Asia Dairy Network
Asian Milk for Health and Prosperity

BANGLADESH NATIONAL DAIRY PROFILE

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Contents

THE PHYSICAL ENVIRONMENT

Latitude/longitude of country

The people`s republic of Bangladesh, a South-Asian country of 147,570 km^2 area, is situated between $88^0$10' & $92^0$41' east longitudes and between $20^0$34' & $26^0$38' north latitudes. It has a long border of about 4053 km with India in the west, north and north-east and an about 193 km with Myanmar in the south-east.

Topography

The topography of the country may be divided into i) **highland**, the area is mostly located in two elevated tracts in the northern and central regions, it cannot hold water and remains above normal flood level; ii) **medium highland**, the area normally flooded about 90.0 cm depth during the rainy season for a couple of weeks and covers different parts of the country; iii) **medium lowland and lowland**, the area normally flooded between 90.0 cm to 300.0 cm and remains inundated up to two months. Similar to medium highland it is distributed in different regions of the country, especially, in the central, south and south-west region; iv) very lowland, it looks like large lakes with a depth of flood water up to 900 cm for a period of up to five months during the monsoon and haors, bills, canals and other water basin forms this area; v) the hilly land, the hilly forest canopies in the northern & eastern border district of the country, occupies the area. The extent of retention of flood water and its depth in different inundated areas vary depending on climate and manmade practices like construction of roads & highways, embankments etc.

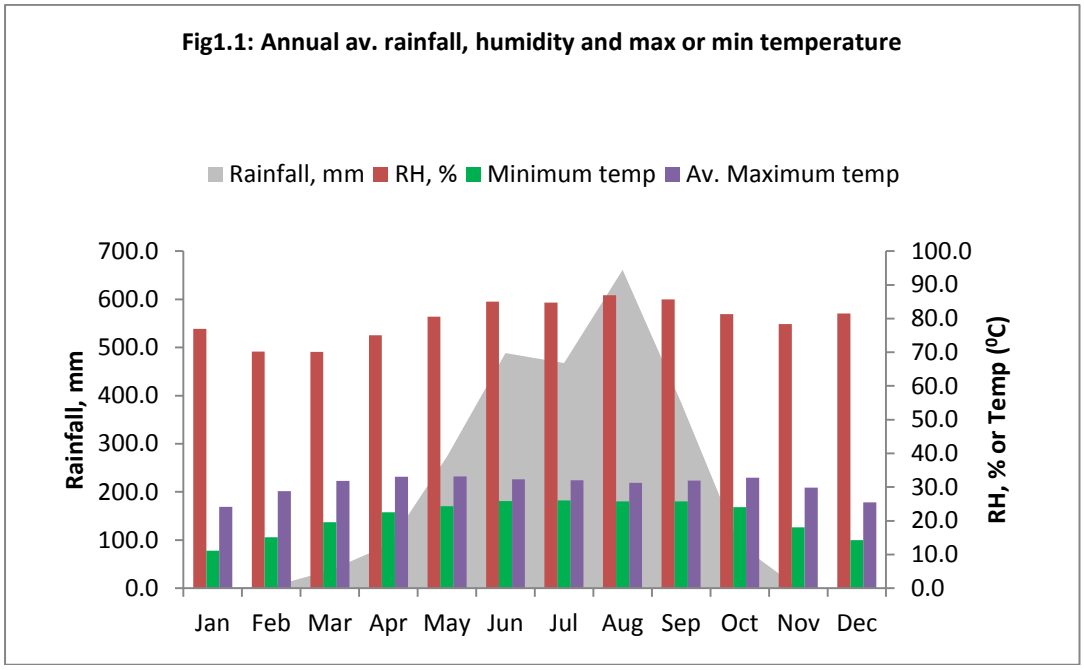
Soils

Based on soil characteristics and their place of occurrence the country is divided into nineteen soil type units, and based on pH range (extremely acid <4.5 pH to strongly alkaline 8.5-9.0) soil reaction regions are identified. The organic matter content of soil varies from high to low or very low in some regions, and taking consideration of these characteristics, the total area is classified into thirty (30) agro-ecological zones (AEZ). The crop production system and intensity vary in different AEZs, and it affects availability of feeds and fodders in different regions and seasons.

Climate

Bangladesh has a tropical and moderate climate with the summer, monsoon, autumn, late autumn, winter and spring season. The average rainfall, humidity, maximum and minimum temperature in different months of a year is shown in Fig1.1. Based on the rainfall, humidity and temperature, the six seasons may broadly be classified into two periods:

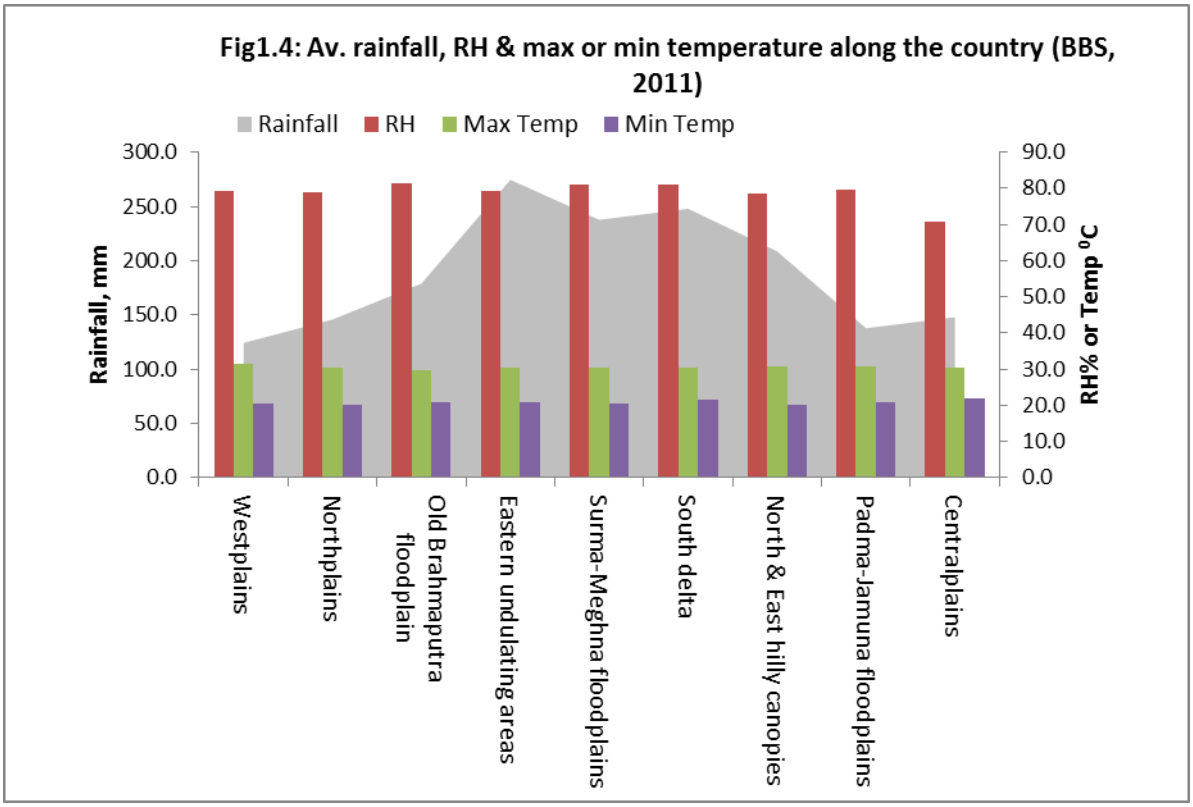
- **November to February** having minimum or no rainfall become dry, and, depending on topography, a huge amount of underground water is pumped up to cultivate rice and other crops.
- **March to October** is the wet period including the monsoon from June to August, when heavy rains results in inundation of about 30% of the total area. The livestock farmers of the low lying area during the monsoon and most of the farmers, except those of the river delta area, during the dry period face a serious feed shortage limits livestock production. The river floodplains and water basin areas receiving new silts during the flood period support winter crop including pulses and other green biomass and they are used for grazing by the ruminant. It helped development of some traditional dairy production system in some regions of the country.



