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A SIX-DECADE REVIEW: RESEARCH ON CATTLE PRODUCTION, MANAGEMENT AND DAIRY PRODUCTS IN BANGLADESH

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ABSTRACT

Background: Historical changes in the demand of animal protein sources (milk & meat) for human consumption have been largely increased due to increased growth of human population, income and urbanization in Bangladesh. Research on cattleproduction and management especially cattle breeding, feeds and fodders, milk production and products have contributed to increase potential production and genetic gains of cattle. A comprehensive review on the published inland research reports on cattle production, management and dairy products are lacking in literature which is required for further research for the cattle development and production.

Objectives: An attempt to review on the published inland research reports on the advances in science and technology on cattle production, management and dairy products in Bangladesh

Materials and Methods: A systematic literature review of research articles on cattle production, management and dairy products published between 1962 and 2020 from Bangladesh has been reviewed. A total of 1185 research articles on cattle production, management and dairy products supported with some international related articles have been reviewed and analyzed.

Results: Research data on cattle production, management and dairy products are compiled from 1185 different research reports supported with some international reports. This review covers the status of cattle breeds and varieties with tabulated summary of 21 reports on draught cattle, 83 on fodder production, 97 on nutrition, feeds and feeding, 88 on trials of different feed formulations in non-dairy cattle and 68 on dairy cattle, 5 on the effects of heat stress on health and production, 39 on fattening of cattle, 27 on genetics and breeding, 75 on semen and AI, 20 on factors associated with conception rate (CR), 8 on oocyte and embryo collection, 9 on genotypes of dairy cows, 7 on management of smallholder dairy farms, 48 on milk production status of dairy cattle, 32 on economics of rearing cattle,99 on productive and reproductive performances of cattle, 7 on estrus and pregnancy diagnosis, 7 problems of dairy farmers, 23 on preservative and adulteration of milk, 20 on constituents and methods of sweet preparation, 11 on cheese preparation, 9 on ice-cream, 56 on yoghurt, 4 on beef cattle production,34on birth weight, and 15 on calf rearing including calf milk replacer and calf starter.

Conclusions: Data based reports are important for priority setting and targeting with mandate for cattle development and increase production. Currently, one of the biggest gaps in the inland datasets on cattle research and this review addresses this gap by bringing together in a review and highlighting some of the major findings. Cross-breeding remains an attractive option for cattle improvement because of the quick results that can be obtained by its use and the potential benefits it has farmers. This review would serve as an archive of research reports on cattle production, management and dairy products for the concerned academicians, research scientists, organizations and government for future planning for education, research and extension on cattle production.

Keywords: Systematic review, Six decades, Cattle, Management, Production, Dairy products, Bangladesh

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CONTENTS

INTRODUCTION

The livestock sector especially cattle production is rapidly changing in response to globalization and growing demand for animal source foods due to increase population growth, increase income and rapid rate of urbanization that changes in food preferences for people. The health and quality of animal is influenced by genetics, management practices, nutrition and environment. The main target of animal production includes good quality healthy animals that reach full production potential and a quality nutritious and safe food supply. Animal production is the science and art of rearing domestic animals with the subjects as animal behavior and management, genetics and breeding, reproduction, nutrition, meat science, dairy science and technology[1]The production of cattle for various purposes especially dairy, beef, hides and other products which can be primarily categorized into dairy industry and beef industry. Cattle domestication and production have a long history and recognized as a most important livestock species because of their production and role in human culture. Many breeds and varieties of cattle that differ in appearance, performance and environmental adaptation are kept on all inhabited continents but the historic origin of the diverse phenotypes is not always clear. Cattle production systems integrate responsible management strategies, environmental principles and stewardship of property and economic awareness and viability whereas management strategies are uniquely linked with forage production and nutritive value, herd size, housing systems and opportunities to match forages with animal requirements for production.[2]Cattle are the most common type of large domesticated ruminant livestock of the genus *Bos* under family *Bovidae*. *Bos indicus* and *Bos taurus* are the two distinct species of cattle. The *B. indicus* is the Indian sub-continent zebu (humped) cattle characterized by lower growth rate, smaller size, late sexual maturity, low production and comparatively more resistant to diseases, whereas the *B. taurus* (temperate cattle) is characterized by medium to heavy size, early sexual maturity and has high milk production potentialities. However, the farmers of Bangladesh have been rearing three types of cattle including indigenous, exotic pure breeds and their crosses for the three main purposes which include (a) milk production mainly from indigenous, some temperate and tropical breeds and their crossbred dairy cows, (b) beef production from fattening crossbred and indigenous bulls especially for Eid-ul-Azha and commonly reared both bull and heifers and also all types of culled cattle including cows and bullock and recently introduced Brahman beef cattle, and (c) draught animal power(DAP) mainly by usingbullock and also cows.[3,4]Bangladesh is primarily an agriculture-based country and the majority of the rural households adopt a mixed farming system by simultaneous cultivating crops and rearing livestock.Livestock contributes as protein food supply (milk & meat), source of income, asset saving, source of employment, soil fertility, livelihoods, transport, agricultural traction and agricultural diversification and sustainable agricultural production.The livestock sub-sector provides full time employment for 20% of the total population and part-time employment for another 50% in Bangladesh.[5]Research is the most direct approach to improve the methods of animal health and production. It appears from the review of available literature that the first published research report on AI in cattle was made in 1964 from the then East Pakistan[6] and an overview of livestock research reports of the twentieth century in Bangladesh has been reported.[7]Later on the 50-year review on the prevalence of clinical diseases and disorders of cattle,[8] review of pre-clinical and clinical research reports on small ruminants[9] and review on research findings on buffalo health and

production[10] in Bangladesh has been published. An up-to-date analysis shows that a huge number of research articles have been published on the different aspects of cattle production and management from Bangladesh. It is of value to look back and see where we have come from on the concerned research which would be required for the future planning of research especially on cattle production, management and dairy products. Therefore, an attempt was made to review and compile the up-to-date available research reports on cattle production, management and dairy productsin Bangladesh.

MATERIALS AND METHODS

The research reports on cattle production published mainly in journals over the last six decades from 1964 to 2020 from the then East Pakistan and now Bangladesh have been reviewed and analyzed during the period for two years from 2019 and 2020 as described.[9,10]

Research findings on cattle production

Bangladesh is a home to different cattle varieties and crosses but it is difficult to identify these animals as system has not yet been developed to keep record of cattle breeding at either farmers' or national levels and only they can be identified based on their phenotypical characteristics, history of animals and somewhat available of cattle at the regions. The most commonly found cattle varieties and breeds in Bangladesh are Red Chittagong cattle (RCC), Pabna variety, North Bengal Grey (NBG), Munshigonj (Mirkadim) variety, Madaripur type, Dinajpur Dwarf cattle (DDC),Non-descriptive native or local type, crossbred and some imported exotic breeds including Holstein-Friesian, Sahiwal, Sindhi and Jersey.[11-13]These so called varieties of cattle have neither been identified (either by phenotypic and genetic characterization) nor has any objective study been made on their conformation or productive and reproductive performance with larger sample sizes in-situ.[14]There is no specific cattle breed has yet been established in Bangladesh but with long natural selection and occasionally imported bulls some improved deshi varieties of cattle exist in some districts in Bangladesh. The Holstein-Friesian, Jersey, Sahiwal, Sindhi, Hariana, Australian Sahiwal-Friesian have been imported in different times to improve the production potentialities of the local cattle. As a result of this program, some pure exotic breeds, their crosses and up-graded cattle are found in the government dairy farms, commercial private dairy farms, milk pocket areas and in urban and semi-urban areas of Bangladesh. With rapid expansion of crossbreeding and urbanization, the indigenous cattle genetic resources of Bangladesh are under threat of extinction.[13] Major constraints for cattle rearing and development are mainly associated with lack of specific cattle breed, unplanned cross-breeding program, cost-effective feeds, morbidity and mortality of cattle, inadequate veterinary medical services and unregulated market price for cattle and its products in Bangladesh.

There are about 24.086 million cattle population in Bangladesh where about 6 million are dairy cattle and its 85 to 93.3% indigenous Zebu type (*Bos indicus*) andonly 6.7 to 15% crossbreds.[13,15-17]Cattle are mostly reared by the smallholder farmers but the living standard of these farmers have not been improved enough as required may be due to rearing indigenous cattle.[18,19]However, almost 75% women are involved moderately to high levels participation in livestock and fisheries activities in rural Bangladesh.[20-22]

Non-descriptive indigenous zebu cattle

Cattle in Indo-Pakistan sub-continent belonging mainly to species *Bos indicus* are also known as zebus or humped.[23]India is believed to be the center of origin of zebu cattle (*B. indicus*) which later spread to Africa and southeast Asia.[24]There are 43 registered native indigenous cattle breeds in India ranging from dairy to pure draught types[25]and about 75 different breeds of zebu cattle are known in the world.[26]The Indian indigenous cattle have been classified into three groups viz. (① Milch purposes (1000-1500 kg / lactation) e.g. Sahiwal, Red Sindhi, Gir and Deoni, ② Dual purpose (500-1000 kg / lactation) e.g. Ongole, Hariana, Kankrej, Gaoao, Tharparkar, Mewati, Ratti, Dangi and Nimadi and ③ Draught purpose (< 500 kg / lactation) e.g. Hallikar, Amritmahal, Khillari, Kangayam, Nagori and others.[27]Zebu cattle differ mainly in the shape and firmness of the hump, horn size, ranging from long-horned to very short-horned or even almost rudimentary horns and horn shape.[28]Zebu cattle have evolved under low levels of selection which has led to high adaptability of these breeds to harsh environment, resistance to tropical diseases and parasites and sustenance on low quality nutritional regimes. Pure zebu cattle can vary in color with coats ranging from red to grey. Their most distinctive features are their large hump, large horns, and even large ears that drop downwards. Zebu cattle are known to be less fertile and have lower levels of milk production than *B. taurus* breeds, but their better adaptation to the environmental conditions make them more likely to reproduce successfully in the tropics. Cross-breeds incorporate the environmental adaptation of zebu cattle with the higher production of *B. taurus* as well as the benefit of hybrid vigor.[29]

Out of 24.5 million cattle population, of which 80.0 to 90.0% are of non-descript indigenous in origin zebu type having developed hump which are distributed all over Bangladesh(Table 1).[13,30,31]There is no breed of zebu cattle of Bangladesh but it is assumed that they have evolved in this country over the centuries for natural selection and farmer's interest on draught power to perform agriculture practices.[13]These indigenous zebu cattle are profitably reared with minimum climatic stress and thrive well in hot and humid temperature and maintaining phenotypic and productive performance in rural Bangladesh.[32]

Indigenous cattle population of Bangladesh are mainly *B. indicus* type encompassing various cattle genetic resources like non-descript, RCC, Pabna variety, NBG, Madaripur and Munshiganj varietiesare localized in some areas in Bangladesh.[33]These indigenous cattle have well adapted in the extreme tropical climates, ability to maintain body condition on low quality feed stuffs, reputed to give birth regularly, comparatively resistance to certain diseases with lower calf morbidity and mortality and suitable for hard working in hot, humid and rainfall condition. The varied morphometric, productive and reproductive traits of native cattle have been reported from Bangladesh.[34-36]Some characteristics of indigenous cattle have been reported as (a) Small size and hence lower metabolic heat production, (b) Regular breeder, (c) Lower calf mortality (<5 to 6%), (d) High variation in phenotypic performance, (e) Better utilization of low quality roughages and (f) Stabilize the existing production and marketing system.[37]The observed coat color of zebu cattle in Magura district have been reported as reddish(29.54%), black with white spot (25%), white (18.18%), black (11.36%), grey (9.09%) and ash (6.82%).[38] Some overall phenotypic characters of the indigenous zebu cattle have also been reported.[13,32,33]

- Their coat color varies from red, grey, white, black or a mixture of them in different proportion.
- They have prominent humps, deep shoulders, well-developed hind quarters but the head is slim

with pointed and crescent-shaped horns.

- The forehead is prominent, convex and broad like a bony shield.
- The overhangs eyes in such as way they appear to be partially closed and the animal shows sloppy appearance.
- Ears are long and pendulous and folded like a leaf with a notch at the tip.
- Horns are curved turning back at the tip.
- They have moderately developed dewlap: males have a large and pendulous sheath.
- The tail is long and whip like, hooves are medium-sized, and hair is short and glossy.
- Skin is loose and pliable, hipbones are prominent, udder is well developed including teat tips are round.
- Adult weigh between 150 to 250 kg and yields 47 to 52% of its weight of meat.

The non-descriptiveindigenous zebu cattle populations have declined due mainly to the mechanization in agriculture and the introduction of high yielding crossbreeding program.

Pabna variety cattle

Pabna variety of cattle, as the name suggests is from Pabna district especially found in Shahzadpur, Bera and Sathia upazilabut it is also distributed in Sirajgonj district as well as areas in Tangail, Dhaka, Manikgonj and Bogura districts(Table 1). They are actually crossbred of imported Sahiwal, Sindhi and Hariana bulls with the native cattle and an intensive selection for milk production for long periods.[39]The main features of large size body than their native counterparts, live weight 250 to 400kg and high milk production in comparison to other local varieties of cows.The coat color is usually red or gray or a mixture of both and mostly deep grey to white with different shades in male cattle.Their physical features like hump and shoulder are similar to zebu cattle. Skin pigmentation pattern have been reported as light red dominated for coat color in both cattle population while black color is most frequently observed in muzzle, eyelid, eyelash, horn, hoof, dew claw and tail switch.[40,41]

The average milk production of indigenous cattle ranged between 0.50 to 2.50 liters per day while 4.79 liter / day in Pabna variety.[42]Unique dairy cattle herd of different cross-bred are available in Baghabari region of Milk-Vita.The genetic admixture in dairy herd showed the combination of several breeds in which the frequency of Holstein-Friesianhas the highest regarding predominant individual breed characteristics followed by Jersey and Sahiwal with local cows (mainly Pabna cattle).One of the major reasons of this admixture is random and unplanned AI between or among breeds which also affecting the performance of cattle population and such situation originated from non/zero-record keeping system.[16]

Red Chittagong cattle (RCC)

The RCC variety is found in the coastal plain zone of the Chittagong district as well as to a smaller extent in Noakhali and southern regions of Comilla(Table 1). The concentrated areas of RCC have been reported in Anwara, Raozan, Hathazari, Chandanaish, Patiya and Bashkhali upazila.[11,43]They have distinct identity with attractive red body color, delicious milk and meat compared to other indigenous cattle make them to preferred in thatregion. The characteristic phenotypic features of RCC have been reported as: (a) Red coat color (deep to light), (b) Whitish red or brick red color muzzle, horn, hoof and eyes, (c) Narrow thin headed, (d) Flat forehead,

(e) Blocky as well as medium body sized, (f) Males are heavier than females, (g) Physical condition is very strong and stout, (h) Large tail with whitish switch, (i) Milk vein is compact and not so prominent, (j) Well developed hump in males but less prominent in females and (k) Prominent dewlap in males.[43-45]The morphological measurements of RCC have been reported to be increased significantly ($p < 0.01$) with the advancement of age.[35]

The average birth weight is 15.4 kg with highest live weight gained at 30 months (122.8 kg) and then declined the live weight of RCC.[46]A typical RC bull weighs 250 to 400 kg and cow 150 to 250 kg and 48 to 52% meat of its actual weight.Horn length and diameter for male and female have been reported to be 11.43 ± 1.17, 11.68 ± 1.08 and 10.84 ± 1.13, 9.187 ± 1.08 cm respectively.The body length, body height and heart girth of cow and bull have been reported as 107.13 to 114.34, 105.94 to 107.71, 136.90 to 130.85 and 131.44 to 134.0, 124.46 to 125.0 and 165.45 to 168.0 cm, respectively.They have medium sized udder with their teats 5.02 ± 0.03 cm in length and 5.84 ± 0.04 cm diameter.[43]

Growth performance and reproductive potential of RCC based on phenotypic and genetic parameters have been reported.[47-50]The productive and reproductive performance RCC is very much promising and appreciablethan other non-descriptive indigenous cattle available in Bangladesh.[43,51]The similar performance of RCC has been reported in both the intensive and traditional management system and equally suitable for both the systems of management.[52]The RCC has been reported to have similar body weight and growth performance in farm and field conditions that indicates their equal suitability in both management systems.[46] The estimation of adjustment factors for standardizing age and season corrected 305 days milk and heritability and repeatability of standardized milk yield,[53]feeding and management practices,[54]economic values for different economic traits,[55] socio-economic status of RCC farmers[56]and farmers' attitude toward rearing RCC[57] have been reported.

North Bengal Grey cattle (NBG)

The NBG cattle are found scattered in the northern district of Bangladesh (Tista meander-flood plain and lower atria basin zone) especially in Rajshahi division (Table 1). This variety of cattle might have been originated from cross-breeding of local cattle with that of cattle imported from northern part of India for long period. A surveyed area of the north Bengal showed that about 54% of the total cattle population recognized as NBG variety.[14]The body is small, compact and less fleshy. The coat color of NBG cattle mostly deep grey to white with differing shades. The head is small and the color of the muzzles, eyelids and hooves is black. The neck region of adult cattle has an ashy shade which is more prominent and increased with age. The horns are small to medium and curved inward with pointed tips. The ears are small and erect with a sideways orientation and have pointed tips. The face is small and narrow with a flat forehead. The skin is tight, the dewlap is medium and the hump is small in cow and developed in bulls. The tail is long and reached to below the hock. They possess good body size and some draft features and famous as a cart bullock in the market.[14]

The major threat to native cattle are scarcity of pure native bulls, indiscriminate national cross-breeding program, lack of conservation and development program and farmers interest for cross-breeding for high production.

Munshiganj variety cattle (MVC)

The MVC is also known as Mirkadim cattle get its name from an area in Munshiganj where they are farmed. However, this variety of cattle is distributed in Munshigonj, Manikgonj and adjacent region of the district(Table 1). These cattle are mostly of creamy to dull pinkish coat color with milk type body conformation have great demand as milk cow in the surrounding regions. Their skin are pigmented, muzzle, eye brow, hoof, horn and switch are black.[58]Some authors have presumed that this variety has evolved in the localities by selecting breeding and no authentic history of cross-breeding could be traced.[45] However, some authors reported that in addition to selective breeding since 1930's several attempts might also been made scatter to increase their production potential through infusion of foreign genes both sub-continental and temperate for different periods to improve the genetic resources of cattle.

The MVC is one of the recognized milk type varieties of cattle with good potentialities but its population is rapidly declining due to unplanned crossbreeding program with exotic genetic resources to produce high yielding crossbred cattle without any breeding policy, conservation and development of MCV.[59]

Dinajpur Dwarf cattle

The dwarf cattle in Dinajpur district are comparatively smaller in size than most of the recognized varietiesor types of indigenous cattle but their coat color showed remarkable variation. The average live weight of yearling bull is 91.32 kg, bull 109.10kg, and cow 89.74kg.[12]Dwarf cattle can be promising cattle type with low feed intake and high milk yield in harsh climatic condition in Northern part of Bangladesh. Morphometric traits have been reported to be smaller than almost all the cattle available in Bangladesh. Productive and reproductive traits are more or less similar with the other cattle. Major constraints of dwarf cattle production are lack of quality breeding, lack of feeds and their cost, disease outbreaks, lack of effective vaccines and medicines and fluctuating market prices.[12]

Exotic and crossbred dairy cattle

The then East Pakistan and Bangladesh government were imported different exotic cattle and semen to upgrade the indigenous cattle in different time. This cross-breeding program has been launched in 1958 by the Directorate of Livestock Service (DLS) with artificial insemination (AI) program which then strengthened during 1975-1976. In 1960s, the Central Cattle Breeding Station and Dairy Farm (CCBS& DF), Savar was established with Sindhi, Sahiwal and Tharparkar breed cattle to upgrade the native cattle. Later in 1973, some Holstein-Friesian and Jersey bulls were imported from Australia which was used for semen production for upgrading the local cattle. The AI service was then extended throughout Bangladesh for cattle development in 1975. A survey of homestead dairy cattle rearing status showed that highest percentage of rural farmers rearing deshi cows (90.0%) in comparison to Holstein-Friesian (5.80%), Red Sindhi cross (1.9%) and Jersey cross (1.9%) cows in Chapai Nawabgonj district.[31]Dairy farmers' views on the rearing of improved variety of cattle have been described.[60]Productive and reproductive performances (potentialities) of the different crossbred have been reported to be varied.[61]

Table 1. Distribution pattern of different available cattle genetic resources in Bangladesh[13,62,63]

SN	Cattle breed & variety	Geographical distribution	Agro-ecological zone/region
1	Non-descriptive deshi	Throughout Bangladesh	All agro-ecological (30) zones
2	Pabna variety	Sirajgonj and Pabna district	Active Brahmaputra and Jamuna flood plain
3	Munshigonj variety	Munshigonj an Manikgonj district	Young Brahmaputra and Jamuna flood plain
4	North Bengal Grey	Northern region (Rajshahi division)	Tista meander flood plain& lowers atria basin
5	Red Chittagong cattle	Chittagong district & CTG Hill tract	Chittagong coastal plain

Morphometric measurement (MM) of native cattle

The MM of animals is usually conducted for the assessment of carcass quality as well as to characterize breeds of animals. Eight different MM of cattle have been described(Table 2)which include: ①Wither height- vertical distance between the fetlock and the point of wither, ② Hip height- vertical distance between the fetlock and the point of hip bone, ③ Body length- distance between points of shoulder to pin bone, ④ Chest diameter- diameter surrounding the heart girth, ⑤ Chest width measures as the broadest portion of the chest, ⑥ Hip width- distance between two hip bones, ⑦ Thurl width- distance between pin bone to hip bone and ⑧ Rump length- distance between parts of base of tail to hip bone.[35]

Table 2. Body measurement of different varieties and types of adult cattle in Bangladesh

SN	Measurement (cm)	Types	Variety of cattle (Mean ± SE) NDD[33]	RCC [11,35*,43,64]	NBG[14]	PV[65]
①	Wither height	Bull	-	125.00 ± 0.87	92.88 ± 2.35	-
		Cow	-	107.71 ± 0.93	93.91 ± 1.13	-
		Overall	100.32 ± 7.79	112.21 ± 0.56 *	-	118.21 ± 3.25
②	Hip height	Bull	-	-	-	-
		Cow	-	-	-	-
		Overall	-	109.82 ± 0.49*	-	
③	Body length	Bull	-	134.00 ± 1.63	99.64 ± 3.48	164.39 ± 2.36
		Cow	-	114.38 ± 1.56	105.16 ± 1.21	-
		Overall	105.78 ± 5.36	110.60 ± 0.45*	-	-
④	Chest diameter/ hearth girth	Bull	-	168.00 ± 1.67	122.23 ± 4.67	-
		Cow	-	139.85 ± 1.63	126.95 ± 1.53	
		Overall	129.26 ± 6.12	137.22 ± 0.48*	-	147.56 ± 1.70
⑤	Chest width	Bull	-	-	-	-
		Cow	-	-	-	-
		Overall	-	28.82 ± 0.45*	-	-
⑥	Hip width	Bull	-	-	-	-
		Cow	-	-	-	-
		Overall	-	30.69 ± 0.50*	-	-
⑦	Thurl width	Bull	-	-	-	-
		Cow	-	-	-	-
		Overall	-	37.95 ± 0.48*	-	-
⑧	Rump length	Bull	-	-	-	-
		Cow	-	-	-	-
		Overall	-	33.26 ± 0.49*	-	-

NDD = Non-descriptive deshi RCC = Red Chittagong cattle NBG = North Bengal Grey PV = Pabna variety
*>66 months of age cattle

Draught cattle

There are three main sources of power used in agriculture: human, mechanical and animal and all have contributed a great deal too human civilization worldwide. Developed world has already converted animal power to mechanical power in the agricultural production. In developing world including Bangladesh, the use of mechanical power in agriculture has increased but the draught animal power (DAP) remains as an important source power in rural agriculture due to small holdings and hill agriculture.[4] All ploughs in Bangladesh require two animals and two bullocks can plough one acre in 2.75 at 6 hours each day. It has been reported that some cows are used for draught purposes, despite problems with fertility and health complications, which result in lower milk production and fewer calving per lifetime.[4] In India, the energy for sloughing two-thirds of the cultivated area comes from animal power and 60 million working animals are saving fossil fuel worth Rs 60 billion annually[66] but similar research report have not been made in Bangladesh (Table 3). In recent decade there has been a trend towards replacing draught animals with mechanization but their status has not been evaluated in Bangladesh (Table3).

Table 3. Research findings on draught animals in Bangladesh

Year	Research objectives	Major findings	Reference
1980	To assess the draught power and mechanization	Draught power shortage and suggestedfor mechanization about 40-50% cows have used as draught animals	3
1984	To assess the performance of draught animal in land preparation	Total time required for complete preparation of an acre of land has been reported to be 60 to 63 hours	67
1985	To assess the single animal ploughing	Cows have been used as a potential single animal ploughing with long term negative effect on fertility	68
1987	To detect the status of DAP	Reported shortage of DAP in Bangladesh	69
1987	To analyze the factors of harassing draught cattle	Good type of harness and anticipated performances of draught cattle have been reported.	70
1990	To detect the types of cattle used in DAP in Pabna	The great majority of the bullocks and the bulls are used as draught animals. More than 80% native cows also have to work compared with only half the PMC.	65
1990	To identify draught power situation and its interaction cropping systems	Results showed that 49% farmers used bullock and 21% farmers used cows as draught animals for land preparation	71
1991	To analyses some farm assets	Shortage of draught animals and cows used for draught purposes.	72
992	To review the draught animal power (DAP) in Bangladesh	Of the 23 million cattle, 11 million are used as draught animals and 25% farmers used cows as DA	73
1992	To detect the relationship between daft animal owner shipand land holdings	The draught animal ownership has been reported to be positively correlated with the size of the cultivated land holdings	74

Table 3: Continued

1992	To estimate the economics of single animal ploughing	The benefit/cost ratio has been reported to be higher with single animal ploughing	75
1992	To detect the factors of adopting single animal ploughing	Shortage of draught animal has been reported to be main factor to single animal for ploughing crop land	76
1992	To detect the effect of single and double animal ploughing	Adaptation of SAP with buffaloes and healthier cattle has been suggested to overcome the shortage DAP	77
1993	To assess single animal ploughing in tillage operations	In shortage of DAP, SAP has been suggested in tillage operation	78
1992	Utilization pattern of DAP and cow dung	The utilization pattern of DAP and cow dung have reported not similar among the four regions in Bangladesh.	79
1996	To detect the relationship between draught cattle owner-shipand land size	Land owner farmers had draught cattle than the landless farmers with positive correlation between land size and number of bullocks	80
1996	To study the feeding practice	Feeding practices of draught animals have been evaluated at village levels	81,82
1997	To study the draught cattle management system	Draught cattle management system at farmers levels with thatched and tin shed house and house-crop-draught cattle have been described.	83
2000	To detect cattle as a source of draught power	Cattle has been reported to be the major animals used as draught animals in Bangladesh.	84
2009	To detect the extent of use cow as draught animals	Reported that cows have been used for cultivation (36.36%), threshing (24.06%), crushing (4.81%), transportation (4.81%) andmilking (29.94%) in the nine investigated districts.	4

DAP = Draught animal power SAP = Single animal ploughing 81 & 82 = Same titles

Live cattle body weight measurement

Live body weight of livestock species especially cattle is the basis for determining ration amount and supplement, trait to evaluate breeding value, to decide the slaughter weight, to detect the correct dose of drugs and fundamental importance for research works. There are different live weight measurement techniques are employed in animals, some of which are Weighbridge, Weigh tape, Rondo tape, Schaeffer's formula, Agarwal's formula and calculator method. Weighbridge is the standard calibrated weighing scale which provides accurate body weight butless preferred by dairy producers because it is cumbersome, time consuming, costly and stress full to the animals. However, it can be used as a reference value to compare for other techniques. Evaluation of the techniques showed that Schaeffer's formula is the most reliable of all these techniques to estimate live weight of cattle.[85]

Schaeffer's formula to detect BW in cattle

The equation is used for calculating live weight; $W = (L \times G^2 / 300$, where W is body weight in lbs, L is the length of the animal from point of shoulder to pin bone in inches and G is the chest girth of the animal in inches. The final weight can be converted into kg by [1 = 0.453592].Prediction of live weight of cattle fitted regression lines[86] and prediction of live weight for Brahman crossbred cattle using linear body measurement[87] have been reported from Bangladesh.

