



## Advancement in the Feeding and Nutrition of Farm Animals of Bangladesh and a Panoramic View 2050

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### ARTICLE INFO

#### Research Article

Received 02 October 2017  
Accepted 11 December 2017

#### Keywords:

Research  
Nutrition  
Advancement  
Sustainability  
Feeding

### ABSTRACT

This article describes genesis and the advances of schooling, research and extension of animal nutrition science and practices in Bangladesh. It portrays sine qua non of the advancement of animal nutrition, fodder production and frontier knowledge of allied disciplines. Domestic growth of good practices and its global and regional competitive advantages are delineated for supporting the growing need of safe animal sourced food pillared with profit, people, planet and the ethics of sustainable production of farm animals. A vision of becoming world middle income country with a national population plateau of around 202.0 million and demographic shifts by 2050 may require the annual production of 130.0 and 27.0 thousand tons of manufactured dairy and beef feed furthering global trading competitions for feed ingredients. This competition may be minimized through the production and supply of domestic sourced unique quality feeds and value additions to roughages. Capacity enhancement in research, education and extension will boost socioeconomic and the production efficiency of farm animals and enhance sustainable growth of feed industry racing with regional and global competitions.

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DOI: <https://doi.org/10.24925/turjaf.v6i2.226-232.1612>

### Introduction

Animal nutrition is a science deals with the intake, digestion and metabolism of feed, good feeding practices and interactions with the environment they are been rose. Feed is defined as any single or multiple materials, whether processed, semi processed or raw intended to be fed directly to food producing animals. Feed ingredients, whether it has nutritional value to animal diets or not, is a component part or constituent of any combination or mixture making up a diet (Codex *Ad Hoc* Intergovernmental Task Force on Animal Feeding, 2008). They may be feed additives, any intentionally added ingredient not normally consumed as feed by itself, whether or not it has nutritional value or affect the characteristics of feed or animal products (Huque and Sarker, 2014). Feed, feed ingredients and/or feed additives produce on farm or procured off farm should be obtained in good conditions and meet generally accepted quality standards for producing safe food. The stakeholder, deal with animal nutrition and allied sciences produce feed and/or feed ingredients, rear animals for use as food, and/or produce such animal products need scientific good practices, policies and professional collaborations for improving production efficiencies minimizing climate pollutions. Besides, the

diversification and up-gradation of contemporary feed value addition systems and the strengthening of regional and global partnerships are of immense importance for gaining national competitive advantages in research, education and the commerce of feeding and nutrition of farm animals of Bangladesh. The country achieved significant advances in the competitive advantages of different spheres of feeding and nutrition of farm animals since pre-independence time, auditing of which may lead to identify strengths and weakness, and further opportunities for development, centering attentions to accelerated scientific practices primarily through educational and informational activities and fostering public-private partnerships. The improvement of feeding and nutrition of farm animals, safe feed productions, feed policy and standard development, and climate resilient animal productions also deserve attentions. The present review research work was, thus, undertaken to evaluate advances so far been made in the field of feeding and nutrition of farm animals of Bangladesh, and identify weakness in the various factors of competitive advantages in the related areas and further needs to cater the growing needs of the country.

## Materials and Methods

The development of feeding and animal nutrition of animals in Bangladesh is reviewed under different sections viz., i) the genesis of Animal Nutrition and its schooling in Bangladesh, ii) schooling of feeding and nutrition of farm animals and further outlooks, iii) research of feeding and nutrition of farm animals and further outlooks, iv) public sector's extension and development services, v) private sector's competitive advantages, and vi) domestic food-feed competitions and global trading are reviewed using secondary sources of data and information. Essential extrapolation of secondary data was made and findings are presented in text, table and figure. Under each section several related sub-sections were made and discussed accordingly. The growing demand of livestock products and manufactured feed is estimated considering the growing needs of animal sourced food of the country. Finally, based on the review findings conclusions were made.