The annual average maximum and minimum temperature of the country varies from 29.5^{0}C to 31.5^{0}C and 19.3^{0}C to 21.5^{0}C. The relative humidity (RH) and rainfall, on the other hand, vary from 78.5% to 84.3% and 113.4 mm to 414.8 mm, respectively. The extreme night time ambient temperature may be as low as 8.0^{0}C in some selected regions, especially, in the northern plain and in the north hill canopy areas, but it rises in the day time, when the sun shines and day length increases. The extreme day time ambient temperature may be >40^{0}C, but it does not exceed 10 days, especially, during the summer in the north plains.

The variations in rainfall, temperature, humidity and surface water availability have made two distinct cropping seasons in a year. Kharif, the longest season covering almost $\frac{3}{4}$ part of a year starts in March and it continues till October, and Rabi, the three months cooler period starts in November and end in February. Depending on topography, soil fertility and inundation period multiple crops are produced regionally, and average intensity of cropping varies across the country with >160% in floodplain or in plain lands and <160% in hilly canopies and in the delta areas. The intensity of cropping is the highest (>200%) in the northern and west plain districts, and is the lowest in the southern delta and hilly canopy districts. The average cropping intensity rises from 175% in 2006 to 192% in 2011.

The range of average temperature and humidity does not vary much among the bovine production zones except the rainfall. The average per month rainfall is 124.3 mm in the north plain to 274.6 mm in the eastern undulating area (Fig1.4). The factors other than climate, such as availability of crop by-products and socio-economic status of the farmer may have more influence on bovine animal rearing and may impact variations in regional dairy production systems.



TYPES OF DAIRY SYSTEMS

Animal agriculture is widely spread throughout the country. Some of the areas have atypical breeding habitats of certain animals, like dairy productions in Shahjadpur or Munshiganj areas; sheep or buffalo producing delta area etc. The former is a low lying area and being silted up every year they support multiple crop production including green fodders.

A map of the production zones of cattle and buffalo with potential for dairy farming were developed, considering household keeping of animals and the topography and is presented in Figure 2. Figure 3 shows that the country can be divided into nine different bovine producing zones. Attributes like climate (average rainfall, maximum & minimum temperature) and animal (average bovine animals number per household, ratio of subsistence to commercial farm, total population) or cereal crop husbandry further characterise the newly developed bovine animal production zones. They may be as follows.

I. North plain
II. Old Brahmaputra floodplain
III. Padma-Jamuna floodplain
IV. Central plain
V. West plain
VI. Surma-Meghna floodplain
VII. Eastern undulating area
VIII. North-East hilly canopies
IX. South delta

North plain, West plain, Old-Brahmaputra floodplains and North-East Hilly Canopies have averages of 2.6, 2.0, 2.7 and 3.1 cattle and buffalo per household while 49%, 45%, 41% and 40%, respectively of these households keep stock. Having a higher number of cattle per household and per cent of households keeping livestock, these four different zones keep about 55% of the total cattle. The

farmers of Padma-Jamuna or Surma-Meghna floodplains, Eastern undulating area and South delta area keep average 2.4, 2.1, 2.0 and 2.9, respectively bovines per household while 37%, 33%, 32% and 35% household, respectively keep cattle. These four different areas keep 41% of the total bovines in the country. In contrast, only 14% of the farmers of the central plain farm cattle.

Fig 2: Dairy potential districts in Bangladesh (coloured), based on % households raising animals and topography

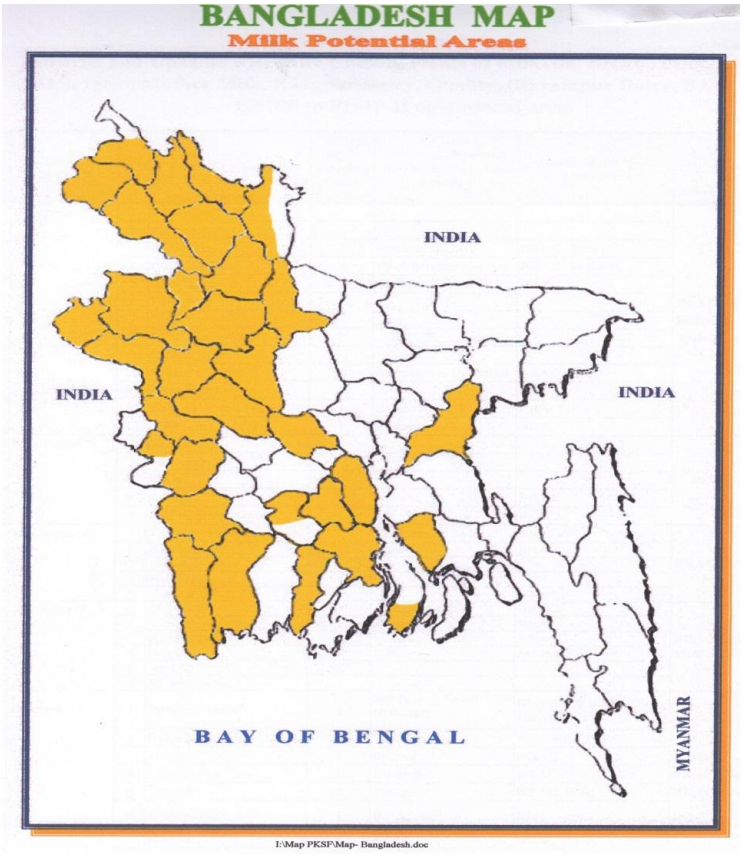


Fig 3: Map of bovine animal production zones

Cattle and buffalo population

The country has 23.2 million cattle and 1.45 million Buffalo. The calculated number of lactating cows varies from 4.08 million to 4.14 million out of the total adult female of 9.04 million to 9.17 million during 2006 to 2011. The adult female buffalo, on the other hand, was 453 thousand in 2011 including 121 thousand lactating buffalo cows. Total animal or the number of different age groups increased during the period of 2006 to 2011. Goats are also lactating animals, but local Bengal does, the population of which is around 14.8 million out of total 24.1 million goats in 2011 hardly spare any liquid milk for human consumption out of mothering their multiple kids.

The average number of bovines per household is 2.0, and the same number (2.0 bovines per household) is also reported as the average of the subsistence system. The later consists about 99.2% of the total 25.1 million bovines. Commercial farming, more correctly, the input supported system consists only 0.8% of the bovines, and an average per household number is 13. It was estimated that the ratio of bovines to human in the country is 0.18:1.