Feeds and feeding practices of cattle

Cattle is one of the important ruminant animals that covert large quantities of pasture forage, harvested roughage and by-product feeds as well as non-protein nitrogen (e.g. urea) into high quality meat and milk for human consumption. Due to lack of pasture land in Bangladesh, most of the cattle are mainly reared by the smallholder rural farmers and their animals are maintained on crop residues and other agricultural by-products. However, the available animal feed resources in Bangladesh traditionally are grouped into four categories which include ①Forages including grasses and tree leaves, ② Crop residuese.g. rice and wheat straw, ③ Agro-industrial by-products e.g. concentrate and ④ Non-conventional feed resources.Different reports indicate that there is a wide ranging deficit of all these categories of feed resources based on the daily requirement of the animals in Bangladesh. The feeding system of ruminant animals practiced in Bangladesh can be categorized into three which include ① Traditional feeding system, ② Feeding system in the milk pocket areas and ③ Feeding in farming condition.

① Traditional feeding system

Three categories of feed sources e.g. dry feeds, green feeds and concentrates are usually supplied to the ruminant animals. The dry feeds include paddy, wheat and rice straws and dry grasses. The green feeds include road side grasses, weeds, natural vegetation of homestead, forest grass, tree leaves, aquatic weeds and cultivated forages like Napier, German, guinea and maize fodders, grazing or tethering fallow or harvested land and vegetable wastes. Concentrates are seldom fed to the animals which are usually consisted of rice polish, wheat bran and oil cakes. The traditional feeding system for smallholder dairy cattle is based on the use of rice straw, natural grasses supplemented with a little or no concentrates.[30]

② Feeding system in the milk pocket areas

Mostly the Milk vita operated regions especially Bhaghabarighat, Sirajgonj, Takerhat and Faridpur are considered milk pocket of Bangladesh and during the winter season especially in the Sirajgonj and Pabna bathan areas, mostly the dairy cows are grazed on developed pasture mainly composed of matikalai, mug beans, chickling vetch and Bermuda grass and varieties of natural weeds. During rainy season and flooded areas, animals are kept in the permanent animal shed and allowed to stall-feeding mainly with rice straw, water hyacinth and excess amount of poor quality by-products such as rice polish, wheat bran and oil cakes and occasionally fed with Napier grasses grown in the high land.[88]

③ Feeding in farming condition

Dairy cattle of the organized government and non-government dairy farms are usually maintained by feeding both roughage and concentrates. Fodder crops are grown in the farming areas and concentrate are purchased from local market for feeding these animals.

Challenges in feeding rice straw

Rice straw is a major agro-residue feed which satisfies 90% of the roughage needs of large ruminants in Bangladesh[30] but feeding only rice straw does not provide adequate nutrients to the cattle even for maintenance due to low nutritional values (low protein content and poor digestibility) with highlylignified material containing high concentration of anti-nutrition factors like lignin, silicates and oxalates.[89,90]

Paddy straw contains 25 to 45% cellulose, 25 to 30% hemi-cellulose and 10 to 15% lignin with low nitrogen, vitamins, minerals and high quantities of silica which hinder the nutrient availability to rumen microbes and eventually limits the necessary nutrients uptake for a satisfactory performance of the animals.[90] The presence of anti-nutritional factors like silicates and oxalates in rice straw with low nutritive value, poor palatability and limited ruminal degradation render paddy straw as non-maintenance type of fodder, so it cannot support nutrient requirement of the animals when fed alone.

The cellulase, hemicellulase and ligninase are required to break down the cellulose, hemicellulose and lignin predominantly present in the cell wall of the rice straw. However, the cellulase and hemicellulae are produced by rumen microorganisms but lignin cannot be breaking down in the rumen due to lack of ligninase. Rice straw has a very high silica content (5 to 15%) which is indigestible phenolic substance that also decreases digestibility of the feed. This high concentration of silica reduces the palatability and the degradability of rice straw in the rumen due to its direct action in preventing colonization by ruminal microorganisms.

The crude protein of 3.0to 4.7% on a DM basis in rice straw requires protein supplementation to meet the nutritional requirements of most cattle. The high oxalates in rice straw decrease the absorption of calcium. Since rice straw does not contain enough sugars, amino acids and minerals for efficient microbial growth, feeding ruminants with only rice straw withoutany supplementation of other requirednutrient sources will result in poor performance of the animals. There are technologies that have been developed to increase the nutritive value, nutrient digestibility and utilization of rice straw, such as physical processing, pre-treatment using chemicals and /or biological treatment.

①**Physical treatment**- grinding, soaking, choppingor pelleting to reduce the particle size or can be treated with steaming pressureand gamma irradiation. Physical treatment of rice straw aims to improve the palatability and increase intake as well as improve the potential digestibility of ruminants.Soaking straw overnight in water which brings softness between the lignin and cellulose component which promotes higher intake of the animal as well as nutrients digestibility.Grinding, chopping or pelleting has beneficial effects in breaking down the cell wall contents of rice straw which reduce the particle size of the straw and the retention time or passage rate of the ingested treated straw that causes negative effect on decreasing the nutrients digestibility of straw because of the less time exposure of the feed materials for rumination and for microbial fermentation in the rumen.[91]Many of these treatments are not practical for use on small-scale farms, as they require machines or industrial processing.

②**Chemical treatment**- most commonly used chemicals in treating rice straw to improve its palatability, intake and digestibility are sodium hydroxide (NaOH), ammonia and urea. The mode of action of these chemicals is to break the links between the lignin-cellulose structures of

the straw which are sensitive under alkaline or acid conditions. Chemical treatments appear to be the most practical for use at farmer's level, the chemicals are relatively cheap and the procedures to use them are relatively simple but safety precautions are needed for their use as these chemicals themselves are not harmless.

③**Physico-chemical treatment**- NaOH /pelleting, urea/pelleting, lime/pelleting, chemical/steam, NaOH/temperature.

④**Biological treatment**- white rot fungi, ensilage with agro-industrial by-products or fortification with proteins, greens or enzymes, probiotics and herb. Among these methods, biological treatment is a much favourable option and is believed to be more environmental friendly and safer.[90]Suitable treatment techniques in combination with nutrient supplementation could result in improved utilization of rice straw with better benefits.

On a straw diet, supplementation of small amount of green grasses is often recommended for optimization of rumen environment or even to meet the maintenance requirement of animals.Dairy farmers are recommended to feed 1.0 kg concentrate for 2 to 3 kg of milk yield and the concentrate feed contain rice polish, wheat bran and oil cakes under local conditions.[30]

Bangladesh has mainly two types of dairy cattle, cross-bred and indigenous dairy cattle. The cross-bred cows are usually stall fedwhile the native cows generally allowed for grazing in day time and fed rice straw *ad libitum* basis. The grass supplied to the cross-bred cows composed of roadside grass, on-farm fodder, weeds of crop fields, aquatic weeds, tree leaves and other browse which varies from season to season. Local dairy cows are supplied to a maximum of 1.0 kg concentrate daily whereas the cross-bred cows are supplied with 2 to 3 times higher than local cows and composed of rice polish, wheat bran, bran of legumes and oil cakes.[92,93]

Research on feeds and fodders

Approximately 68.0% of the farmers involved in crop production and 6.5% involved in livestock rearing in Bangladesh.[94]Livestock farming is crucially important for provision of animal-based food products for the population and as a source of income for mainly rural smallholder farmers in low income countries including Bangladesh. Recently the demand of livestock products has increased greatly due to increased human population and economic growth in Bangladesh. However, the main constraints to livestock development in Bangladesh are the scarcity of quality and quantity of feed supply (88.1%) and diseases.[62]

Large ruminants are mainly fed on low quality roughages including natural grazing and agro-industrial by-products like cereal straw, sugarcane feedby-products and other similar products in developing countries including Bangladesh. The smallholder cattle farmers are usually supplied with green grasses mostly grown on fallow lands, crop field boundaries, embankments and side of roads. These feeds are deficient in protein, energy, minerals and vitamins. Sometimes seasonal influence also deteriorates the grazing and browsing that cause to decline lactation unless supplements are offered. Addition of foliage from tree leaves and supplementation with seed meals, urea-molasses multi-nutrient blocks are used to improve the utilization of low quality roughages mainly through the supply of nitrogen to the rumen microbes.Cereal milling by-products, grains and oil cakes are the three major types of ingredients constitute concentrate feed

and the total demand is met only 19.4% in Bangladesh.[95]However, an average 56.2% deficit of roughage DM and 79.6% of concentrate DM results in a very poor plane of nutrition for farm animals in Bangladesh.[95]There is a requirement of 70 million metric tons of green grasses for cattle feed per year but produced only 24 million metric tons. Thus, there is about 60% deficit of animal fodder feed which hampering the livestock development in Bangladesh.[96]

Fodder production

Fodder is any agricultural foodstuff used specially to feed domesticated livestock. Fodder crops are crops that are cultivated primarily for animal feed. Natural grasslands and pastures are included whether they are cultivated or not. There is a lack of pasture land and huge shortage of green fodder to feed large ruminants in Bangladesh. In 1960 a fodder crop, namely pangola grass (*Digitariaeriantha*) was imported from USA and propagated in a limited area of the then East Pakistan and proved to be high yielding fodder crop suited for local condition. However, the land scarcity, lack of extension services to encourage farmers for fodder cultivation and absence of fodder feed bank have been considered as the main reasons for green fodder shortage in Bangladesh. Recently interest has been grown among the scientists to provide livestock farmers with a suitable variety of fodder crop which could be cultivated abundantly and preserved as hay as well as silage to feed the animals during scarcity period. In addition to different varieties of fodder experimentally cultivated in Bangladesh and even hydroponic fodder has also beentried under experimental condition (Table 4).

Table 4. Research findings on fodder production and fertilizer used in Bangladesh

Year	Fodder grass cultivated	Fertilizer used (@ kg / ha)	Results (Total harvested /DM produced)	Reference No.
1968	Pangola grass	N + P + K fertilizers	Reported some mineral compositionof the cultivated fodder	97
1972	Sorghum	NPK 200/Varity	Honey sorgo (V-4) produced highestfodder yield (119339 kg/ha)	98
1972	Para grass	Urea 0, 30,60 lb/ acre land	DM yield 4380.0, 4894.5 and 6958 lb. with 58.87% increased with used / acre group.	99
1974	Pangola grass (PG)	3 rates of N & P, 2 rates potash	N & P application hasincreased yield significantly but little effect with potash	100
1975	Para grass	Urea 0,34, 68 ; TSP 0,34, 68& MP 0, 34	The N and P application has progressively and significantly increased the grass yield at all stages of cutting.	101
1975	German grass	Urea 0, 22,45& 67	Total yield of forages / ha on bothPG & DM basis increased progressively & significantly with theincrease in fertilizer level.	102
1975	Pangola grass	TSP 0, 30 & 60	TSP fertilizer progressively increased total yield of PG and DM with increased level of TSP application	103
1986	Different fodder	-	Potential crop mixture for fodder production has been described.	104
1986	Tama Rye grass	Application of mefluidide and PP-333	Mefluidide has reported more effective than PP-333 on growth of the grass	105
1987	German grass	NPK 10,20,40; MN 2,4,8 & Mo 2, 4	Highest yield (17 kg/plot) & highest protein content (17.62%) reported with NPK, Mo1 & Mn2.	106

1988	Maize forage	Urea 0, 21, 42, 63	Urea @ 63kg / ha resulted in significantly higher yield of fodder(41.03 MT/ha) at 7 weeks	107
1990	Wheat straw	Phosphorus 60, Sulfur 30	Optimum doses for producing betterquality of wheat straw	108
1990	Khaki Bhutto	Urea 50, 100, 150	Highest green forage & nutrient yield with 100 kg urea/ ha.	109
1992	Cowpea forage	Urea 20 + Rhizobium 63	Significantly higher values for ME & NE concentration for lactation	110
1992	Maize forage	Plant thinning & leaf removal	The highest total green stover yield 15.84ton/ha & 17.85 ton / hac during 1989-90 and 1990-1991, respectively	111
1992	Mixed fodder	To estimate DM and CP of single & mixed fodder	Intercropping of leucaena with cowpea and sun hemp resulted an advantage of more biomass/ nutrients compared to single crop.	112
1993	20 species of fodder crops	Not used any fertilizers	Highest yield reported in Napier-17 (17.81/ ton/ha), followed by Napier-bazra (16.54ton/ha), Splendida (14.32 ton/ha), Napier-Pusha (13.42 ton/ha) & Pospalum (13.04 ton/ha) in terms of DM.	113
1993	Dal grass	Urea 0, 45,60, 80, 100	Total DM yield/acre/yr increased from 13.4 ton at zero N to 18.4 ton at 60 kg N/acre which was optimum for highest DM & CP.	114
1993	Maize forage	NPK 30-3-15	Cumulative yield of winter (40,60&80)fodder higher in dibbled plot (9.93 ton/ha) than transplanted plot (7.26 ton/ha)	115
1993	Kent, Swan, Barseem & Oat-barseem	Urea 20 for oat & 100 kg for barseem plots	Higher bio-mass in kent (30.8-42.3 t/ha)variety than swan (21.5 to 39.0), barseem(12.3-21.5) and oat-barseem (32-42.5 t/ha)	116
1993	Maize forage	-	Dibbling of Savar-1 variety maize in rows at 50 cm apart with a seed rate of 40 kg/ha & NPK 15/5-3-15 kg/ha produced optimum fresh yield with CP 8.12%.	117
1994	Oat forage	-	CP contained declined with advancingmaturity which have reported as 16.58%,10.64% & 8.75% at 50, 65 & 80 days, respectively	118
1994	Sorghum	-	Production as inter has been reported highly feasible without affecting highly feasible without affecting the grain yield of rice	119
1994	Maize with Khesari	Urea 0, 30, 45 & 60	Highest seed rate with highest urea resultedpeak yield (65.35t/ha) & lowest seed rate with lowest urea resulted lowest yield (38.49 t/ha).	120
1994	Maize + Cow pea mixed	-	Green grass yield (28.5 t/h) has reported maximum in T2 (75% maize + 25% cowpea) group that mixed cropping has encouraged.	121
1994	Sun hemp	Composition, digestibilityME	ME contents has reported to be significantlyreduced with the increased the age of plant	122
1995	Oat forage	-	The stage of plant growth had a marked effecton the chemical composition, OM digestibility and ME content	123
1995	Maize forage	Urea 0, 50, 75, 100	Application of 100kg N/ha resulted significantlyhigher yield of both fodder and DM	124
1996	Oat & Maize	Urea 0, 50, 100	Higher yield of oat forage (61.5 vs. 48.9 t/h) and CP (1.3 vs 0.8) CP (1.3 vs 0.8) compared to maize. Nutrient yield and CP content reported better in oat but higher digestibility and energy content better in maize.	125

1996	Oat fodder	Urea 0, 25, 50, 75, 100, 150	Oat fodder harvested at 57 days of age throughapplication of 150 kg N/ha reported superior for both green and dry fodder, whereas 100 kg /ha tended to be superior in respect of digestibility of nutrients as well as nutritive value.	126
1996	Native grasses	Urea +	Yield of native grasses has increased with urea application but not consistent with N- rates	127
1996	Sun hemp forages	Rhizobium+ TSP 45, 60,75	Suggested that the Sun hemp forage may be cultivated for feeding ruminants as a good source of nutrients using 60kg TPS / ha.	128
1996	Seasonal & perennial fodders	Cost of producing fodder	Cost of production of seasonal (maize, jowar, cowpea, oat) & perennial (para, napier) fodders have been analyzed. Highest cost for jowar (Tk. 20944.18/ha) and lowest for para (Tk. 10349.86/ha). Highest cost for maize (Tk. 0.66/kg) and lowest cost for oat (Tk. 24/kg) fodders	129
1996	Native grasses	Chemical composi-tion (g/100g DM)	Certain naturally growing native grasses like durba, kanaibashi, kalimona, heicha available during dry and wet seasons can effectively be used as a good source of nutrients for feeding ruminants either as sole feed or in combination with dried roughage	130
1997	Oat fodder	-	Highest yield and DM reported when 1st cut at 40 days after sowing and statistically similar with 2nd cut or single cut at 50% flowering	131
1997	Maize fodder	Urea 120	Higher maize fodder yield has been reported with the application of 120kg N/ha	132
1997	Maize fodder	-	Practice of thinning plants and removing leaves at different growth stages provided a profitable & acceptable level of grain and fodder	133
1998	Intercrop-ping	-	Intercropping of maize with legume forages didnot affect the yield of main maize crop. Nutritionally maize + kheshari intercropping showed best results.	134
1999	Native grasses	Urea +	Urea and cow-dung has increased 28.2% CP contentbut decreased 19.5 of DM. The naturally grown grass species have proved high quality which further could be improved by using N-fertilizer.	135
1999	Native grasses	-	About 20, 11 and 12 native grass species have been identified in fallow land, rice crop land and other crop land in the district of Noagaon, respectively.	136
2000	Triticale	Urea 120	Higher fodder and grain yield of triticale have beenreported with 120kg N / ha land	137
2001	Oat and Maize	-	Oat forage has been reported superior than maize forage in relation to CP yield and nutrient digestibility as well as nutrient value.	138
2001	Maize, Khesari, Sun hemp, Maticoli	Urea 100	All forages harvested at the pre-flowering stage -50 days. Application of urea showed significant positive effect on GG, DM, OM and CP yields ofmaize forage. Maize + Khesari production suggested.	139
2001	Napier, Gaba, & Para grass	-	Napier (29.9) and Gaba grass (37.6) resulted highest biomas yields (t/ha/harvest) and lowest in Para (20.5) in the hill slope of the CTG	140
2002	Roadside grass	Yield & nutritive value of roadside grasses	*Phaseolus mungo* has been reported to be the bestfor yield, nutritive value and adaptability	141

2003	Napier grasses	-	Five varieties of Napier grasses (Arusha, Hybrid,Pusha, N-17 and Bazra) have been evaluated. Napier Pusha contained the highest CP (9.0%) and lowest in hybrid (7.0%).	142
2004	Zamboo fodder	Compost & farm-yard manure	Zamboo grass harvested at 60 days of age of using 14 ton compost /ha resulted better for biomass (30.17 vs 29.0) and CP (34.0 vs 8.97 g / 100g) content in comparison to used farmyard manure	143
2005	Cowpea fodder	Rhizobium + Urea	Application of 50% urea + 1000 kg cow dung atthe time of land preparation and 50% urea at 35 days of plant age resulted highest biomas& CP. Treatment of the cowpea seed with Rhizobium inoculum and apply fertilizer grade urea @ 25kg N/ha resulted highest nutritive values at 40 days.	144,145
2005	Dal grass	Urea/faces/droppings/ Control	Significantly highest biomas (33.3 MT/ha), DM (7.6 MT/ha) and OM (7.0 MT) yields have been reported with urea than other groups	146
2005	Maize fodder	Urea 100 & 200	Resulted higher yield of forage estimated as GG,DM, OM and CP	147
2005	Oat forage	Urea 0, 55, 110 + TSP 0, 10	Highest yield of oat forage has been reported with 110 kg urea and 10kg TSP/ha harvested at 80 days after sowing	148
2005	Oat forage	Urea 0, 55, 110 + TSP 0, 10	Optimum nutritive value and macro-minerals with 110 kg urea and 10kg TSP/ha harvested at 80 days after sowing have been reported.	149
2007	Napier grass	Urea 120 + TSP 20	Reported optimum yield and nutritive value of Napier fodder	150
2008	Maize fodder	DS 0,10,12,14	Maize fodder cultivated through the application of 12 ton DS/ha resulted higher yield and nutrient content	151
2008	Maize fodder	Effect of cattle slurry	Application of 12 tons cattle slurry/ha resulted optimal production of biomass& nutrient content	152
2008	Triticale fodder	Detect the potentiality in nutrition	Triticale is a crop with good potential to produce quality fodder and grain for small scale farmers	153
2008	Triticale fodder	Evaluation of dual purpose fodder	Suggested to produce WRF-7 dual purpose triticale fodder for cattle and feed for poultry	154
2009	Jumbo, Napier & Mustard	To evaluate the eco-nomic profitability offodders	Comparative economic profitability of Jumbo,Napier and Mustard-BB29 T Aman croppingpattern have been evaluated.	155
2010	Gama, Oat & Sorghum	-	Highest fresh yield recorded with gamma (45.06MT/ha) than oat (17.1 MT/ha) and sorghum (38.87 MT/ha) forages but sorghum reported better than oat and gamma in terms of nutrition	156
2010	Cowpea fodder	Urea 0,15, 25,30	Application of N fertilizer @ 25 kg /ha resulted 96.25 cm plant height, significantly increased the GG, DM, OM and CP	157
2010	Triticale fodder	Cow dung	Effect of cow dung on biomass yield and nutrientcomposition of triticale fodder have been reported	158
2010	Sorghum fodder	TSP 0,40,80,120	Application of TSP 80kg/ha resulted highestplant height (160 cm) at 60 day, yield GG 25.58 MT/ha and DM 4.0 MT/ha at 66 days	159
2010	Maize fodder	Biogas slurry as a N source	Application of 70 kg of biomass slurry N/ha improved the production of biomass & nutrient	160

2012	Triticale fodder	-	Out of 10 varieties of triticale fodder, TYT-03 have been reported to be potential variety for its higher CP yield	161
2012	Para, German & Dhal fodders	-	Comparison of the nutritive values of the threefodders, of which German grass showed the best result in respect of nutritive value	162
2013	Para, German and Dhal fodders	Organic + Chemical fertilizers	All the three fodders reported suitable for animal feeding but German fodder showed significantly higher in CP and OM with result in respect of biomass production	163
2013	Struvite compost	Other fertilizers	Comparison of struvite compost with other fertilizers on maize fodder production recorded	164
2014	Jumbo fodder	Urea 0,50,100,150 TSP 0,50,60,70 Manure 10 ton/ha	Urea 100kg/ha plus TSP 60kg/ha along withmanure have been suggested to use for highest production of Jumbo fodder (55.22 ton/ha) and its nutritive values	165
2015	Five single & 4 mixed fodders	-	Benefit cost ratio (BCR) of Khesari + Napier dwarf early cropping method has reported to be 1.73 which was higher than other cropping methods, which has suggested for cultivation in the bathan land.	166
2015	Para grass	Pangasius pond water	Higher level of lipid and protein content of paragrass have been reported which has a stimulatory factor to dairy cattle production	167
2015	BLRI-Napier-4	Fertilizer*/ Biogas slurry/ Broiler litter/ Layer litter	Highest biomas yield (t/ha) has been reported with biogas slurry (26.80), followed by fertilizer (26.56), broiler litter (22.34) and layer litter (22.34) and layer litter (22.20). Higher DM yield (t/ha) with biogas slurry (3.94) and lowest with layer litter (3.13) and suggested to use slurry.	168
2015	Jumbo grass	Different levels of N & P fertilizers	Reported that Jumbo grass can be cultivated with the application of 80 kg N/ha and 10kg P/hac for maximum production	169
2016	Napier, Splendida, Andropogon	Fodder cultivation in fallow lands	Napier showed highest biomass yield and growth parameters, whereas Splendida has reported in between Napier and Andropogon.	170
2016	Hydroponic fodder	Production & chemical analysis	Maize and wheat seeds have been cultivated as hydroponic fodder with high production and nutritive values in tray condition	171
2016	Napier fodder	Effects of organic manure on production	The production performance and nutritive valuesof different napier fodder have been evaluated.	172
2017	German & Napier	Floating bed fodder	Napier grass could not survived but German grassproduced 7.7-8.6 ton/acre in floating bed system of cultivation.	173
2017	Napier fodder	Survey of farmers	Biomass yield estimated to be 207 ton/ha/year with BCR (Benefit cost ratio) 1.92 for producer and 2.01 for producer cum seller	174
2017	Feeds & forages	Survey of farmers coastal region	Seasonal availability of feeds and forage, utilization and management practices for livestock in coastal areas have been reported.	175
2017	Native grasses	Survey of native grasses	About 48 different native green grasses have beenidentified in different agro-ecological zones, amongest which dubra, badla, kawn, shama, khesari, gamma, ura, gobra and maskkalai are commonly available	176
2017	Rice vs Jumbo Napier	Comparative profita-bility between fodder and rice production	Farmers earned more profit from fodderthan rice (Tk.) production. Significantlyhigher income generation has suggested with fodder than rice cultivation in the Milk-shed area of Shahjadpur	177

2017	Napier fodder	To assess the economics of fodder production for dairy farms	Fodder production along with dairy cattle rearing has been reported highly profitable. Higher profit has been reported with fodder crop cultivation in the same land.	178
2018	Napier-4 fodder	Production on loamy & sandy soils at 3rd cutting	BLRI developed Napier-4 showed better performance in loamy than sandy soil at 3rd cutting	179

NPK= Nitrogen (urea), Phosphorus (TSP) and K (muriate of potash) Mn = Manganese sulfate Mo = Molybdic acid
90S = Summer only +@ 25g/ kg seed Intercropping = Kheshari, Cowpea and Berseem with maize
DS = Dried slurry (ton / ha) Fertilizer* = Not available in the main text

There are approximately 30 species and varietiesof fodder have been cultivated and evaluated in Bangladesh for feeding large ruminants (Table 4). Highest number of research reports have been published with Maize (n= 17) and Napier (n=14) forages (Table 4). However, intercropping Maize and Kashari production reported best results,[134,139]Oat forage has reported superior than Maize forage as nutrient values,[138,148]German fodder showed best result in respect of nutrient values in comparison to Para and Dhal grasses,[162,163]moreover, German grass can be produced in floating bed but not Napier grass.[173]In addition, triticale has been reported to be a dual-purpose crop for grain and forage biomass, which is a non-traditional cereal that grows well during the cool and dry rabbi season (November to March) when small-scale dairy farmers face a severe shortage of fodder. Winter has considered as a lean season for the growth of the popular fodder including Napier and Para in Bangladesh. To meet the shortage of green fodder in the rabbi season, triticale can be produced 6-15 t/ha fodder, followed by grain yields that are similar to those from wheat for poultry feed.[137,153,154,161]

Cattle nutrition, feeds and feedings

The research reports on the cattle nutrition, feeds and feeding practices have been reviewed into three sub-headings which include (a) nutrition, feeds and feeding practices, (b) feeding trials on non-dairy cattle and (c) feeding trials in dairy cattle (Tables 5,6,7). A balanced ration should provide protein, energy, minerals and vitamins from dry and green fodders, concentrates, mineral supplements and others in appropriate quantities to enable the animal to perform optimally and remain healthy. Inadequate and imbalance feeding may results in: (a) low milk production than their genetic potential, poor growth and reproduction, (b) shorter lactation length and longer calving intervals, (c) dairy cows more prone to metabolic disorders milk fever, ketosis, (d) slow growth in growing animals and delayed age at first calving, (e) shorter productive life and lower profit to farmers.[180] A software has been developed by NDDB, India to supply the balance ration of their animals using locally available feed resources[180] that system could be used for the development of cattle industry in Bangladesh.

