



Existing feeding practices and production performance of lactating buffaloes in selected agro-climatic zones of Bangladesh

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Abstract

A study was conducted to observe the existing feeding practices, nutritional supply and production performance of the lactating buffaloes in some selected agro-climatic zones of Bangladesh, viz. Bhola (AEZ-18, Coastal area), Mymensingh (AEZ-22, River basin area) and Dinajpur (AEZ-27, Drought area). Data on availability, amount and types of feeds and fodders fed to the lactating buffaloes, body weight, milk yield and quality and lactation length were collected from 30 farmers of the each selected locations. In this investigation, the mostly used feed ingredients found were rice straw, locally available green grasses, wheat bran, broken maize, mustard oil cake and broken rice. Total feed supply (DM kg/h/d) to lactating buffaloes were 17.4, 14.5 and 13.0 in coastal, river basin and drought areas, respectively, ($p > 0.05$). But significantly ($p = 0.000$) different amount (DM kg/h/d) of concentrate were supplied in coastal (1.5), river basin (1.8) and drought (2.7) areas. The highest amount (kg/h/d) of green grass was supplied in coastal area (5.0) followed by river basin area (4.3) and drought area (1.3). Accordingly, amount (kg/d) of DCP and TDN were supplied was higher in coastal area (0.365 and 6.417, respectively) than that of the river basin and drought areas (0.247-0.248 and 5.501-5.891, respectively), which were below their requirements. Significantly ($p = 0.000$) larger lactating buffaloes were found in the river basin and drought areas (weighed 372-380 kg/h) than that of coastal area (242 kg/h). The average daily milk yield was found significantly highest ($p = 0.000$) in the drought area (5.3 L/d) which was 1.4 L and 3.1L more than that of the river basin and coastal area, respectively. The 4% FCM yield was found two times more ($p = 0.000$) in drought area (7.7 kg/d) than that of the coastal (3.1 kg/d) and river basin (3.6 kg/d) area. On the other hand, the significantly ($p = 0.000$) highest lactation length and lactation yield were 294 d and 1085 L, in the river basin area, which were 189 d and 1007 L in drought area and 197d and 429 L in coastal area, respectively. Among the milk constituents, protein, ash and lactose content was found higher in drought area than that of the other two areas ($p = 0.001$). In conclusion, the prevailing variations are evidently considerable. Therefore, suggesting further works for large scale baseline data regarding buffalo populations, nutritive quality of feeds and fodder, effectiveness of existing management tools and adoption of new technologies.

Key words: feeding practices, nutritional status, milk production, lactating buffaloes, climatic zone

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Introduction

The world buffalo population is estimated to be approximately 195 million spread in 42 countries, of which 180 million (92.52%) are in Asia and the rest are in other parts of the world (FAO, 2012). Bangladesh has only 0.72% buffaloes of total world population (FAO, 2012) and very thinly 3.77/Km² (0.39 to 15.4/Km²) distributed (Huque and Khan 2017). The number of buffalo in proportion to the human population (B:103 H) in Bangladesh were 10.1-32/10³ in coastal areas (south delta), 5.1-10/10³ in drought area (the north the west districts) and rest of the districts (river basin) holding 0.3-5.0/10³ (Huque

and Khan 2017). Bangladesh has thirty agro-climatic zone (AEZ) which represent different land form, depth and duration of seasonal flooding, cropping pattern, temperature, humidity, day light, length and rainfall. Climatic condition of Bangladesh is nearly similar to India and has lots of river and marshy lands that is favorable for raising buffaloes (Rahman *et al.*, 2018).

Buffalo production system varies widely in accordance with climate, soil, feed resources and socio-economic opportunities in Bangladesh (Saadullah, 2012). Buffaloes are well adapted to adverse climatic condition e.g. flood, drought, high tidal wave in coastal areas and they can

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thrive well under minimum or without housing facilities. Buffaloes are resistant to several tropical diseases in South Asia, while enduring divers harsh climates making it a preferred climate-resilient livestock species (Siddiky, 2018). The contribution of buffalo milk in national milk supply in India, Pakistan and Nepal is 51.2%, 59.5% and 66.6%, respectively (FAO 2014) whereas in Bangladesh it is only 2% (Hamid, 2016). Though the trend of increase in buffalo population (2.20%) in recent year is relatively higher than that of the cattle (0.44%) but buffalo milk production is not contributing significantly to national production in Bangladesh (Islam, 2017), though in some parts, buffalo milk is frequently mixed with cow milk and sold as cow milk (Islam, 2014). So if we want to achieve the requirement of animal protein as SDG, Buffalo will be an important option. However, being the closest neighbor, Bangladesh has never given buffalo as prioritized milking animal despite of their important role in the national economy. Most of the buffalo farmers followed conventional feeding practices based on locally available crop residues both concentrates and roughage. Feeding of locally available feed resources would be the only way for sustainable animal production in developing countries (Devendra and Leng, 2011). Crop residues has been utilized efficiently by buffaloes as prevalence of higher rumen microbial population that produce more ammonia nitrogen in buffalo leading to higher production of microbial protein (Poondusit, 2001). In order to express full genetic potentials of milk yield, it is necessary to provide suitable and balanced nutrition. According to Jatinder *et al.* (2018) feeding balanced complete feed mixture with available feed ingredients could improve the milk production of buffaloes. Supplemental feeding could also improve the milk production (Siddiki, 2017). Over-feeding, under-feeding and imbalanced diets lead to nutritional and reproductive disorders of buffaloes (Chavda and Parnarker, 2016). Still now there is no recognized feeding system in Bangladesh. Farmer provides daily ration without considering production, especially daily milk yield and fat content in milk. They have neither scientific knowledge nor following any feeding system to satisfy the nutrient requirements of the buffaloes. As a result, under/over nutrition is a great threat to express the productive and reproductive potentialities of buffaloes. Moreover, there were few scientific attempts to evaluate the existing production status in relation to feed availability and nutrient requirement of lactating buffaloes in Bangladesh. Hence, the present investigation was undertaken to assess the existing feed supply

and production performance of lactating buffaloes that could contribute in preparing a nutritional plan for increased buffalo milk production with locally available feed resources.

Materials and Methods

Study area and selection of buffalo farmers

A total of 30 buffalo farmers were randomly selected from each of the three different agro-climatic districts, namely-Bhola (AEZ-18, coastal area), Mymensingh (AEZ-22, river basin) and Dinajpur (AEZ-27, drought area). Bhola sadar, Trishal and Birganj sub-district have been chosen, respectively owe to the availability of the buffalo. The selected farmers have at least one lactating buffalo with calf and had the intensive or semi-intensive management system. The buffaloes at the farmers' level were of non-descriptive type.

Conducting survey and sample collection

An interview schedule and well planned questionnaire was prepared to collect data on - available feed resources for buffaloes, amount of feed supplied to the buffalo, and buffalo milk production. Face-to-face interview was conducted by visiting each of the farmers. During visit, 15 individual milk samples (50 mL/sample) were also collected from each of the sub-district. The milk samples were immediately placed in a home freezer, transported in an ice box and again placed in a regular freezer in the Dairy Chemistry Laboratory, Department of Dairy Science, Bangladesh Agricultural University, Mymensingh-2202, until further analyses. Milk samples were analyzed for fat, protein, lactose and ash content by auto-milk analyzer (Lactoscan, Ultrasonic Milk Analyzer; Model MIA-SLP-60, S/N-70148; MILKOTONIC Ltd., Bulgaria 6000. Stara zagora). During the survey, heart girth of the buffalo was also measured by a measuring tape (HMBR SINO-U.S.A) and corresponding body weight was recorded.

Determine nutrient availability and requirements

The nutrient content of the different feed ingredients was calculated by consulting Feedipedia (2018), NRC (2001), TNAU Agritech Portal (2018) and Kearl (1982). Subsequently the nutrient supply was calculated by using feeds and fodder supply record. The DCP and TDN requirements of buffalo were worked out as per Kearl (1982). The 4% fat-corrected milk (FCM) yield was calculated from milk yield and fat percentage data using standard formulae (Gaines, 1928). (FCM for each kg of milk = $0.4 M + 0.15F$;

FCM was the weight of fat corrected milk (Kg); M is the quantity of milk, F is fat content of milk).

Table 1: Climatic data of selected coastal, river basin and drought area of Bangladesh

Characters	Coastal	River basin	Drought
Climate type	Tropical wet	Tropical wet	Tropical wet and dry
Temperature (Min-Max)	19-29°C	12 - 33 °C	5-45°C
Humidity (%)	71	76	79
Average yearly rain fall(mm)	2424	2174	1728

Source:https://en.wikipedia.org/wiki/Köppen_climate_classification visited 03.02.2018 13.53PM;<https://www.timeanddate.com/weather/@1336136/climate> visited 31.01/2018 17:23 PM.

Statistical analysis

Statistical analyses were carried out through SPSS version 16 computer package and analysis of variance was done by ANOVA. Duncan Multiple Range Test (DMRT) was used to determine the significant difference among the mean.

Results

Feeds and fodder availability

Available feeds and fodders fed to lactating buffaloes by the selected farmers in studied agro-climatic zone are presented in Table 2. Among the roughages, local green grass like dol (*Dichanthium annulatum*), durba (*Cynodon dactylon*), halancha (*Enhydra fluctuans*), sesbania (*Sesbania rostrata*), water hyacinth (*Eichhornia crassipes*) and rice (*Oryza sativa*) straw reveals the mostly used in all three areas. It also indicates that the farmers under this study in coastal and river basin area used diversified roughages than that of the respondents in drought area. The green roughage fed either fresh as pasture or in a cut-and-carry system. Wheat bran, broken maize, mustard oil cake, khesari (*Lathyrus sativus*) and broken rice were used as concentrate for feeding their buffaloes. All other ingredients had region specific responses. Most of the roughages and concentrate items were found available year round with a little fluctuation except Mash kalai (*Vigna mungo*) being available only in late winter.

Feed supply to lactating buffalo

Table 3 represents the average feed supply (DM kg/day/head) of lactating buffalo under different agro-climatic zones of Bangladesh. Farmers provided similar ($p > 0.05$) amount of feed (13-17

DM kg/day/head) to their buffaloes among the three agro-climatic zones, but highest amount of concentrate was supplied in drought area (2.72 DM kg/day/head) which was significantly ($p=0.000$) higher than that of the river basin (0.9 kg more) and costal (1.2 kg more) areas. Result also indicates that concentrate supplementation was a common feeding practice of all farmers in drought and river basin areas but only 57.14 % farmers supplied concentrate feed in coastal area. Farmers in river basin (18%) and drought (57%) area added salt (0.1-0.3 DM kg/day/head) in concentrate mixture but this practice is completely absent in coastal area due to salinity of water. The result revealed that availability of green grass was significantly ($p=0.000$) lower in drought area (1.3 DM kg/day/head) which was 3.0 and 3.7 kg less than that of river basin and costal area respectively. Around 17% farmers in drought area did not provide green grass to their buffalo but in case of costal and river basin area this value was 0-5 % only. Availability of green grass in coastal areas was more (range 2-11 DM kg/day/head) as there was more chare land which ensure green grass availability for buffaloes. The land of river basin area was inundated by the water for 4-6 month during flood season, it may facilitate the relatively more supply of green grass than drought areas. The range of green grass supplied was very low (0.320-4.00 DM kg/day/head) in drought area due to the land was occupied by several crops and vegetables throughout the year. Buffaloes of the studied areas were received around similar amount (9-11 DM kg/day/head) of rice straw. Range of paddy straw supplied was wide in drought area, as cropping pattern was friendly for more rice production.

Nutritional supply

The average estimated levels of nutrients supplied to lactating buffaloes in different agro-climatic zone of Bangladesh are presented in Table 4. Result revealed that buffaloes of costal area got 1.5 times more DCP than that of buffaloes in river basin and drought area. Similarly buffaloes of costal area received 0.5 Kg (8%) and 0.9 Kg (14%) more TDN than that of buffaloes of drought and river basin area, respectively. Results also indicated that around 72-87% DCP and 8-32% TDN comes from concentrates sources among the study areas. Drought buffaloes are more (87% for DCP and 32% for TDN, respectively) dependent on concentrate than that of the buffaloes of other two areas (72-78% for DCP and 18-25% for TDN, respectively).

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Table 2: Feeds and fodders used to fed the lactating buffaloes in selected coastal (C), river basin (RB) and drought (D) areas of Bangladesh

Name of feed resources	C	RB	D	Time of availability
Local green grass (non-descriptive)	+	+	+	Year round available but more in summer than winter
Kheshari hay (<i>Lathyrus sativus</i>)	+	-	-	Seasonal but more in late winter than summer
Mash kalai hay (<i>Vigna mungo</i>)	-	+	-	Available in late winter
Rice straw (<i>Oryza sativa</i>)	+	+	+	Year round available
Rice polish (<i>Oryza sativa</i>)	-	+	-	Year round available
Broken rice (<i>Oryza sativa</i>)	-	+	+	Year round available
Rice gruel (<i>Oryza sativa</i>)	-	-	+	Year round available
Rice bran (<i>Oryza sativa</i>)	-	-	+	Year round available
Rice husk (<i>Oryza sativa</i>)	+	-	-	Year round available
Wheat bran (<i>Triticum aestivum</i>)	+	+	+	Year round available but more in late winter
Broken maize (<i>Zea mays</i>)	+	+	+	Year round available
Mustard oil cake (<i>Brassica spp.</i>)	-	+	+	Year round available but more in late winter
Soybean meal (<i>Glycine max</i>)	+	-	-	Year round available
Ready concentrate feed (Commercial mixed feed)	-	-	+	Year round available
Crushed kheshari (<i>Lathairus sativus</i>)	-	-	+	Seasonal but production is more in late winter than summer
Molasses (<i>Saccharum officinarum L.</i>)	-	-	+	Year round available

+, used by respondents for the feeding of lactating buffaloes; -, not used by respondents for the feeding of lactating buffaloes.

Table 5 and Figure 1 clearly demonstrate that DCP and TDN were deficit in all three areas. Deficit of DCP (Kg/day) was 47%, 68% and 69%, for coastal, drought and river basin areas, respectively as compared to Kearn, (1982). Result also indicates that coastal buffaloes were deficit in 0.35 Kg /day/head TDN (5%) compared to Kearn 1982 requirement and this value was 6 times and 7 times more in case of drought and river basin buffaloes, respectively (Table 5 and Figure 1).

Production variables

Production performances of lactating buffaloes in different climatic areas of Bangladesh are illustrated in Table 6. The heaviest lactating buffaloes were found in river basin and drought area ($p>0.05$) and the average live weight was varied from 372-380 kg. The coastal area had the comparatively smaller lactating buffalo which was

130-138 kg less than that of the other two groups ($p=0.000$). The average daily milk production per buffalo per day among the three areas differed significantly ($p=0.000$). The highest milk production was 5.3 L recorded in the drought area which was 3.1 L and 1.4 L more than that of the coastal and river basin area, respectively. The highest average lactation yield (L/lactation) was 1085 L (in river basin area) followed by drought and coastal area with a production of 78 and 656L less than that of the river basin area, respectively ($p=0.000$). However, the lactation length was found similar in the Coastal and Drought areas (189-197 d; $p>0.05$). They differ significantly with the River basin area ($p=0.000$) which was 96-104 d more than those two areas.

Table 3: Average feed supply (DM kg/h/d) of lactating buffalo in selected coastal (C), river basin (RB) and drought (D) areas of Bangladesh

Items	C			RB			D			P value
	Mean±SD	Range	Use % in farms (n=30)	Mean±SD	Range	Use % in farms (n=30)	Mean±SD	Range	Use % in farms (n=30)	
Concentrate feed	1.5 ^b ±0.8	0.4 -2.6	57.1	1.8 ^b ±0.3	1.8 -2.6	100.0	2.7 ^a ±0.7	0.9 - 4.4	100.0	0.000
Rice Straw	10.9±2.8	4.5 -16.0	90.5	9.1±2.3	9.0 -10.8	95.5	9.1±8.0	4.5 - 36.0	100.0	0.262
Green grass	5.0 ^a ±2.9	1.6 -11.3	100.0	4.3 ^a ±0.5	3.2 -4.8	95.0	1.3 ^b ±1.0	0.3 - 4.0	83.0	0.000
Common salt	-	-	-	0.1±0.03	0.1 -0.2	18.2	0.2±0.1	0.03 - 0.3	56.7	0.000
Total supply	17.4±3.3	6.4-20.3	-	14.5±3.4	1.8 -16.6	-	13.0±8.9	7.1 - 42.9	-	0.109

Table 4: Average estimated levels of nutrients supplied to lactating buffaloes in selected coastal (C), river basin (RB) and drought (D) areas of Bangladesh

Name of the feed resources	Fresh (kg/h/d)			DM (kg/h/d)			DCP (kg/h/d)			TDN (kg/h/d)		
	C	RB	D	C	RB	D	C	RB	D	C	RB	D
i. Broken Maize	0.840	0.336	1.232	0.750	0.300	1.100	0.040	0.016	0.058	0.563	0.225	0.825
ii. Soybean meal	0.616			0.560			0.228			0.459		
iii. Rice bran	0.216			0.200			0.015			0.120		
iv. Broken rice		0.561			0.500			0.006			0.464	
v. Mustard Oil cake		0.376	0.331		0.340	0.300		0.092	0.081		0.252	0.222
vi. Wheat bran		0.784	0.806		0.700	0.730		0.067	0.069		0.427	0.439
vii. Kheshari crushed			0.660			0.600			0.008			0.431
A. Total concentrate mixture (i+ii+iii+iv+v+vi+vii)	1.672	2.057	3.031	1.510	1.840	2.730	0.283	0.181	0.216	1.142	1.368	1.917
Percentage in concentrate mixture							19	10	8	76	74	70
viii. Straw (Oryza sativa)	11.990	9.339	9.999	10.900	8.490	9.090	0.022	0.017	0.018	4.578	3.566	3.818
ix. Grass (native mix)	8.7648	7.128	1.971	4.980	4.050	1.140	0.060	0.049	0.013	0.697	0.567	0.157
B. Total roughage (viii+ix)	20.754	16.46	11.97	15.88	12.54	10.28	0.082	0.066	0.031	5.276	4.133	3.975
C. Total (A+B)	22.426	18.51	15.00	17.390	14.38	13.01	0.365	0.247	0.248	6.417	5.501	5.891

DM, DCP and TDN of feeds and fodder using value as given by Kearn (1982) , Feedipedia.org (2018) and TNAU Agritech Portal (2018).

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Table 5: Deficit (-) and surplus (+) of DCP and TDN in lactating buffaloes in selected costal (C) , river basin (RB) and Drought (D) area of Bangladesh

Areas	Total requirement of DCP (g/d)	Total supply of DCP (g/d)	Deficit (-) /surplus (+) of DCP	TDN requirement (g/d)	TDN supply (Kg/day)	Deficit (-) /surplus (+) of TDN
C	697	364.790	-332.210	6.770	6.416	-0.353
RB	786	246.855	-539.145	8.090	5.500	-2.589
D	786	247.84	-538.160	8.090	5.891	-2.199

Figure in the parenthesis indicate the percentage of nutrient deficit (-) /surplus(+) than requirement; Requirements for DCP and TDN were worked out according to Kears 1982

The protein content of the milk in coastal and river basin area were found similar (3.6 – 3.7%; $p>0.05$) which differ significantly ($p=0.001$) with drought area (4.1%). Lactose percentage was varied from 4-5 and showed highly significant difference ($p=0.000$) among the study areas. The fat percentage of the milk from these areas showed a non-significant difference ranging from 6.6–7.8. However, drought area had the highest 4% fat corrected milk yield (8 kg/d; $p=0.000$) which was more than double of the 4% FCM yield of the coastal and river basin area. The ash content in milk of river basin and drought area were found similar (0.7; $p>0.05$) which differ significantly from the coastal area ($p=0.000$).

Discussion

Available feed resources

Local grass, crop residues, agro-industrial by products were potentially available for using by the buffalo farmers in our study which is mostly depends on season and soil types. Rice straw and naturally grown local green grasses were the basal feed (main roughages) for feeding buffalo and concentrate provided as supplement with roughages. The result of present study resembles with the findings of Uddin (2001), Sarker *et al.* (2017). Uddin (2001) found that hundred percent lactating buffaloes offered rice straw, local grass, and wheat bran in river basin area (Trishal of Mymensingh; Dhunat of Bogra) of Bangladesh. About 95% households (HHs) fed rice straw and about 81% HHs fed cut and carry green grass to their animals. Most of the native grasses are grown more in summer and some others like Kawn, Khesari and Maskalai are grown in winter (Sarker *et al.*, 2017). Different species of local natural grasses e.g. durba, dol, baksha, kolmi and shama were found in all climatic zone (coastal , river basin and drought) of Bangladesh which were used as animals forages (Rahman *et al.*, 2017). Local grass e.g. dol, durba, halancha, sesbania, water hyacinth mash kalai and kheshari

kalai were fed to lactating buffaloes in different climatic areas in the present study which is similar to Rahman *et al.* (2017). Islam *et al.* (2002) identified more than fifty different types of local green grasses from different Agro Ecological Zones (AEZs) in Bangladesh which were mostly common and more potential native grasses for animals. Similar findings are found in present study. Rice straw has traditionally been used as a feedstuff in many parts of the world (Nader and Robinson, 2008; Akbar, 1992). Farmers were practiced stall feeding and sometimes they were tethered their animals to the roadsides, riverbed and fallow lands due to shortage of grassing land (Rahman *et al.*, 1998). But in our study, animals were considered grassing for 4-5 hours in a day for coastal and river basin areas, however, stall feeding was followed in drought area. Ahmed (2006) showed that common concentrates like wheat bran, rice polish, pea bran, khesari bran, matikalai bran, lentil, sesame oil cake, coconut oil cake and mustard oil cake were available round the year for dairy animal which support our findings. The result of the present study is in accordance with Tareque (1991) and who claimed that rice straw and naturally grown local green grasses were the major contributor of roughages for feeding buffalo. Rice straw alone contributed 87% of roughage portion of the dairy feed during the rainy and winter season when green grasses are very limited.

Feed supply

Dairy buffalo productions depend on quantitative and qualitative feeds and fodder supply that influence performance of milking animal. Nahar *et al.* (2015) found that 22.23% farmers supplied only straw, 95.55% farmers supplied straw with roughages, and 8.89% farmers supplied only concentrate under extensive system in Bhola district. In the Ganges-Brahmaputra flood plain, dairy buffaloes were reared in a semi-intensive system in which farmer raised buffaloes with