Registration of dairy farms

The country has no large scale dairies and all the farms under the three production system are smallholder in nature. The smallholder farmers in the absence of any domestic protection system are reluctant to have their farm registered in the concerned bureau of the government. The Department of Livestock Services (DLS) reported that it has registration of 55,174 farms in different regions, and it is only about 20% to 25% of the total dairy farms in the country.

Production systems for dairy production

The smallholder dairy of Bangladesh through its economic contributions shares 18.6% of the animal farming gross domestic product (GDP) that shares 2.4% of the national GDP and it excludes livelihood contributions of the dairy farming in the country. The livelihood of the land-poor rural farmers depends on their income sources other than the land, and livestock play a vital role here. About 52.3% of the total cattle owners have ≤1.0 acre of land, and the household having even no homestead (HS) area or have HS but zero cultivable land (CL) keeps cattle, and their average number per household varied from 1.7 to 2.5. It was reported that the production of one tonne liquid milk by rural farmers and marketing after processing may support at least 30 rural farm families. Dairy farming supports more than 50% of the annual income of farmers irrespective of their gender or land ownership, and on average 0.85 L/day of milk is available for a family that keeps dairy stock. Thus, smallholder dairy supports family income, nutrition and women empowerment.

Smallholder dairy production systems in Bangladesh being integrated with crop agriculture may be classified into i) **Rural**, ii) **Peri-urban** and iii) **Structured market**. Summaries of different attributes of these three dairy production systems based on a survey research conducted by the Bangladesh Livestock Research Institute (BLRI) in some selected areas of different districts (eleven (11), four (4) or seven (7), respectively) of the country during 2001 to 2002 are described below.

Rural dairy

Most of the land poor farmers under rural dairy keep cattle and 61.1% of the respondent farmers had less than 1 ha of total land, and they were categorized again into landless having ≤0.2 ha, marginal having ≤0.4 ha and small having ≤0.4 ha of total land. The rest 38.9% of the total respondents keep cattle were medium having ≤3.0 ha and large farmers having ≥3.0 ha of land. Landless, marginal, small, medium or a large farmer of the selected regions had an average total land of 0.1, 0.3, 0.6, 1.3 and 4.7 ha/farm, respectively keeping an average of 1.2, 1.7, 1.2, 1.9 and 2.3 milking cows, respectively which produce 3.9, 4.2, 3.7, 7.8 and 8.2 L/day of milk, respectively. Irrespective of land categories and region a rural dairy farmer kept 5.7 cattle of 2.41:1 local to crossbreds, produces 5.6 L/day of milk with a benefit to cost ratio of 1.78:1. About 63% of their annual income depends on the dairy.

The rural dairy farmers feed rice straw, cut-and-carry green grass and average concentrate mixture of 50% rice bran, 24% wheat bran, 19% oil cake and 6% broken rice. Irrespective of farm category, the average daily allowance per animal of individual feed was 5.2 kg dry rice straw, 5.4 kg cut-and-carry grass and 1.5 kg concentrate.

About 47%, 29% and 24% of the dairy farmers feed their animals in stalls, stall cum open or open system, respectively. The average daily milk production per cow and days in lactation of local and crossbred cows under the rural dairy system was 2.1 and 6.4 kg and 248 and 300 days, respectively. Milking, feeding, cleaning and milk marketing are the major works in dairying, and irrespective of

farm category men and women average share the activity almost equally (59% and 41%, respectively).

Structured market dairy

The dairies under the structured milk marketing area of the BMPCUL, shares 46% of the processed milk in the country, are termed as structured market dairies. Similar to rural dairy 60% of the respondent farmers were small (landless, marginal and small as described above) and the remaining 40% were medium and large farmers. It was reported that a landless farmer keeps about 9.2 cattle of 0.34:1 local to crossbreds, produce 20.4 L/day of milk from an average number of 3.4 milking cows, and support 76% of family annual income. Marginal, small, medium and large farmers have an average total land size of 0.3, 0.6, 1.6 and 4.1 ha/farm, respectively kept average 2.7, 3.1, 3.6 and 8.0 milking cows, respectively and produce 16.4, 24.5, 27.1 & 61.9 L/day of milk, respectively. Irrespective of land categories a dairy farmer under the structured market dairy keeps 12.2 cattle of 0.53:1 local to crossbreds, produces 30.1 L/day of milk with an average benefit to cost ratio of 1.23:1. About 67% of their annual income depends on dairy farming.

Except a higher daily allowance of green grass, the average daily dietary composition was almost similar both in the respect of type of feed or their daily allowance to that of the rural dairy. The concentrate mixture contains as usually rice or wheat bran, oil cake and broken rice at an average rate of 42%, 35%, 19% and 3%, respectively. Irrespective of farm category the average daily allowance per animal of individual feed was 4.1 kg dry rice straw, 7.3 kg cut-and-carry grass and 2.6 kg concentrate.

About 51%, 43% & 5.3% of the dairy farmers feed their animals in stalls, stall cum open or open feeding system, respectively. They are managed both by men and women almost equally (54% vs 46%). A trend similar to rural dairy in average daily milk production per cow (3.2 vs 7.9 L/day) and days in lactation (231 vs 269 days) of local and crossbred cows irrespective of their rearing system was reported.

Peri-urban dairy

Peri-urban dairies are developed on higher price and demand of milk in urban and peri-urban areas. A similar distribution of land area and cattle number was found to that of the rural or structured market dairy was found in the peri-urban system. About 74% of the respondent farmers belonged to small (landless, marginal and small) farm category and the rest (26%) were medium and large farmers.

The land size of the peri-urban and urban dairy farmers has less impact on their dairy keeping compared to other dairy systems. The average land size of five different categories of farmers (landless, marginal, small, medium and large) was 0.1, 0.3, 0.6, 1.7 and 5.6 ha/farm, respectively. Farm average of total cattle was 12, 7, 8, 27 and 12%, respectively including average milking cows of 4.7, 2.3, 3.0, 7.5 and 3.2 and their daily average milk production was 28.7, 12.7, 20.8, 57.2 and 25.4 L/day, respectively. Medium and large farmers had a lower benefit to cost (1.01 and 1.02) compared to landless, marginal and small farmers (1.35, 1.32 and 1.45, respectively). Compared to large farmers, share only 19% of their annual income from dairying; the landless, marginal, small and medium farmers largely depend on dairying (52, 43, 71 and 79%, respectively) for their annual income. Irrespective of land categories, a peri-urban dairy farmer kept 13.4 cattle of 0.52:1 local to crossbreds, produced 28.9 L/day of milk with an average benefit to cost of 1.23:1.

Similar to rural or structured market dairy farmers, the peri-urban dairy farmers fed rice straw, green grass and concentrate mixtures containing rice or wheat bran, oil cake and broken rice at an at average mixing proportion of 28%, 30%, 34% and 8.0%, respectively. Irrespective of farm category, the average daily allowance per animal of individual feed was 5.5 kg dry rice straw, 4.0 kg cut-and-carry grass and 2.3 kg concentrate.