Table 5. Research findings on nutrition, feeds and feeding practice in cattle

Year	Research objectives	Major findings	Reference
1965	Use of urea-molasses	Utilization of molasses and urea-molasses as a livestock feed.	181
1968	Nutritive values of four forages	Significantly varied nutritive values of four forages at the different stages of maturity and both the TDN and DOM. Varied within the same species of fodder	182

1968	Concentrate feeding	High level concentrate feeding practice in dairy and beef cattle	183
1968	Relative values of protein supplement	Meals or cake made from soybean, cotton seed, linseed and guar evaluated as protein supplement in cattle	184
1968	Ration mixed with urea, water or rice gruel	Ration mixed with urea utilized without any harmful effects but water or rice gruel mixed with urea caused toxic effect.	185
1969	To estimate the rumen microbial protein	Methods on quantitative estimation of rumen microbial protein synthesis has been described.	186
1972	Partial replacement of vegetable protein	The effect of partial replacement of vegetable protein by urea nitrogen on CP digestibility by ruminants have been reported	187
1974	Role of N in nutrition	Nitrogen- a limiting factor in animal nutrition	188
1980	Chemical composition of water-hyacinth	The chemical composition of three types of water-hyacinthvaried from type to type but leaves found best for feeding	189
1981	Feeding of mixed diet with water hyacinth	Rice straw, water hyacinth and concentrate mixed diet has been reported to be used efficiently in bullock	190
1981	Water-hyacinth as cattle feed	Water-hyacinth (*Eichhomia crassipes*) as cattle feed has been suggested in Bangladesh	191
1982	Supplemented alkali treated rice straw	The supplement of protein (fish meal, rice bran) relativelyupgraded in the rumen as an essential supplement to urea-treated rice straw for growing calves	192
1982	Treated and untreated rice straw for calves	Evaluation of 5.0% urea, 4.0% lime, 3.0% caustic soda plus1.0% lime treated straw showed that the better result reported with urea-treated rice straw.	193
1982	Effect of feeding oil cake on COD of DM and OM in comparison to urea feeding in cattle	The feeding of oil cake as protein nitrogen source, the COD(co-efficient digestibility) of DM and organic matter (OM)have reported to be always higher than obtained with urea mostly due to preferential growth of cellulytic bacteria in the presence of protein nitrogen rather than non-protein nitrogen	194
1982	Physiological factors	Influencing intake and digestion of rice straw by native cattle	195
1983	Nutritive values of Bazra-Napier grass	Results showed that Bazra-Napier grass contained 1.59% protein, DM intake 1.26 kg/100kg bwt, CP intake 207g daily and N retention 21%	196
1986	Effect of feeding urea-molasses treated straw	Utilization of rumen microorganisms and ammonia concentration in the rumen have been reported	197
1987	DMdegradability between urea-treated and un-treated wheat straw	The DM degradability of wheat straw has been reported to beincreased significantly from 34.96% in untreated to 46.6% in6% urea-treated wheat straw at 2 liter moisture for 15 days	198
1987	Nylon bagdegradability of of DM & N in different tree leavesand forages	The highest and lowest CP contents have been reported to be 28.12 and 0.95% in Ipil-ipil and mango leaves respectively. The effective protein degradation at rumen outflow rates haverecorded as 2.2, 4.4 and 6.6% per hour in different tree leaves.	199
1987	To detect composition of shoti rhizome	Protein in various soluble fractions and the amino acids composition have been reported.	200
1988	To evaluate the rice straw ensiled with poultry excreta (PE) &/or urea and molasses	The digestibility has increased when rice straw ensiled with 30% PE or 15% PE + 1.5% urea or 10% PE + 1% urea. The highest DM (66.73%) and OM (73.02%) digestibility has been reported with 30% PE than 15% PE + 1.5% urea	201

1988	Production of water-hyacinth in earthen pots	Relationship between the content of nitrogen in water andwater-hyacinth and its production has been reported.	202
1989	Proximate composition of tree leaves, vegetables and wastes	Sajna leaves have reported highest CP (24.0%) and moderate CF (16.0%), badha kapiand sheem shak contained highest CP (20.0%) and low CF (8.0%)	203
1989	To investigate the feeds used for feeding animals at flood areas	Farmers used alternative feed items at flood area like deepwater weeds, water-hyacinth, banana plant for their adult animals.Rice straw, rice polish and mustard oil cake have also used.	204
1989	To detect the effect of feeding wheat straw treated with cattle urine	Wheat straw treated with cattle urine @ 0.5, 1.0 and 2.0 L/ kg straw and ensiled in mini-silos for 5, 10 and 15 days at 5, 20 and 40 ^{0}C. The CP (5.5% to 7.1 and 8.0%) and digestibility (33% to 43 and 45%) increased due to feeding of urine treated straw	205
1989	Water hyacinth based diet	Nitrogen balance study has been reported with waterhyacinth based diet	206
1989	Ensiled water hyacinth based diet	The physical and chemical characteristics of the waterhyacinth silage have been reported.	207
1991	To investigate the feeds & feeding practices of large ruminants in rural areas	Farmers used dry straw, green straw, green grass, gruel, rice bran, pulse straw, oil cake, water hyacinth as animal feeds. In addition, tree leaves, banana plant, climbing vines used in feed crisis.	208
1991	To investigate the feeds & feeding practices of large ruminants in rural areas	Farmers used rice straw, rice bran, rice gruel, green grass,kitchen waste (vegetables) and salt are the conventional feeds. Molasses, green plan & tree leaves and herbs also used.	209
1991	To investigate the feeds & feeding practices in large ruminants at rural level	Crop residues and by-product used as animal feed of which rice straw accounts nearly 100% feed energy along with rice polish, oil cake, salt and green grass. Only 36% owner urged to grow fodder crops and 64% did not due to lack of land.	210
1991	To identify feed & fodder situation & its impact	Inadequate nutrition are directly related to poor health, low milk yield and low work output	211
1991	To detect potential shrubs and tree fodder	The potential shrubs and tree fodder have been suggested for smallholder livestock production	212
1992	Yield, chemical composition&*in-vitro* digestibility of groundnut straw	DM yield varied from 0.91 to 1.92 tons/ha and the proximatecomponents of DM varied from 19.86 to 24.20, CP 12.57 to13.19, CF 31.15 to 33.22, EE 4.14 to 4.72, ash 5.69 to 6.94,NFE 41.98 to 45.07 & OM 93.10 to 94.31% on DM basis	213
1992	To investigate the feeds & feeding practices of large ruminants in rural areas	Conventional feeds- dry straw, green straw, green grass/ weeds, water hyacinth, green khesari/kalai, pulse straw, oil cake, rice bran and salt. Crisis period feeds-water hyacinth, green grass,banana tree, jack fruit tree leaves and bamboo leaves.	214
1992	To investigate the feeds & feeding practices of large ruminants in rural areas	Majority of the farmers practiced stall feeding and tethering(38.4%), followed by stall fed (34.3%) and grazing or tethering (17.3%). Also supplied concentrates mixed with water (74.1%),followed by mixed with roughage and water (10.3%) or fed alone (5.6%)	215
1992	Feeding of jiga leaves	Nutritional utilization of jiga leaves in cattle	216
1992	Influence of acacia pod and soybean meal	Ruminal fermentation pattern and serum mineral status in local bull calves have been detected due to influence of Acacia pod and soybean meal	217

1992	Effect of lime treatment on paddy straw	The effect lime treatment on the chemical composition and digestibility of paddy digestibility of paddy straws have been reported	218
1993	The *in vivo* digestibility of ureatreated rice straw	The NDF or hemicellulose determination of straw treatedwith either Ca $(OH)_2$ or mixtures of Ca $(OH)_2$ and urea not recognized for prediction of digestibility	219
1993	To detect the OM and CP of ensiled sugar cane tops (SCT) mixed with urea and molasses	The SCT chopped at a length of 3 to 5 cm and mixed with 0, 1 and 2% urea and all the three groups mixed with 20% cane molasses, wheat bran and 2% common salt and then ensiled for 246 days. No significant differences for OM but significantly higher CP reported in urea treated SCT	220
1994	Comparative digestive capacity of cattle& buffalo	Buffalo heifers have reported more efficient than cattle heifers with respect to utilization of nutrients (DM, CP)from mixed diet	221
1994	Evaluation of legume forage and rice straw	The effect of legume forage supplements on chemical composition, OM digestibility energy contents of rice straw have been reported	222
1994	To investigate the major constraint to animal production in flood plain area of Patuakhali	Feed shortage is the major constraint to animal productionespecially during January to February and June to October in the non-saline tidal flood plain area. Farmers are usually keep their animals grazing on road sides, green and tree leaves	223
1994	To detect the urea and moisture level in straw	Reported that the rice straw could be treated at 5% urea with 55% moisture level and ensiled for optimum period of 14 days	224
1995	To detect the possibility to use algae as a substitute for oil cake for growing calves	For the 120 days feeding trial of using unicellular algae as feed for cattle, the estimated net economic loss has been reported as US $ 5.0/ animal on oil cake while US $ 14.4 profit/animal on algae	225
1995	To compare the quality of different varieties of rice straw	Higher rates of straw and grain production reported in improvedthan native of rice. Pasam straw has reported as a best based on chemical composition and energy content.	226
1995	To investigate the seasonal availability of green grasses & their effect in live weight	Higher intake of DM of cattle at bathan during winter due toavailability of green forages which corresponds to better LWG whereas due to scarcity of green forages during summer, thedaily intake of DM decreased which corresponds to lower LW.	227
1995	To assess the farmers' knowledge & technology on animal feeds & feedings	Limited knowledge of farmers in feeds and feeding and culti vation, storage and processing. Effective extensive program for fodder cultivation within the existing cropping system is required	228
1995	To investigate the availability of livestock feed ingredients	Twenty different livestock feed ingredients have been reported toavailable in the Pabna Milk shed areas.	229
1995	To investigate the effect of replacement wheat bran by rice polish in growing calves	Significantly higher feed efficiency and LWG have been reported with 100% replacement of wheat bran with rice polish. Rice polish appears to be promising substitute of wheat branfor growing bull calves	230
1995	To evaluate the energy conte-nt & digestibility of grasses	The effect of drying temperature and collection procedures ofrumen inoculum on digestibility *in vitro* and ME contents of grasses have been reported.	231
1996	The feedstuffs & composition of concentrate commonly used to fed animals	Straw, green grass, tree leaves and water hyacinth, legumes and sugar cane tops are the major feedstuffs fed by most rural farmers. Composition of concentrates includes rice bran, wheatbran and admixture of different oil cakes.	232
1996	To evaluate the dried duckweeds as a component of a concentrate mixture	The diet has supplied with a concentrate mixture contained duckweeds @ 279 g/kg. Both DM and CP of the duckweeds as acomponent of a concentrate mixturehas been suggested.	233

1996	To find out the feasibility of preservation of seasonal wet rice straw with urea	Seasonal wet rice straw mixed with 50 to 70g urea / kg DMand ensiled for 180 days. Such preservation increased the CP contents of straw by 3.6 to 6.4 times than of the dry straw	234
1996	To evaluate the effects and benefits of feeding preserved wet straw with 5% urea in native growing bulls	Of the two groups of growing native bull calves, of which one group fed with dry straw and other group fed with urea preservedstraw *ad libitum*. Fresh and wet rice straw with relatively lowermoisture (400-500g H_2O/ kg straw) have been preservedwith 5%urea without polythene or any other cover.	235
1996	To compare the nutritive values between thepreserved straw (PS) anddry straw on feedinggrowing bulls	Results showed that > 96% of the wet straw has been excellently preserved for over 5 months when covered with polythene in heap. The increased of the CP content (95 vs 50g/kg) in urea preserved wet straw and DM degradability. However,feeding of PS resultednervous disorders due to unknown reasons.	236
1996	To detect RDP values of feedstuffs used in ruminant ration	Large differences of degradability of CP contents among 9 roughages (rice straw 16.7 to sun hemp & Daincha 78.4) and 8 concentrates(auto rice polish 30.9 to sesame oil cake 74.2) have been reported.	237
1997	To detect the existing management and economic status of private dairy farms	Napier, para and maize are the main fodder cultivated by the private dairy farmers. Approximately 42.0% dairy farmers used stall feeding and 58.0% used both grazing and stall feeding of cows.	238
1997	To detect the effect of feeding dried cow-dung (DCD) on growth and nutrient utilization in growing bull calves	Feeding of DCD (0, 250, 400g/kg) mixed with concentrate for 75 days resulted 16.35, 15.5 and 13.66 kg LWG, respectively. However, authors have suggested to use DCD to replace 40% rice bran of the concentrate mixture in bull without any harmful effect	239
1997	Chemical analysis & nutritive values of fruitwastes	The extraction rate of jackfruit, pine-apple and mango wastes have been reported as 50.0%, 25.0% and 20.0% by weight, respectively	240
1998	To determine the comparative rumen degradability of different protein supplements in adult bullock fitted with permanent ruminal cannula	Each experimental animal has supplied a maintenance diet containingstraw, green grass, wheat bran and supplemented with either coconutoil cake, til oil cake, or soybean meal. Effective degradability of CP for soybean meal (84.07%) has reported highest than that of til oilcake (78.97%) and coconut oil cake (63.23%).	241
1998	Replacement of til oil cake by dried poultry excreta	Results showed that til oil cake can be replaced by dried poultryexcreta in bull calf ration	242
1998	Role of energy in cattle	Energy cycling through cattle tohuman utility seems in ecological framework	243
1999	To detect the effect of graded levels of mustard oil cake (MOC) supplementation on a urea-molasses-straw based diet onnative bulls	The basal diet includes urea-molasses-straw (3:15:82, UMS) ad lib.,wheat bran 200g, molasses 200g, oyster shell 40g and common salt 70g daily. Mustard oil cake has supplied at 0, 200, 400 & 800g daily. UMS with MOC up to 800g has reported little or no effect on intake, digestibility, rumen parameters and microbial N yield but slightlyincreased the N balance.	244
1999	Probabilityof feeding biodigestereffluent in bulls	Biodigestor effluent has been fed to native bulls but it has beenreported to be inferior to mustard oil cake as a supplement for a straw-based diet.	245
1999	Effect ofRDP from urea on rumenfermentation in cattle	Results showed that the straw based diet containing 100% RDP reported superior to others RDP levels when urea was used as RDP supplement	246
1999	To evaluate the urease source in ammoniatreated straw	The addition of soybean to urea at a ratio of 1 : 1 has been reported to be the most satisfactory urease source for the treatment of urea and wheat straw	247
2000	To investigate the degraded different rumen protein	Fish meal and soybean meals have been reported to be degradedslowly up to 12 hours and thereafter rapidly up to 48hours of incubation	248

2001	To find out the major feed-stuffs of cattle during normal and shortage period	The major feedstuffs for livestock has been reported as straw, green grasses, rice bran, wheat bran, oil cake and kitchen wastes.Water hyacinth, banana & jackfruit leaves during shortage period.	249
2002	To find out the availability of feeds and amount intake by large ruminants	Mean intake of different feeds in ruminants (kg/head/day) includestraw 2.0 kg, green grass 5.0 kg, tree leaves 0.3 kg, legumes 0.1kg, sugar cane top 0.01kg, rice, bran 0.5kg wheat bran 30g, oil cake 10gand grazing 6.0 hours.	250
2002	To estimate the quantitative availability of acids in the ruminal fluids in cattle	The concentration of PAA (phenylacetic acid) and PPA (phenyl-propionic acid have been reported in the rumen fluids and seemed to be able to stimulate cellulose digestion in the rumen.	251
2002	To investigate the effects of different levels of RDP on growth and nutrient utili-zation in native bull calves	The feed intake, digestibility of nutrients (except CP) and liveweight gain have not been significantly improved with the increased level of RDP (rumen degradable protein) level in the diet. The diet containing 6.95g RDP/ MJ ME has suggested to use in cattle.	252
2002	To evaluate the nutritive potential value of different aquatic plants	A wide variability in protein, mineral composition, gas production, microbial protein synthesis, rumen degradable nitrogen and in situ DM and CP degrada-bility have been recorded in duckweed, azollaand water-hyacinth and these have suggested to use supplementarydiet to ruminant animals.	253
2003	To detect the level of mycotoxin excretion in milk of cows fed fermented rice straw	Fermentation of rice straw due to dampness reduced its soluble nutrients, *in vitro* digestibility and degradation of DM and increased effective degradability of CP. Dampnessof CPresulted to excrete ingested aflatoxin M1 (0.001-0.006 µg/kg milk) from fermented straw to milk	254
2003	To detect the traditional feeds and feeding practices in large ruminants	The overall consumption of straw, green grass, leaves, legumes,and sugarcane tops have been reported as 1.9. 5.1, 0.3, 0.1 and 0.01kg/head/day respectively Concentrates consisted of ricebran, wheat bran and oil cakes as 0.5, 0.03 and 0.01 kg/head /day respectively.	255
2004	To compare the feed intake, feces outgo, digestibility and LWG in RC & HF cross cows	Feed intake and feces outgo have been reported to be muchlower in RCC (4.94 kg/d & 6.16kg/d) than HF cross cows (6.23 kg/d & 8.26kg/d), respectively. Low feed intake and high digestibility have reported to be theprofitable for RCC	256
2004	Effect of OMof digestibility &ME in legume foliage	Results showed that acacia, albizia and sesbania containedhigher CP and ME and suggested to use as supplement to ruminants fed low quality forages	257
2006	To improve the nutritive value of rice straw by treating with urea and different sources of urease enzyme	Results showed that the silage made by using 4% urea, 2%molasses, 4% soybean seed meal and 40% Dhaincha leaf with 50% rice straw which has preserved under anaerobiccondition for a period of 21 days. The highest CP content (16.42%)has been reported with 40% Dhaincha	258
2007	Effects of the feeds and fodder on milk production	Cattle feed constituted 27-49% rice straw. Napier fodder productionhas practiced in Sirajgonj and Satkhira whereas limited grazing facilities in Sirajgonj and CTG	259
2008	To compare the effect of supplement between bone meal and TSP in local cattle	Supplementation of bone meal (1.87 g/kg) and triple super phosphate= TSP (1.10g/kg) in the diet of local cattle resulted in highblood serum P with no difference between them.	260
2008	To evaluate the nutritional quality & preservation status of 4% molasses mixed straw	Addition of 4% molasses and 90 days ensiling of maize straw showed good color, smell, softness, nutritional quality and longer preservation capacity.Suggested that maize stover may be ensiledfor 90 days by adding 4% molasses and 20% water.	261
2008	Effects of nitrogen on yield, chemical composition and nutritive value of dal grass	Urea (240kg/ha), cattle manure (25.7 ton/ha), goat manure (13.2 ton/ha), rabbit manure (7.6 ton/ha) and poultry manure (5.9 ton/ha)have been evaluated of which poultry manure has suggested as a source of N fertilizer for dal grass production.	262

2008	Effect of ureasesources on proximate composition, NH_3-N production, energyvalue of urea ensiled rice straw	Nutritive value of rice straw reported to be improved by adding 5% urea and 5% urease containing plant sources like soybean seed meal, cowpea seed meal and preserved for at least four days under anaerobic condition at 40% moisture level.	263
2008	To assess ensiling rice straw with urea, molasses, soybean mealwith aquatic plants	Results showed that the nutritional values of rice straw has beenimproved by ensiling with supplementation of urea (4%), molasses (2%), soybean meal (4%) and aquatic plants (water hyacinth, azollaand two varieties of duck weeds).	264
2009	Effects of feeding rice straw with woodash extract (WAE) in growingbull calves	Feeding of rice straw mixed with WAE in growing bull calveshave reported to be improved nutritive value and increased digestibility value of rice straw and LWG of animals within 60 days	265
2009	Supplementation of water hyacinth in a rice straw	Wilted water hyacinth (*Eichhornia crassipes*) with rice strawbased diet resulted positive effect on intake and growth of beef cattle.	266
2010	To assess the nutritive values of different varieties of rice straw to develop a feeding system for its efficient utilization	The dry matter (DM), organic matter (OM), crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF), lignin, Ca and P contents of pajam, nijershail, kablabadam, RB 11, BINA5 and BRRI 29 verities of rice straw have been evaluated of whichBRRI 29 has been reported as best straw based on CP, P, OMdigestibility and ME content.	267
2012	To detect the status of fodder cultivation at rural levels	Fodder cultivation is limited at 35% dairy farmers and 65%farmers are not usually cultivate fodder due to limited land.	268
2012	To estimate the arsenic level in rice and rice straw in the arsenic contaminated areas	The concentration of arsenic in rice and rice straw has been reported to be 0.235 ± 0.014 ppm and 1.149 ± 0.119 ppm, respectively, which has recorded as higher levels than the maximum permissible level in drinking water (0.05ppm)	269
2012	Effects ofdifferent levels of RDP onintake, digestibility andMPS by supplementing MOCon rice-straw based diet	Supplementation of RDP from MOC (mustard oil cake)enhanced the intake, digestibility and microbial proteinsynthesis which ultimately increased utilization of low-quality feed resources for developing cost-effective feeding systems on a straw-based diet	270
2015	To detect an alternative source of protein by feeding moringa leaves in ruminants	Moringa leaves have been shown to alter favorably ruminal protein fermentation characteristics thus spare protein by a decreased breakdown /deamination of protein/amino acids that functions as of monensin	271
2015	Chemical composition and nutritive value of water hyacinth	100g water hyacinth contains DM (8.7-9.3g), CP (10.1-11.2g), CF (26.1-27.4g, EE (1.1-18g), NFE (47.2-50.2g) and TA (12.3- 12.4g) which indicates that water hyacinth can be used as feed for ruminants especially during scarcity period.	272
2015	To evaluate tree leaves and natural grasses chemically &*in vitro* gas production	Nutritional variations exist between & among the natural roughages and foliages. Foliages reported as the best and herbs better than natural grasses.Suggested that the potentialsources might be considered prior to feeding the animals	273
2016	To determine the biomass yield, morphological charac-ters and nutritive value of highyield napier cultivars	Results showed that the biomas yield in order from BLRI Napier hybrid > BLRI-Napier-4 > Merkeron > Wruk-Wona > Napier-Japan. The 3rd cutting contained more DM compared to 2nd and 21st cuttings.Higher oxalate in BLRI N-4 and higher CP in MarkEron	274
2016	Effect on growth perform-ance and metabolites in cattle fed withrice straw used as bedding for mush-room	About 10% rice straw of control group replaced by the used bedding rice straw of mushroom cultivation whichfed to treated group for 60 days. The higher reported in treated than control group of cattle, whereas lower valuesof total cholesterol, triglyceride, HDL-C and LDL-Creported in treated than	275

2018	To select best combination of roughage & concentrate based on TMR, better rumen environment& RMF in cattle	The best combination of roughage to concentrate ratio (30:70)has been reported in T5 group (30:70) for better N utilizationto achieve maximum performance through proper feeding which might reflect the gross return of cattle production	276
2018	Preparation of ensilage with WRS treated with BGS and ensiled with molasses to increase nutritional and preservationof straw	Among all the treatments, T_2 (5% BGS= Biogas slurry) and T_3 (10% BGS) have been reported acceptable for preparing ensilage.Ensilage of WRS (wet rice straw) with BGS not only reduced waste disposal and pollution problem but also provide inexpensivefeed components for ruminants	277

Table 6. Trials of different feed formulations for the enhancement of growth and body weight in non-dairy cattle

Year	Major objectives	Major findings	References
1981	Effect of feeding water hyacinth in bullocks	Rice straw, water hyacinth and concentrate mixed diet hasbeen fed to bullocks efficiently	190
1982	Effect of feeding urine treated rice straw	Performance of cattle fed treated paddy straw with animal urine as a source as a source of ammonia.	278
1984	Voluntary DM intake & feed efficiency	Feed efficiency of Nili-Ravi buffaloes has been reported higher than Red Chittagong cattle	279
1986	To utilize sugar cane bagasse as a partial replacement of rice straw in growing crossbred bull calves	Four groups of crossbred (SL × L) bull calves fed with four different combination of feed ingredients with basal diet straw. No significant differences on live weight gain and feed efficiencyin different groups has been reported. However, 50% replacement of straw by bagasse may be recommended for the growing calves.	280
1986	Replacement of straw by sugar cane bagasse	Approximately 50% replacement of rice straw by sugar canebagasse for feeding to young bulls has been recommended by nylon bag technique.	281
1986	To detect the digestibility of DM and OM of rice straw treated with poultry excreta or urea	Poultry excreta up to 30% has been reported to be superior to ureain increasing the digestibility of straw in cattle. Supplementation of leucaena leaves decreases the digestibility of straw probablydue to presence of toxic factors (mimosine) in these leaves.	282
1988	Effect of feeding urea-treated straw on CP level	The CP has reported to be increased significantly from 2.99%in untreated straw to 5.7% with 1 liter moisture level at 6% urea level in 6 days.	283
1988	To detect the effect of DMI from different sources of roughageson LWG in heifers	The initial LW of Sahiwal, Red Sindhi, RCC, SL x L heifers have reported as 211,154, 148 and 166 kg and the daily DMI / 100 kg BW as 2.42, 3.19, 3.36 and 2.98respectively. The DMI has beenreported higher in younger animals of lower BW.	284
1988	To detect the effect in vitro digestibility	Effect of addition *Leucaena leucocephala* to rice straw ensiled with poultry excreta and/or urea on its *in vitro* digestibility	285
1989	To compare the LWG, DM intake and feed efficiency of bull calves fed with urea supplemented,urea treated and urine treated rice straw	Significantly higher LWG and feed efficiency have been reportedin all the three treated groups, urea supplemented (4.67kg & 25.47), urea treated (7.5 kg & 17.61) and urine treated (7.0kg & 16.27) ascompared to untreated control group (2.67 kg 41.38) respectively.However, significantly higher DM intake has been reported in urea-treated group (131.39kg) in compared to urea supplemented (117.3kg), urine treated (113.67kg) and untreated control (108.88kg)	286

1990	To detect the benefit of adding CaOH + urea or NaOH + urea treated ensiled barley straw	CaOH or NaOH with urea treatment of straw, urea hydrolysis has inhibited and nitrogen content has increased compared to controlurea alone treatment. No benefit has been reported of adding urea with CaOH or NaOH in ensiled straw.	287
1991	To detect the effect on voluntary intake of dried stover mixed with other feed ingredients	The voluntary intake of maize stover (3kg / bullock) chopped and soaked overnight and mixed with other feed ingredients have been reported higher when mixed with paddy straw (0.75kg/bullock) + mustard oil cake (0.25kg / bullock).	288
1991	To detect the perfor-mance of growing cattle fed 1-2% urea water soaked rice straw	Highest LWG has been reported in growing cattle fed with 2% urea soaked rice straw supplemented with rice polish (900g), molasses (100g) and common salt (50g) per head per day. However, 1% ureasoaking rice straw has been suggested with supplementary feed.	210
1991	To compare the natural protein supplement with urea-treated rice straw on LWG in calves	Highest daily average LWG has been reported in urea untreatedmustard oil cake treated group (302.3g) in comparison to 1% (273g) and 2% (201.6g) urea-treated groups of bull calves.The natural protein (mustard oil cake) supplement has proved betterthan urea-treated rice straw, however, it is expensive	289
1991	Leucaena alternative to fish meal in lactating cows	Performance of lactating dairy cows has been evaluated by feeding *Leucaena leucocephala* as an alternative protein supplement to fish meal	290
1993	Effects of feeding urea-treated straw & urea directly in bullocks	The daily LWG, feed efficiency, CP and CF digestibility havebeen reported to be significantly higher in animals fed with urea-treated rice straw than feeding urea directly to animals for 75 days.	291
1993	To compare the feed values of Napier, Para and German grasses	Crossbred (Sahiwal × Local) calves between 448 and 538 days of age have been used to compare the feed values of these grasses. No significance difference has been reported of feeding these grasses in growing calves	292
1993	To detect the effect of feeding water-hyacinth (WH) in crossbred bull calves	Highest LWG recorded in calves fed with urea-treated rice straw (UTRS) + WH (ILW 50kg &FLW 83kg) in comparison to fed untreated rice straw + green grass (ILW 58kg & FLW 67kg) andfed with UTRS + green grass (ILW 58kg & FLW 77kg). [ILW = initial live weight and FLW = Final live weight]	293
1994	Effect of feeding urea-soaked andurea-ensiled rice straw inbull calves	Considering the labor, tediousness and acceptability to the farmers,treatment of straw by soaking in urea-water has been reported asbetter than urea-straw ensiling method.	294
1994	To determine the optimum level of urea treated rice straw (UTRS) for heifers	LWG has been reported to be higher with UTRS than urea supplemented straw at all levels but 6% level of UTRS showed best performance on the growth of. heifers. About 42.5% higherLWG has been reported with UTRS than control.	295
1994	To detect the growth and LWG performance of local calves by feeding different sources of proteinin diets	The diets of growing calves contained UTRS, green grasses andwheat bran as basal feed with either (kg/d) fish meal (0.15), fish meal + Leucaena (0.5) or only Leucaena (1.0). Fish meal showedpositive effect on the performance (LWG 160 and 143 vs 101g/d)	296
1994	To detect effects of UMB with straw diet in cows	The UMB supplementation to rice straw diets has clearly altered the eating and rumination behavior in cows.	297
1994	To evaluate the different types of urea-molasses feeding technologies at sustainable level in cattle	Feeding of urea treated straw (UTS), multinutrient blocks (MNB),direct feeding of urea-molasses solution (UMS) and urea mixedstraw (UMS) have been evaluated.Farmers who fed UTS and MNB discontinued when supply of input whereas feeding of UMS and UMS continued even after withdrawn of support.	298
1994	Effect of feeding urea/high protein to breeding bulls	Results showed that the excessive quantities of urea in the urinefluid of high protein fed cows may be detrimental to the viability (1994-98)of spermatozoa.	299