## Results and Discussions

The result and discussion are presented under the following sections and sub-sections under different disciplines.

### *The Genesis of Animal Nutrition and its Schooling in Bangladesh*

Antoine-Laurent de Lavoisier in 1743 introduced balance and thermometer in nutritional studies and provided the evidence of oxidative process as combustion, and it is thought to be the start of the genesis of animal nutrition (History Highlights of Nutrition). However, through the revelation of "The holy Qur'an" during 610 to 632 Allah (swt) taught the mankind the science of animal production and nutrition. It is stated in al-Nahl (The Bee, Verse: 5) and Yā sīn (Ya Sin, Verse: 73) Sūrat of the Holy Quran that HE created cattle and tamed them for warmth, benefits, riding, drink and food to eat; gave lessons for mankind through producing pure milk to drink out of their excretion and blood (al-Nahl, Verse: 66) and caused to grow green fodder (Abasa, Verse: 28). The divine wisdom of animal nutrition and fodder production remains in the Quran throughout the centuries but hardly related to practices by the mankind, especially by the believer in Islam.

### *Schooling of Feeding and Nutrition of Farm Animals and Further Outlooks*

The schooling of animal nutrition started through the first introduction of veterinary education in 1877 at Babugarh in the then undivided India. After the bifurcation of India, the Animal Husbandry Institute including an animal nutrition section was established at Comilla in the erstwhile East Pakistan in November 1947 and the institute was brought to function under Agriculture department. A veterinary college, established at Comilla in December 1947 and shifted in Dhaka in 1951, introduced a five year B.Sc.(AH) degree course including the schooling of animal nutrition under the University of Dhaka in 1952. The East Pakistan College of Veterinary Science and Animal Husbandry of Dhaka

shifted at Mymensingh in 1958. The schooling of animal nutrition continued twinning with fodder production under a full-fledged department of the Faculty of Animal Husbandry, one of the six faculties of the Bangladesh Agricultural University established combining the academic activities of the college at its extended campus in August 1961. The combined schooling of animal nutrition and feeds and fodder production is still being exercised by the animal nutrition department of the BAU. The different disciplines of veterinary and of animal husbandry and their allied sciences advanced, multiplied and diversified with time, and help the production of animal sourced food to feed growing population of the world. The growing need of the good practices of animal nutrition and the production and processing of fodders on farm and the gaining of competitive advantages of private feed manufacturing in the country over the decades demand an intensive schooling of animal nutrition and fodder science independently.

The science of animal nutrition outstretched to deal with the feeding and management of animals under different climates and the mitigation of climate pollutions and clean air production. In such an era, the schooling system of animal nutrition without deepening into frontier sciences has been extended in the new schools of the universities (Chittagong Veterinary and Animal Science University, Sylhet Agricultural University, Patuakhali University of Science and Technology, Hajee Mohammad Danesh Science and Technology University, Rajshahi University, Bangabandhu Sheikh Mujibur Agricultural University, Sher-e-Bangla Agricultural University) established recently in the country. The new schools have diluted attentions through twining of animal nutrition with other allied disciplines, eg, animal science or with animal breeding and genetics.

This has horizontally expanded the schoolings of animal nutrition without further improving the quality of human resources used for farms and factories. The domestic competitive advantage of quality human resources is being faded over the domineering attitude of the concerned professionals. This, in addition to slow growth of the development of feed and nutrition science and technology, one of the major factors dictates the production and productivity enhancement of livestock, has been favoring the influx of alien experts. Professional's outlooks towards the development of science and industry including the schooling of animal nutrition and fodder sciences must have goals for the development of socioeconomics of livestock farmers and feed value additions along with clean air production. This requires the revision of ongoing educational courses focusing field problems and the emerging demand of good practices and knowledge.