The peri-urban farmers did not keep their animals in open rearing systems, rather 43% of them keep under stall cum open and 57% under stall-fed conditions. Similar to other production system, peri-urban dairy is managed by both the genders (70% by male and 30% by female). Crossbred cows yield higher milk daily (7.3 L/cow/d) compared to local cattle (2.5 L/cow/d), and their average lactation length was 265 days compared to 222 days of local cattle.

Average cost of milk production

The average cost of milk production varies according to production systems and availability of feeds and fodders, the feed cost varied from 81% to 83% of the total variable costs and an average 70% of the total cost incurred in feeds. Depreciation on the fixed cost was 14% of the total cost and it varied from 9% to 28% in different production systems. Including the cost of feed, labour (8.2%), veterinary & AI (4.9%), and the interest (5.3%), the total variable cost varied from 71.7% of the total cost of dairy production in rural to 94.2% in the peri-urban system. The average cost of feed, labour, health and housing is 65.3%, 31.6%, 9.9% and 2.1% respectively of the total costs of dairy farming.

Production system of buffalo dairy farms

Buffalo, apart from sporadic distribution all over the country, are available in a higher concentration in some areas, where high availability of pastures favours their concentration. A buffalo pasture, locally called Bathan, is a common land where the animals are kept for a major period of the year. Buffaloes raised in other than Bathan are termed as non-Bathan production systems. The buffalo farmers also keep cattle. The average number of the bovine (cattle & buffalo) per household in different regions varied from 6.5 in the North plain non-Bathan to 134.8 in the North-east undulated Bathan area. It shows that the South delta and North-East undulated areas had the highest number of bovines per household.

The share of buffalos varies from 31% to 64% in the Bathan of the South delta. Irrespective of production system, the average bovines per household vary from 6.5 to 134.8 (average 31.0) and per cent buffalo from 31% to 64%, averaging 52.4%. Average per cent of adult female or male and young stock among the study areas varied from 4.8% to 56.8% with an average of 42.9%, 1.9% to 58.0% with an average of 12.7%, and 13.8% to 90.3% with an average of 44.9%, respectively. The lactating and non-lactating buffalo cows varied from 22.5% to 73.0% with an average of 47.8% and 27.0% to 77.5% with an average of 45.5%, respectively.

Most of the buffaloes, irrespective of their sex, are kept for draft purpose and milk or meat is considered as the secondary products. Draft use often affects their production and reproduction performances.

Performance of local or exotic purebred dairy cattle

The production and reproductive performance of different genotypes of cattle varies according to their rearing conditions and the regions of the country. Both the production and reproduction

performance of different genotypes are better on government stations than on commercial farms. The Red Chittagong Cattle (RCC) cows has 170 to 190 kg mature live weight and the lowest lactation performance (461 to 675 L) among all the genotypes, however it is the most efficient animal in respect to post-partum heat period and age of puberty (49 to 64 days and 18.8 to 32.1 months, respectively). Considering the economic selection index or total merit compared to other available genotypes, the RCC is recommended for rural dairy farming. Having an average mature weight of 280 kg, Pabna cows had lactation yield of 918 L, post-partum heat period of 106 to 150 days and age of puberty of 28.1 to 38.5 months. The Pabna cattle, instead of dairy, is more efficient in beef production and compared to Brahman crossbreds with the local, it was more efficient in beef production both in respect to feed efficiency and meat to bone ratio at different ages. Friesians had the highest average lactation yields (2661 L) followed by 1056 L in Sahiwal. Their post-partum heat period and age of puberty was 120 days and 22.0 months and 126 days and 39.1 months, respectively. Similar performances of the local common cow were 653 L, 32.6 months, and 120 days, respectively.

Performance of crossbred dairy cattle

Similar to pure-genotypes, the performance on-farm of different crossbreds was lower than that of their on-station. Friesian x Sahiwal crossbreds had the top milk production (2239 L lactation yield) among the various genotypes followed by local crosses with Friesian (1956 L) or with Jersey (1605 L). But, age at puberty, one of the important economic factors, was the lowest with Jersey x local crosses (average 16.7 months) at on-station condition. The local crosses with Friesian, Sahiwal or Jersey produced 3.7, 3.0 and 2.3 L/day of milk, had 156 days, 117 days and 239 days post-partum heat periods and ages of puberty of 34.0 months, 33.6 months and 36.7 months respectively.

Average herd composition of the three dairy systems and their performance

The average performance of the three defined dairy production systems can be further compared with the performance of the dairy of the north Palin, a non-defined common production system. Under the three defined systems, farmers on average kept 10.2 cattle including 5.3 cows, 0.6 bulls, 1.8 growing animals and 2.5 calves. About 54% of the cattle were genetically assembled and 62% of the cows were lactating.

Data on non-defined common dairies has been collected from Kurigram, Thakurgaon and Sirajganj (other than structured market dairy area) districts of the north plain area of Bangladesh, the FAO Smallholder Dairy Development Project (SDDP) sites. It shows that an average cattle farmer keeps 3.5 cattle with 1.8 cows (50.9%) consisting 72.0% lactating cows and 47.0 % crossbreds. It shows that even a common dairy farmer keep 47.0% crossbred cows. The farmers of Baghabari, one of the milk potential areas of the country under the structured milk marketing system of the BMPCUL, supports better feeding and nutrition to their animals. Being a breeding habitat of local potential cattle (locally called Pabna cattle) the farmers used to have their Pabna cows crossed with Friesian or Sahiwal. The Pabna or its crosses or the crossbred of Friesian and Sahiwal reared in the Baghabari area had production and reproduction performances similar to that of their performances found at on government stations. The performance of Local x Friesian crosses in a poor feed base on the other hand had lactation yields of only1402 L being poorer than that of its performance on government stations (lactation yield 1956 L). At a poor feed base, the average milk yield of the local cow was 3.0 L/day and that of the crossbred cow was 6.1 L/day; lactation lengths were 219 and 231 days respectively while average services per conception were 1.44 and 1.55 respectively.

Performance of dairy buffalo

The average puberty age, service per conception, post-partum heat period, and calving interval of buffalo cows were reported to be 3.03 years, 1.80 times, 66.4 days and 383.3 days respectively. The average milk production is only 2.8 L/day with an average lactation length of 227 days.

FEEDING MANAGEMENT

Feed dynamics

Cattle are mostly raised on fibrous crop-residues and cereal milling by-products. The total roughage production in the country was estimated to be 51.06 million ton in 2012, of which 5.78 million ton comes from cut-and-carry and road side grazing. The annual green grass availability however varies according to regions, seasons, and most importantly with dairy production system. About 27.32 million ton (53%) of the fibrous biomass produced in the country is available to animals as feed, and the rest of the bulk is gone off, and used otherwise. Cereal milling by-products, grains and oilcakes are the three major feed ingredients constitute concentrate feed in the country. About 2.04 million ton of corn is used annually, mainly for commercial poultry, and it covers 41% of the total concentrate feeds. Total cereal milling by-products is 2.91 million ton (58%) and they are used both for ruminants and poultry. The rest is oilcakes of different oil seed millings shared both by the two groups of animals. The country produces around 72.0 thousand ton of molasses every year, with most of it exported and used for ethanol production locally.