1995	Leucaena alternative to fish meal in calves	Performance of calves has been evaluated by feeding *Leucaena leucocephala* as an alternative protein supplement to fish meal	300
1995	Influence offeeding urea-treated ricestraw with fish meal ondressed carcass weight in bull calves	1.5% urea-treated rice straw fed ad libitum and supplemented with different levels of fish meal (g/day) to the bull calves more than one year old for 120 days. Results showed that there has little effect ondressed carcass weight supplemented more than 50g fish meal inbull calves.	301
1995	Effects of feeding between urea andTil oil cake + fish meal in local bull calves	The 40% of CP of the ration A (Til oil cake + Fish meal) has beenreplaced by urea nitrogen (0.06 kg/day) in ration B and C. Overall LWG has been reported with Gr. A (20.7kg) in comparison withGr. B (13.0kg) and Gr. C (12.0kg).	302
1995	To detect the effect of feeding UMB on rice straw intake and biochemical changes in cattle	Rice straw supplemented UMB containing 3%, 6% and 12% urea for 5 days. The voluntary intake of rice straw, ruminal pH, ammonia nitrogen and BUN increased significantly in UMB supplemented cattle in comparison to control. Maximum feed intake recorded up to9% UMB but decreased with 12% UMB	303
1995	To use cow feces *in vitro* digestibility	Cow feces has been used as a source of microorganisms for *in vitro* digestibility assay with effect of stages at different fecal concentrations & incubation periods.	304
1996	To evaluate the nutritional value of local grasses as a feed for ruminants	Certain naturally growing local grasses like durba, kanaibashi,kalimona, heicha which are available during dry and wet seasons in Bangladesh which have been used for feeding ruminants.	130
1996	To find out the percentage of smallholder farmers adopted urea-treated rice straw feeding in their cattle	About 73.1% smallholder cattle farmers have adopted urea-treatedstraw, 4.8% urea molasses block (UMB), 14.1% urea +molasses+ untreated straw and 9.0% urea-treated straw + UMB to feed theircattle. The urea-treated straw and UMB have been shown profitable.	305
1996	Effect offeeding tea waste in aparts of the concentrate in the zebu bull calves	The sun dried tea waste collected from local restaurant has been used to feed zebu bull calves @ 100g/calf/day along with 900g concentrate showed higher LWG of 314.g / day than 239.8g LWG reported with only feeding of 1000g concentrate.	306
1996	To use cow feces in vitro digestibility	Cow feces has been used as a source of microorganisms *in vivo*digestibility assays of forages.	307
1997	To determine theminimum level of leucaena required for performance of bulls	Four levels of leucaena, namely 0 (0%), 2kg (10%), 4 kg (18%) and 6 kg (27%) of dietary DM intake have been supplied to nativebullsof 355 kg BW. About 20% leucaena would be required on a rice straw diet to improve animal performance.	308
1997	To detect the effect of different levels of RDP in straw based ration on purine derivatives excretion & microbial N supplyin cattle	Rumen degradable protein (RDP) is required for microbial proteinsynthesis. Four formulated rations at the same amount of energy but varying RDP include 50 (U0), 75 (UI),100 (U2) and 159 (U3) % level of RDP have been used for trails. Rumen NH_3-N concentration increased from 43 to 130 mg/L in response of RDP intake. Purine derivatives excretion increased significantly withincremental level of 203g RDP/d (U2) intake and positively correlated with amount of RDP intake.	309
1997	To detect the effect of rice meal feed (RMF) on straw DM intake in bulls	Rice bran commonly available in Bangladesh is a mixture of hulls (60%), bran (35%)and polishing (5%), referred here as rice meal feed (RMF). RMF supplementation had no significant effect on thestraw DM intake. The inclusion up to 2 kg level (25% of the DMI)has been recommended for feeding.	310
1997	To detect the effect of feeding green grass with and without rice straw *ad libitum*	Growing bulls of 304 kg BW and 32 months old fed rice straw withcombination of green grass at 0, 2 kg, 4kg and 6 kg. All level of grass supplementation decreased the straw DM intake and rumenNH_3-N concentration increased with the increasein grass level &ranges from 8-46 mg/liter. Green grass supplementation is often recommended for optimization of rumen environment of a straw diet but no such beneficiary effect observed up to 6 kg level.	311

1997	Effectof UMS on DM intakeand digestibility andreduction of in vivo methane production in growing bulls	Results showed that the feeding of rice straw with 15% molassesand 3% urea as an intimate mix (UMS) in growing bulls increased its digestion and intake in association with a reduced methane emissions in the rumen. When compared with that of UMB lick, theUMS also resulted highest straw intake and digestion and LWG andaccordingly UMS has been suggested for feeding in ruminants.	233
1998	To use cow feces in vitro digestibility	Cow feces has been used as a source of microorganisms *in vivo* digestibility assays of forages.	312
1998	To investigate the available feeds and feeding practices of livestockby the farmers at rural levels	Rice straw and green grass are the roughage feeds supplied by the farmers to their animals at village levels. Rice polish, wheat bran mustard oil cake are supplied as concentrate. Straw supplied aswhole (dry / wet), chopped (dry / wet), and / or mixed with greengrass. About 90% of the farmers are unable to offer concentrate to their animals due to high price.	313
1998	To compare the effects of wheat bran and rice polish on growth performance& nutrient utilization in growing bullcalves	Three groups (A,B&C) of native growing bull calves of 20-24 months old have been supplied rice straw *ad libitum* along with 1.75 kg green grass and 250g sesame oil cake daily for 84 days. In addition, Gr. A received both wheat bran and rice polish,Gr. B wheat bran and Gr. C rice polish only. The results showed thatreplacement ofwheat bran at 100% level in the concentrate improved feed intake, nutrient digestibility, feed efficiency and live weight gain.	314
1998	To compare the effects of different protein supplements on growth performance and nutrient utilization	Formulated three rations using rice straw, dal grass, wheat bran and supplemented with either coconut oil cake (Gr. A), sesame oil cake (Gr. B) and soybean meal (Gr. C) have been evaluated in bull calvesof 105.7 kg BW for 78 days.Highest growth rate reported with coconut oil cake (TLWG 48.33kg) and utilizestraw more efficiently than those of sesame (41.0 kg) and soybean (44.42kg) oil cakes.	241
1998	To detect the use of rice gruel compared to that of molasses as a source of readily fermentable energy in urea treated straw diet in growing bulls	Three groups of calves fed with urea (3%) treated straw (US), 3% US + 15% molasses (UMS) and 3% US + 30% rice gruel (UGS), respectively for 60 days. Feeding of US showed highest LWG (292 g/d) in comparison to UMS (125g/d) whereas decreasedLWG (-19g/d) in UGS group. However, authors suggested to use rice gruel where molasses not available or costly.	315
1998	Effect of replacing til oil cake by poultry excreta on growth performance and nutrientutilization in calves	Results showed that the til oil cake can be replaced by driedpoultry excreta in bull calves ration without any harmful effect. Approximately 50% replacement of til oil cake by ground driedpoultry excreta has been recommended for growing bull calves	242
1999	Different protein supplement on growth and nutrition utilization in bull calves	Feeding of coconut oil cake, sesame oil cake and soybean meal with a basal diet of rice straw, dal grass and wheat bran have been evaluated in bull calves. Results showed that protein conversion efficiency and growth reported highest with coconut oil cake	316
2000	Evaluation of different ration in bull calves	Maize silage in combination with straw and concentrate mixturehas been suggested for feeding growing animals for better performances. Fresh water hyacinth leaves has also suggested in combination with straw and concentrate	317
2000	Evaluation of pre-and post-partumsupplementationof UMMB to native cows	The UMMB has been supplied to 30 cows from 6 months of pre- partum to six months post-partum period whereas 30 cows servedas control fed only traditional feed. The supplementation of UMMBto cows resulted higher birth weight (14.61kg/12.00), calf LWG(117.0 / 55.0 g/d) but low mortality of calves(0/ 9.0%).	318
2001	To evaluate three types of rations in local bulls	12 native bull calves, 2.5 years old, live weight 139.9kg, divided into three treatment groups, studied for 66 days based on DM basis.	319

2001	Evaluation of feeding ensiled urea-treated rice straw in cross-bed calves.	The highest LWG has been reported in calves of group C fedtreated rice straw and water hyacinth in comparison to Group B fed urea-treated rice straw without water hyacinth and Group A fed only untreated rice straw.	320
2001	To compare the effects of feeding normal protein (NP), bypass protein (BP) and BP + bypass energy (BE) in two years old native bull calves	Three experimental diets consisted of basal ingredients include: ricestraw, dal grass, wheat bran, molasses and urea supplemented with Til oil cake (normal protein : OC diet), fish meal (bypass protein, FMdiet) and the mixture of fish meal and broken rice (bypass protein andbypass energy, FM + BR diet). Results showed that significantly highertotal feed intake (kg/d) fed on FM + + BR diet (3.71) compared to thosefed on FM diet (3.06) and on OC diet (3.07). So, supplementation of straw-based diets with FM + BR improved feed intake, fiber digestibilityand LWG in bull calves.	321
2001	To detect the effects of UMMB supplement on LWG and ovarian activity of zebu heifers	The supplementation of urea-molasses-mineral block (UMMB) withnormal diet heifers has significantly increased LWG from 49.45 ±10.23 to 64.24 ± 8.59 kg. The ovarian activity (progesterone assay) did not show any significant LWG and ovarian activity has delayed.	322
2001	Evaluation of graded levels of cotton seed cake (CSC) on a urea-molasses -strawbased diet in bulls	It has been reported that unless the proteins in being protected from rumen degradation, addition of CSC to UMS diet would have little nutritional or economic advantages. Supplementation of CSC had little beneficial effect the overall productivity of the animalsbased on UMS based diet in growing	323
2001	To detect the effect of feeding water hyacinth on the performance of indigenous heifers	Highest daily LWG (0.128kg/d) recorded in heifers fed rice straw (RS) + water hyacinth (WH) + green grass (GG) at the ratio 1 : 0.5 : 05 in comparison to 0.086 LWG fed with RS + GG (1:1), 0.078 fed with RS + GG (1 : 1) and 0.044 LWG fed with only fed RS. Partial replacement of GG (1:0.5:0.5) by WH has suggested.	324
2002	Effect of feeding UMS and wheat bran on LWG in steers	Feeding of mixed UMS (3.5kg/d) and wheat bran (0.5kg/d) havebeen reported to increase the live weight gain (LWG) @ 418.75kg /animal/day for 4 months study period in zebu steers	325
2002	To evaluate the nutritional status of locally available feedstuffs in Bangladesh	Nine roughages and nine concentrates have been evaluated withrespect to the chemical composition, organic matter digestibility (OMD), ME and rumen degradable protein (RDP) content. Amongthe roughages, straw showed much lower of CP and RDP valueswith high NDF content.	326
2002	To detect the effect of urea and/or soybean treated rice straw on feed intake and growth in growing native bull calves for 56 days	Three groups of bull calves fed with 4% UTRS, 4% urea + 4% soybean treated rice straw (STRS) and 4% urea + 6% STRS. Results showed that 4% UTRS with 2kg green grass + concentratedidn't produce any adverse effect on fed intake and growth. Soybeanmeal 4 or 6% added to the UTRS caused rapid hydrolysis of urea, which resulted an improvement in nutrient digestibility and better utilization of rice straw for growth of growing bull calves	327
2002	To evaluate of some aquatic plants	Mineral composition, in-vitro gas production and in situ degradation measurements have been evaluated in some aquatic plants.	328
2003	Growth performance of growing bull calves	Growth performance of crossbred growing bull calves fed bysupplementing molasses with straw based diet and conventionalconcentrate have been reported.	329
2004	To detect the effect of phenolic compounds of legume forages on OMD and ME	The presence of phenolic compounds and their effect on organicmatter digestibility (OMD) and metabolic energy (ME) content in acacia, albizia and sesbania have been reported to be containedhigher CP and ME which has been suggested to use as supplement to ruminant fed low quality forages.	257

2005	Effects of protein source bacteria,NH_3-N & VFA in the rumen of cattle	This research has concluded that among the protein sources, soybean meal has contributed most to the bacterial population growth, ammonia and VFA production compared to those of fish meal and leucaena leaf meal in cattle.	330
2005	Effect of differentdietary energy incrossbred heifers	The effect of different dietary levels on the performance of cross-bred dairy heifers have been reported.	331
2005	Digestive performances of cattle and buffalo calves	The nutrient intake, digestibility and growth fed on maizesilage and concen-trated mixture have been compared betweencattle and buffalo calves	332
2007	To identify types of rations have used in feeding trials in cattle	Three types of rations have been identified as (a) dry straw, (b) urea-molasses-straw and (c) grass silage based on basal roughages used in different feeding trials to evaluate live weight gain and FCR	333
2007	Influence of age on the intake,digestibility & FCR in native bull calves	Silage with supplemented concentrate feeding in three age groups of bull calves showed that the age variation above six months had no significant effect on the intake and digestibility of feed or feedconversion ratio	334
2007	Effect of feeding UMB in heifers	The effect of feeding urea molasses block (UMB) on the performance of heifer under farm condition have been reported	335
2007	Effect of Cu supplemen-tation on nutrient utilization & Cu status in bull calves	Supplementation of copper in diet has improved only copperretention and blood copper status other than live weight gain, feed intake, nutrient digestibility, TDN and apparent and trueabsorption of copper	336
2007	To determine the calcium, phosphorus and ME content of four foliages	Higher Ca content has been reported in Gliricidia (0.60%)compared to Ipil-ipil-1 (0.44%), Ipil-ipil-2 (0.54%) and Calliandra (0.48%), while P (0.23-0.32%) content was not significantly different.	337
2008	To evaluate the three concentrate mixture in RC heifers	Highest LWG (25kg) has been reported with concentrate mixture consisting of wheat bran (21.7%), rice polish (22.42%), cracked maize (21.62%), mustard oil cake (13.15%), soybean meal (17.03%), DCP 2.0% & salt (2.0%) for 90 days trial.	338
2009	To investigate the bio-availability of phosphor-us (P) sources in feed ingredients of cattle	From analysis of six different groups of rations it has concludedthat bone meal (00.46 g/100g), mustard oil cake (00.44g/100g),sesame oil cake (0.45g/100g and poultry litter (0.45g/100g) may be used as phosphorus supplemental in cattle ration.	339
2010	UMB on growth perfor-manceof RCC×HF bulls	The effect of urea molasses block (UMB) on the growth performance of Red Chittagong and Holstein-Friesian crossbred bull calves have been reported.	340
2010	Performance of buffalo & cow calves supplemented with UMB with straw based diet	The cow calves (1 year & 8 month age and 111kg BW) and buffalocalves (1 year & 10 months age and 89 kg BW) have been fed UMB0.5 kg/d/animal for 60 days with straw based ration. The BWG hasbeen reported to be higher in buffalo (0.40 kg/day) than cowcalves (0.36 kg/day) by feeding UMB with straw based diet.	341
2010	To investigate the use of Triple super phosphate (TSP) as a source of Phosphorus in growing bulls	Four groups of local growing bulls of 30 months old with 150 kg BW are used for this trial for 60 days. TSP has supplied as 0 (T-0), 0.5 (T-1), 1.0 (T-2) and 1.50 (T-3) kg/100 kg diet. The mean serum P levels fed diet T-1, T-2 and T-3 has been reported P levels fed diet T-1, T-2 and T-3 has reported significantly higher than that of animals fed on diet T-0. Therefore, supplementation of0.21% P from TSP may be used in growing bulls.	342

2010	To detect the nutrient digestibility and growth of native bull calves by feeding urea and urease enzyme sources treated rice straw for 75 days	Digestible nitrogen free extract (DNFE), digestible organic matter (DOM), total digestible nutrient (TDN) contents and LWG have been reported to be significantly higher in diet of 3.5% UTRS + 2.5% chick pea or 2.5% midden soil treated ensiled straw. Suggested to feed such diet consisted of UTRS + 3.5% chick pea to growing bull calves after 7 days of ensiling.	343
2010	Effect of protein density of conc mixture on growth performance of RC heifers	The CP concentration of 20% in conc mixture containing 10.5 MJ reported cost effective with the UMS-based diet of RCC heifers for better nutrient digestibility and growth	344
2012	To detect the effect of fish meal on growth & reproductive performa-nce in crossbred heifers	Supplementation of fish meal (5-10% of concentrate) with rice strawbased diet have been reported as a best option to obtain better performance in terms of DMI,digestibility, daily weight gain and reproductive performance especially estrus in crossbred heifers.	345
2013	To detect the feed efficiency of breeding bulls	Residual feed intake has reported to serve as an appropriate selectiontool for improving feed efficiency of breeding bulls without adverselyaffecting early growth performance of the progeny.	346
2013	To evaluate the quality of rice straw through treatment with urea and midden soil for large ruminants	Midden soil has been reported to be a good source of urease enzymewhich is found in lower part of the cow dung pit. The DOM, CP, DCP,DNFE and TDN contents have been reported significantly higher in straw based diet treated with 3.0% urea and 5.0% midden soil. Suggested to use rice straw treated with 3.0% urea and 5.0% midden soil for feeding	347
2013	To use of wastage with poultry droppings and oat forage as a cattle feed	Results showed that ensiling oat forages up to 60% caged layer excretaand 5% molasses significantly improved the nutritional values of wastage with oat forages.	348
2013	Effect of particle size of para grass and maize grain on crossbred heifers	The effect of particle size of para grass and maize grain on intake,digestibility and growth performance of crossbred heifers have been reported	349
2014	To compare the effect of feeding between molasses and rice gruel on growth performances of growing calves	Two groups of calves of 20 months of age with mean BW193.3kg have been used for feeding of 2% molasses of concentrate mixtureand rice gruel @ 2 liter/ 100 kg BW once in a day for 60 days. No significant differences has been reported between two groups in thegain of body weight.	350
2015	To detect the effect of single and twice times drenching of soybean oil for growth perfor-mance in growing bulls	Each of the bull calf has been drenched with Soybean oil @ 3g/kg BW single and 2nd dose after 30 days after the first dose. All the cattle fed *ad libitum* straw based diet supplemented with urea-molasses (3% urea, 20% molasses) plus a concentrate mixture. A single dose drenching of vegetable oil at farmer level resulted better growth performance in cattle.	351
2015	To detect the effect of UMS and UMS + Conc. feeding in Brahman (L × B) cross bulls	Feeding a mixed concentrate as a supplement to a UMS diet increasedthe growth performance of crossbred (L × B) bulls. Replacing 50% of an all concentrate diet with urea-molasses impregnated straw reducedgrowth rate only slightly, led to proper feed conversion.	352
2015	To detect the effect of feeding matikali on feed intake, digestibility and growth rate in local bull calves	Indigenous bull calves, aged between 2 to 3 years with average liveweight 83.4 kg have been used for feeding diets with matikali (*Vigna mungo*) to detect the feed intake,digestibility and growth rate. Supplementation of straw-based diets with vigna hay improves linearimprovement of feed intake, nutrient digestibility and LWG in calves	353

2015	To detect the effects of genetic and non-genetic factors on growth traits of crossbred calves	Both the genetic and non-genetic factors like season, sex, year of birth, had no significant effects on growth traits in crossbred dairy cows. But year of birth and dams' milk yield capacity have been reported to be played significant role for the considered growth traits of calves.	354
2016	To detect anthelmintic efficacy of neem & ata leaf& effect on milk yield& LWG in cows	The anthelmintic efficacy against gastro-intestinal parasites in lactating cows in order of albendazole > neem leaf > ata leaf. Increased milk yield has been reported significantly ($p < 0.01$) after 28 days of treatment. No significant differences on LWG in the three treatment groups	355
2017	To find out the suitable ration/diet for the rapid growth and fattening of the cross-bred bull calves	Highest LWG (25.33kg) in crossbred bull calves has been reported with a ration (g/100g DM) composed of rice straw (16.45), green grass (29.62), crust maize (29.62), wheat bran (3.62), rice polish (3.62), mustard oil cake (13.15) and common salt (3.92).	356
2019	Effect of protein rich ingredients into conc. dieton BWG in heifers	Feeding of soybean meal and mustard oil cake added in concentrate with para and German grasses as basal roughage resulted 16% higher LWG than control heifers. Protein supplement also increased thegrowth measurements and blood serum status.	357
2020	To evaluate the effect of conc supplement on growth, milk yield and reproductive response in crossbred cows	Results showed that supplying an additional amount of concentrate to the cows before and after two months of freshing had a positive influence on milk production as well as reproductive performance.Basal diet – 22 kg green fodder (Para : German= 2 :1) and 2.0 kgconc (wheat bran 82.28, mustard oil cake 13.72, salt 3.7 and DCP 0.3%	358

Table 7. Effects of different feed formulations on productive and reproductive performance of dairy cattle

Year	Research objectives	Major findings	References
1969	To evaluate the economical limited roughage feeding	Limited roughage feeding would be economical provideda certain minimum level (1% hay equivalent) of roughage in the rationof lactating cows is maintained.	359
1974	Effect of voluntary rough-age intake and its economic influence on milk yield in cattle and buffaloes	The DM intake and feed efficiency of Murrah buffalo have been reported to be higher than cattle both the Sahiwal and Red Sindhi breeds. The feed cost in buffaloes in terms ofmilk production has not that much high which could possibly compensate higher feed cost.	360
1980	To compare the effect onmilk production in lactating cows fed 3 different grasses	German, napier and para grasses have been fed ad libitum to lactating cows to detect their effects on milk production. Feeding of German grass caused better result in respect of quality and quantity of milk in comparison to Napier andPara grasses	361
1982	Effect of feeding UTS on Milk yield composition in lactating cows	The milk yield and milk fat (%) increased due to feedingUTS in lactating cows but it has no effect on solids-not-fat (%) and total solids (%). Feeding of UTS has increased digestibility, utilization of straw and as a source of NPN.	362
1984	Effect offeeding urea-treatedrice straw (5%) on milk constituents of Pabnavariety cows	Two groups (A & B) of cows, of which cows of group A fed urea-treated rice straw and group B fed untreated rice straw. Higher fat (%) has been reported in urea-treated cows (5.7%) in comparison to cows fed untreated straw (4.76%). The SNF and total solids did not differ significantly.	363
1987	To detect the effect of fish meal supplement on milk of lactating cows	Fish meal has been supplied in three different groups ofcows resulted higher final LW (kg) and milk butter fat (g/kg) in cows fed 600g (198kg; 50g), foll-owed by 500g (161kg; 49g) and 400g (178k; 41g) fish meal, respectively.	364

1988	Effect of feeding water-hyacinthon milk yield in lactating dairy cows	Feeding of rice straw (RS) & German grass (GG) (1:1), RS + GG + water-hyacinth (WH) (1 : 0.5 : 0.5) and RS+ WH (1 : 1) in lactating cows insignificantly increased up to 192.9,182.5 and 197.5 ml/liter, respectively.	365
1990	To detect the effect of different levels of fish meal in cross-bred dairy cows in late lactation	Fish meal levels 0, 400 and 800 g /day/cow have beensupplemented in crossbred dairy cows in the 8.5 monthsof lactation and continued for 2 months with straw baseddiet resulted in increased milk yield and milk protein withup to 400g/head/day fish meal supplied group of cows.	366
1990	To detect the effect of different levels of fish meal in Pabna variety at early lactating cows	Fish meal levels 100, 200 and 300 g/cow/day have beensupplemented at 3 weeks of lactation stage on the basal dietincludes 5% UTS, green grass and wheat bran. The resultssuggested that 200-300g/day fish meal in UTS based diet may be prescribed for beneficial effects.	367
1990	Effect of ammoniated straw on milk yield in native lactating cows	Comparatively higher average milk production per day has been reported with ammoniated straw supplemented cows 0.52 and 0.57L/cow/d) in comparison to non-supplementedcows (0.45 and 0.46 L/cow/day)	368
1990	Effects of feeding urea-treatedrice straw on milk composition of cows	Milk composition especially protein, fat, ash, total solids and solids-not fat content have been reported to be increasedsignificantly in cows fed with urea-treated rice straw thanuntreated rice straw that increased the quality of milk.	369
1990	Effectof feeding urea-treatedrice straw in native cows	The effect of feeding urea treated and untreated rice strawwith undegradable protein on voluntary feed intake, milk yield and body weight changes of local cows have been reported	370
1991	To investigate the milk production, disposal pattern and marketing	An average of 34.2% families have lactating cows and an average of 1.68 liter milk is produced / cow. Out of total milk production, 58% of milk is consumed, 41% sold and 1.0% distributed.	371
1992	To compare the effect of fish meal and wheat bran on lactating cows	Insignificantly higher av milk yield (0.75 and 0.71 L/d), butter fat (79 & 75g/kg), milk protein (52 and 47 g/kg) and LWG (0.16and 0.12kg/d) have been reported in cows fed with fish meal incomparison to cows fed wheat bran, respectively. So, wheat barn can replace the costly fish meal in lactating dairy cows.	372
1992	Effects of feeding ammo-niated rice straw supple-mented with UMB licks	Comparatively higher DM intake and milk production in lactatingcows fed with ammoniated rice straw supplemented with urea molasses block (UMB) lick than untreated and supplemented control lactating cows	373
1993	To detect the effect on LWG and milk yield in lactating cows fed urea-treated rice straw	Results showed that the average milk yield reduced (2.96 to 2.68, 4.13 to 3.62 & 3.46 to 3.23 kg/d) but LWG increased for dairy cows by feeing urea treated rice straw. The cost and return analysisshowed negative result and found uneconomic for lactating cows	374
1993	To determine the urea level in milk in lactating cows fed urea treated & untreated rice straw	The urea level in the milk of lactating cows fed with urea treated rice straw increased (27.07-59.97 with an average 35.29 ± 1.87 mg/100ml) significantly ($p<0.05$) in comparison to lactating cows fed untreated rice straw (1.39-39.57 with an average 24.16 ±5.13 mg/100ml)	375
1994	Effect of feeding UTRS incomposition of milk in lactating cows	Results showed that feeding of UTRS in lactating cows increased the gross energy value (3.28 vs 3.05 MJ/kg), milk fat (43.40 vs 38.80g/kg) and solids-not-fat (90.0 vs 87.20 g/kg) in comparisonto feeding of untreated rice straw, respectively.	376
1994	Effect of supplementing ureamolasses block lick (UMBL) on performance mance of cows	The feeding UMBL with straw based diet improved the dailymilk yield, extended lactation period, shorten dry period and higher calving rate compared to non-fed UMBL cows. The higher birth weight of calves of dam fed with UMBL (16kg) in comparison to 14kg in dam without UMBL.	377

1994	To detect the effects of genetic and non-genetic factors on milk yield & birth weight of calves	Highest milk yield has been reported in the pure Friesian cows followed by and Sahiwal at CCBSDF. The average dailymilk yield has been Jersey reported lowest in first lactation and gradually increased up to 8th lactation. Male calves hadhigher birth weight than female calves	378
1995	Effectof feeding UMS onmilk production and its economics on Pabna variety lactating cows	The effects of feeding UMS on milk production has been studied on Pabna variety lactating cows for 60 days. Cows fed UMS as a replacer of dry straw increased daily milk yield by 1.37 liter which has reduced the daily requirement of 1.0 kg /cow concentrate.	379
1995	To compare the effect on milk yield between cows feeding with rice straw plus legume and only legume as a control in the bathan	In addition to the basal diet, both the groups have also supplied with 4.0 kg/cow/day concentrate. Both the initial and final LWG and daily yield (liter/day/cow) have been reported to be increased significantly in 'rice straw & legume' fed group (338.06/344.33kg and 8.24/8.64L) than only legume fed group (329.87/330.25kg and 7.68/7.74L) respectively of lactating cows. Feeding of straw@ 2.5 kg/day/cow has reduced legume consumption @ 12kg/d/cow.	380
1996	Effect of feeding of urea-treated rice straw + fish mealon induction of estrus in crossbred heifers	The crossbred (Sahiwal × Pabna variety) heifers aged 4 years which have been fed 5% urea-treated rice straw supplemented with 150g of fish meal daily had shown estrus but those heifersfed ≤ 100g fish meal did not show any signs of estrus during the 14 weeks of experiment.	381
1996	To detect the effects of parity and lactation stages on milk yield in Sindhi cross cows	This study has reported significantly highest milk production in Sindhi crossbred cows at early lactation up to 90 days in allthe three parities (416.40, 375.0 & 299.20L) in comparison with mid of 90-180 days (276.85, 249.4 & 263.15L) and late of 181-270 days (183.85, 156.6 & 174.7 L) lactation stages.	382
1996	To compare the DMI & milk yield between cross-bred& native cows	The dry matter intake and milk yield of local and crossbredcows have been reported to be 4.10% and 3.10% live weightand 2.5 liters and 9.7 liters per cow per day, respectively.	383
1999	To evaluate the effect of UMMB on reproductive performance of post-partum zebu cows	Feeding of urea molasses multi-nutrient blocks (UMMB) with10% urea @ 250g/day/cow along with the traditional feed from calving to 6 month of post-partum period resulted better reproductive performance of zebu cows under village conditions.	384
1999	To evaluate the effect of replacing conc. by urea-molasses in the diet of cross-bed dairy lactating cows	Highest milk yield (4.4 L/cow/d) has been reported with 7.0% replacement of concentrate with urea-molasses in comparison with 9.6% (3.0 L/c/d), without replacement (2.8 L/c/d) and 19%(2.1L/c/d) replacement during the 91 days study period. Overall milk composition has reported better in only concentration feeding cows.	385
2000	To explore the extent of urea level in milk and blood of cows fed with three different types of urea molasses blocks	Three types of blocks such as medicated urea-molasses-mineral block (MUMMB, 7% urea), urea-molasses-mineral block (UMMB-1, 7% urea) and UMMB-2 (21% urea) have been used @ 250g / cow/dayto detect urea level in milk and blood of native lactating cows. Both the feeding of UMMB -1 and UMMB-2 increased the urea levels in both in the milk and blood significantly in comparisonto the initial levels.	386
2000	Effects ofurea molasses multi-nutrient blocks (UMMB) on BW and milk yield in native cows	The UMMB with 6, 8 and 10% of urea have been used @ 250g/d/cow resulted higher LWG, milk yield and BCS with supplemented UMMB contained 10% urea than other groups. The UMMB with10% urea may be recommended up to 6 months of post-partum formore milk yield and better health of native cows.	387
2001	To detect the effects of feeding UMB on milk yield and LWG in lactating crossbred cows	Four levels of UMB: 0 (T), 350 (T1), 500 (T2) and 650 (T3) g/d/cow have been supplied to lactating cows resulted similar buthigher av. lactation milk yield (6.03 & 6.05L) in groups T2 & T3 in comparison to T (4.80L) and T1 (4.86L) groups.	388