### *Research of Feeding and Nutrition of Farm Animals and Further Outlooks*

Animal nutrition research, the extent to which it was done along with schooling in the past, was very much academic in nature, and the promotion of good practices addressing on farm problems was weak. Out of the way of an inbuilt schooling based research, a few isolated research approaches was made through establishing an animal nutrition section along with the vaccine production laboratories of Livestock Research Institute, Mohakhali

and a nutrition laboratory with disease diagnostic activities at Baghabari, Shahjadpur established by the Australian Cattle development Project and the Milk Vita. With the establishment of the Bangladesh Livestock Research Institute in 1984 the research and development (R and D) activities of animal nutrition and fodder production was strengthened focusing field problems further. But, it again was twinned with other animal production related research activities. Over the decades, a substantial domestic knowledge base is created through both schooling based research and national research systems. Some of the conventional research works of feeding and nutrition of farm animals are still remained unaddressed and/or required to address. With the emergence of frontier and allied sciences, climate issues, competitive advantages in feed value additions and safe feed production, the R and D of animal nutrition and fodder production needs to enter into the innovation and knowledge of second generation as outlined below.

#### *Study of Cellular Processes of Feeding and Nutrition*

As a result of a growing population, national economy, and urbanization the consumption of animal products is being increased sharply and will rise further in the future. It will create a huge demand of feeds and fodder impacting their production, supply and safe utilization. A better understanding of various interactions effects of feeding and nutrition of different farm animals exploring fundamental frontier sciences such as, nutrigenomics; deals with understanding the role of nutrition on gene expressions, nutriproteomics; deals with the understanding of protein structures in nutrition, metabolomics; chemical fingerprinting of cellular processes, synthetic biology; that combines biology and engineering, in utero nutrition; nanotechnology may generate new knowledge of and good practices for effective and safe utilization of feeds for maximizing production and productivity of farm animals. All these warrant the support of schooling, research and the development of good practices for farm animals through holistic approaches of experts of concerned different disciplines.

#### *Oxidative Stress, Antioxidants, Animal Interactions*

Intensification of animal productivity, global warming and climate changes have been impacting production performances and health of animals. It is intensified further through the oxidative stresses due to the imbalances of dietary pro-oxidants and antioxidant contents. Strategic feeding and nutrition and the management of animals may manage these metabolic conflicts/imbances and maintain harmonic tissue metabolism, especially, during the intensive metabolic functions in certain physiological and climatic conditions. The knowledge and sciences related to oxidative stress and metabolic disorders, health and climatic factors required to explore further in different local animals. Considering the complexity of interactions between antioxidants and body systems, a thorough analysis of antioxidants-animal interactions is necessary to understand the effects of antioxidants supplementation in ruminant diets. This may help the improvement of production and productivity of animals under stressed

conditions and it requires the support of scientific maneuvering integrating related sciences.

#### *Feeding and Nutrition for The Quality Improvement of Livestock Products*

Safe feed is the precondition to have safe food of animal origins. The quality control of feeds and feed additives is a state function. But, this requires the support of database on the nutritional and anti-nutritional compounds in feeds and fodder available in the country. In addition to the generation of primary data; secondary data, available with acceptable/ unacceptable quality in accredited/non-accredited labs may required to be validated and compiled through a national process of consultation. A national feed directory consisting feeds and fodders available in different regions of the country is required to be developed to have support for the safe food production in the country.

#### *Enteric Methane Emission Mitigation Options in The Rumen*

Methane, a high value natural gas, represents a significant source of greenhouse gas. The dairy sector of the country is responsible for about 52.2 million CO<sub>2</sub>eq and the green house gas profile is dominated by CH<sub>4</sub> (79%). The manure of dairy cattle of the country, on the other hand, is responsible for about 62.96 Gg methane emissions representing about 35.6% of the total livestock manure management system (Huque et al., 2017). The improvement of feeds and feeding system reduces CH<sub>4</sub> emission in the rumen and increases production and productivity of animals (Knaap et al. 2014; Huque et al., 2014). Similarly, the improved management of livestock manure may reduce methane emission in the rumen up to 83.7% (Huque et al., 2017). The default factors of CH<sub>4</sub> emission in different ruminant animals at different feeding systems may vary and they are essential to be determined in local conditions for devising mitigation options. Moreover, searching different phytochemical and biological options available in the country and their uses may reduce methane emission in the rumen. In addition, the performance of different biological additives on the mitigation of CH<sub>4</sub> emission in the rumen is required to be explored in local conditions. The exploration of knowledge and database is essential to have good practices for feeding ruminants help clean air production.