Plane of nutrition

The country requires 73.80 million ton of total dry matter (DM) annually to feed existing ruminant animals. An average ruminant diet sharing roughage and concentrate DM at a ratio of 2:1 will make a total demand of the two feeds 49.20 million ton and 24.61 million ton respectively. The total annual roughage DM production is 51.06 million ton surpassing by 3.8% of its total annual demand. Nevertheless, the loss of roughage results in a deficit of 44.6% of its demand.

The most important factor is the mismatch of production and supply of the biomass. Most of the fibrous residues are produced in the monsoon, when sun drying, the lone system for preservation of crop residues, is difficult hence farmers fail to make them available for their animals during the dry season. Collection, processing and preservation of fibrous crop residues and their value addition may increase their availability to animals.

The demand and supply situation of concentrate feed is very poor. About 20% of the total demand is met by the domestic production of 5.02 million ton. The required dietary concentration of metabolisable energy (MJ ME/kg DM) and digestible crude protein (DCP, %DM) of ruminants varies with age, sex, physiological stage and production. An average mixed diet for ruminant animals other than calves may contain 7.5 to 11.0 MJ ME/kg DM and 3.5 to 11.0% DCP. The total requirements of MJ ME and DCP are met by only 63% and 78% respectively.

The plane of nutrition on which ruminant animals are raised is reflected further by the calculated average diet using the feed produced or the feed available to animals. Compared to a common diet (a diet containing 6.20 MJ ME/kg DM and 4.51% DCP) for all the farm animals of the country irrespective of their physiological conditions and productions, an average diet of feed produced contains 6.75 MJ ME/kg DM and 1.63% DCP or an average diet of feed available to animals

containing 7.74 MJ ME/kg DM and 2.32% DCP. The feed availability data shows that about 89% of the roughage produced or available is fibrous crop residues that contain negligible amounts (2%) of DCP and the rest 11% is green biomass. The concentrate production or availability, on the other hand, is far below than the requirement of farm animals, and its deficit is 80% compared to its demand. Similarly, DCP production deficiency is 71.2%, and only 22.5% of the demand is available.

Fodder cultivation

Fodder cultivation, especially in Rabi Season, is a conventional practice in the country, and many of the areas lost the practice due to change in cropping system. Kheshari (*Lathyrus sativus*) and Mashkali (*Vigna Mongu*) are the traditional legume fodders used for cultivation in the Rabi season after receding of flood water. High yielding fodder cultivation, like Napier, Sweet Jumbo, a recent farm practice is being developed in different regions of the country with gradual transformation of subsistence keeping of dairy animals into input supported system. Green fodders are also being sold in different local markets and farmers of certain places sporadically grow Napier and market it to livestock farmers. A year-round supply of protein rich fodder like locally available winter legumes (Kheshari or Mashkalai) or internationally traded alfalfa hay may minimise quantitative and qualitative deficiency of dietary protein of ruminant diets.

BREEDING

Bangladesh, inheriting a succession of cattle breeding programme through introduction of Sahiwal, Hariana and Sindhi bulls in pre-independence periods since 1915, has been implementing country-wide artificial insemination (AI) programme for dairy development since 1973, when Friesian and Jersey from Australia were newly introduced. Friesian and Sahiwal overriding the use of Sindhi in 1972 and that of Jersey in 1982, occupied almost the whole public sector AI programme. But, the BMPCUL has been continuing the use of Jersey semen since 1998, and it imported Jersey bulls later in 2001.

Some of the local cattle (Red Chittagong Cattle, Pabna) in respect to their many economic aspects have potential, and a few of them are conserved *ex-situ* or *in situ* for protecting their genetic dilutions and for their improvement following the breeding policy of the government. The local cows common in nature are used for production of crossbreds with Friesian or with Sahiwal bulls. These two purebred animals were imported in different times in the past, and still, in addition to semen import, some of the existing bulls are being replaced to produce semen.

There are 6.90 million productive cows and heifers of different genotypes, of which 2.22 million (32.0%) are reported to be crossbreds of various assembled genotypes. It does not support the claim of extending AI services to 66% adult female of the country by the Department. Nevertheless, this differs with the estimated adult female cattle population of 9.22 million, and the average of assembled genotypes, 47% in the north plain area or average 54% in the three dairy production systems, as reported earlier.

The DLS produces and extends semen of purebred bull of Friesian, Sahiwal, and RCC, and that of the first cross Friesian x Sahiwal or local x Friesian bulls. The Central AI laboratory of the DLS has 190 bulls of different genotypes, with a target to have 325 bulls producing 4.80 million doses of semen by 2021. In addition to the central lab, there is one regional lab, 22 district AI centres and 1059 AI sub-centres which provide a country-wide AI network of the public sector to implement the AI activities. Some of the areas remain out of its reach, and a few of them are served by the

Bangladesh Rural Advancement Committee (BRAC) through its 70 AI points covering 101 milk collection centres in different districts. The BRAC serves about 46,000 farmers. The BMPCUL, including marketing support, provides AI services (about 107,000 in 2012) to 99,144 members of 2025 primary societies of 32 milk shed areas in 23 districts. Other private AI services are very limited both in number and areas serviced.

Various types of genetically assembled cattle are available in different region of the country. Friesian is the most preferred exotic breed used to produce crossbreds followed by Sahiwal. The combinations of the two breeds with the local are also available sporadically. Nevertheless, in the absence of strict recording system, the genetics of the animals are not reported. Both experts and farmers favour adoption of a long term strategy for selection and grading up of the best performing local breeds, following it up with exotic blood at a later stage. There is little support to the current casual and haphazard approach to continue crossbreeding with exotic animals.

Extent of using of artificial breeding

Artificial insemination, natural or both the method are used by the farmers of the rural, peri-urban or structured dairy production systems for breeding their cows. With a variation of 32% in the rural to 58% in peri-urban system about 45% of the respondent farmers use AI, followed by 39% natural and 16% both natural and AI. A higher number of farmers of peri-urban or structured market dairy used AI (58% and 45%) compared to other systems. 46% of farmers use AI followed by 21% and 32% who practice natural or the both AI and natural systems.

Buffalo breeding

A buffalo development programme has been implementing by the DLS using imported semen of Mediterranean buffalo since 2009. In addition, a private company also initiated crossbreeding programme for dairy buffalo development.

ANIMAL HEALTH

Problems

Foot and mouth disease (FMD), anthrax, haemorrhagic septicaemia (HS), dystocia, abortion, diarrhoea, bloat, black quarter (BQ) and mastitis are the major health problems of the dairy cattle. Most of the farmers report that FMD and bloat are the major problems followed by diarrhoea and mastitis. Dystocia and abortion are the least prevalent problems among the rural, structured milk market and peri-urban dairy production systems. Mastitis, compared to structured or peri-urban system is less prevalent disease in rural production system.

Most of the animals die from FMD, anthrax, dystocia, diarrhoea, bloat or BQ. Anthrax and BQ are the cause of death of most of the animals in the rural dairies, while diarrhoea, on the other hand, is the major cause of death in the structured market area. In addition to diarrhoea, bloat or dystocia are the major causes of death in the peri-urban dairies. The calves are most susceptible to diseases compared to the growing or adult animals.

Dairy farmers report that most of the health problems (72%) occur during April to September, the hot and humid period of the year. November to March are comparatively cooler and less humid, and disease incidences are less frequent.

Veterinary services

The animal health support is mostly given by the public sector, and the major of them includes i) limited **preventive health** services, ii) **disease diagnostic services** through a laboratory network at district, regional & central level, and iii) **treatment support**. Most of the farmers of the systems use anthelmintics against endoparasites (68% to 84%) and vaccinate (51% to 76%) their animals. Rural farmers had the lowest preventive measures compared to others, and a higher number (33%) of them utilise support to treat their animals. Structured market or peri-urban dairy production system are better supported in terms of veterinary services (72% and 86% of the farmer, respectively receive vet support) compared to rural dairies.

Housing and waste management

Dairy farmers of different production systems use locally available plant materials (Straw, Bamboo, etc.) metal (CI sheet, iron bars etc.) and/or concrete materials for the construction of dairy houses. Plant materials were used by 40%, 44% and 14% farmers respectively (average 33%) of the rural, peri-urban and structured market dairy, and the use of metal & concrete materials were higher (60%, 55.8% and 86%, respectively; average 67%) than the plant materials.

The majority of farmers in the three system (60%) dispose of dung and other refusal to pits for further use while the rest (40%) use them otherwise (as fuel and other purposes). Biogas plants are a very new concept to farmers during the early 2000s, and a very negligible (1%) of farmers had them.

MILK SUPPLIES AND DEMANDS

Milk production and trend in consumption & price

The total milk production in the country is 3.46 million ton in 2013 and it has increased inconsistently during the present decade. The Household Income and Expenditure Survey showed that the consumption of milk in liquid, product or SMP forms to be 934, 934 and 272 thousand tons, respectively in 2011. It calculated the total annual consumption of milk in 2011 in liquid form as 2.14 million tons including 0.27 million ton of liquid milk equivalent to imported powder milk. The trend of consumption of liquid milk or product equivalent liquid milk has been increasing slowly but consistently since 1996/97.

The retail price (US$/kg) of liquid milk in the present decade has also been increasing despite a drop during 2005 to 2008. The retail price of liquid milk per kg was US$ 0.48 in 2003, reduced to US$0.33 in 2006, and it increased again at US$0.77 in 2013.

Trend in consumption of milk products

The consumption of indigenous products increased consistently during the last decades, and it reaches at 139.0 tons in 2011. The use of Chana, a coagulated milk solid based sweet, Ghee or the total curd increased at a higher rate than that of the others.

Projection of milk production

Considering the total liquid milk production of 3.46 million ton in 2012, the estimated per capita annual intake of liquid milk is estimated to be 21.5 kg/yr. (23.6% of the requirement). Extrapolation

of the data shows that the predicted total milk production and its per capita consumption will be 4.91 million ton and 27.5 kg, respectively in 2021. This is calculated to be only 30% of the per capita annual requirement of 91.2 kg. The annual per capita availability of milk will remain below than that of the average of the developing country (55.0 kg/head in 2015 or 67 kg in 2030). This trend of production may not support the vision of supplying quality nutrition to 85% of the people by 2021 envisaged by the government.

Data delusion and estimation of production and demand

The total liquid milk consumption in the country was 1.868 million tons (except the import), while the total liquid milk production in the country was 2.95 million tons in 2011. The data of producing 3.46 million ton of liquid milk in 2012 further results in a surplus production of 1.32 million tons of liquid milk. The country, on the other hand, having supply of only 24% of the total annual requirement in 2012, imports about 0.27 million ton of SMP equivalent liquid milk. Thus, a delusion in data of milk production and consumption exists, and it does not support sound planning for dairy development in the country.

Estimated milk production

The country has 4.16 million lactating cows with 47% of them estimated to be crossbreds. This estimates total local and crossbred lactating cows of 2.20 and 1.96 million respectively, while the buffalo lactating cows number 0.13 million. The average daily milk yield and lactation lengths of local and crossbred cows were 2.7 and 230 and 6.9L/cow/day and 266 days, respectively. Buffalo cows, on the other hand, yield only 2.8 kg/day with an average lactation period of 227 days. This then calculates to be full lactation yields of 619 kg for local cows, 1838 kg for crossbred cows and 636 kg for buffalo cows.

Multiplying the lactation yield by the total lactating cows results in the annual liquid milk production of 1.36 million tons, 3.60 million tons and 0.08 million tons respectively from the three genotypes. This leads to an estimated annual total liquid milk production of 5.04 million tons. The cattle produce 98% (4.96 million tons) of the total liquid milk, and the rest (2%) is produced by the buffalo cows. However, considering a total 3.87 million lactating cattle with only 5.2% of them crossbred and a total 0.05 million milking buffalo in 2009, the total liquid milk production is estimated to be only 2.67 million ton.

The population of the country is about 160 million in 2012, and, if the present growth rate does not decline over time, it will reach at 178 million by 2021. Moreover, 1% of the cultivable land has been disappearing every year thus narrowing down the scope of horizontal expansion of dairy farming. The growth of population, urbanisation and literacy will further boost future milk demand in the domestic market. Considering these demand conditions of milk and milk products, the domestic competitive advantages of dairy enterprises needs to be improved through all out support of both the public and private sector. The present production, demand and supply condition of milk and milk products should be analysed further and based on that, formulation of strategic plans for meeting the growing demand in the changing and challenging socio-economic conditions.

MARKETING OF MILK

Liquid milk, and milk products and powder milk of imported or domestic origins are marketed through different systems. Liquid milk produced by farmers is marketed i) traditionally in **local**

markets directly by the producers, ii) through **middlemen** (milkmen and wholesaler), iii) to **structured marketing organisations** like, the BMPCUL or iv) **to product manufacturers**. About 54%, 52% & 38% farmers under rural, peri-urban and structured dairy, respectively sell their milk in the local market. The price of milk in the local market in the peri-urban and urban areas fluctuates up to 50%, while the milk demand in the local market gyrates depending on socio-economic factors. Farmers of certain areas, instead of selling milk individually in local market, sell the daily milk of a group of 10 to 12 farmers to the nearby towns or cities to fetch a better price, with each member of the group rotationally responsible for the milk marketing. This is locally called **Pali system,** and it ensures better market price and safer working hours for the farmers.

Middlemen (milkmen or wholesalers) procure milk from 34%, 39% and 16% farmers of rural, peri-urban and structured dairy areas, respectively. Farmers are being exploited by the middlemen both in terms of low price (up to 40% lower than market price) and higher weight (up to 25% additional weight of a kg). Middlemen, trusting enhanced shelf life and/or reduced bumpy milk, use leaves of banana, date palm and bamboo or water hyacinth in their milk containers during transportation. They also use water, dried chillie or mustard oil as organic preservatives; and H_2O_2, $NaHCO_3$ or even formalin as chemical preservatives to increase shelf life of liquid milk during marketing.

Composition of milk

Variations in milk composition according to animal genotypes, dietary composition, seasons and other physiological factors are natural. The milk of RCC had the highest percent of fat, protein, SNF or total solid than that of local Pabna or Friesian x local cow (5.3, 4.1, 10.9 and 16.2%, respectively for RCC; 4.9, 3.9, 10.4 and 15.3%, respectively for Pabna and 4.1, 3.7, 9.8 and 14.0%, respectively for Friesian x local cow. The milk composition of RCC is similar to that of Jersey (5.5, 3.9, 9.5 and 15.0%, respectively). Lactose (5.9, 6.2 and 5.3%, respectively) or mineral (0.69, 0.72 and 0.84%, respectively) content of milk of the three genotypes were similar.

In milk collected from farmers in different regions with a difference in quality of diets, except for fat% (3.9 vs 3.7%), other milk components were similar both for local or crossbred cows raised on similar diets. However, the milk of cows reared on good quality diets has a higher level of fat, protein, lactose, SNF, minerals and total solid (4.0%, 3.8%, 5.5%, 10.1%, 0.6% and 14.1%, respectively) compared to that raised on poor quality diets (3.7%, 3.6%, 5.3%, 9.8%, 0.6% and 13.5%, respectively).

The milk sample collected from the chilling centre of the milk marketing organization had 3.7%, 3.3%, 4.7%, 8.7% and 12.4% fat, protein, lactose, SNF or total solid, respectively. But, a lower quality (3.5%, 3.2%, 4.6%, 8.5% and 12.0%, respectively) was found in milk sample from the middlemen of the same area.

Marketing of processed milk

The BMPCUL, a pioneering public shared dairy marketing organization established in 1973 based on the recommendation of FAO & DANIDA under the Rural Development and Cooperatives Division (RDCD) of the Govt. of the People`s Republic of Bangladesh, shares 46% of the total processed milk in the country. The remaining 54% of the processed milk is marketed by dairy marketing organizations of the private sector, and they, without following cooperative principles, collect liquid milk through establishing chilling centres in different dairy potential areas and market it after processing. The Dairy and Food project of BRAC in the brand name of Arong, established in 1988, markets about 97,000 litres of milk daily and shares 25% of the total processed milk. The Pran Dairy

ltd. shares 15% of the total processed milk markets about 60,000 litres of liquid milk in the brand name of Pran Milk. The Akij Dairy ltd. started their dairy marketing business in 2007 in the name of Fresh Milk and daily markets about 24,000 litres of milk (6%). Abdul Momen Ltd. in the brand name of Amo Milk, Shilaidaha Dairy Ltd., Aftab Dairy Ltd., Rangpur Dairy Ltd., Baro-Awolia Dairy Ltd. are some of the private dairy entrepreneurs market 1% to 2% of the total processed milk in the country. Only about 7.6% of the total liquid milk produced locally is processed and marketed through structured marketing system of the country.

Some of the organizations market a lower quality milk in respect to standard fat content (as low as 3.3%) keeping their SNF% even higher than the level approved by the Bangladesh Standard and Testing Institute (BSTI). Sometimes sugar and other adulterants are used to follow national standard during marketing of adulterated milk.

Biological quality of milk

The biological quality in terms of total viable or Coliform count (cfu/ml milk) of milk shows that the viable count of the brand milk sample varies from 30.3 to 0.3 million, all within the maximum permitted level approved by the FDA Pasteurized milk ordinance. All the milk samples collected from the middlemen of different areas had a total viable or Coliform count more than the fresh liquid milk of Grade A (contains total bacteria <50,000/ml) or Grade-B (50,000 to 200,000/ml), and boiling is the only option to get rid of this huge bacterial load in market liquid milk.

Indigenous milk products

Bangladesh uses about 50% of its liquid milk for the production of different types of products (934 thousand tons). These are locally called Rashogolla, Chomchom, Rasomalai, Kalojam, Sandesh, Chomchom, Dahi, Danadar, Rashkadam, Malaikari which are available in different regions of the country. Some of the milk products (Muktagacha-Manda of the Old Brahmaputra, Bogra-Dahi of the North plain, Comilla-Roshomalai of Eastern undulating, Austagram-Cheese of Surma-Meghna floodplain etc. have typical specific taste and flavour in some regions. Manufacturing of indigenous products from one ton of liquid milk may create average employment of 28 man days and an estimated 72,640 persons are employed in the dairy cottage industries of in the country.

Milk products of marketing organization

Some of the dairy entrepreneurs produce various types of milk products, other than indigenous products, using domestic liquid milk and some of them use imported powder milk. There are 17 different entrepreneurs who annually produce about 177 thousand tons of different types of milk products including powder and flavoured milk, ice cream, butter, butter oil, curd (dahi), condensed milk and cheese. Their calculated annual production is 585, 912, 19475, 1004, 865, 1865, 153300, and 102 ton, respectively. Most of the condensed milk is produced from the imported powder milk. Butter oil is the common item produced both by indigenous manufacturers and dairy entrepreneurs.

DAIRY DEVELOPMENT PROGRAMS

Dairy production and extension

The DLS, a public sector extension organisation, has been implementing AI programmes for genetic development of dairy cattle in the country since 1973. Recently it has been jointly implementing the Smallholder Dairy Development Programme (SDDP), a regional initiative of FAO since 2010. Dairy marketing programmes, such as i) Milk cooperative society extension and ii) Development of cooperative based milk production sustainably projects have been implemented by the RDCD since 2009.

The BAU, Mymensingh using research grants of the USDA and IAEA developed a Community-based Dairy Veterinary Foundation (CDVF), a non-profit but market driven initiative of veterinarians and dairy farmers and has been delivering productivity and veterinary services to smallholder dairy farmers through organising them in association in some selected areas of the country.

Milk marketing

In addition to the BMPCUL a dozen of private marketing organization annually market about 143 thousand tons (391 t x 365 days) of liquid milk. All these dairy entrepreneurs, instead of receiving any domestic public support, have to compete with the marketing of imported powder milk. Creation of enabling environments for dairy development and coordination of private and public sector activities through enacting a coordinating body may help further development of the dairy industry. Moreover, strengthening dairy value chains integrating social safety and development issues, like that of school milk programmes, diversification of production and processing technologies may be the major programmes under Public-Private-Partnership to address food security, rural employment and income generation, and women empowerment of the country.

Dairy research

The Bangladesh Livestock Research Institute (BLRI) initiated development programme on RCC conservation *ex situ* and improvement in 2001, and their conservation *in situ* and community improvement in their habitats in 2006. The research programme of the BLRI showed that the rearing of RCC is profitable in rural dairy production systems. The programme, being implemented by periodic funds under the development activity of the government, ended in June 2011, and considering RCC, a potential dairy cattle breed, the institute has been continuing the conservation *ex situ* programme. The Bangladesh Agricultural University (BAU), Mymensingh, also implemented RCC conservation and improvement programme financed by the USDA, and the programme is being continued through multiplication of the animal in the area other than the breeding habitats of RCC.

The BLRI also initiated Pabna local cattle conservation *ex situ* programme in 1988, till to date the herd is improved into native beef cattle. Feeds and fodder development, a core R&D programme of the institute, is being implemented to provide technological support for dairy farmers.

However, the prevailing research environment has limitations to support a market-driven dairy industry through integrated approaches of both public and private sectors. Most of the research related to dairy ends up as producing reports and other publications but has limited visions on the development of dairy-business in the country. Limitations on competitive advantages in human factors and R&D policies have failed to keep pace with the demand of generating knowledge based dairy business through R&D activities. Moreover, scientist access to infrastructural facilities for experimental development of system, prototypes, models and limitations of existing public rules and

regulations, reluctance of private sector to invest in R&D etc. are some of the factors that are not conducive to development of animal resources.

Dairy education

The BAU, Mymensingh, is the only agricultural university in the country offering post-graduate and PhD degrees in Dairy Science. The Bachelor of Animal Husbandry degree offered by the Faculty of Animal Husbandry of the BAU, Mymensingh only covers 31 credits on dairy sciences out of the total 196. Recently the Science and Technology University, Patuakhali started offering Bachelor degree in Animal Husbandry consisting of a similar course in dairy sciences to that offered by the BAU, Mymensingh. A limited course on dairy science is also included in the Bachelor degree on Veterinary Sciences offered by the Chittagong Veterinary and Animal Science University, Sylhet Agricultural University, Haji Danesh Science and Technology University, Dinajpur; Rajshahi University, Sher-e-Bangla Agricultural University, Dhaka and Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur. Including the BAU at Mymensingh, none of these universities or colleges offer any exclusive diploma or bachelor degree on Dairy Sciences in the country. A very sporadic farmers training programme on dairy is offered by the BLRI, DLS and other related organisations.

School milk programmes

FAO Bangladesh, aiming at twin objectives of enhancing milk production and school children nutrition, has been implementing concurrently a tri-country South-East Asian regional SDDP jointly with the DLS, the BMPCUL and Grameen Fishery and Livestock Foundation (GFLF) in Bangladesh, and its link School Milk project partnering with the BMPCUL. The SDDP financed by the Common Fund for Commodities (CFC), FAO and the Animal Production and Health Commission for Asia and the Pacific (APHCA) with the objective of enhancing milk production, milk marketing and capacity strengthening is being implemented in Sirajganj, Thakugaon, and Kurigram, districts. The SDDP, since its inception, supports celebration of the World Milk Day and the World School Milk Day every year. The World School Milk Day of 2013 was jointly celebrated on October 3, 2013 by FAO Bangladesh and the BMPCUL in Chittagong, the business capital of the country under the auspices of the SDDP. Echoing the slogan of "drink milk for a healthy nation" the school children supported the SDDP vision *A glass of Asian milk a day for every Asian child.*

The link School Milk project is being implemented among 2039 students including 1037 girls and 1002 boys of six government primary schools and the BMPCUL Junior High School of Shajadpur Upazila of Sirajganj district by a committee consisting the concerned Upazila Nirbahi Officer (UNO), Upazilla Education Officer, Upazilla Livestock Officer, Head Master of the participating school, a representative of the BMPCUL and the Project Manager. The project activity is steered by a committee consisting representative of the Ministry of Fisheries and Livestock, the Ministry of primary and Mass Education, the Ministry of Public Administration, the Ministry of Rural Development and Cooperatives, the BMPCUL; FAO Representation and the concerned UNOs. The BMPCUL, a partner of the project, daily supplies sufficient packs of processed milk free of cost by rickshaw-vans fitted with insulated containers, and recycle empty milk packs to help clean environment in the school. The administration of each school has been collecting student`s contribution of BDT 1.0 from each student, and it has been using the fund for student awareness building on hygiene and nutrition. The programme, starting from August 24, 2013, has been impacting student enrolment and their health positively.

THE WAY FORWARD

Public sector policies

The Ministry of Fisheries and Livestock (MoFL) coordinates and monitors livestock development activities through the DLS, and the BLRI, the two public sector organisations. Both these organisations have limited capacity to support dairy development in the country. Private sector plays major roles on dairy production and marketing, a techno-based economy links fork users with farmers. The capacity of the public sector for strengthening smallholder dairy industry through partnership building between the public and private sector is weak and disjointed. Mandates for dairy production rests on the organisations of the MoFL, but, marketing and quality regulations are coordinated by different Ministries. The government approved different policies and regulations of the MoFL to support livestock development including dairy in the country. They are as follows:

- Final draft of National Livestock Extension Policy 2013, with a vision of becoming self-reliant to satisfy the national demand of milk, meat and eggs for fast growing populace through increased productivity thereby accelerating economic growth, employment and income generation and reducing poverty.
- Animal Slaughter and Meat Quality Control Act-2011
- Animal Feed Act-2010
- Animal Disease Act-2005
- Bangladesh Animal and Animal Product Quarantine Act-2005
- National Livestock Development Policy-2007

The National Livestock Development Policy

The government of the People`s Republic of Bangladesh approved National Livestock Development Policy (NLDP) in 2007. It also documented policies for dairy development in the country and these are:

- Expansion of cooperative dairy in potential areas following the BMPCUL Model
- Replication of pro-poor models for community based smallholder dairy
- Promotion of integrated dairy farming
- Strengthening of forward linkages to dairy farmers
- Establishment of a National Dairy Development Board to promote dairy
- National Dairy Research Institute to strengthen dairy research and development activities

Moreover, encouraging private sector`s participation, establishment of farmers' information network taking help of the private sector, increasing easy access to micro-finance and insurance, establishment of a livestock credit fund in the Central Bank are some of the important policy issues included in the document for smallholder dairy industry development.

Dairy feeding and nutrition

Limitation in land availability to fodder cultivation, quality control and spiralling prices over the time have been affecting dairy farmers with profit slashes. The public sector policy stated to have:

- Community-based fodder development programmes
- Supports for utilization and promotion of agro-industrial by-products, crop residues and unconventional feed resources
- Promotion of market driven feed industries
- Enacting feed quality control system

- Rendering training to farmers and
- Human resource development for further improvement of livestock including dairy.

Dairy breeding

An approved cattle mating plan was initiated in 1982 by the MoFL with an objective to develop first cross local x Sahiwal or local x Friesian in peri-urban, urban and structured market area and to use these first cross bulls for upgrading the cattle in rural areas. The mating plan was revised in 1997 rephrasing the former areas into intensive, where the use of purebred Friesian or Sahiwal semen was approved. The rural breeding area was rephrased into extensive area and recommended continuation of using same breeding bulls. Finally a breeding policy for increasing milk production was introduced by NLDP in 2007, aiming at developing cows with 6000 L 305 day lactation yields through introducing purebred Friesian semen from 9500 to 10,000 L lactation yield cows through short, medium and long term plans of actions. Pure breeding of RCC of the North-East undulated area, Pabna cattle of Padma-Jamuna floodplain areas, Munshiganj cattle of Surma-Meghna floodplain area were also recommended. Production of first cross local with Murrah, Nilli-Ravi or Mediterranean buffalo bulls was approved in the plan.

Health

The policy document identifies that non-existence of disease surveillance system, public health support and quality control system as the major weaknesses exist in the public sector animal health services. Development of private, community-based and mobile veterinary services, strengthening veterinary research, human resources, establishment of autonomous quality control agency, strengthening veterinary public health services, control of trans-boundary animal diseases, and encouraging private veterinary diagnostic services are the major policies focussed in the NLDP (2007).

Dairy research

Bangladesh Livestock Research Institute (BLRI), a state-run research organisation under the MoFL, was entrusted to conduct research on livestock development of the country. The institute, started functioning in 1986 on a land area of 500 acres covered with greeneries, terrains and waterways in Savar, a suburb in 30 kilometer north-west of the capital city Dhaka. The BLRI is mandated to work on all disciplines of livestock development including dairy production and technology. Identifying the limited dairy research and development (R&D) capacity in the BLRI, the NLDP (2007) recommended establishment of a separate dairy research institute in the country.