2001	To detect the beneficial effect on milk yield by feeding supplementary concentrates containing more UDP	Three groups of native lactating cows, of which two groups have supplied un-degradable protein (UDP) concentrate by keeping one group as untreated control. Feeding of supplementary concentrate containing more UDP showed higher milk yield (1.79 & 1.69 L/d/c) than untreated (1.32L/d/c) native lactating cows.	389
2001	Effectsbetween mustard andsesame oil cake on milk yield and LWG in lactating dairy cows	The sesame oil cake supplement resulted higher LWG (0.77; 0.35 kg/d) and milk yield (4.39 ; 4.17 L/d) than supplement of mustard oil cake (MOC) in dairy cow ration, respectively. However, MOC (9.97%) could replace costly sesame oil cake and reduce the milkproduction cost in the dairy cows.	390
2002	To detect the effect of legume forage supplementation on milk yield in Pabna variety cows	The milk production has been reported to be increased in Pabna variety lactating cows supplemented with legume forage to rice straw-based diet from 2.70 liter to 3.30 liter/day /cow. Only 20% level of forage to rice based diet has been .recommended	391
2002	Effect of feeding of UMS on productive and reproductive performance of native cows	The comparatively higher average milk yield (2.52 / 1.83 L/d) and calf LWG (139.35/ 96.99 g/d) and lower values of average calving to 1st service interval (113.0/182.0 days), average calving to conception interval (134.0/210.0 days) and No. ofservice/conception (1,94 / 2.11) have been reported, respectively.	392
2002	To detect the effects of restricted and *ad libitum* feeding during last trimester of pregnancy on the performance of cows	*Ad libitum* feeding of cows at pregnancy caused to deposit morefat and gain weight at pre-calving resulted less milk yield during post-calving. Feeding *ad libitum* during last trimester of pregnancy is neither economic for getting maximum milk yield nor for calfgrowth rate and MAFF recommended level of dietary energyduring third trimester of pregnancy could be applied in cows.	393
2003	To detect the effects of supplementing UMB & UMMB on LWG, BCS, milk yield & composition in dairy native cows.	The initial and final LW (kg) of Gr. A (Control: 239.3; 238.3), Gr. B (UMB: 205; 206.8) and Gr. C (MUMB: 240; 242.6), and initial and final milk yield in liter between 31-45 days of Gr. A (2.5 ; 2.0), Gr. B (2.5 ; 3.03) andGr. C (2.5 ; 3.42) have been reported. Both LWG and milk yield have increased in both the supplemented groups in comparison to control group.	394
2003	To compare the effect of concentrate supplement with control on milk yield in RCC	Out of the three groups, Gr. A has supplied wheat bran 375g, sesame oil cake 125g, fish meal 75g and molasses 20g, and Gr. B has received wheat bran 375, sesame oil cake 125g,molasses 104g and urea 11g and Gr. C served as untreated control. The higher TLWG (kg/cow) and milk yield (L/C/d) have been reported in Gr. A (6.0 & 2.2) than Gr. B (4.0 & 2.0) and Gr. C (1.5 & 1.8), respectively.	395
2004	Effect of UMB supplementation on post-partum reproductive performance in crossbred dairy cows	Two groups of crossbred cows, of which one group receivedcontrol diet and another group received UMB supplementeddiet. The UMB supplemented with basal diet has improved thereproductive efficiency and the better performance reported inSahiwal cross than Holstein cross cows.	396
2004	Effect of feeding UMMB onhealth and productive performance in zebu lactating cows	The urea molasses multi-nutrient blocks (UMMB) has been fed @ 250g/cow/ day to zebu post-partum cows from the dateof calving to the date of confirmation of pregnancy. Positiveeffect of feeding UMMB has been reported on LWG, milkyield, BCS in cows and LWG in calves under rural condition	397
2004	To detect the effect of feeding UMMB on reproductive performance of post-partum native cows	UMMB @ 250g/cow/day has been fed from the calving that decreased the days of calving to 1st service (130 & 194), calving to conception (162 & 199) and calving interval (443 & 480) incomparison to their respective control cows. UMMB supplement with straw based diet has appositive effect on reproduction.	398

2004	Effect of feeding UMMB onhealth and productive performance of zebu lactating cows	Out of the two groups of cows, Gr. A has fed with rice strawbased basal ration whereas the Gr. B cows received UMMB @ 250g/d/c in addition to basal ration. The higher LWG in cows and calves, BCS, milk yield (1.93 / 4.43L) and DMI in comparison to control Gr. A	399
2004	Effectsof pre-and post-partumenergy level and feeding pattern on the performanceof crossbred cows and their calves under farm conditions	Two groups of selected dairy cows, of which one group fed 30% less and another group 30% more energy than MAFF's (1984). At post-calving all cows fed same diet *ad libitum* toassess the effects of feeding during pregnancy on their performance. This study reported that 30% less dietaryenergy level of MAFF's (1984) recommendation during thelast trimester of pregnancy not suitable for crossbred cows.	400
2005	Effect of supplement of UMB lick in dairy cows	The effect of feeding supplementing UMB with straw-based diet on productive and reproductive performance of cross-bred dairy cows have been reported.	401
2005	To detect the effect of UMB feeding on productive and reprod-uctive performances in crossbred (HF × L) lactating cows	Higher milk yield (6.29 / 4.75L/d & 5.57 / 4.48L/d) and LWG LWG (135/18g /d & 50/22g/d) have been reported on feeding of UMB in cows in both the dry and rainy seasons, respectively.Calving to 1st estrus, conception and calving interval has been reduced and obtained better economic return with UMB supplement in cross-bred cows.	402
2006	To detect the effect of feeding ration with poultry droppings on yield and composition of milk in cows	Wheat bran (53%) (Gr. A) has been replaced by 10% (Gr. B) and 20% (Gr. C) dried poultry droppings in ration of lactating crossbred cows. Average daily initial and post-treated milk yield in Gr. A (4.2 ; 4.482 L), Gr. B (4.2 ; 3.8) and Gr. C (4.2 ; 4.6).Suggested that 20% wheat bran can be replaced by droppings.	403
2006	To determine the effect of UMMB supplemen-tation on productive and reproductive per-formances in cross-bred cows	Two nutritional groups (A & B) of crossbred cows, of whichboth the groups received rice straw (3kg), concentrate (2kg) andgreen grass (15-16kg) but Gr. B supplied with UMMB @ 250g/ per day per cow. Higher average LWG has been reported in Gr.B (18.3 ±3.2kg) than Gr. A (8.4 ± 3.4kg). Similarly, higher av milk yield (L/d) and lactation yield (L) have also be reported inGr. B (4.8 & 432.0) than Gr. A (3.3 & 297) cows.	404
2006	To detect the impact of dairy farming and labor	There is a significant inefficiency effect in the dairy farming and labor has negative impact on the inefficiency effect for all types of farms	405
2007	Influence of drenching oil for milk production	Drenching of oil for increased protein availability for determining milk production of dairy cows have been reported.	406
2009	To detect the effect of feeding on productive and reproductive per-formance in deshi cows	Dhaincha (0.7kg/day) and Ipil-ipil (0.8kg/day) could be used as alternative sources of protein for ruminants, which may result in better weight gain, milk yield and reproductive performanceduring post-partum period in indigenous cows.	407
2009	To detect the effects of maize-based concentrates on milk yield in cows	Two groups (A & B) of cows fed basal roughages (straw & green grass) with concentrate @ 1kg/ 100kg BW daily for 60 days. The maize-based concentrates feeding in cows led to better milkyield with good economic return.	408
2009	To detect the effects of UMRS productive and reproductive traits of RCC	Two groups (A & B) of RCC, of which Gr. A fed UMRS, green grass &conc., whereas Gr. B fed rice straw, green grass & conc.feeding UMRS adversely affected the reproductive performance. But no changes in milk yield (2.0 / 2.0 kg/d). Feeding of UMRS has been reported not suitable for breeding bull because it decreased volume (3.0/3.7 ml) and motility (58.6 / 68.4%) of sperm.	409

2010	To detect the effect of different rations on productive and reproductive performance in dairy cows	Three groups of lactating cows have been used for trial of threedifferent conc. to detect milk yield, services per conception, calving to 1st service interval and pregnancy rates in nativeand crossbred cows. Feeding intervention had significantinfluence on services per pregnancy, calving to first serviceinterval and milk yield.	410
2010	Urea-molasses treated straw technology	Field trial and demonstration of urea molasses straw technologyof feeding lactating animals have been reported.	411
2010	To detect the effect of vitamin-mineral supplement on productive and reproductive performance of lactating cows	Two groups (A & B) of cows, of which control group has provided conventional diet and supplemented group has provided Vitamix powder @ 1g/ 1kg concentrate powder @ 1g/ 1kg concentrate for two months before calving. The micro-nutrients supplementation has improved the BW of pregnant cows (137.16/186.33kg), birth weight of calves (17.33 / 19.33kg), milk yield (3.07/4.10kg/d), and fat (36.9/ 39.7g/kg) content of milk.	412
2010	To detect the effect of feeding Napier grass on Ca and P level in cattle	Relationship between increase of oxalate intake from Napier silage and these ingested oxalate combine with available calcium in the rumen that formed insoluble calcium oxalate and excreted in feces at a higher level than that of phosphorus.	413
2012	Effect of genotype & lactation on milkcomposition	The effect of genotype and lactation on milk urea nitrogen, bloodurea nitrogen and milk composition of dairy cows have beenreported.	414
2012	Effect of dietary protein on BUN in native cows	The feeding effect of dietary protein sources on blood or milk urea nitrogen in native cows.	415
2014	To evaluate the feeding effect of di-calcium phosphate (DCP) on Ca balance & BCS of dairy cows fed Napier grass	The oxalate content of the Napier grass has been reported as 3.77% of the DM in early summer season. Soluble oxalate can bind with Ca in the intestines and in the blood to form insoluble CaO crystals,lowering blood Ca levels. Diets with 150 g DCP has been suggestedfor optimizing Ca balance and BCS of dairy for optimizing Ca balance and BCS of dairy cows fed Napier grasses.	416
2015	Effect of different rations on milk yield in crossbredlactating cows	Feeding of legume hay (khesari hay + concentrate) has produced highest milk yield (10.76L/d), followed by UMS + concentrate (10.76 L/d), Napier silage + + concentrate (9.86 L/d) and lowest with rice straw + concentrate (7.31 L/ d).	617
2015	To estimate the milk urea nitrogen (MUN) and its risk factors in crossbred cows	The milk composition along with MUN (6.7-29.0 with average 14.58 ± 0.158) of crossbred lactating cows (n=724) and associated risk factors (season, parity & herd size) have been evaluated. Results showed that herd category and parity influenced the MUN levels.	418
2017	To detect the effect of Ca-salt of fatty acid on milk yield	German grass + concentrate mixture + 2.5% soybean based calciumsalt of fatty acid has reported to be produced highest milk production et in comparison to other groups.	419
2017	To compare effects of restricted and standard feeding on reproductive performance in heifers	The average level of estrogen and progesterone have been decreased significantly in restricted feeding than standard feeding heifers. Under-feeding heifers have showed irregular estrus and anestrous. Standard feeding has been suggested to improve the cattle production efficiency	420
2017	To investigate the feed and nutrient intake and status and performance of the RCC	The total LWG of pre-natal RC cows has recorded to be 14.50kg andthe calf's birth weight 10.95kg. The pre-natal nutrition of cows affected the LWG of cows the LWG of cows before calving and calf birth weight. Improved small scale farm feeding has been suggested to obtain optimum production.	421

2018	To evaluate the concentrate supplement on the performance of lactating RC cows	The farmers' diet (63%) plus formulated concentrate to meet 100% requirements of lactating RC cows significantly increased the milk production (4.82 vs 2.4kg/d),milk fat (5.45 vs. 4.32%) and decreased the post-partum anestrus period (62 vs.104 days) and service/ conception.	422
2018	To monitor the influence of green grass-based diet on growth &reproductive performance in dairy heifers	Heifers fed with green grass, soybean hay and concentrate had significantly higher heart girth gain, serum Ab, urea and BUN than the heifersof other groups. Supply of green grass especially a mix of leguminous and non-leguminous have been reported to be advantageous in heiferfeeding.	423
2018	To investigate the effect of different types of silage on milk production in dairy cows	Maize or chopped Napier silage have been reported to be an effective alternative to green fodder during fodder scarcity for continuing milk production in dairy cows.Maize silage found better than Napier silageand chopping napier silage reported better than whole Napier silage.	424
2018	Effect of pre- and post-Partum conc supplement-Action in crossbred cows	Results showed that offering superfluous concentrates (25% of total conc) during pre-and post-partum resulted positive impact on milk yield, milk protein and post-partum heat period.	425
2019	Effect of mixed or block Form ration in milk yield Native cows	Total mixed ration (TMR) either in block (3.61 L/d) or mash (3.61 L/d) forms resulted significantly higher milk yield in native cows for the period of 45 days. TMR & block ration consisted ofMaize stover 50% & roughage 50% & conc. included wheat bran (8%), kheshari bran (4%), soybean meal (25%), molasses (10%) and salt (0.5%).	426

Review of research of reports on the nutritional trials on native male cattle reveals that three major types of feed formulations have been tried based on basal roughages to evaluate thegrowth performances since 1965 in Bangladesh.[333] These three categories of the evaluated rations include (a) dry straw, (b) urea-molasses-straw and (3) Fodder &silage based diets (Table 8). In Bangladesh, 27 to 49% of cattle feed is based on rice straw, only Sirajgonj and Chittagong districts have limited, periodic grazing facilities, fodder (Napier) cultivation has been reported are in practice in Sirajgonj and Satkhira and fodder availability increased milk production and decreased disease occurrence.[243]

Ration increased milk production

- In addition to rice straw, feeding of 22 kg green fodder (Para : German = 2 : 1) and 2 kg concentrate (wheat bran 82.38%, mustard oil cake 13.32%, common salt 3.7% and DCP 0.3%) in lactating cows increased milk production and reproductive performance.[358]
- German, Napier and Para grasses have been fed *ad libitum* to lactating cows but German grass caused higher milk production in comparison two other grasses.[361]
- German grass + concentrate mixture + 2.5% soybean based calcium salt of fatty acid has reported to be produced highest milk production in comparison to other groups.[419]
- The milk production has been reported to be increased in Pabna variety lactating cows supplemented with 20% legume forage to rice straw-based diet.[391]
- Dhaincha (0.7kg/day) and Ipil-ipil (0.8kg/day) have been suggested to be used as alternative sources of protein for ruminants, which resulted in better weight gain, milk yield and reproductive performance during post-partum period in indigenous cows.[407]
- The oxalate content of the Napier grass and its silage has been reported to be high in comparison to other fodders as 3.77% of the DM. Soluble oxalate can bind with calcium in the

rumen and intestines that formed insoluble calcium oxalate and excreted in feces at a higher leveland even in the blood to form insoluble CaO crystals, lowering blood Ca levels.[413,416]

Table8.Effect of feeding different diets on growth of native male cattle

S/N	Feed type & comparison	Conc. %	No. of animals /diet	Days on feed	Daily intake of total nutrients / head DM, kg	ME	CP,g	Initial live wt. kg	Daily gain g/head	FCR	Ref. No.
I.Feeding effects of straw and supplement											
A.	Straw + grass +	9.0	4	56	4.1	-	480	127	420	10.2	402
	concentrate	9.0	4	56	4.09	-	486	127	442	09.39	
		9.0	4	56	4.18	-	496	126	457	09.43	
B.	Straw + Conc.	39.7	4	60	4.65	-	-	123	473	-	403
C.	Straw	0	4	60	3.84	20.1	110	276	-19	-	294
D.	Straw + Conc.	0	4	28	4.74	21.95	246	264.5	-186	-	404
		29.6	4	28	6.08	31.47	568	267.8	346	-	
		42.2	4	28	6.41	36.9	1070.8	264.8	554	-	
E.	Straw + Conc.	46.6	4	43	6.43	-	563	281	669	9.63	220
F.	Straw + Conc.	0	4	120	4.26	-	-	145	204	-	304
II.Feeding effects of urea-molasses-straw (UMS)											
A.	UMS	0	4	93	4.66	41.2	341	263	233	26.0	217
B.	UMS	-	5	60	-	-	-	319	982	-	403
C.	UMS	0	4	60	4.81	27.64	113	272	292	-	294

Evaluation of feeding of urea-molasses treated straw in cattle

Rice straw is the major sources of roughages for cattle which are characterized by low level of CP and high level of structural polysaccharides that affect the DM intake, digestion and ultimate performance. This low quality roughage can be improved by physical, chemical and biological methods and treatment with nitrogen sources of ammonia and energy. In Bangladesh, research reports on different methods of feeding urea in cattle have been published. Some of these are: Urea-treated rice straw (UTRS),[294,296,298,305,315,327,343,362,369,370,376,379,381]Urea water soaked straw (UWSR),[294] urea-ensiled straw (UES),[294]urea-molasses straw (UMS),[325,352,385,392]urea molasses block (UMB)[297,303,335,340,341,373,377,388,394,401,402]urea-molasses solution (UMS),[298]and urea-molasses-mineral block (UMMB).[318,322,384,386,387,394,392,398,399,404] The UMSwhich is usually enriched with 3.0% urea and 15.0% molasses on dry matter basis whereas UMMB usually consisted of urea 10%, molasses 39%, rice polish20%, wheat bran 20%, calcium oxide 6% and common salt 5%.

- The LWG has been reported with feeding UTRS in growing bull calves[340] but it has been reported that feeding of UTRS found not suitable to breeding bulls because it decreased quantity (3.0 / 3.7 ml) and quality i.e. motility of spermatozoa (58.6% / 68.4%).[385]
- The supplementation of UMMB @ 250g/cow/day with normal ration in local post-partum cows reported increased LWG and milk yield [397] and decreased calving to 1st service, calving to conception and calving interval.[398] whereas the supplementation of UMMB with normal ration in heifers has significantly increased LWG from 49.45 to 64.24 kg but the ovarian activity has delayed.[322]

- The urea level in the milk of lactating cows fed with UTRS (35.29 mg/dl) and UMMB @ 250 mg/cow/day increased significantly in comparison to untreated control cows (24.16 mg/dl).[375,386] In addition, better milk composition in only concentrate fed cows in comparison to UMMB supplement has been reported.[385]
- The UMMB supplement @ 250g/head/day reported a positive effect on the productive and reproductive performance of cross-bred lactating cows[404] but urea feeding in dairy cows reported that it may adversely affect early embryonic development.[427]
- Review of these reports revealthat the breeding bulls and dairy cows including lactating cows are not suitable for feeding any forms of urea-molasses straw preparations.

It appears that the lack of pasture land with shortage of cattle feeds is one of the main constraints for development and production of cattle in Bangladesh. The cattle feeds and feeding practices have been suggested to be enhanced by biotechnology to develop better cattle nutrition packages.The ultimate goal of using nutritional biotechnology in animal feeds and feeding systems is then to improve the plane of nutrition through the feeding of urea-molasses treated rice straw other than breeding and dairy animals, roughage improvement using non-toxic fungus especially white rot fungi due to its abilityto dignify the plant materials, produce genetically modified fodder crops, use of genetically modified micro-organisms to enhance rumen fermentation and thereby increase nutrient availability to the host cattle and use of enzymes to improve the availability from feed and to reduce the wastage of the feed. However, the application of nutritional biotechnology in cattle feeds and feeding practices has limited value due to current status of technology, prevailing environmental and social constraints in Bangladesh.

Effects of heat and transport stress in dairy cattle

Stress may be considered as anything that is applied to an animal from an outside source that has an effect on that animal's normal physiological activity. Stress can be categorized into four major types as: ① Environmental stress- toxic metal pollutants, chemical fertilizers and pesticide contamination, ② Physiological stress- heat stress, advanced pregnancy, dehydration and cold stress, ③ Nutritional stress- acidosis, bloat, hypocalcaemia, ketosis, hypomagnesaemia, and mycotoxin / plant toxins and ④ Managemental stress- handling and transportation and seasonal changes. Among these stressors, heat stress causes more losses to dairy cattle.[428] High environmental temperature and high relative humidity is the primary factors that cause heat stress in dairy animals.

Temperature humidity index (THI)

The combined effect of temperature and humidity can be measured by the use of THI, which is calculated by the formula: THI = 0.72 (W + D) + 40.6where, W = Wet bulb temperature ^{0}C and D = Dry bulb temperature ^{0}C

The THI values of ≤ 70 are considered comfortable, 75 to 78 stressful and a value > 78 causes extreme distress with lactating cows being unable to maintain thermo-regulatory mechanisms or normal body temperatures. It appears that the stress caused by heat and transportation in cattle have been reported from Bangladesh (Table 9).

Table 9. Effects of heat stress on health and production in dairy cattle

Year	Research objectives	Major findings	References
1967	Effect of climate on dairy cattle production	Climatological factors influencing dairy cattle performance have been been reported	429
2016	To detect the effect of heat stress on milk yield and composition in HF crossbred cows	The HF crossbred lactating cows fed with green grasses(German, Para) *ad libitum* and concentrate @ 2.0 kg/day/cow. The effect of heat stress on milk yield and composition havebeen analyzed based on barn temperature and RH%. Heat stress has found strong effect on milk yield and compositionof HF crossbred cows in Bangladesh. Management strategies could be helpful to minimize heat stress through water sprinkle or other means to attain optimal performance of dairy cows.	430
2016	Effectof transportation physical stress of cattle used forbeef purpose	Increased number of injury and abrasion and other physicalstatus indicators during transportation indicates higher degree of stress and suffering	431
2017	To detect the effect of heat stress on feed intake, milk yield and composition in lactating dairy cows	The comfortable environmental temperature for dairy cattleranges 5 to 25 ^{0}C and feed intake begins to declineat the ambient temperature of 25-26 ^{0}C and drops more rapidly above 30 ^{0}C and 40% decline at 40 ^{0}C rapidly above 30 ^{0}C and 40% decline at 40 ^{0}C.The av milk yield (L/d) has reported significantly higher in cool period (14.92 & 19.54) that hot period (12.84 & 15.0). The milk yield and composition are greatly affected by the heat stress during early lactation period.	432
2018	Effect of long distance transport on haematobio-chemical& hormonal	The value of Hb, TEC, TLC, Lymphocyte, Neutrophil and eosinophil varied significantly. The value of TSP, creatinine kinase, triglyceride, Ca, P and alkaline phosphatase significantly differed in cattle	433

Research findings on cattle fattening

Cattle fattening for beef production have become an income generating important business of the smallholder farmers in Bangladesh.[434]Majority of the cattle fattening farmers involved in cattle fattening just before 3 to 5 months of Eid-ul-Azha, when they sell the animals with profitable price.[435,436]Feeding of urea molasses treated rice straw in beef cattle resulted higher body weight, dressing percentage and also in better carcass quality than feeding untreated straw (Table 10). Farmers are usually used three years old cattle for beef fattening and maximum growth rate between 1.1 to 1.4 years age for a period of 4.5 months.[435]It contributes in poverty reduction, creation of self-employment opportunities in rural areas andanimal protein supply. However, the problems and prospects of small scale beef cattle fattening program have been reported as lack of training, high cost of vaccines, limitation of knowledge and inadequate veterinary medical services.[436]

Table 10. Trials of different feed formulations (rations) for fattening of cattle

Year	Research objective	Major findings	References
1969	To detect the optimum dose of urea with efficient utilization in calves	A mixture of rice polish, wheat bran and til oil cake in addition to rice straw and urea-molasses @ 45g/200lb BW showed betterBWG @ 0.929 lb / day / head in comparison to other groups.	437

1977	To detect the effects of a synthetic hormone on the growth and BW in Sahiwal male calves	The ethinyloestradial (Lynoral® Organo) 0.05 mg tablet has been used orally in both the castrated and un-castrated 18 months old Sahiwal calves. The supplemented groups of calves showed significantly higher LWG than non-supplemented groups.	438
1982	To compare efficacy of feeding of urea, lime &/or NaOH treated straw in local calves	It has been concluded that the 5.0% urea (ammonia) treated straw (13g N / kg) found as the best method of feed young cattle as the method has found uncomplicated and urea is the cheapest of the chemicals	439
1983	To compare the benefit of feeding between untreated rice straw and urea or urine treated rice straw in calves	The daily LWG from straw treated with ammonia, using either urea (0.181kg) has been reported as highest in comparison to urine (0.166kg) treated and untreated straw (0.110 kg). Use ofurea-treated straw could be best to feed young bulls for benefit.	440
1986	To detect the effect of supplementing 2.0 ml of phosphoric acid in the basal ration in bullocks	Higher DMI and rate of LWG but lower dressing percentages have been reported with phosphoric acid supplemented groups. These findings did not differ significantly but old and emaciatedanimals showed better performance.	441
1986	To evaluate the profit of cattle fattening program	Feeding of cattle by rice straw, wheat bran, rice bran, oil cake, rice gruel, molasses and green grass resulted net profit of Tk. 50,266/- and 96,606/- from 77 and 99 cattle, respectively.	442
1986	To compare the effect of feeding arail grass and sweet potato leaves in local cattle for 32 days	The average DM intake and BWG have been reported to be higher in cattle fed with arail grass (63.70 kg & 3.58kg) thanfed with sweet potato leaves (54.93kg & 2.84kg), respectively.	443
1986	A feeding trial with rice straw and plant leaves	Rice straw + Banana plant with leaves and rice straw + karal leaves fed to two groups of bull calves found not encouraging.	444
1990	To find out the level of protein required for fatt-ening the local bull calves	Protein level 20% below the NRC standard (0.29kg protein/day/animal) could be successfully used for computing fatteningration for local bull calves.	445
1993	To evaluate the effect of hygienic management of the herds	Regular cleaning of the cattle-shed, washing habit, treatment during illness have been reported to be the reasons for good health of the herds.	446
1993	To compare the efficacy of feeding urea-treated straw in the forms of ensiled, soaking & wetting in crossbred calves	Rice straw has been chopped at a length of 5 cm and mixedthoroughly with 5% urea, 15% molasses and tape water andprocessed as ensiled, soaking and wetting and fed to 3 groupsof calves. The ensiled straw showed better performance thansocking and wetting process of feeding in crossbred calves.	447
1995	Effect ofmolasses supple-ment ofUTS feeding on the growthperformances	Results showed that the molasses utilized as supplement to UTS (3.0%) at 150g / kg or forages at 100g / kg diet for theprofitable beef production from young growing bulls.	403

1998	To compare the LWG in growing native bull fed with or without wheat bran on straw based diet.	The straw based diet supplemented with 2.0 kg wheat bran/day (30% of the diet) resulted significantly higher LWG 346g/day with FRC 17.57. If the maximum utilization of roughageis the main concern,the optimum BW has suggested as 3kg/day	404
1999	To investigate the cattle fattening program in 26 districts for the target of Eid-ul-Azha of 1998	Cattle have been used for fattening aged between 2-3 years (60.4%) and (60.4%) and 1-2 years (32.2%), bulls (70.4%) as well asheifers (5.2%) for a period of 3-6 months (42%) and 7-12 months (30%). Average buying, selling and net profit (BDT/ cattle) has been reported as 5043, 8360 and 3648, respectively.	448
2001	To detect the effects of supplementing UMS on the LWG in bull calves	Growing bull calves (95.33 kg LW) divided into Gr. A (control)fed with rice straw + green grass and Gr. B (treatment) fed withUMS + UMS + green grass showed higher LWG in Gr. B (169.23kg) than Gr. C (150.17kg) and suggested of feeding UMS for fattening.	449
2002	To compare the LWG in bull calves fed with untreat-ed rice straw (URS) and urea-molasses treated rice straw (UMTRS)	Both the URS and UMTRS groups of calves have also fed green grass and concentrate equally. The UMSfeeding has been reported to be beneficial to farmers for cattle fattening. Cattle fattening has increased the use of local feedresources, income and employment opportunity for farmers.	402
2002	To detect the effect of feeding urea and soybean-treated rice straw for fatten-ing of growing bull calves	Feeding of rice straw treated with 4% urea and 4-6% soybean meal with 2 kg green grass and 0.45 kg Til oil cake have been reported successful for the fattening of growing bull calves without any adverse effect on feed intake and growth	327
2002	Effects offeeding untreated straw, urea-molasses straw (UMS)and UMS + wheat barn in growing calves	Average LWG/animal/day has been reported to be 204.17g in untreated straw, 400g in UMS and 418.75g in UMS + wheat fed calves. Thus, the combination of UMS and wheat bran had an influencing effect of LWG in growing calves.	325
2004	To compare the feeding effect between UMS and feeding straw in bull calves for 4.5 months	Control group of bull calves received rice straw + green grass whereas the treatment group received UMS + green grass.Live weight at finishing has been reported as 153.50kg in control and 170.88kg for treated group.	450
2004	To compare the effect of supplement with UMS and MUMS in fattening of bull calves for 5 months	The initial and final live weight of bulls in control (192.26 & 205.81kg), UMS (130.89 & 148.51 kg) and MUMS (168.29 & 187.18kg). The UMS and MUMS feeding in growing bull calves have been reported as beneficial for fattening.	451
2004	To assess economics of cattle fattening	The cost and returns of on-farm cattle fattening by rural farmers have been reported	452
2005	To evaluate the feeding of urea supplemented and urea ensiled straw with or without soybean meal on growth performance of bull calves	Daily weight gain has been reported to be higher in Gr. C fed on 4% urea + 3% soybean meal ensiled straw (0.694kg) than Gr. C fed on 4% urea ensiled straw (0.634kg) and Gr. A fed on 4% urea treated straw (0.509kg). Soybean meal as a urease source with urea treated straw increased the digestibility.	453

2005	To detect the effects of TSP and bone meal supplementation to native cattle	It has been concluded that the dietary bone meal (0.44% P) triple super phosphate (TSP; 0.44% P) supplement in the basal diet increased the final LW 180.33kg and 179.0kg respectively.	454
2006	To evaluate the effects of growth promoters Metafos® and Biomix-DB® on growing crossbred bulls	Total BWG has been reported to be highest in calves treated with both Metafos® and Biomix-DB® (45.25kg) than only treated with Metafos® (32.50kg) and without any treatment (27.75kg) during 90 days period.	455
2007	To detect the age, fattening period and population size for fattening of cattle	About 56.7% of 2 to 3 years and 36.7% of 1 to 2 years age for the period of 3-6 months and 7-12 months of cattle have been used for fattening in small size by farmers, respectively.	456
2009	To evaluate the feeding of UMS with different level of conc. in emaciated bulls	All the four groups of emaciated bulls received UMS (80%) and green grass (20%) but conc. at 0, 10, 20 and 30% of the DM. The 10% conc. has found effective for economic fatteningthan 20 or 30% concentrate supplement.	457
2010	To investigate the small scale cattle fattening in the 24 districts in Bangladesh	Most of the small scale cattle fattening farmers (79.1%) fattened their cattle for 3 to 6 months and other in long period. About 63.7% farmers used cattle fattening tablets, 27% used UMS and 51% followed conventional feeding.	458
2010	To evaluate and compare the effect of growth promoter 'Megavit-DB®' in bull calves of Red CC & HF cross cattle	Megavit-DB® (Novartis BD Ltd.) @ 17g / animal / day has been supplemented with the daily ration to bull calves. The final LWG has been reported to be higher in both the RC (35.17 ; 26.05 kg) and HF (44.16; 35.21kg) bull calves in comparison to their respective controls. Megavit-DB® has suggested for use in cattle fattening.	459
2011	To identify socio-economic characteristics and economic efficiency of cattle fattening	Small scale cattle fattening has been reported to be profitable with a BDT 5559/- cattle. Farmers have used 3 years old cattle for fattening period 4.5 months with urea-molasses straw diet.	460
2012	To survey the use of anabolic steroid and feed additive for cattle fattening	This reported that 58% cattle fattening farmers have been used different anabolic steroids and feed additives for the duration of 3 to 6 months for cattle fattening program.	461
2012	To investigate the existing status of cattle fattening programs of rural farmers	Factors and problems associated with beef fattening andsuggestions by farmers have been described to enhance thebeef fattening in the district of Dinajpur.	462
2014	A survey of cattle fattening program at rural level using 14 growth promoters in 7 districts of Bangladesh	Majority of the cattle fatteners (60%) have used only straw and 40% have used treated straw of which 28% used UMS and 12% used UTS. In addition, 90% farmers have used growth promoters, of which 78% used vitamin-mineral premix, 8% vitamin-mineral and enzyme premixes (VMEP) and the rest 4% used antibiotic and VMEP for fattening cattle.	463
2016	To detect the effect of Metaphos injection on LWG in fattening cattle	Highest percentage of LWG has been reported with anthelmintic treatment followed by Metaphos (19.79%), Butaphospen (10.06%) and UMS (9.97%) treated cattle. Metaphos has caused LWG from initial 126.93 to 158.25 kg at 70th days of experiment.	464

2016	To investigate the present status of organic beef cattle production in the district of Sirajgonj	Beef cattle constituted of 12.0% indigenous and 88.00% crossbred cattle, 83.0% farmers used cultivated fodder and 17.0% used cultivated fodder and roadside grass. About 53.0% farmers fattened cattle for 3 months and suggested for organic beef cattle production	465
2017	To detect the effect of age of native Pabna bulls on FCR, digestibility and carcass yield characteristics	Beef cattle farming with native Pabna variety bulls of 25 to 36 months has been reported highest LWG (597g/d) in comparison to 13 to 24 months (519g/d) and lowest in 6-12 months (294g/d). The 25-36 months old bulls has been reported to be more profitable compared to younger bulls.	466
2018	To compare the different breeds and crossbred of beef fattening cattle with their age and attraction of the consumers	The native cattle (52.5%) has mostly used for fattening, followed Holstein cross (25.5%), Sahiwal cross (12.0%), RCC (5.0%) and RCC cross (5.0%), of which native cattle of black and red color have reported highly attractive to consumers during Eid-ul-Adha. The fattening period for 60% cattle has reported as 3-6 months and 30% as 7-12 months.	467
2018	To detect the effect of UMS feeding on feed intake, digestibility and growth of native growing bull calves	The average LWG has been reported to be higher in UMS treated bull calves than that of untreated control calves. It has been suggested that the UMS could be fed for fattening of native bulls because it has enhanced rapid growth and development of the body of animals and earned relatively higher net profit for people.	468
2019	To assess the mixed feeds, feed ingredients & growth promoters in cattle fattening	Approximately 27.5% farmers are dependent on livestock of which 64% practiced fattening for 3 months periods before Eid-ul-Adha. About 86% reared uncastrated males and 59% farmers used steroids (Dexavet, Pednivet, Oradexon, Decason, Paractin, Gludex etc.)	469
2020	To investigate the live-lihood improvement of farmers through cattle fattening	The income of the beef cattle fattening farmers' family has estimated to be BDT 11283.33 which has contributed 31.39% of the increased family income. Cattle fattening has been suggested to be the most suitable way to increase the socio-economic status of the farmers	470

Research on cattle genetics and breeding

Genetics is the science of heredity which is concerned with physical and chemical properties of the hereditary material, how the material is transmitted from one generation to the next and how the information it contains is expressed in the development of an individual. Genetic make-up of animals control their structural configuration and productive abilities either via single genes or by multiple genes situated in different loci. Genes are compost of nucleotide sequences packaged into chromosomes in the nucleus. Milk production is largely affected by a combination of factors namely, genetic make-up in terms of the use of improved breeds selected for milk production, a favorable nutritional environment and improved managerial practices.[471]

Some traits of cattle are under genetic control (heritable) and can be exploited to increase herd profitability. Traits that are economically important and are heritable should be included in the breeding objective of the beef or dairy herds. Variation for economically important traits occurs within breeds and between breeds and some variation can be created by crossbreds. All sources of genetic variation should be considered when planning a breeding program.[472]

Cross-breeding native cattle (*B. indicus*) with exotic (*B. taurus*) and crossbred bulls is now a widely used method of improving reproduction and production of cattle in Bangladesh. Although the selection and crossbreeding are the two strategies that can be employed to alter yield of milk and its components, random crossbreeding of native cows without selection is usually performed in Bangladesh. Importation of inappropriate genetic material coupled with indiscriminate crossbreeding and a clear neglect of indigenous cattle has created a situation, where the native cattle are under the threat of extinction.[473,474]

Cattle cross-breeding program has been hunched in Bangladesh since 1970s and only 20% crossbred cattle have been made available in Bangladesh.[474] Within the existing cattle breeding services including AI, dairy farmers have little or no idea of the merit and quality of the semen being offered by the breeding service providers. Currently, DLS, BRAC and other organizations are being involved with AI services throughout the country without any national cattle breeding policy.[473] Importation of inappropriate genetic material with inappropriate crossbreeding program and a clear neglect of native cattle has already created situation where a number of native varieties of cattle are under threat of extinction.[41,474]

A survey study on the management system and identification of the causes of genetic erosion of indigenous cattle in the district of Mymensingh showed that only 33.66% cattle population recognized as local and other different crossbreds (Table 11). This results contradict the earlier report[13] who reported about 85% of cattle of Bangladesh are of non-descriptive and indigenous in origin.

Table 11. Status of cattle genotypes for 151 households in Mymensingh district [37]

SNCattle	Number with percentage of types of cattle					
	Local	HF × L	SL × L	SD × L	RCC × L	Overall
1.Cows	148 (61.16)	41 (16.94)	31 (12.81)	12 (04.96)	10 (04.13)	242 (38.97)
2.Bull calves	43 (20.67)	71 (34.13)	43 (20.67)	28 (13.46)	23 (11.06)	208 (33.49)
3.Breeding bulls	18 (10.53)	82 (47.95)	42 (24.56)	21 (12.28)	08 (00.68)	171(27.54)
Overall	209 (33.66)	194 (31.29)	116 (18.68)	61 (09.84)	41 (06.60)	621 (100)

HF × L = Holstein-Friesian SL × L = Sahiwal × Local SD × L = Sindhi × L
RCC × L = Red Chittagong cattle × Local

Practices of indiscriminate crossing between unrelated animals might have been thought to be the major cause of genetic erosion of indigenous cattle in Bangladesh.[37] So, there is a need to develop sustainable guidelines by the relevant authorities for proper breeding practices to minimize the uncontrolled and misdirected crossing between exotic and local cattle for conserving and protecting the valuable indigenous cattle in Bangladesh.

In 2002, the CCSDF, Savar had a local (21%), pure breed Sahiwal (12%) and crossbred (67%) dairy cows with an average age and milk production have been reported as 94.9 months and 3.9 liter/cow/day, respectively.[475]Cattle breeding data of 528 animals for 10 years from 1972 to 1982 of the CCBSDF, Savar has been analyzed based on first lactation length, first lactation milk yield and first calving interval which have shown that standard breeding procedures have not been followed and therefore the breeding procedure need to be adjusted in the scientific fashion for a steady genetic trend in the herd.[476]

Out of 6.9 million breed-able cows and heifers, HF × L crossbred contributes about 31.29% (Table 11).[37] The milk production performance of HF × L crossbred cows under Bangladesh condition substantially improved (from 5 to 12 (average 10.41) liter/day) gradually over the decades.[474] More than 80% of the breeding bulls used in government AI program are HF × L crossbred.[473] Table 12 shows the summary of the research findings on cattle genetics and breeding of Bangladesh (Table 12).

Table 12. Research findings on cattle genetics and breeding in Bangladesh

Year	Major objectives	Major findings	References
1997	To detect breeding profile profiles of bulls & cows	The breeding profiles of Sahiwal bulls and native cows in dairy pocket of Bangladesh have been reported.	477
2002	To estimate the genetic parameters and breeding values of sires and cows	All the variances estimated in native cattle have been reported low compared to both Red Sindhi and Sahiwal. The production in both Red Sindhi and local cattle reported not satisfactory	478
2002	To estimate the heterosis and reciprocal effects of local, crossbred & optimum crossbred system	The native cattle and their crosses are raised mainly for draft animals, then it is recommended that the crossbreds between the local cows and HF bull semen are used for dairy purposes and more than 75% HF blood (LB ×HF × HF × × HF) is used for beef cattle.	479
2003	Estimation of heterosis	Heterosis for some quantitative traits in dairy cattle have been estimated	480
2005	To detect the genetic status of Red Chitta-gong cattle (RCC)	The mean No. of alleles per locus of the RCC has been estimated as 6.22 with a total of 56 alleles and frequency varies from 1.61 to 75.93% across all loci and observed and expected hetero-zygosities as 0.594 and 0.649.	481
2007	To evaluate the traits to detect the breeding policy at the CCBS	The traits of 1st lactation length, lactation milk yield and calving interval have been used to detect the cattle breeding policy at CCBS. Suggestions have been made to improve the breeding program in scientific fashion for a steady genetic trend in the herd.	476
2007	To assess the oocyte collection procedure in cows	The intact follicle collection method and CL-absent group ovaries have been reported as suitable for oocyte collection for *in vitro* nuclear maturation and fertilization of bovine oocytes.	482
2007	To determine the origin and genetic diversity of RCC	Results showed that RCC maintain high genetic variability within the population. Nucleotide sequence divergence showed almost similar age of origination of Indian Zebu breeds as well as RC cattle.	483
2008	To detect the genetic diversity of NBGC	The genetic diversity of North Bengal Grey cattle (NBGC) of Bangladesh based on microsatellite markers have been reported.	484
2008	To detect the heritability & genetic correlation of economic traits of BLRI cattle breed-1 (BCB-1)	The moderate to high heritability along with high genetic correlations with milk yield trait has emphasized continuation of selective breeding program for maximum genetic improvement. This may also be used in planning breeding program for other native cattle germplasm of Bangladesh.	485
2009	To estimate phenotypic & genetic values of RCC for growth traits	The RCC has been reported to have capability for quick response in selection and breeding program for BW improvement. This breeding characteristic would help to establish a local beef breed.	486

2009	To detect the genetic diversity of RCC in Bangladesh	The dendrogram segregated the five population of RCC into two clusters: RCC BLRI and Anwara is one cluster whereas Satkania, Chandonish and Potia made another cluster. The genetic diversity of RCC is relatively higher for a prescribed breed and therefore, have an opportunity to improve them using selective breeding like ONBS.	487
2010	To determine the in-breeding status in a small nucleus herd of RCC	The inbreeding coefficient (IC) of RCC herd has been reported to be 0.019 which is much less than that of other cattle population as well as far below the risky level.	488
2010	To identify the constraints of native cattle genetic resource conservation	Native cattle genetic resource has been reported to be declinedday by day due to indiscriminate crossbreeding through AI. This may cause loss of valuable FAnGR, decrease of draught cattle.	489
2011	To estimate the impact of bull performance on progeny early growth and genetic relationships	Records of 4 bulls and 96 of their progeny born 2005 to 2011 withpedigree information have been used to estimate the impact of bulls. Metabolic body weight and residual feed intake of crossbred breeding bull has significant impact on progeny early growth performance.	490
2012	To calculate the heritability and repeatability of standardized milk yield for the RCC	The heritability estimates for TD (test day) and 305-day milk yield have been reported as 0.41 ± 0.08 and 0.35 ± 0.08, respectively. The repeatability of 305-day and TDs milk yield estimated as 0.28 ± 0.12and 0.49 ± 0.04 respectively using intra-class correlation	53
2012	To estimate regression factors for extending part lactation milk yield from test day record	The best single month for predicting total milk yields by regression method is 5th month's test day record with correlation coefficient of 0.81 with complete yield. The correlations of those monthly records with complete record have been reported as 0.74 to 0.81	491
2012	To estimate genetic trends of some dairy traits of seven genetic dairy cows	The high genetic variability of birth weight, lactation yield, fat and SNF% have been reported for a good opportunity for genetic improvement with these selected traits in cows.	492
2012	To predict breeding values of dairy sires using individual daughters performance	The heritability values have been estimated as 0.27% for birth weight, 0.45% for lactation yield, 0.37% for fat and 0.46% for SNF. The high genetic variability indicates a great scope for genetic improvement.	493
2013	To detect the seasonality of reproduction and to estimate reproductive efficiency of RCC	The month of the year had significant effect on both estrus and calving but not for CR. No significant effect of season with estrus or CR or calving but numerically highest estrus (36%) and CR (38%) in summer and calving in winter (36%) have been reported.	494
2013	To assess the status of cattle breeding system at rural levels	Breeding status of estrus cattle at smallholder levels have been reportedas signs of estrus (prominent 99.64% & silent 1.36%), type of service (natural 38.94% & AI 61.06%), source of semen (Govt 25.0%, BRAC 13.63% & BAUAI center 61.36%), system of AI (cows at AI Center 60.0% & inseminator at home 40.0%), bull used in naturalservice (native 58.87% & crossbred 41.13%) andgenotypes used in AI (HF cross 43.07%, Sahiwal 14.6%, native 39.41% & others (2.92%).	495
2013	To estimate the genetic parameters of Holstein crossbred dairy cows	The mean calving interval has been reported to be 442.59, 449.86 and457.88 days in H × L, H × SL and H × Sl × L crossbreds, respectively. The H × L genotype has been reported most efficient among the 3 genotypes.	496
2015	To select the dairy breeding bulls based on their progeny performance	Out of 5 HF cross-bred candidate bulls, of which two have been found promising due to their positive breeding values based on100-day milk yields of 199 first calving daughter.	497

2016	To find out the reproductive performance of native cows with using Brahman crossbred bull	The overall 63.11% CR and 90.96% calving rate of native cows breeding with Brahman semen have been reported. Satisfactory reproductive performance of indigenous cows has been reported by using frozen semen of Brahman crossbred bull	498
2019	To estimate ratio factors and regression coefficient to extend milk yield for 300 days in RCC	Results showed that both ratio factors and regression coefficients estimated have been suggested to be used more accurately to estimate 300 day milk yield for the indigenous cattle includingRCC in Bangladesh	499
2019	To estimate the genetic evaluation of RCC	The high estimates of heritability reported except average daily milk yield indicates that the genetic improvement of these traits can be achieved through selection and breeding in RCC	500
2020	To estimate the genetic (heritability& correlation) and breeding value of Brahman crossbred cattle	The high magnitude of heritability estimates for growth traits reported indicates that the selection can be highly effective in changing growth traits in Brahman crossbred cattle. Strong genetic and phenotypic correlation of growth trait indicatedthat selection for one trait will improve the others simultaneously	501

Semen collection and crossbreeding by using artificial insemination

High reproductive performance is an essential requirement to ensure maximum food animal production and satisfactory economic return. The AI promotes genetic and economic gains through the use of superior genetic bulls. However, implementation of AI programs based on estrus detection is hampered mainly by post-partum anestrous and estrus detection failure. The timed artificial insemination (TAI) has been applied routinely in the reproductive programs on farms. TAI protocols are designed to promote control of both luteal and follicular function, permitting the TAI with satisfactory pregnancy per AI.Crossbreeding is the mating of individuals from different lines, breeds or populations with the objectives (a) to utilize the different additive genetic levels between breeds to generate offspring with better economic ability caused by new combinations of additive genetic components and (b) crosses between pure lines / breeds express heterosis. Crossbred cattle are more robust and economically efficient compared with the parental breeds.[502]

The cattle of the then East Bengal was mainly indigenous type (*Bos indicus*) with low productive potentiality and this situation was somewhat improved by introduction of improved variety of *Bos indicus* Hariana bull from northern India in limited regions by the British Viceroy Lord Ainlith Gow in 1936. After independence from British Raj in 1947, second effort was made to upgrade the native cattle by importing Sindhi and Sahiwal bulls from West Pakistan to East Pakistan for natural services.

Dairy cattle improvement program in Bangladesh was started in 1958 by DLS with AI program which was strengthened in 1975-76. However, the absence of following the proper process of improvement like registering, recording and others, the government has not achieved any marked over this long period of 55 years.[503]The dairy cattle improvement program has been launched with the aims to improve the indigenous cattle through crossbreeding program by using both tropical bulls (Sindhi and Sahiwal) and temperate bulls (Holstein-Friesian and Jersey). Accordingly, in 1973, some Friesian and Jersey bulls were imported from Australia and ultimately crossbreeding program by using artificial insemination program started rapidly in Bangladesh.

DLS was started AI for dairy cattle improvement in the 1960s,BRAC was started cattle breeding program with AI services using government liquid semen in 1985 in Manikganj district using trained technicians. Up to 1996, BRAC worked in collaboration with DLS for a decade for AI. But this partnership discontinued due to management, non-cooperation and lack of control over AI volunteers by BRAC. BRAC has established its own bull station and started actual frozen semen production and started its AI program in 2000. This NGO have trained 2523 AI technicians and operating AI services in 61 districts (440 upazila). This organization have produced 13,00,000 doses frozen semen (including previous frozen semen stock) and inseminated 13,24,000 cows throughout the country.[504,505] Currently DLS, BRAC, Cooperative Dairy Production System and other organization have been working in crossbreeding program in Bangladesh. Accordingly, huge number of inland research reports has been published on semen and AI services in cattle in Bangladesh (Table 13).

Table 13.Summary on research reports on the collection semen from breeding bulls and artificial insemination (AI) services under field conditions in Bangladesh

Year	Major objectives	Major findings	References
1964	To assess the use of AI in indigenous cows	Reported 60.52% conception rate (CR) of AI by first insemination in East Pakistan indigenous cows	6
1968	To detect the influence of feeding on semen production in bulls	Low level of feeding has been reported to be associated with the delay the onset of semen production by a few months in compares to moderate and high levels of feeding in bulls.	506
1968	To assess bull semen	Repeatability of semen characteristics of yearly bulls have been reported	507
1969	To detect the major causes of AI failure in cows	Five major causes have been reported to be associated with the failure in AI in cows which include (a) failure of ovulation, (b) failure of an ovum and sperma-tozoa to meet, (c) failure of fertilization, (d) failure of implementation and (e) embryonic mortality and abortion.	508
1971	To detect the CR by AI based on psychic conditions in cows	The CR by AI has been reported to be associated with psychic condition of the estrus cows. Highest CR has been recorded in quiet (62.55%) in comparison to moderately nervous (58.59%) and nervous (46.52%) cows.	509
1974	To evaluate the dilutors and extender for storage of semen	Extenders glucose citrate (sperm motility (SM) up to 4th day 25%), Cornell University-16 (SM up to 4th day 39%) and egg yolk citrate (SM up to 7th day 25%) have been reported.	510
1975	To assess the sires	Assessment of dairy sires by contemporary comparisons have been reported	511
1982	To determine the size of head and tail length of bull spermatozoa	Average head length, head breath and tail length of bull spermatozoa have been reported to be 9.538, 4.692 and 58.578 μ, respectively.	512
1982	To differentiate the X and Y chromosome and their effect	Dimorphism of sperm cells with X-chromosome bearing sperms being heavier than Y-bearing ones. Centrifuged spermatozoa fromthe top as well as bottom of the layer need to be inseminated for actual sexing of the calves.	513
1985	To detect the seasonal and genetic influence on semen characteristics	No significant seasonal effects on volume and initial motility of L × HF and SL × HF bull semen whereas the highest semenconcentration during winter than summer have been reported.	514

1990	To compare the SM and EYC diluents for presser-vation& CR of semen	The quality of the preserved semen has maintained better in soybean milk (SM) than in egg-yolk citrate (EYC) for 6 days. The conception rate (CR) of the AI has found higher with semen preserved in SM (68.1%) than EYC (64.7%).	515
1990	To evaluate the imported deep frozen Sahiwal semen in fertile zebu cows	An overall 62.51% CR has been reported in zebu cows withimported deep frozen Sahiwal semen with highest CR in first AI (63.53%) in comparison to 2nd (51.11%) and 3rd (50.0%)AI. Significantly higher CR at the mid-cycle (69.69%) than early (58.8%) and late (33.8%) cycle of AI.	516
1992	To detect the seasonal effect on CR / non- return rates in zebu estrus cows	The spring (Feb-March) has been reported to be the best season for fertility (AI) of cows and heifers in both the dairy farms (CR 62.12%) and smallholder farmers (CR 84.97%) but lowest during rainy seasons.	517
1993	To evaluate the impact of AI to upgrade the native cattle at rural level	The use of AI has resulted 71% crossbred cattle at the rural levels under the Milk-vita cooperative society. The author has suggested five criteria to improve the cross-bred cattleat rural levels	518
1993	To evaluate the breeding soundnessof 12 AI bulls	An average 37 ± 1.62 cm scrotal circumference of bulls with significantdifference in volume of ejaculates, sperm concentrations/ mm^3, mass activity and motility among bulls have been reported.	519
1993	To assess the status of AI and cost of local and imported semen	The AI technique has introduced in Bangladesh in 1958. Currently the AI program has been operating through 23 AI centers, 416 sub-centers and 425 points covering all the 64 districts.	520
1994	To find out the effective genetic group, season & age of bull on the semen characteristics	Highest volume of ejaculate has recorded in ½SL×½ HF cross (8.46 ml) with lowest in ½SL × ½SL (5.15ml). Highest concentration of sperm has recorded in 100% Sahiwal (1234.77 million / ml) and ½SL × ½SL crossbred (1125.44 million/ ml) bulls. No significant seasonaleffect but age has effect on volume and sperm conc.	521
1994	To detect the reasons of adopting and non-adop-ting AI at smallholders farmers' levels	Out of 960 smallholder farmers, 640 (28%) adopted AI but 320 (23.0%)non- adopt-ing farmers. The reasons for non-adopting AI included high calf mortality (46.86%), non-conception (38.84%), availability of local bulls (38.75%), distance of AI points (37.19%), high fee for AI (19.69%),bothering job (20.0%), lack of breedable cows and feed problem (11.25%).	522
1994	To detect the seasonal influences on the AI with Sahiwal imported frozen semen from NZ	Out of 680 estrus cows, significantly higher numbers has been inseminated in spring (n=208) and lowest in monsoon (n=100) but significantly higher non-return rate (NRR) in winter (89.47%) and low in monsoon (86.47%) .Highest number of calves has borne in winter (n=94) and lowest in summer (n=73) season.	523
1996	To evaluate the different crossbred bulls for semen characteristics	The predictions has been reported to be highest in ¼ Local × ¾ Friesian, followed by ¼ Friesian × ¾ Sahiwal, Sahiwal, ½ Local × ½ Friesian, ½ Local × ½ Frie-sian, ½ Sahiwal × ½ Sahiwal × ½ Friesian and ½ Sindhi × ½ Sahiwal.	524
1997	To evaluate the semen of four imported Sahiwal bulls from Pakistan	Semen has been collected from each of four bulls at the same age (3-4 years) twice a week and 11480 cows have been inseminated with these semen. Bull-wise breed-ing performance in terms of semen values, non-return rate, calving rate, pre-natal loss and calf mortality up to 3 monthhave been evaluated.	525
1997	To assess bull and semen	Reported that the semen of the seminal vesiculitis affected bulls have been routinely used for artificial insemination	526
1998	To detect the effects of ambient temperature onbull spermatozoa	Ejaculates harvested at a temperature of 19 to 25 ^{0}C had a lower (1.7%)abnormal acrosome bearing spermatozoa than that collected at >25- 30 ^{0}C (5.4%) and > 30-33.5 ^{0}C (4.9%).	527

1998	To detect the hygienic status of quality of bull chilled semen used for AI in cows	The chilled (4-7 ^{0}C) semen has retained good proportion of normal, motile spermatozoa for 2 days at the AI center but not after transport-action to sub-centers that contained live bacteria in an AI dose. This indicates contamination of semen during collection and processing.	528
1998	Factors of AI to detect fertility of cows	The fertility of cows has been reported to be significantly affected by the site of semen deposition, skill of inseminator and time of onset of estrus.	529
1998	To assess the status of AI in the field levels	172 farmers of 27 Upazila inseminated their cows have been evaluated. Insufficient number of AI center, inadequate knowledge of heat detection,unscientific transfer and storage of semen have been identified as major drawback of cattle production by AI.	530
1999	To evaluate the semen between native cross-bred bulls and imported Friesian bulls	The imported bull semen possessed better post-thaw sperm motility(60% vs 45%), more motile spermatozoa / cow dose (14.7×10^6 vs 9.9×10^6), higher proportion of spermatozoa with normal acrosome, mid-pice and tail (83.0% vs 61.4%) and higher serviceCR (59.9%) than with the semen of native bulls (52.9%).	531
1999	To detect the effects bull quality and type of semen on the first service CR of AI	Cow inseminated with good bull semen (55.2%) conceived at a higher rate than those inseminated with poor bull semen (37.1%). Higher CR has been reported with frozen semen (58.2%) than that for chilled semen (35.9%). High fertility bulls could be used for AI	532
1999	To evaluate the storage of frozen semen straw in 2-liter LN	The frozen semen straws has been reported to be stored in 2-liter liquidnitrogen (LN) container with acceptable quality for 10 days without loading of LN under field conditions.	533
1999	To identify the risk factors associated with service per CR with AI in dairy cows	A total of 6052 AI records of CCBSDF and 525 cows of AI Center, Mymensingh have been evaluated for CR. The minimum service per CR has been reported in spring (1.68), on 5th parity (1.77), in village condition (1.63) and in the month of December (1.64).	534
2001	Sizeof head and total length of spermatozoa	Average head length, head breath, head shape and total length of bull spermatozoa have been reported as 10.12, 5.05, 2.0 and 73.98 μ respectively.	535
2001	Semen characteristics of bulls	Phenotypic variation and repeatability of semen characteristics of bulls have been evaluated.	536
2001	To evaluate the individual bull and season factors affecting semen production	Semen parameters have been reported to be affected with individual AI bulls. Season has significantly influenced the volume and the sperm concentration. Highest semen volume has obtained in winter (8.34 ml) and lowest in summer (7.02ml)	537
2002	To evaluate the quality & fertilizing capacity of locally produced chilled & imported frozen semen	Quality of imported frozen semen has been reported better than locally produced chilled semen in respect of motility and sperma tozoa with normal head. Higher CR of imported semen (57.33%)has been reported than locally produced chilled semen (45.33%).	538
2002	To investigate the effects of breeding groups and environmental factors on conception rate (CR)	The highest CR has been reported in heifers (52.11%), spring season (51.30%) and inseminated between 8 to 14 hours after onset of estrus (53.24%). The interaction effects of PB × HF dams × SLsires (52.75%), SL sires × spring (52.17%) and PB ×HF dams ×winter (52.21%).	539
2002	To detect the age & seassonon BW, SC,libido & ejaculatesinterval in bulls	The age group of 3 to 4 years and summer season have been reported to have better influence on body weight (BW), scrotal circumference (SC), libido and time required between twoejaculates of Sahiwall bulls at the CCBSDF, Savar	540

2003	To evaluate the success of AI & service required per conception of cows	The CR of AI has been reported to be 55 to 73% during 1998-99 and 55-66% during 1999-2001 in Pahartali district. The service has required per conception varied from 1.3 to 1.8.	541
2003	To evaluate the quality of semen in different genetic groups of bulls	Highest sperm conc. (1332 million/ml), motile sperm/ ejaculate (5621 million / ml, motility (64%) and no. of semen collection / month (5.84) with an interval of < 6 days have beenreported in 100% Sahiwal and 50%SL× 50% HF bulls	542
2003	To assess semen characteristics and AI in cattle	Effects of breeds and age of bulls on semen characteristics used in AI in cattle have been reported.	543
2004	To compare the semen quality of different genotypes of bulls	Among the seven genotypes of bulls, only Friesian bulls produced the largest volume of semen (14.26 ml), mass movement (4.87 grade) and forward movement (61.29%) of sperm. Bulls of 4-5 years of age,600-700 kg BW of bulls and summer produced better quality semen.	544.
2004	To compare the quality of bull semen preserved as homo-and hetero-spermic forms	Spermatozoa of three different breeds of bulls (HF, RCC & SL) have mixed in number and preserved for 3 days. The hetero-spermic semen has found better preserved in terms of mass motility, normal and live sperm % compared to homo-spermic ones.	545
2004	To compare the relative efficiency of homo-and hetero-spermic AI to fertility judged by conception& calving rate	Spermatozoa of HF, RCC and SL have been mixed in equal number and preserved for 3 days and inseminated at different days. The hetero- spermic AI did not show any significant superiority in conception and calving rates in cows compared to homospermic AI. However, no riskhas been reported by using hetero-spermic semen in AI.	546
2004	To evaluate the bull performance through semen quality and 30-day non-return rate	Data of 245 ejaculates and 12750 services of 5 Sahiwal bulls for fiveyears have been evaluated. High variability in the potentiality of semen quality and fertility of bulls have been reported. The evaluation of breeding bulls on the basis of semen quality and herd fertility has suggested.	547
2004	To detect the effect of genetic groups of bulls on sperm and CR	Minimum sperm abnormalities has been reported in pure breed bulls than crossbred bulls, and 100% Local, 100% Friesian and ½ SL× ½ HF bulls have reported better CR in cows.	548
2004	To evaluate the adoptation status of AI	Approximately 47.17% households have been rearing cattle at village level of which 44.0% smallholder farmers adopted AI technique for breeding their cows.	549
2005	To assess the semen quality at chilling condition	The semen quality has been reported to be decreased in chilling condition with the advancement of preservation and remained suitable for use up to day 2 as judged by motility and morphology.	550
2005	To evaluate the semen parameters of breeding bulls	Significantly highest semen volume per ejaculate, % individualin motility (progressive) and sperm concentration have been reported 87.5% HF ×12.5% L and lowest in 50% HF × 50% L bulls.	551
2005	To evaluate the spermatozoa of six genetic groups of bulls	Genetic groups of 100% Friesian and 50% SL × 50% HF crossbred have been reported to have better performance of the dimensional characteristics of spermatozoa	552
2006	To evaluate the chilled and frozen semen by AI in cows	Results suggested that the 78.54% NRR of cows at 60 days after 1st AI under field condition has suggested a good practice to discard poor fertility semen, type (chilled & frozen), quality of bull semen and sources of semen.	553
2007	To evaluate the performance of breeding bulls	Reported that 100% Friesian breed had better phenotypic performance and summer favored good performance	554

2007	To evaluate the semen	The semen and non-return rate of bulls have been evaluated in AI	555
2007	To assess AI in cattle at rural farmers' level	The adaptation condition of rural farmers toward AI in cattle the district of Sirajgonj has been reported	556
2008	To evaluate frozen semen	The frozen semen of Red Chittagong cattle has been evaluated.	557
2008	To evaluate the performance of breeding bull based on semen quality	Evaluation of the bull performance based on semen quality and 60 days non-return rate (NRR) showed that HF cross bulls ranked top and RC bulls reported inferior among the bulls tested.	558
2008	To evaluate the breeding bulls based on physically and semen quality	The HF × L crossbred bulls produced better quality semen than othergenotypes of breeding bulls based on semen volume, sperm motility, sperm concentration and % of dead sperm.	559
2009	To detect the relationship between scrotal circumference and semen parameters	Scrotal circumference has been reported to be correlated with semen volume, sperm concentration and number of spermatozoa per ejaculate. Results showed that crossbred bulls aged 18 months or more with scrotal circumference > 30 cm, yielded good quality semen.	560
2010	To assess the semen production of different breeds of bulls at CCBS and their performances	Approximately 1.7 million doses of semen have been produced by the 145 bulls of nine different breeds during 2008-2009. The HF cross cows has been reported highest milk yield (7.4 L/d) in comparison to other cross-bred under field conditions in Bangladesh.	561
2011	Risk factors associated withpregnancy rate with 1st AI	The pregnancy rate of L × HF crossbred (34.9%), first parity cows(37.3%), summer season (43.1%) and less skilled AI technician have been reported as the risk factors for low pregnancy rate at first AI in cows.	562
2012	To find out the physical and chemical properties of different breeding bull semen	Highest ejaculate volume has been reported with SL × HF crossbred (12.9 ml) and lowest volume in L× HF (7.4 ml). The ejaculate volume, concentration, pH and motility of sperm have substantially influenced by freezing and breed type. Better semen characteristics have been reportedin Sahiwal followed by local and SL × HF crossbred bulls.	563
2012	To evaluate the imported semen of Brahman bulls in native cows to produce graded calves	The 233 Brahman grade-1 calves (127 male & 106 female) with average birth weight 22.25kg & 20.33 kg, daily weight gain of 547.42g & 470.34g and yearly live weight of 222.07 and 191.76 kg respectively have been reported. This crossbred may generate to produce beef cattle.	564
2012	To detect the fertility status of female RCC	The service per conception required 1.4 AI with an overall 85.0% pregnancy rate in RCC which is encouraging as compared with others.	565
2013	To evaluate the effect of α-tocopherol in presservationof chilled semen	Semen treated with 2 mg/ ml α-tocopherol (50% BASF, Germany) has been reported to be best for improving keeping quality of chilled bull semen up to 5 days. It acts by preserving cell membrane damagefrom lipid peroxidation.	566
2014	To compare the provision of the existing AI-SDS among public, private autonomous institutions to smallholder farmers	The existing AI-SDS (service delivery-system) from public, private and autonomous organizations are not in the line with the expectation al of the farmers. The relatively lower incentives, higher transaction cost, poor network coverage, institutional barrier to make access to the farmers' complain about their service – all these make inefficient.	567
2014	To detect the risk factors associated with CR of AI in cows	Cows (n=184) have been inseminated between 6-12 hours of onset of heat with AI by using frozen semen resulted an overall 54.9% CR. Higher CR in cows has been reported in spring (78.9%) than summer (29.8%), winter (72.1%) and rainy (35.7%) seasons. Higher CR has been reported in 1st and 2nd AI (89.7%)	568

2015	To detect the risk factors associated with CR of AI in cows	Breed, parity and number of service have been evaluated in 350 inseminated cows. CR has reported comparatively higher in Local (69.23%) than SL(67.92%) and HF (57.22%). The 3rd parity cows showed highest CR (79.63) than other parities. Higher CR reported in 1-2 services (65.0%) than ≥ 3 services (50.0%)	569
2015	To evaluate the factors affecting the rates of pregnancy, calving and peri-parturient disorders in crossbred heifers	Crossbred heifers (n=101) inseminated with Sahiwal (n=61) and Friesian (n=40) semen resulted pregnancy (54.1% & 47.5%), calves borne (49.9% & 35.2%) and peri-parturient disorders (23.5% & 50.0%), respectively. The rates of pregnancy, calves borne and peri-parturient disorders did not differ significantly with age, BW, BCS and source of semen.	570
2015	To detect the risk factors associated with fertility and pregnancy rate in cows due to first AI	Breed, parity, BCS, LW, milking, feeding and open period have been evaluated as risk factors of pregnancy rate in inseminated 450 cows. Highest pregnancy rate has been reported in 5th (62.5%) and 6th (75.0%) parity than others, BCS between 2.1 - 4 (34.5%) than < 2 (0%) and > 4(25%), lactating (39.3%) than dry (22.5%) period.	571
2015	To detect the effect of ejaculation frequency on semen characteristics and sperm output	Ejaculation of Brahman × Local F_1 crossbred breeding bulls at 4× weekly yielded 1.6 times more motile sperm output per week than ejaculation at 2× weekly. The scrotal circumference reported highly correlated with semen volume and total progressive motile spermper ejaculate	572
2016	To evaluate the AI and factors affecting CR	The CR of different genotypes varied from 59.13 to 63.65% with highest CR in summer and winter and lowest in rainy season. The CR associated with semen quality& preservation, time of AI, breeds and season	573
2016	To detect the risk factors associated with pregnancy rate in AI inseminated cows	Cows (n=224) have been inseminated between 12 to 18 hours from onset of estrus, from which 59.29% become pregnant. Age, breed, parity and bull semen semen have been evaluated as risk factors, of which 4 years (70.27%), local (69.07%), 3rd parity (67.74%) and 62.5% SLbull semen showed highest pregnancy rates.	574
2017	To review the status of existing CBBPs, their prospects& limitations	The sustainable community based breeding programs (CBBPs) has reported as a major challenge due mainly to short-term funding, lack of commitment and rapid urbanization and self-sustained program is not sustainable. Coordinationsof the research institutes, govt livestock department, cooperatives and agribusinessagent would be required for sustainable breeding program.	575
2017	To assess the motility & velocity of ejaculates sperm of Brahman crossbred breeding bulls	The computer assisted sperm analyzer (CASA) with android vision software has been used to assess the motility and velocity of ejaculates sperm. The CASA has been found effective for a quick and objectiveanalysis of motility and velocity in Brahman crossbred bull semen.	576
2018	To compare the performance of breeding bulls based on libido, semen quality and fertility	The HF crossbred breeding bulls have been reported to besignificantly higher libido and better sperm quality than that of Brahman and RCC. Results also showed that the libido, semen qualityand fertility are linked together	577
2020	To evaluate the frozen semen quality of imported pure HF and Sahiwal breeding bulls	Frozen semen quality of HF breed has been reported better than Sahiwal breeding bulls but no difference of non-return rate between HF (64.19%) and Sahiwal (64.71%) bulls. Suggested to use frozensemen of both the breeds for genetic improvement of cattle	578
2020	To characterize, compare, estimate of heritability and genetic & phenotypic correlations of semen of three genetic bulls	The maximum sperm conc (× 10^6/ml) has been reported for local (1516.59), followed by Brahman (1380.38) and lowest HF (1105.03). The heritability for semen production varied from 0.39 to 0.51 (BG), 0.36 to 0.48 (HF) and 0.35 to 0.44 (LG) bulls. Brahman genotype ranked 1st in comparison to other genotypes.	579

Milk-vita (Bangladesh Milk Producer's Cooperative Union Limited= BMPCUL)

Milk vita, the trade name of BMPCUL started dairy business based on genetic improvement of dairy cattle through AI services of their cooperative farmers in 1972. In addition to semen, Milk-vita has periodically imported Sahiwal bulls from Pakistan (1991) and four Friesian and three Jerseys bulls from Australia (2002). Initially, Milk-vita started to produce and use liquid semen, later they shifted towards producing frozen semen.[503]

Lal Teer Livestock Limited (LTLL)

The LTLL has started cattle and buffalo improvement program since 2009. They are producing semen from locally produced environmentally supported proven bull at different blood levels crossing with the imported frozen semen of Holstein, Frisian, Jersey and Sahiwal breeds and distributing / marketing it through AI services for increasing milk production throughout the country.[503]

Pran Dairy

The Pran Dairy has started dairy breed improvement program with frozen semen and AI services imports from World Wide Sire, USA.

Gentech International

The Gentech International has started dairy breed improvement program with frozen semen and AI services imports from World Wide Sire, USA. They have also started to develop AI inseminator to provide training to the local field participants.

BAU AI services

Two departments of the BAU are also involved in AI services to the farmers in and around the university areas. The frozen semen is originated from the government AI Laboratory while liquid seem is produced by their own bull studs.

Central Cattle Breeding Station & Dairy Farm (CCBSDF)

Research on semen production and their uses for AI have been conducted at the CCBS, Savar during 2008-2009 on 145 breeding bulls of various breeds and breed combinations.[561]Approximately 1.7 million doses of semen were produced from these bulls (Table 14).

The AI is the first generation reproductive biotechnology that has made a profound contribution to the genetic improvement as well as recognized breeding tool of the cattle.[580]The majority (58.0%) of the smallholder farmers have reported to faced medium problems while 39.0% withhigh and only 3.0% with low problems in adopting AI in their cattle. The inseminator problem and heat stage have been recognized as the most critical problems.[580]Crossbred cattle contributes about 24.0% of the 6.9% million breedable cows and heifers and HF × L crossbred cow's milk production performance considerably improved over the decades.[581]Approximately 87% smallholder dairy farmers have used AI for breeding cows in Rangpur.[582] Cows are inseminated 76% by AI and 24% both AI and natural services in Jossore.[583]

Table 14.Breeds of bulls at CCBS, Savar and uses of semen for AI[561]

SNBreed	No. of bulls	Dose of semen (000')	SN	Breed of bull	% used in AI
1. Friesian (F)	02	039.6	1.	Friesian (F)	54
2.Sahiwal (Sl)	10	-	2.	Friesian (F) × Sahiwal (SL)	17
3.Local (ND)	08	116.1	3.	Sahiwal (SL)	10
4.RCC	02	005.0	4.	Friesian (F) × Red Sindhi (RS)	09
5.SL× F	30	-	5.	Friesian (F) × Pabna (P)	03
6.L × F	93	1556.9	6.	Red Sindhi (RS)	03
7.L × F × F	-	-	7.	Red Sindhi (RS) × RCC	02
8. SL× F × F	-	-	8.	Friesian (F)× Jersey (JS)	01
-	-	-	9.	Red Sindhi (RS) × Sahiwal (SL)	01
Total:	**145**	**1717.6**		**Total**	**100**

- = Data not available

Conception rate (CR) of AI in cattle

The CR plays a major role to achieve a successful reproductive performance of dairy cattle. However, the successful outcome of an AI is a combination of both bulls and cows fertility-linked factors. The AI technique has been used from more than 50 years in Bangladesh and this program is extended every year.The first service CR for particular group can be determined by the number of heifers or cows given first service multiplied by 100. CR = No. of pregnant ÷ Total No. of cows inseminated × 100.Pregnancy rate is the percent of cows eligible to be bred that actually get bred that become pregnant multiplied by the CR of those inseminations in any 21-day (average length of a cow's estrus cycle) period of time.Table 15 shows the conception rate under different breeding methods in heifers and cows in Bangladesh. Research findings on the factors associated with the conception rate have been reviewed (Table 16)

Table 15. Conception rates under different breeding methods with services in heifers and cows

SN	Breeding methods & results of service	No. of cattle	Conception rate (%) with services					
			1st service	2nd service	3rd service	4th service	5th service	Ref. No.
A. Breeding methods								
1.Natural service		237	62.45	06.75	05.91	04.64	79.75	584
2. AI with liquid semen		802	55.86	48.31	41.53	39.62	38.46	584
		323	25.08	18.58	12.69	02.48	58.83	584
3.AI with frozen semen		325	42.15	14.46	05.85	02.46	64.92	584
B. Results of service								
1. Live calves borne		802	410 (51.1)	151 (42.7)	69 (37.7)	39 (36.8)	23 (35.4)	585
2. Abortion/stillbirth		802	038 (8.5)	020 (11.7)	07 (09.2)	03 (07.1)	02 (08.0)	585

Table 15 shows that the CR and calving rate reported highest after first AI services (55.86% and 51.1%) respectively, reduced gradually with the increasing the number of services and lowest after 5th AI 38.46% and 35.4%, respectively.

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Table 16. Factors associated with conception rates in cattle

Year	Objectives	Major findings	References
2003	To evaluate the CR of AI in cattle	The overall average CR of 59.0% with varied between 55 - 73% with an average of 1.7 number of service per conception	541
2004	To evaluate the effects of genetic, environmental and their interactions affecting CR in cattle	Highest CR in native (46.14%) than HF × L crossbred cows (35.39%), up to 2nd parity (46.8-52.57%) then decreased(50.27-25.57%), 60.26% when inseminated between 11-14 hrs on the onset of estrus, during spring (53.07%) than summer (37.89%) and winter (39.42%).	586
2010	To identify factors affecting the CR in RCC	The average overall 63.85% CR in RCC which can be increased by taking different measures like AI at observing clear mucus and 10-14 hours after the onset of estrus, thawing of straw at 37 ^{0}C for at least 10-12 seconds, heating of AI devices, service at docile condition, placement of semen at the body of the uterus and avoid cross-breeding of RCC with exotic blood to ensure protection from reproductive disorders like difficult calving and retained placenta.	587
2010	To determine the PR and No. of services/ pregnancy in RCC	The overall average 65.8% PR with 1.4 services per pregnancy have been reported in RCC. The NRR varied from 53.1 to 70.6%with an average of 63.9%.	588
2011	To determine the factors that limit PR of first AI incows in Sirajgonj district	The overall average 57.3% PR and 42.7% first AI PR with an averageoverall 1.7 number of AI required for early pregnancy. The HF × L cross (34.9%), first parity (37.3%), rainy (34.5%) and less skilled AI technician (38.6%) have been reported as risk factors for low PR at first AI in cows	562
2012	To determine the affecting the first service CR of cows in smallholder dairy farms	The overall CR has been reported to be 50.7% which varied between 43.4% and 58.6% based on AI technicians. BCS, heat detection signs, months of AI and their interactions had greateffects on 1st service CR in cows. AI based on mounting activity, genital discharge and restlessness yielded CR of 53.6%, 48.8% and 50.1% respectively	589
2012	To introduce and adopt two different estrus synchronization protocols and their effects on pregnancy rate in local and cross-bred heifers	Heifers of group A treated with GnRH at first day followed by a single dose of $PGF_2\alpha$ at day 11 and GnRH at the day of AI, whereas heifers of group B treated with GnRH, two dose of $PGF_2\alpha$ at day 11 day apart and GnRH at AI. The overall pregnancy rates have been reported as 33.3% and 36.6% in groups A and B respectively. In addition, the higher pregnancy rate in treatedgroups (35.0%) in comparison to control (28.3%) groups.	590
2014	To determine the CR of cows & heifers inseminated artificially	The cows have been inseminated between 6 to 20 hours of onset of estrus and an overall 54.9% CR has been reported with higher in HF × L cross (62.3%) than local (52.95) and Sahiwal cross (40.0%)	568
2015	To determine the effects of some factors on first service pregnancy rate (PR)	Overall PR 52.6% with highest in 3 to 5 years of age (56.1%), parity 1 to 2 (57.4%), 2 to 5 liter yield (62.1%), fed green grass, straw and concentrate (63.5%) than only fed straw (38.5%), BCS3 to 4 (58.0%) than 1.5 to 2.0 (35.0%), inseminated 6 to 12 hours(58.8%) than 13 to 24 hours of onset of estrus (40.4%) in cows	591
2015	To evaluate the factors affecting pregnancy rate, calving and post-parturient disorders in heifers received AI	The overall average 51.5% pregnancy rate, 45.5% disorders and 32.6% periparturient disorders have been reported in heifers received AI. The use of Sahiwal bull semen resulted 54.1% PR with 49.9% calving rate whereas HF bull semenresulted 47.5% PR and 35.2% calving in heifers	570

2015	To determine the factors influence the CR in dairy cattle at first service in char areas of the north-erndistricts	Higher CR between 2.5 to 3.0 years (68.0%) than 4.5 to 5.0 years old cows, cows provided improved diet and managed with regular vaccination and deworming practices. CR reported higher in the cows inseminated in spring (66.0%) than summer (45.0%), rainy (51.0%) and winter (59.0%) seasons	592
2015	To compare the CR between indigenous and crossbred cows after AI	The overall average 62.86% CR with highest CR in native (69.23%) than SL × L (67.92%) and HF × L (57.22%). Highest CR in age between 4 to 5 years (72.31-70.51%) than aged ≥ 9 years (43.48%), parity 3 (79.63%) and 4 (75.00%) than ≥ 5th (73.91-41.67) parity.	569
2016	To determine the factors affecting CR in cattle	The CR of different genotypes varied from 59.13 to 63.65% with highest during summer and winter than rainy seasons. CR associated with semen quality and preservation, time of AI, breeds and seasons	573
2016	To detect the factors affect the PR in inse-minatedcows	The overall pregnancy rate (PR) has been reported to be 59.29% with highest PR at 4 years of age (70.27%), local cattle (69.07%) than RCC (60.0%) and and crossbred (48.75%) and 3rd parity (67.74%)	574
2017	To synchronize estrus and AI with its success rate in cattle	Injection of GnRH (Fertilon®, Synthetic gonadorelin 100µg/ml, Techno Drugs, @ 5 ml/ cow) at the first day and injection PGF2α (Dinoprost®, Trometamol 5mg/ml Techno Drugs @ 5 ml/cattle) at 8th day then again injection GnRH at day 10 was injected. Overall CR was 54.54% and service per conception rate was 1.38	593
2017	To investigate the influ-ence of GnRH adminis-tration on CR at the time ofAI in healthy cross-bred dairy cows	The overall higher CR of 71.11% has been reported in GnRH(200-300µg at the time of AI) treated than control cows (55.56%) CR without GnRH treatment in cows. Significant effect of age and milk yield but no effect of doses, timing, BCS and parity in CR within GnRH treated cows	594
2018	To investigate the semen quality of Gov & private sectors and to improve the CR of dairy cows	Higher motility conc of semen in BRAC (30.16 ± 18.98) and lowerin ACI (8.72 ± 0.77), whereas motility of spermatozoa also higher in BRAC (49.40 ± 9.76) and lower in Milk-vita (19.96 ± 3.16). Higher abnormalities in Pran Co. (22.86 ± 3.22) and lowest in ACI RAD (13.24 ± 1.80). The higher CR reported with PRAN (65.68%) and lower in Milk vita (39.01%) semen	595
2019	To determine the extent of influence various risk factors affecting the CR following AI in dairy cattle in the Sirajgonj district	The overall CR 72.0% with higher CR in crossbred (HF × L 70.02%) than local 73.98%), removal of placenta > 6 hours (64.28%) than 0.5 to 1 hour (80.66%), age of cows < 2.5 years (50.0%) than 4.6 to 6 years (85.89%), 0 parity (58.89%) 0 parity (58.25%) to ≥ 5 (64.81%) than parity 3 (81.14%). AI after onset of estrus < 3 hours and calving interval > 551 days have been reported tobe associated as risk factors of low CR in dairy cows	596
2019	To assess the perform-ance of frozen semen of Brahman bulls with CR & influencefactors	The overall average 55.3% CR with Brahman bull semen hasbeen reported with highest CR in HC × L crossbred (68.9%), followed by SL × L (66.7%) and lowest in local (46.0%) cows. The CR has been reported to be influenced by breeds, milkyield and interval between estrus to AI in cows	597
2019	To comparison the CR in cows inseminated with DLS and BRAC semen	The CR of AI has been reported to be higher with BRAC semen (80.0%) than DLS semen (60.0%) and also thehigher calving percentage with BRAC (75.0%) thanDLS (55.05) semen	598

Effects of the stages of estrus and semen on CR

The effects of the different stages of estrus cycle (Table 17) and semen (Table 18) on the conception rates in cattle is reviewed.

Table 17. Conception rate (CR) inseminated at different stages of the estrus cycle and problems associated with CRin dairy cows[584,599]

SN	Breeding method	AI at different stages of estrus Early	Middle	Late estrus	SN	Problems related to CR	Prevalence,%
1.	AI with 1st day LS	61.54b (52)	69.01a (71)	34.88c (43)	1.	Errors in estrus detection	29.94
2.	AI with 2nd day LS	60.87b (46)	66.67a (69)	30.95c (42)	2.	Delayed insemination	35.03
3.	AI with FS	57.61b (92)	72.20a (205)	35.71c (28)	3.	Abnormalutero-vaginal secretion	09.98
					4.	Cystic ovaries	02.94
					5.	Miscellaneous causes	22.11

Estrus period[596]		Estrus period[597]		Estrus period[586]	
1. 09.1-12 hrs	CR 78.06	1. ≤12 hours	CR 38.1% (8/21)	1. 07-10 hours	CR 48.32%
2. 12.1-15 hrs	80.36	2. 13-18 hours	53.2 (42/79)	2. 11-14 hours	CR 60.26%
3. 15.1-18 hrs	76.61%	3.19-24 hours	66.0 (33/50)	3. 15-18 hours	CR 39.42%

Insemination of cows and heifers at mid-cycle (12 to 15 hrs.) had significantly higher CR as compared to early and late cycles Table 17). Concluded that estrus detection, correct timing of insemination, maintenance of proper cold chain of liquid and frozen semen, proper handling of semen with veterinary control would enable to achieve higher CR.

Table 18. Effects of semen on conception rate in cows[595]

SN	Sources of semen	No.AI cows	Conception No. (%)	SN	Sources of semen	No. AI cows	Conception No. (%)
1.	DLS	1201	593 (49.62)	2.	Milk-vita	314	124 (39.01)
3.	ACI	392	150 (40.34)	4.	BRAC	600	378 (63.06)
5.	PRAN	405	266 (65.68)		**Overall**	**2912**	**1511 (51.88)**

Embryo transfer (ET) in cows

The production of the first calf by embryo transfer in 1951 in Wisconsin following the surgical transfer of an abattoir-derived day-5 embryo,[600,601] since then the method has been progressively improved so that it can now be used for commercial ends.[602]There are two procedures presently available for production of embryos from donor females, (a) superovulation followed by AI and then flushing the uterus to gather embryos and (b) in vitro fertilization (IVF) consists of the recovery of eggs from the ovaries of the females then outside the body unit they are ready for implementation in foster females.[603] Although this technology is not commercially available in developing countries including Bangladesh, ET could provide opportunities for the conservation

and the development of minor breeds.[601] The achievements of the AI are still not satisfactory in Bangladesh due to mainly unplanned AI practices as well as insufficient extension activities up to the farmer's levels. Moreover, only the AI practices cannot improve the genetic merits of

native cattle and multiple ovulation and embryo transfer (MOET) technology could be used for the development of cattle genotypes in Bangladesh. Recently some works on the MOET have been conducted in Bangladesh (Table 19).

Table 19. Research findings on bovine oocyte and embryo collection and production

Year	Research objectives	Main findings	References
1982	A review on estrus synchronization	The role of estrus synchronization as a method of increasing animal production has been described	604
2000	To determine the effective dose of PMSG for the super-ovulation response in zebu cows	Regularly cycling dry native cows has been synchronized with IM injection 3.0 ml of Alfaprostol (Gabbrostim®) to each cow 48 hrs after the injection of PMSG for inducing estrus. Estrus cows haveinseminated by AI with frozen semen 2-3 times at 12 hours apart. The uterine content then flushed with 150-200 ml medium and collected embryos have evaluated and graded. Results showed that the super-ovulatory response depends on the doses of PMSG and 1500 and 2000 iu found appropriate for cows.	605
2003	To collect bovine cumulus-oocyte-complexes from slaughter house ovaries	Follicles have been collected from three categories of ovary. Type I: having functional corpus luteum (CL), Type II: CL is in almost regressed condition and Type III: without CL. Significantly highernumber of follicles of 2-6 mm diameter has found in Type III ovaries.	606
2012	To detect the ovarian response to different doses of FSH in three genotypes of cattle	The excellent quality embryos showed significantly highest yield(1.80) in the 240 and 280 mg FSH in local genotype. The highest yield (2.0) recorded with 320 mg FSH in Pabna variety, and 2.20 yield recorded in HF × L genotype with 180 mg FST.	607
2016	To adopt *in vitro* production (IVP) of bovine embryo using abattoir ovary	Results showed that 74.16% of the total immature cumulus-oocyte- complexes (COCs) have matured as detected by the presence of first polar body. It appears that the culture system support development of bovine embryo *in vitro*.	608
2016	To evaluate ovary, follicles and COCs and to compare collection techniques	Ovaries without CL and blunt dissection technique have been reported to be cumulus more suitable for harvesting the higher number and superior quality of cumulus -oocyte-complexes from slaughter cows	609
2017	To compare the maturation rate of immature oocytes after verification and warming between cryo devices	The*in vitro* maturation rate of COCs has been reported significantly higher in oocytes vitrified and warmed using crytop (47.1%) than that of French mini straw (15.9%). Significantly higher rate of in vitro maturation has also been reported in control (84.5%) than that of vitrified oocytes.	610
2018	To determine an effective basic medium and its hormone and protein of supplementation for IVMof oocytes of cows	It appears that both TCM (tissue culture medium) and MSOF (modified (modified synthetic oviduct fluid) may be used as a hormone supplement in basic medium for optimum IVM (in vitro maturation) rate of indigenous cows' oocytes.	611

Dairy industry in Bangladesh

The first dairy plant was set up in 1946 by the National Nutrients Company at Lahirmonhanpur (Sirajgonj) in the then Indian subcontinent. After partition in 1947, the Eastern Milk Products

Company took over through an exchange of properties. Milk and dairy products marketing eventually started in 1952 under the brand name Milk vita in the then East Pakistan.[612] Since 1973, cooperatives of smallholder dairy farmers have reorganized first as a dairy development program, the cooperative Dairy Complex with financial assistance from Denmark and later as the

Bangladesh Milk Producers' Co-operative Union Ltd. (BMPCUL; trade name as Milk-vita), formed in 1977. Currently, approximately 40,000 smallholder dairy farmers have become members of primary dairy cooperatives covering 925 villages in 15 districts including Sirajgonj,Tangail, Manikganj, Takerhat, Baghabarighat, Sree Nagar, Rangpur, Bhairob and Raipur, supplying over two million liters of milk daily. Of the total national consumption of 18 million tons per year of liquid milk, 15 million are produced domestically.[613]

Dairy farming is one of the ancient occupation established in smallholder farmers system in Bangladesh but its development is not at the satisfactory level mainly due to unplanned breeding, shortage of feeds and fodders, management, diseases and marketing of milk.[582,614-618]The dairy sector is an integral part of farming systems and has created both direct and indirect employment opportunity, improved food security and enhanced supply of quality protein to people's meals, contributing country economic growth and reducing poverty level in rural and urban areas of Bangladesh.Cattle, buffalo and goats are considered dairy animals in Bangladesh. Out of total milk production, about 90% is coming from cattle, 8% from goat and the remaining 2% from buffaloes.[619]There are about 6 milliondairy cattle of which about 85 to 90% are indigenous and 10 to 15% are crossbred,[503]whereas3.53 million are milking cows and 2.61 million are dry cows in Bangladesh.[620]However, the milk production depends on the genotype, proper feeding, management, breeding, housing and preventive measures against diseases and parasites.

Dairy production system in Bangladesh

Dairy farms having more than 200 lactating cows and land for fodder cultivation are categorized as large dairy farms. Most of the large dairy farms in Bangladesh are two types managed which include Government owned and private sector dairy farms. These dairy farms have mostly crossbred cattle and some extent to some pure breeds cattle. Smallholder dairy farms distributed all over the country. However, the private dairy farms based on location can be categorized into three types, (a) Rural dairies (smallholder farms), (b) Pocket diaries(milk producing areas like Baghabarighat, Munshiganj, Tekerhat) and (c) Metro diaries (developed at urban areas). There are four major dairy production systems in Bangladesh based on farm input and output levels. (a) Traditional, (b) Extensive, (c) Intensive and (d) Bathan systems.[621]

(a) The **traditional** system is characterized by small family farms (stallholder farms) in an integrated animal-crop production system with herd size vary from oneto six cattle. Traditional smallholder farmers fed their cattle mainly on crop-by-product and residues, natural grasses and graze on communal land and also use shrub and tree leaves without any concentrate.

(b)The **extensive** system is practiced mainly by market-oriented dairy farmers operating on a small, medium and large scale farms. Animals are grazed for part of the day and are stall-fed during the rest. In addition to rice straw and green grasses, also provide some concentrate.

(c)The **intensive** system is characterized by zero grazing, with 2-10 cows, and the application of stall feeding systems using concentrate, rice straw and green fodder.

(d)The **bathan** system is characterized by a group of animals is reared near the banks of river, especially when monsoon disappears and water drains from the arable land, different leguminous

fodders like matikalai, khesari kalai and also Jumbo, Napier and German grasses are cultivated and farmers allowed to graze these land during December to May every year.[621] Approximately 68% of the animals in Pabna and Sirajgonj districts are reared under the bathan system and 32% in the non-bathan system.[622]

Research on smallholder rural dairy farms

Due to lack of pasture land and heavy demand of animal sources of protein especially milk, more than 70 to 80% of the cattle population is reared by individual farmers in the rural village management system with low productivity.[621,623]Smallholder producers dominate in the dairy sector and more than 70% of the dairy farmers are smallholders and produce 70-80% of the country's total milk.[621]Smallholder dairy farms in rural Bangladesh usually consist of 2 to 45 native lactating cows[624,625]with an average milk yield of 1.70 liter per cow per day.[624]Milk demand measured by per capita consumption is increasing by 4.0% per year which is higher than the growth in milk production (3.6%) and this has led to a continuous widening of the gap between milk supply and demand.[621]Smallholder dairy farms support the family income, nutrition, women employment and develop a village micro-economy in order to improve rural livelihoods and to alleviate rural poverty.[259,626,627,628]The Bangladesh Government launched a national program to increase milk production in 1991 by providing subsidies to dairy farmers who were rearing a minimum of five lactating dairy cows, either deshi, crossbred or exotic. This program was quite successful and the milk production greatly increased.[613]Currently, high milk yielding different crossbred cows are reared under smallholder farming system.Many scientists have performed their research on cattle production and health and also some important review articles have been published of the work of the different scientists.

Breeds and population of dairy cows

Indigenous cattle consisted of (a) Non-descriptive deshi, (b) RCC, (c) Pabna cattle, (d) North Bengal gray, and (e) Munshigonj white cattle. Cross-bred cattle are the results of crossing between local with different exotic breeds like Holstein, Friesian, Sindhi, Sahiwal, Jersey at different level.[503,629]Approximately 85% cattle in Bangladesh are indigenous in origin.[13]Inclusion of quality genes over the past decades of crossbreeding resulted in crossbred cows of about 47% with an average lactation yield of 1838 liter in 266 days, while the similar performance of a local cow is 619 liter in 230 days, respectively. The crossbred cattle population has also increased milk production horizontally at the expense of genetic dilution.[630]

Smallholder dairy farmers are rearing different cross-bred at rural levels and most commonly 25.0% farmers rearing HF cross, 20.0% Sahiwal cross, 22.0% Sindhi cross and 33.0% indigenous cows in Bogura district in Bangladesh.[631]Farm owners had 85.4% crossbred (Friesian and Jersey) and 14.6% indigenous cows in Rangpur district.[582]Some research findings on breeds and population of cattle have been reported (Table 20)

- The small farmers by keeping 8 to10 crossbred cows could earn a modest living by adopting small dairy farming as a profession[582]
- Holstein-Friesian crossbred cows were ranked best as dairy cattle.[259]

  A total of 50 smallholder dairy farms have been investigated to study the management system of the farms and an average of 5.12 lactating cross-bred cows with an average milk production 5.78 liter/ cow / day have been reported from Jossore.[632]

- The results showed that 98% of the dairy cattle are cross-bred (Pabna x HF, SL x Jersey) in Milk-vita area of Sirajgonj and Pabna with highest cross-bred population in the Shahjadpur, which is located close to the Milk-vita center and accordingly used of concentrate and AI better than other areas.[622]

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Table 20. Genotypes of exotic, crosses and native breeds of dairy cows in Bangladesh

Year	Major objectives	Major findings	References
1999	To evaluate the different breeds of dairy cows	Sahiwal cross-bred has been reported to be more suitable in BAUDF in terms of total milk yield and fat percentage.	633
2003	Smallholder dairy production system & its impact in the livelihood of farmers	HF cross, Sahiwal cross, Sindhi cross and indigenous cows have been used as the major breeds of lactating cows in the district of Bogura. Problems faced by the smallholder dairy farmers have been reported.	631
2005	To investigate the types of dairy breeds, productive & reproductive performances	Dairy farm owners had 85.4% cross-bred (HF & Jersey) and 14.6% indigeonous cows, and 87% farmers used AI services. The productive and reproductive performances of dairy cows have been investigated.	582
2010	To determine the distribution pattern of crossbred dairy cattle and management practices in Milk-vita areas	The results showed that the 98% of dairy cattle in Milk-vita areas of Sirajgonj and Pabna are cross-bred (Pabna × HF, SL × Jersey) with highest population in the Shahjadpur. Shahjadpur is locatedclose to the Milk-vita center and accordingly used more AI services.	622
2011	To assess the status of milk production and strategies for dairydevelopment	The per capita consumption of milk demand is increasing by 4% per year which is higher than the growth in milk production (3.6%). Institutional support and sound policies are required for development	621
2012	To investigate the adaptability of different crossbred dairy cows under comercial farming condition in CTG	Dairy farmers in CTG areas reared cows with Holstein (HF x L) genetics in higher proportion (n=122) in comparison to SL x HF (n=50), SL x L (n=24) and J x L (n=11). Breed, farm condition, overcrowding, environmental stress, season of birth, feeding,management condition, diseases and replacement heifers are the main factors affects adaptability and survivability.	634
2012	Economic and genetic evaluations of RCC, L and H × L crossbred cows under rural level	RCC generated intermediate profit than HF × L crossbred and local cows for a one year operation. When life time productivity and calving interval has considered, RCC is supposed to generatehigher profitability than the HF × L and local cows	635
2012	To estimate the genetic progress of RCC, local and crossbred cows and karyotype of RCC	Results showed that HF × L crossbred genotype have superior for all traits than RCC and local cattle. The RCC gives birth regularly that is one calf in a year and accordingly, the lifetime performance of RCC would be better than local and crossbred cattle.	636
2014	To investigate the scenario of dairy industry and the role of private sectors for its development in BD	There are 6 million dairy cattle in BD, of which about 85-90% are native and only 10-15% are crossbred. Native cattle consisted of (a) non-descriptive deshi, (b) RCC, (c) Pabna variety, (d) North Bengal gray and (e) Munshigonj white cattle. Crossbred consisted of crossing between local and exotic breeds like HF, Sindhi, SL and Jersey at different levels.	503

Management of smallholder dairy farms

Smallholder dairy farming is the main source of milk supply in Bangladesh with a herd size 3.5 cattle per household being managed in traditional ways. Small and marginal dairy farmers rear lactating cows in the homestead for economic generating purposes.[637]General managemental information, feeding, breeding, housing and milking, productive and reproductive performances of the small scale dairy farms have been reported (Table 21).

Table 21. System of management of rural smallholder dairy farms in Bangladesh

Year	Objectives	Major findings	References
1998	To detect the problems of dairy farms	Problems associated with establishing of dairy farms in private sector have been reported	638
1999	To know the extent of involvement of family members in management of rural dairy farms	Approximate 60% house wives have been reported to be involved in rural dairy animals with highest participation in feeding (49.75%) and management (48.75%). Women havealso involved in milking (27.0%), manure disposal (60%),milk selling (20.0%) and watering (82.0%) activities.	627
2001	To detect the management system of rural dairy cattle	Feeding of rural dairy cattle have been reported to supply 96% rice straw, 90% rice gruel and 83% green grass. The breeding of estrus cows are performed both AI (35.0% and natural services (22.0%).	639
2004	To investigate the management system of smallholder dairy cows at villages	Approximately 78% lactating cows milked once daily and 31.0 cows are bred by AI. Overall improved management practices have beensuggested to improve the milk production.	640
2007	To study the management system of smallholder dairy farms	An average of 5.12 lactating cows producing 5.78 L/cow/d and 76% cows are inseminated by AI and 24% with both AI and natural services. Milking by 76% male, 20% female and 4% both	632
2007	To assess the status and prospectus of small dairy	The present status and prospectus of small scale dairy farming in the selected areas have been reported	641
2014	To assess the management of small scale dairy farms	Profitability of native has reported low in comparison with crossbred cows. Main problems in veterinary medical services and fodder	642

Milk production and processing

Dairying is considered a major source of nutrition and income, and offers good opportunities for both farm families and non-farm rural and urban employment. Milk demand, measured by per capita consumption, is increasing by 4% per year, which is higher than the growth in milk production (3.6%).[621] The indigenous cows have been reported to produce 1.9 liter of milk per day against crossbred cows producing 7.8 liters/day.[643]The production and rural consumption of milk and milk products have decreased while import and urban consumption have increased. The urban consumption has increased due to increased urban population and faster increased urban income.[644]The municipality town households consume more milk, sweetmeats and dahi than rural and metropolitan city whereas metropolitan households consume more powder milk, condensed milk, ghee and ice cream.[645]Institutional support and policies play a major role in narrowing this gap and should therefore be considered in developing strategies for dairy development.[646] The research findings on milk production status in dairy cattle in Bangladesh have been reviewed (Table 22).

Table 22. Milk production status in dairy cattle in Bangladesh

Year	Objectives	Major findings	References
1994	To investigate feeding practices and milk yield based on farm size	The highest mean milk yield (liter/day) has been reported in large(2.43 ± 0.87), followed by medium (1.88 ± 1.84), landless (1.10 ±0.44) and small (0.88 ± 0.13) native cattle dairy farms.	647

1994	To detect the efficiency of cow milk production	The cow milk production efficiency in a selected area of Bangladesh has been reported	648
1994	Milk yield of local and cross-bred cows	Comparative performance between local and crossbred cows has been reported in Bangladesh	649
1995	To investigate the milk production of crossbred and native cows	The crossbred and native dairy cows are reared as 0.16 and 0.87 per household in selected areas and produced maximum of 7.57 liter and 2.13 liter milk daily per cows, respectively.	650
1995	To evaluate the profitability of dairy raising	The analysis of dairy farm level data to detect the profitability of dairy farming in Bangladesh has been reported	651
1995	To compare the milk yield of different breeds of dairy cows in Sylhet	First lactation average daily milk yield has been reported highest in (L× F) × SL cows (5.56 kg) while for second lactation highest has been recorded in L × HF cows (5.15kg)	652
1996	To compare the milk yield of different genotypes of cows at CCBSDF	The pure breeds Local (n=274), Sahiwal (n=308) and HF (n=77) have produced 653, 1056 and 2661 kg lactation milk, respectively F1 HF x L produced highest lactation milk (1956L).	653
2000	To find out the relation-ship between skin thickness and milk yield	Average milk production of low, medium and high skin thickness of hind-quarter cows have been reported to be 3.55, 3.27 and 2.79liter per day in cross-bred (L × SL) lactating cows, respectively.Skin thickness may be associated with 29% variation of milk yield.	654
2001	To identify the develop-ment and production pattern of milk in BMSA	The milk collection, number of society members and the productivity of the lac-tating cows have increased due to extension activities and breeding policies of Milk-vita but the economic status of the dairy farmers remain unchanged.	655
2001	To compare the milk yield between native and crossbred cows in mini dairy farms	The average ranged of milk production in native cows varied from 0.52 to 3.62 liter/cow/day whereas in crossbred it varied from 1.78 to 10.15 liter /cow/day. The average lactation period of native cows (221.25 days) has been reported to be lower than crossbred (281.7 days). Rearing of crossbred cows is more economical than native cows.	656
2001	To detect the effect of udder shape and size on milk production in crossbred cows	Three types of udder shape with their milk production including bowl (16.0%; 3.6kg), round (55.0%; 2.7kg) and goaty (9.0%; 3.2kg) have been reported in crossbred lactating cows. A bowl shaped udder with large proportion of secretary tissue with highest milk yieldhas been reported as an asset for a milch cows.	657
2001	To assess the genetic lactation of cows	The genetics of lactation of Pabna and its crosses with Sahiwal and Friesian cows have been reported	658
2002	To detect the differences of milk yield between native& crossbred cows	Milk production (L/cow/d) of native cows has been reported significantly higher in Munshiganj (5.72) and Sirajgonj (5.66) than Tangail (2.94), Rangpur (2.24) and Madaripur (2.11) mainly due the availability of fodder whereas crossbred cows produced 7.86 L/cow/day.	659
2002	To identify the quality milk production trend of Milk-vita throughout the year	Results showed that the highest milk production recorded in February(10.01%) and lowest in September (6.46%). The year round monthly milk production of Milk-vita recorded as 9.97, 10.01, 9.20, 8.59, 8.17, 8.37, 7.27, 6.50, 6.46, 6.86, 8.73 and 9.88%, respectively	660
2003	To detect the effects of milkvein and parity on milk yield in dairy cows	Higher milk yield has been recorded at 3rd lactation and thereafter decreased. Linear length (33.0 cm), tortuous length (3.5 cm) and thickness (1.43cm) of milk vein had maximum size at 3rd lactation. A well develop milk vein indicates	661

2004	Performances of native & cross-bred cows	Comparative performances of crossbred and indigenous dairy cows under smallholders management have been reported	662
2005	Performances of native & cross-bred cows	Comparative performances of crossbred and indigenous dairy cows under small orders management have been reported	663
2005	Performances between Local & crossbred cows	Performances of different crossbred and local dairy cows at Takerhat milk shed area have been reported.	664
2005	To detect the productive reproductive status of dairy cows	Daily milk yield / cow/ farm has been recorded as 4.27 liter for cross-bred and 1.78 liter for native cows. Smallholder dairy farmers could earn a modest living by rearing 8-10 dairy cows.	582
2005	Teat and udder shape and milk yield in cows	The udder shape and teat measurements and their relation with milk production in indigenous dairy cows have been reported	665
2005	Economic benefit of rearing native and crossbred cows	Economic benefits of rearing indigenous and crossbred dairy cows under smallholder dairy farming system in Bangladesh have been reported	666
2006	To assess the effects of management on fertility and milk production	Management improvements directed towards increased average milk production cow/day. The age of first calving 35-44.3 months, calving interval 14-17.6 months, lactation length 249-286 days and3.5-7.2 liters milk yield have been reported.	667
2007	To detect the effects of feed and breed on milk production in dairy cows	HF crossbred cows has been reported as ranked best dairy breed of cattle. Feeding of fodder has increased milk production and decrease disease prevalence.	259
2007	To detect the influence of month on milk production in dairy cows.	The highest milk production has been recorded in February (10.01%) and lowest in September (6.46%) and then gradually increased up to February that indicate a specific trend of milk production in the year.	668
2007	To detect the milk production trend	The milk production trend of Takerhat milk shed area of Milk-vita around the year has been reported	669
2008	Performances of local & crossbred cows	Productive and reproductive potentials of native and crossbred dairy cows under farm condition have been reported.	670
2008	To detect the daily and lactation milk yield in RC lactating cows	Analysis of five lactation milk yield of 41 RC lactating cows showed an average daily milk yield as 1.99 liter and 453.86 liter/ lactation. The milk yield of RCC and other native cows is below the expectation.	671
2009	Effects of seasons & feed on milkyield in native & cross-bred dairy cows	Native cows yielded an average of 1.5 liter milk /cow/day against 5-8 liter in crossbred cows. The low milk production in dairy cows in Bangladesh has been suggested due to mainly to genetic andnutritional constraints.	30
2009	Relationship between genotypes & milk yield	The predicted highest lactation milk yield (1813.62 kg) has been reported for cow which carried 75% of HF blood (e.g. 75% HF × 25% local)	672
2011	To compare the milk yield between native and crossbred cows	The overall milk production of native cows has been reported to be1.672 liter/ day and crossbred yield 9.55 liter/ day and accordingly, the crossbred cows have reported to be superior to local cows.	673
2011	Influence of genotypes on milk production	The milk production of different genotypes of dairy cows have been reported.	674

2011	To estimate the BLUP breeding values of milk yield traits of cows	The best linear unbiased prediction (BLUP) breeding values of production traits for HF and its crosses have been estimated. The HF × Local scored higher when compared to othergenotypes.	675
2012	To evaluate milk yield and composition based on region, season, genotypes& lactation in cows	Milk yield and composition have been reported to be associated with feed base region, genotype and lactation of cows. Milk yieldnegatively correlated with the percentage of fat, protein, lactose,SNF and milk composition.	676
2012	Cross-bred status in rural semi-urban areas	Only 35% farmers adopted crossbred of which 17.5% in rural and 70% semi-urban regions	677
2014	To identify a suitable milk-recording protocol for small-scale dairy production	The higher average daily and lactational milk yield has been reportedin HF × L than SL × L crossbred cows. The test day milk yield of 1 and 2 weeks interval has found to be fitted with the actual 210-days milk yield by using Wood model for both crossbreds.	678
2014	To compare the lactation milk yield between crossbred and deshi cows	An average lactation milk yield of 1838 liter in 266 days has beenreported in crossbred cows while it has been documented as 619 liter in 230 days in indigenous dairy cow.	630
2014	Milkyield between native and crossbred cows	The average daily milk yield has been reported to be 8.71 literin crossbred cows whereas only 1.78 liter in indigenous cows	642
2014	To quantify the influence of dietary energy and protein intake on yield & composition of milk	The average ME (94.59 MJ/d) and CP (1675.80 g/d) significantly influenced milk yield, milk fat, protein , lactose, TS and ash content of milk in crossbred (HF × SL) cows. Adequate dietary ME and CP are required for optimum yield and composition of milk of crossbred cows	679
2015	To quantify the influence of BCS on yield and composition of milk	BCS significantly has reported to be affected milk yield, milk fat & ash content in crossbred (HF × SL) cows. Highest milk yield (13.45l/d) recorded with moderate BCS (3.0) compared to lower (2.75-2.25) &higher (3.25-4.0) BCS	680
2015	To detect relationship between milk yield & ovarian cyclicity (OC) in dairy cows	The highest milk yield reported in HF x L cross cows (5.4 L/d) in comparison to SL x L (3.6 L/d) and local (2.0 L/d) cows. The HF x L cross cows has started ovarian cyclicity earlier (80.2 days) with higher rate (37.9%) than local (84.8 days) with 13.3%	681
2016	To compare the morning and evening milk of dairy cows	The evening milk has been reported to be better than morning milk. Morning milk showed less yellowish than evening milk, higher specific gravity in morning (1.030) than evening milk,and higher TVC and coliform count in morning than eveningmilk.	682
2016	To detect the seasonal effect on milk production and qualities of crossbred dairy cows	The highest milk production has been reported during rainy season (3354.0kg) followed by summer (3116.7kg) and lowest during winter (2925.5 kg). Season had a significant effect on the milk quality and quantity except for protein, lactose, SNF & coliform	683
2017	To compare the milk productionof crossbred cows maintained in household& bathan levels in Milk-vita regions	The genetic admixture with the combination of several breeds in which the frequency of HF has been reported to be highest predominant breed characteristics, followed by Jersey and Sahiwal with local mainly Pabna cattle. No difference on the peakmilk yield (PMY) in both the household (18.95) and bathan (18.57) in HF x L but higher in PMY reported higher in household (19.33) than bathan (15.57) by the Jersey cross cows.	684

2017	To detect the age and lactation-wise milk yield in 100 HF x L crossbred cows	The highest milk yield (13.11 L/cow/day) and longest lactation period (247.14 days) have been reported in cows aged between > 72 to 150 months of age. Approximately 87.0% cows have produced peak milk at the second month of lactation period.	581
2018	To estimate the genetic parameters of milk yield traits and performance of RCC	The average lactation length (LL), lactation milk yield (LMY) and daily milk yield (DMY) have been reported to be 205.65 days, 455.53 kg and 2.20 kg in *in-situ* and 204.79 days, 702.35kg and3.40 kg in ex-situ, respectively in RCC.	51
2018	Factors & profitability of dairy farming	Despite problems and constraints in dairy farming and milk yield, it is is still profitable in the CTG	685
2018	To evaluate the effect of lifetime milk production performance of different crossbred cows	The productive performances of HF x L genetic group has been reported superior compared to other crossbreds. However, the LH x F (Local x Hariana x Friesian) ranked the highest in termsof total lifetime produc-tivity in comparison to other crossbred.	686
2018	To determine the effect of UMN and DCP on silage quality and milk yield of cows	The 23.70, 23.19 and 27.06% milk production increased those crossbred (HF × L) cows received Napier, UMN (urea-molasses napier) and DCPN (di-calcium phosphate napier) silage, respectively.The addition of DCP as additive during silage making would bebeneficial for the dairy cows	687

Dairy cattle production in Bangladesh is characterized by low productivity levels mainly due to genetic and nutritional constraints. Local cows yield on average 1.5 liter milk per day against 5 to 8 liter in cross-bred cows in Bangladesh.[30]The cost of rearing cross-bred cows reported higher than indigenous cows but it is compensated by higher milk yield, hence rearing of cross-bred cow is advisable in study area Sirajgonj district.[651]A local cow is produced an average of 256 ± 2.64 liters of milk per lactation that increase in overall family income at the rural level in Bangladesh.[688]

Milk production (L/d) of local cows has been reported to be significantly higher in Munshiganj (5.72 liter) and Sirajgonj (5.66 liter) followed by Tangail (2.94 liter), Rangpur (2.24 liter) and Madaripur (2.11 liter), these difference of milk production of local cows has been explained mainly due to the availability of fodder and genetic status. The average daily milk production and average lactation period of cross-bred cows have been repowered as 7.86 liter and 269 days, respectively.[659]Daily milk yield /cow/farm has been reported to be 4.27 and 1.78 liters for crossbred and local cows respectively in Rangpur.[582]

- The per day milk production has also been reported to be 1.86 liter in local cow whereas 5.94 liter in cross-bred cows and the income level from milk yields of crossbred cows reported as 3.19 times higher than the local cows.[689]
- The highest milk production has been reported during the month of February (10.01%) and lowest during September (6.46%) of Milk-vita societies in Bangladesh.[668]

- An average lactation yield of 1838 liter in 266 days in crossbred cows, while the similarperformance of a local cow 619 liter in 230 days has been reported.[630]
- Approximately 78% smallholder dairy farmers are milked their cows once daily and about 31.0% are used AI for breeding their cows.[640]
- Milking is usually done by male 76%, female 20% and both 4% milkers in Jossore.[632]

Market share of milk by the different companies

Currently, around 10% of the total milk production goes to brands produce pasteurized milk and dairy products whereas 90% milk sale in the local market immediately. A total of 14 companies have registered under Bangladesh Standards and Testing Institution (BSTI) and they produce and supply pasteurized milk and dairy products in the markets (Table 23).[690]

Table 23. Market share of liquid milk among different companies[503,691,692]

SN Processing Co.	Established Year	Av. Milk collection (liter/day)	Market share (%)	No. of small-holder farmers	BSTI tested milk samples (dhakatribune.com)[690] (Established year)
01. BMPCUL (Milk-Vita)	1973	200,000	52.08	150,000	01. Aarong Dairy (1998)
02. BRAC Dairy (Aarong)	1998	80,000	20.83	70,000	02. Farm Fresh milk (2007)
03. Pran Dairy Ltd.	2001	40,000	10.42	30,000	03. American Dairy (2010)
04. Amo milk	1996	10,000	02.60	05,000	04. Milk-vita (1973)
05. Bikrompur Dairy	1998	10,000	02.60	06,000	05. Aftab (1998)
06. Ultra Shelaide Dairy	1998	10,000	02.60	04,000	06. Ultra
07. Aftab Dairy	1998	08,000	02.08	04,000	07. Tania
08. Tulip Dairy	1998	03,000	00.78	02,000	08. