, broken pulse, coconut oil cake and broken pulse. Purnomoadi (2015), reported that methane production depends on number of feeds, animal size, and concentrate feeds. She also observed that result of rice straw as sole feeding produced 34 g methane per kg DM which was supported to the present findings although in this study farmer provided some concentrate feeds with roughages. The emission of methane is responsible for global warming. By increasing the quality of existing feed resources, CH4 production could be reduced in Bangladesh.

Conclusion

The study revealed that different types of local grasses were available, among them 2-3 locally available common natural grasses were also found in saline, drought and flood prone areas. In addition, certain fodder crops like Khesari, Chickpea, Doincha , Cowpea, and Mushur were cultivated flood prone and drought areas. Durba (*Cynodon dactylon*), Katla and Mutha were found as more drought tolerant. Kolmi, Baksha and Arail were more suitable in water logging areas. Fodder tree like Dumur (khoksha) was found under water logging situation. Mash Kalai, Khesari , Jambo, and Napier grasses were cultivated after recedes of flood water in flood prone areas of Bangladesh. Tale Shapna, Nona Shapna and Baksha were also found in saline areas. The study revealed that calculated total DMI (Kg/h/day) was the highest (14.14±1.06) in flood prone followed by drought (13.80±1.30) and saline areas (4.43±0.20),respectively. Similarly, the milk production was also higher (12.06±1.19 litre/h/day) in flood prone area followed by drought (4.47±0.60 litre/h/day) and saline (1.83±0.11litre/h/day) areas, respectively. The calculated total methane emission (g/h/d) was significantly higher in flood prone (478.31±36.36) and the lowest in saline (153.35±7.14) prone areas. Whereas, methane production per unit of milk yield, was the lowest in flood prone (46.55±6.78) and the highest (110.48±21.69) in drought prone area and the difference was statistically significant ($p<0.05$). Therefore, it may be concluded that farmers' rearing animals under climate vulnerable areas utilizing natural grasses are more prone to higher methane production compared to animals rearing better feed resources though their availability was varied with the seasons and locations. Hence, further research is needed to explore more suitable natural grasses in addition to introduction of high yielding fodder with higher biomass and nutritive values based on the existing cropping systems in those climate vulnerable areas for higher milk production and low enteric methane emission in the country.

Acknowledgement

The authors' are very much thankful to the sponsor organizations, the Bread for the World, Germany and Climate Change Unit of CCDB for their financial help to conduct this piece of research work. Authors' also gratefully acknowledge the contributions of the farmers' who have been actively participated in the Focus Group Discussion (FGDs) for providing the value information on feeds and feeding systems on livestock rearing by spending their valuable time. Without their active participation, cooperation and help, it would not be possible to complete this research investigation.

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