minimum inputs. In our study, 57%, 90.47%, and 100% farmers supplied concentrate mixture, straw and green grass, respectively under semi-intensive system of Bhola District (coastal area). All farmer provided concentrate feed and 95% farmers provided straw and green grass in river basin areas (Table 2). The overall average DM intake of the buffaloes in Patan district of India was observed as 16.94 kg/d which indicated that the buffaloes in the district got adequate DM as per the requirement that produced 11.18 L milk/d (Chavda and Parnerkar, 2016). Similar observation was recorded by Bakshi and Wadhwa, (2011) in dairy animals of western plain zone of Punjab State of India. However, Vidya *et al.* (2013) reported that dairy animals in Sonbhadra district of Uttar Pradesh of India got less DM than the requirement. But Total feed supply to lactating buffaloes were 13-17 kg DM /day/head, in the study areas, respectively where average milk production were very 2-5 L/d. The dry matter intake (DMI kg/d) of milking buffaloes in different locations was varies from 13-15 (Siddiki, 2017) but in our study dry matter supply (kg/d) of milking buffaloes in different locations varied from 13-18 (kg/day). Similar observation (14-16 kg DM/h/d) had also be reported by Uddin, (2001). Present study for feed supply on DM basis is closely similar to feed intake of milking buffaloes studied by Siddiki, (2017) and Uddin, (2001).

Nutritional supply

Existing feeding practice of buffaloes without considering their milk production and composition negatively affects the productivity of the buffaloes as well as the farmer economy. Feeding practice deprives the potential high milk producers by providing less nutrient in terms of protein and energy and also over burdens the low producers by providing over nutrition that causes economic losses of the farmers (Habib *et al.*, 2007). In the present study, more energy came from low quality roughages (e.g. rice straw) than concentrate mixture. On the other hand, more DCP supplied from concentrate mixture than roughage (Table 4). Daily average DCP supply in the buffaloes in Bhola, Mymensingh and Dinajpur district were 364.79, 246.85 and 247.84g/d, respectively, which were deficit as per requirement (Table 4). Daily average DCP intake in the buffaloes in Patan district of India was observed 1.049 kg/d/h that the buffaloes got adequate DCP as per the requirement (Chavda *et al.*, 2016). However, according to Kearn, (1982), it was undersupplied (varied from 300-500 gm/d/h) as compared to standard requirement

(Table 5). Other studies aimed at evaluating the nutritional status of dairy animals in India based on survey of different districts/regions showed variable trends. Most of them showed undersupply of DCP as compared to standard requirements (Bakshi *et al.*, 2010; Jawale *et al.*, 2007; Singh *et al.*, 2003; Vidya *et al.*, 2013). These findings agreed with our present observation. Daily average TDN supply in the buffaloes in different climatic areas of Bangladesh were observed 5.936 kg/d (Table 4) which was 0.350-2.589 kg/d deficit as compared to requirement according to Kearn (1982).

Daily average deficit of TDN supply in the buffaloes were 0.353, 2.589 and 2.199 kg/d for coastal, river basin and drought areas, respectively (Table 4). Chavda *et al.* (2016) got surplus amount of average TDN intake (10.17 kg/d) in the buffaloes in Patan district of India as compared to standard requirement. The findings of Chavda *et al.* (2016) are supported by the observations of Patange *et al.* (2002) and Singh *et al.* (2003) indicating a surplus TDN supply against requirement of the buffaloes surveyed. However, deficit supply of TDN in lactating buffaloes was also reported by Chaturvedi *et al.* (2009) and Singh *et al.* (2008) in their study. As a part of the traditional feeding system, milking buffaloes were given fixed allowance of concentrate (1 to 3 kg/head/day) without taking into account their relative daily milk production capacity in Bangladesh. As they provide concentrate to the buffalo not considering the productivity, it causes nutritional deficiency in high productive buffaloes. This situation can be improved by grouping the buffaloes according to milk yield and providing one kg concentrate for each two liters milk production (Habib *et al.*, 2007). Indian Council of Agricultural Research (ICAR) has been recommended some standard concentrate mixture containing about 20% CP and 70% TDN for lactating buffalo based on Indian feed resources. In comparison to Kearn, (1982) the majority of the lactating buffaloes in different climatic areas in Bangladesh were not being adequately fed in terms of energy and proteins. Therefore, animals remain deficient and the milk production was not increased to its potential. The overall supply of DCP and TDN in comparison to their calculated requirements to buffaloes indicated that the farmers of those areas used their traditional practice in feeding their livestock.

The concentration of CP on DM should be between 11 and 14% (Rai and Aggarwal, 1991) but Verna *et al.* (1992) and Verna *et al.* (1994)

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showed that protein levels in the diet of lactating dairy buffalo varies around 12% (DM basis). Changes in protein levels of diet can affect the concentration of protein in milk as well as blood urea (BU) concentration. Milk production (kg/d), milk protein quantity and milk urea (MU) increased with increase of CP% in diet (Campanile *et al.*,1998). Inadequate energy and minerals in the supplement, microbial population in the rumen would not efficiently utilize resulting ammonia and the excess will be absorbed and converted to urea in the liver (Sarwar and Zia-ul-Hassan, 2001) and will ultimately be excreted in the urine. Javaid (2007) suggested that feeding diets containing rumen degradable protein (RDP) to rumen undegradable protein (RUP) ratio (50RDP:50RUP) increased DMI, milk yield in lactating dairy buffalo. High circulatory levels of urea have been widely advocated to adversely affect reproduction and health of the animals and also contribute to environmental pollution through excretion of large amounts of nitrogen by the animal (Shukat, 2004). Based on the above discussion, energy and DCP should be supplied according to the demand for the climate resilient production system.

Production variables

Production performances e.g. milk production, lactation length, lactation yield and milk composition of buffaloes are affected by feeding, management, nutrition, disease and in most cases heritability. Climate variables (i.e. air

temperature, humidity, wind velocity, solar radiation) also influence the lactation length, lactation yield and buffalo milk production in tropical climate.

Body weight of lactating costal buffaloes was observed significantly ($p=0.000$) lower (35%) than that of the drought (130 kg/h less) and river basin (138 kg/h less) buffaloes. Similarly Lapitan *et al.* (2008) conducted an experiment in Philippines where crossbred young water buffalo were used and body weighted ranged from 300-389 kg. In the contrary, havier lactating buffaloes, body weight ranged 470-478 kg were used in feeding trail in river basin and coastal area of Bangladesh, Siddiki (2017).

From the study it is comprehensible that the average daily milk yield was significantly higher (1.6-3.1 L/d higher) in drought area than that of the river basin and costal area, respectively. Average milk yield was 2-5 L/d among the three studied areas. This findings similar to Siddiki (2017) and Karim *et al.*(2013). Siddiki (2017) reported that average daily milk production varied from 1.65 to 3.46 kg/d for non-descriptive lactating buffaloes in coastal and river basin area of Bangladesh. Karim *et al.* (2013) also claimed that that the average milk yield of lactating buffalo under coastal district (Barguna and Pirajpur) of Bangladesh was 3.3-3.4L/day.

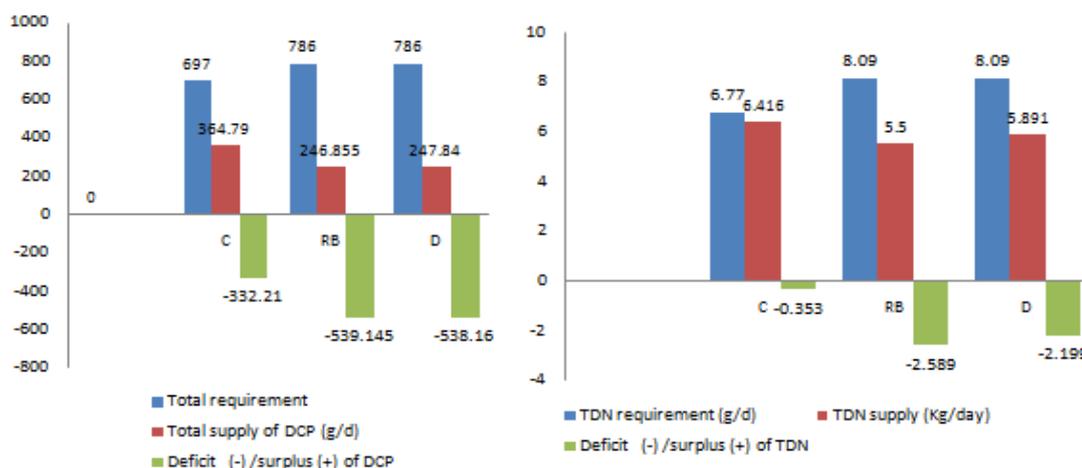


Figure 1 : Deficit (-) and surplus (+) of DCP and TDN in lactating buffaloes in selected coastal (C), river basin (RB) and Drought (D) area of Bangladesh.

Table 6: Body weight, milk production and milk quality of lactating buffaloes in selected coastal (C), river basin (RB) and Drought (D) areas of Bangladesh

Production parameters	C	RB	D	P value
Average BW (kg)	242.0 ^b ±45.1 (182.0 – 320.0)	380.0 ^a ±26.0 (340.0 – 420.0)	372.0 ^a ±45.1 (356.0 – 381.0)	0.000
Average MY (L/d)	2.2 ^c ±0.6 (1.0 – 4.0)	3.7 ^b ±2.0 (1.3-7.3)	5.3 ^a ±1.3 (3.0 – 7.0)	0.000
Lactation yield(L)	429.0 ^c ±124.3 (196.0 – 784.0)	1085.2 ^a ±568.5 (392.0 – 2156.0)	1007.3 ^b ±252.4 (567.0 – 1512.0)	0.000
Lactation Length(d)	197.4 ^b ±29.1 (150.0 – 270.0)	293.9 ^a ±18.2 (240.0 – 325.0)	188.7 ^b ±13.1 (170.0 – 210.0)	0.000
Protein (%)	3.6 ^b ±0.4 (3.0 – 4.4)	3.7 ^b ±0.3 (3.1 – 4.1)	4.1 ^a ±0.4 (3.7-4.7)	0.001
Lactose (%)	4.0 ^c ±0.3 (3.6 – 4.8)	4.9 ^a ±0.5 (4.3-5.8)	4.6 ^b ±0.2 (4.3 – 5.0)	0.000
Fat (%)	7.3±2.7 (4.1 – 12.0)	6.6±1.5 (5.1 – 10.3)	7.6 ±1.1 (6.1 – 10.0)	0.274
4% FCM yield (kg/d)	3.1 ^b ±1.3 (1.5 – 5.9)	3.6 ^b ±2.1 (1.6 – 9.0)	7.7 ^a ±2.0 (4.0 – 10.4)	0.000
Ash (%)	0.6 ^b ±0.1 (0.5 – 0.8)	0.7 ^a ±0.1 (0.6 – 0.9)	0.7 ^a ±0.0 (0.6 – 0.7)	0.000

BW, Body weight; MY, Milk yield; d, day; FCM, Fat corrected milk. Values in the parenthesis represents the data range of the respective mean. $FCM = 0.4M + 0.15F$; M is the quantity of milk in Kg, F is fat content (Kg) of non-standard milk (Gaines, 1928)

The non-descriptive buffalo herd at Bangladesh Livestock Research Institute had an average production of 1.5 – 3.0 L/day (Islam *et al.*, 2014) which also agreed with our findings. As average daily milk yield was highest in drought area, but significantly higher (1085 L) lactation yield was found in riverbasin area than that of drought (78 L more) and costal (656L) area due significantly higher (96-105 day more) lactation length in river basin area. It might be happened due to management, environment, and genetic factors. Similar findings were also reported by several authors (Faruque *et al.*, 1990 and Shabede *et al.*, 1993). Karim *et al.* (2013) found 286 days of lactation period in similar kind of buffaloes under extensive production system in Mathbaria and Pirozpur, which was 290 days in Pathorghata and Barguna. The findings of this study were also more or less similar to the findings of other

authors (Faruque *et al.*, 1990; Faruque and Amin, 1994).

Milk composition attributed for breed, physiology of animal, environment, and management system (Ravikala *et al.*, 2014). Nahar *et al.* (2014) found different milk composition of buffalo, for different selected areas of Bangladesh. In the present investigation the range of protein, lactose and ash percentage of buffalo milk collected from different climatic zone were 3.64-4.12, 4.03-4.92 and 0.62-0.70, respectively. The range of protein and lactose percentage were 3.50-4.37 and 4.83-6.26 respectively, found in different district of Bangladesh (Nahar *et al.*, 2014). The average fat percentage of buffalo milk from Noakhali, Sirajgang, Potuakhali and Bagerhat was 8.16, 7.54, 7.18 and 6.92 respectively (Nahar *et al.*, 2014) which was similar with Khan *et al.*,

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(2007). Compared to the present results, a lower fat content in non-descriptive buffalo milk (5.8%) was reported by Islam *et al.* (2014), on the other hand, Khan *et al.* (2007); Islam *et al.* (2018) reported 8.4 and 7.3% fat in swamp and water buffalo milk from Trishal, Mymensingh. However, the fat content in the non-descriptive buffalo may showed a higher range of variation, for instance 3.4 – 14.4% in high altitude area like Kumaon Hills of the central Himalayas (Meena *et al.*, 2007). The present investigation in case of fat % is agreed with Nahar *et al.*, 2014. The FCM yield varied from 3.08 to 7.77 kg/day which might be depending for nutrition supply as well as genetic variation. Zhou Caixia (2012) reported that the FCM increased significantly with increased of CP level from 13.6 to 14.4%, but the FCM production decreased from 13.1 to 12.2 kg/d with the increased dietary CP % from 15.2 to 16.0 in lactating buffaloes in china. Meng *et al.* (2016) showed that high crude protein level of diet did not significantly improve the yield of FCM. Hongyu *et al.* (2010) also claimed that, above a certain level of dietary protein, can reduce the yield of FCM.

Conclusion

Buffaloes in the studied areas were mainly reared in traditional management system. Buffalo farmers provide local green grass and rice straw as basal diet with or without very little amount of concentrate supplement consisting of one or few concentrate ingredients separately or in the form of mixture to their buffalo without considering their nutrient requirement (especially energy and protein requirement) based on milk production and composition. As a result the nutritionally deficit buffalo cannot express their full genetic potential in terms of milk production and quality and over supply of nutrient also affects the farm profitability. Therefore, assessment of local natural resources including feeds, fodder, animals and management tools is of greater importance.

Conflict of interest

The authors have no conflict of interest to declare.

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