#### *Comparative Nutrition and Metabolism*

Energy metabolism and imbalances in metabolic processes may induce various diseases in animals. Monitoring ATP production in tissues through energy metabolism is an effective way to understand the health conditions of animals. For example, the pentose phosphate pathway and the malate-aspartate shuttle are accelerated remarkably in tumor cells and in diabetic conditions and ATP production is decreased. Further, the relationship between energy metabolism, endocrinology, and immunology is a key to understanding metabolic disorders in animals. Moreover, immunology and metabolic diseases is important for understanding the prevention of metabolic disorders. A research thrust on comparative nutrition and metabolism may be given to understand the problems and device nutritional solutions for them.

*Public Sector's Extension and Development Services*

The extension services of animal nutrition and fodder production has been strengthened over the decades both in public and private sector. The conservation and extension of high yielding fodder crops started with the establishment of the Central Cattle Breeding Station and Dairy Farm at Savar in 1960, and it was revamped through the collaboration of the government of Germany in 1969. Fodder production on roadsides also initiated at that time but it did not continue further. The conservation programme of fodder germplasm was also discontinued and/or interrupted. A fodder production project was implemented by the Department of Livestock Services (DLS) in late nineties and implemented in different districts. Feeds and fodder extension services should always be a continued support to farmers and entrepreneurs, like that of cereal crops. But, the extension support the DLS being given till now through development projects was like thunderstruck to users. They were initiated but ended without follow ups. After almost two decades, a development project of feeding and nutrition is being implemented again since 2015 by the DLS and if logical exit strategy is not followed, its closing may surprise users again. However, feed analyses and lab services over the decades have been strengthened through the establishment of a central nutrition lab twining with district level routine labs in the country. A strong coupling of extension and research of nutrition and fodder production and human resource development in the respective discipline are essentially required to shoulder emerging and newly emerged challenges for meeting the demand of quality feeds and fodders production avoiding climate pollution and food-feed-fuel competitions.

*Private Sector's Competitive Advantages*

Bangladesh produces total 4.464 million tons of manufactured feed for dairy, beef, broiler, layer and aqua compared to 658 million tons for the same in the world, shown in Fig.1 (Alltech, 2016). The share of broiler (46.1%), layer (27.69%) or aqua (20.16%) in Bangladesh manufactured feed is higher than the global average (44.8%, 21.6% and 5.30%, respectively). The share of dairy and beef manufactured feed, on the other hand, is far below (3.81% and 2.24%) in the country compared to that of global average (17.8% and 10.5%). Bangladesh annually produces 0.17 and 0.1 million tons of dairy and beef feed compared to world production of 117 and 69 million ton, respectively (Alltech, 2016). Feed manufacturing depends on the production potentials of animal species and the social acceptance of animal sourced foods. Dairying in India is popular and it favors annual production of 9.42 million tons of dairy manufactured feed, almost 8.05% of the world. The dairy and beef manufactured feed production of Bangladesh, a Nonveg dominant Muslim country, requires further support of knowledge and good practices along with the investment of private sector.

*Domestic Food-Feed Competitions and Global Trading*

Feed manufacturing favored the double production of domestic corn over a period of five years (2011-2015) and it increased 51.2% annually. The oilseed production,

sources of cakes for livestock, is increased 6.84% annually, at a slower rate than corn. The import values of meals and cakes is increased almost five times (Million US\$ 18.98 to 95.79) compared to three times (17.83 to 59.92 million US\$) of that of corn (Fig 2).

The consumption of meals and cake has been rising (139.0 million tons in 2015-2016, FAO Food Outlook, 2016) resulting in a strong global market competition furthering cost of the ingredients. The growing uptake of manufactured feed as a result of increased growth of input supported farm animal productions underpinned the demand of cakes and meal, especially, that of soybean meal, a major quality protein source used by almost 96% of feed millers (Altech global feed, 2016) of the world. The price hikes of corn, meals and cakes always pull the reins of rising feed prices both locally and internationally. The domestic production of corn, and meals and cakes or their alternative feed ingredients is essentially required.

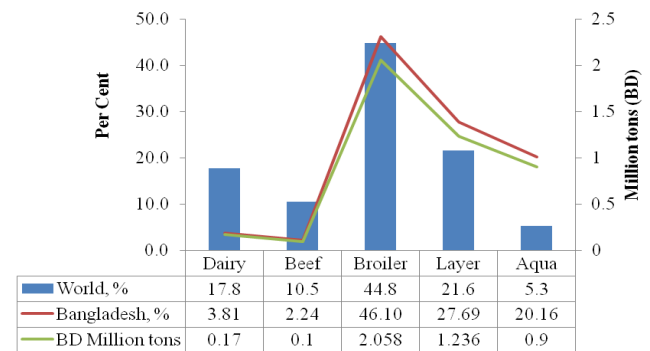


Fig. 1 Global & Bangladesh manufactured feed share (%) for different animals

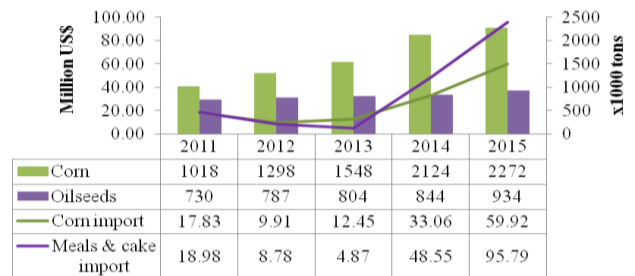


Fig. 2 Domestic production of Corn & Oilseeds (x1000 Tons) and import (Million US\$) of Corn and Meals & Cakes (BBS, 2015)

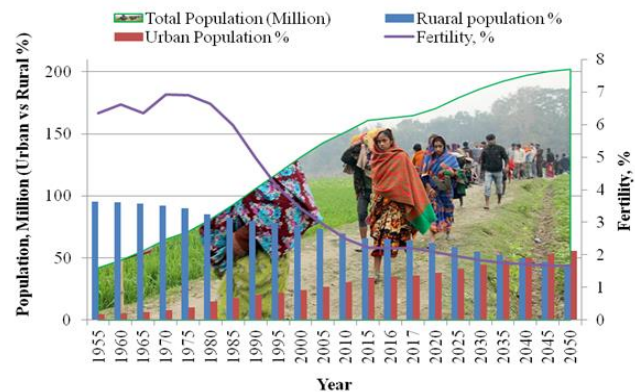


Fig. 3 Trend in population growth (Urban vs Rural %) & fertility of Bangladesh by 2050

Moringa feed, a feed containing an average ratio of acid detergent fibre to crude protein of 2.0:1, may not only replace imported cakes and soyabean meals in the diet of dairy, beef or small ruminants but, also may make dietary feed conversion efficiency more cost effective and enhance product quality. Moringa feed production and value additions may economically enrich and diversify feed manufacturing industry of the country and reduce import expenditure for meals and cakes (Fig 2) avoiding global market competitions. Competition for protein meals between ruminants and poultry may be compromised by adjusting the ratio of acid detergent fiber to crude protein in the Moringa feed and value added antioxidant rich product development for human may make Moringa feed production cost effective avoiding food-feed competitions.

However, competition for the use of cultivable land, increasingly disappearing over the decades, has been rising impacting the types of crop to be cultivated in addition to agro-ecology. The efficiency of cost and return of a crop has also been impacting farmers' decision for the adoption of crop types.

#### *Growing Demand of Livestock Products and Manufactured Feed*

At a fertility rate of 6.92%, the population of Bangladesh was 65.05 million in 1970, and it increased to 164.83 millions in 2017 while fertility rate stands to 2.20%. The fertility rate will decline further to 1.67% in 2050 when the population may take a plateau of around 202.21 millions, shown in Fig 3 (Worldometers, 2017). About 35.6% of the total population lives in urban area in 2017 and it is predicted to rise to 55.6% in 2050. Thus, the increasing number of population and ratio of urban consumer to rural producer along with literacy and economic growth may help reaching at the peak of the demand of livestock sourced food by 2050. It is estimated that an annual increase of 261.6 and 8.95 thousand tons of liquid milk and bovine meat may be required to produce for supporting quality nutrition to peoples by 2050. Manufactured quality feed is one of the dire needs for the vertical improvement of milk and meat production using bovine animals, like that of commercial poultry. The increased production of milk and meat may require 130.0 and 27.0 thousand tons of manufactured dairy and beef feed annually creating a huge opportunity for the expansion of existing feed milling system. Better feeding and nutrition to animals will boost their productivity favoring the goal of climate smart agriculture. However, new options for the increased supply of feed ingredients both of domestic, regional and international origins have to be explored keeping considerations of land crises and food-feed competitions.

#### *Feeding and Nutrition- Status Quo*

Chaffs (straws and stovers) are the source of about 70% of dry matter, 55% of crude protein and 70% of metabolizable energy for farm animals; brans, husks, skins and polishes together contribute about 11.0%, 21.0% and 11.0% of nutrients, respectively; oil cakes and meals contribute about 5.0% of each of the nutrients and natural vegetation and cultivated fodder supports only 2.0% (FAO 2017, unpublished data; Huque and Sarker,

2014). An average ruminant diet of chaffs and other feeds produced in the country with 6.75 MJ ME/Kg DM and 1.63% digestible CP (Huque and Sarker, 2014) is not facilitative to sustainable ruminant animal production, thought to be smart on the quadri-pillars of profit (animal productivity), planet (climate pollution), people (poverty and hunger) and ethics (Makkar, HPS, 2016). Chaffs support 90% and 75% of the dietary ME and CP of large ruminants and the remainder being provided by brans, cakes and food grains. The commercial chicken, on the other hand, get 50% of their dietary ME and CP from grains and the rest from cakes, meals and bran. Their diets contain about 75.0% of the imported feed, dairy and beef feed take 10% and the rest is used for aqua and others. The unavailability of quality roughage and concentrate feeds limits minimum options for the formulation of diets of higher metabolizability and quality protein especially for high yielding dairy and beef animals. Farmers in most cases use imbalanced diets of roughage and concentrate for boosting animal production and productivity minimizing profit margins. Annual biomass demand and supply mismatch, harvest loss, bulk transfer problem, and otherwise uses of fibrous residues further limit feed supply to animals irrespective of their quality. Thus, dairy and beef feed, consisting fibrous roughage and concentrate, requires further value additions to built sustainable quadri-pillars for the domestic dairy and beef industry of the country.

Chopping, shredding, densifications of fibrous roughages enriching with or without quality feed ingredients, cost effective production of quality fodder and even the import of quality fibrous biomass may widen roughage feed baskets multiplying the on farm use of mechanical devices and their domestic markets, as the Wage Rate Index in agriculture is being multiplied exponentially over the last decades (BBS, 2015). The conventional practices for minimizing the demand and supply gaps of fibrous feeds are becoming unattractive to farmers due mainly to increased agricultural labor cost and fibrous crop residues, in most cases, are being lost at fields. The extent of mismatches of demand and supply of fibrous feeds to livestock farmers gyrates again in different regions and production seasons. Dairy and beef feed entrepreneurs, in addition to extending their existing value addition system for concentrate feeds, may add values to fibrous roughages for furthering increased milk and meat production in the country.

#### *Food Production Efficiency*

The food-feed competition expressed in terms of animal crude protein (Animal CP) output to human edible plant crude protein (HE CP) of different farm animals and poultry of Bangladesh is shown in Table 1. The commercial poultry compared to ruminant animals are less efficient in converting human edible plant protein to animal protein. Only 0.0175 parts of HE CP is converted to animal protein wasting almost 0.982 parts while the ruminant animals convert 0.604 parts of HE CP (Table 1). Among the ruminant animals non-dairy cattle (growing and beef animals) and small ruminants convert HE CP much more efficiently than dairy animals and their animal CP to HE CP is above 1.0 (1.288 and 1.767, respectively).

Table 1 Conversion efficiency of animal CP to HE plant CP by different farm animals of Bangladesh (FAO, 2017, Unpublished)

Types of farm animals	Animal CP to HE plant CP
Commercial poultry	0.0175
Dairy cattle	0.341
Non-Dairy cattle	1.288
Small ruminants	1.767
Ruminant average	0.604

Table 2 Conversion efficiency of human edible plant protein (HE plant CP) to animal protein (Animal CP) of livestock (FAO, 2017, Unpublished)

Countries	Livestock	Dairy	Poultry
	Animal CP:HE plant CP		
Bangladesh	0.188	0.341	0.0175
India	6.899	10.91	1.542
Pakistan	3.969	11.85	0.545
Nepal	0.210	0.628	0.075

Comparing to Bangladesh (0.0175) or Nepal (0.075) the commercial poultry of India or Pakistan converts HE CP more efficiently reflecting a ratio of 1.542 and 0.545, respectively (Table 2). This, one hand, makes broiler meat and commercial eggs of Bangladesh more expensive than that of India or Pakistan, and, on the other, it is tending more to dilute food-feed competitions and pollute environment. An immediate research work may be undertaken to explore factors for such a huge noncompetitive operation of commercial poultry in the country.

Similar to commercial poultry, the dairy or the livestock farming as a whole of Bangladesh and Nepal is 0.341 and 0.188 and 0.628 and 0.341, respectively, compared to 10.91 and 6.899 of India and 11.85 and 3.969 of Pakistan. The dairy of Bangladesh, especially of peri-urban and urban types and that of sub-humid regions, of which the length of crop growing period is limited by flood water, is fed with a huge amount of concentrate disarranging the kinetics of rumen feed degradation (Huque, 2011; Huque *et al.*, 2002). Feeding bulk diets to ruminant animals with good quality and/or nutritionally enriched roughages may reduce carbon footprints and food-feed competitions.

## Conclusions

Feeding and nutrition of farm animals grounding on knowledge and good practices represent a galactic share of livestock industry being expanded with the increased demand and production of animal sourced foods. The science of animal nutrition and allied disciplines, like that of mechatronics, economics along with good practices of home and abroad provided a strong tribune for the benefit of the people of the country. The professional of all concerned arenas have been shouldering challenges over the decades for making sciences into practices and reaching out to farmers and consumers to meet the increasing demand of safe animal sourced food for the peoples of all spheres. The science of animal nutrition and

allied disciplines are becoming smarter globally and even regionally for tackling hunger, poverty and climate pollutions with a vision of climate smart animal agriculture. Global competitions for value additions to livestock feeds have been rising spirally over the decades and the countries, like Bangladesh, practices narrow crop diversities, will face them intensely. Better utilization of domestic feed resources, production of unique quality feed and the improvement of feeding and nutrition on farm may ameliorate sustainable livestock production averting global competition for meals and cakes.

Thus, enhancing capacity in research, education and extension tracking the pathways of globalization may support the increased production efficiency of farm animals racing with the increased demand of animal sourced foods..

## Acknowledgements

The authors acknowledge contribution and support of their colleagues extended during the preparation of the article. All reviewed works are duly referred in reference section.

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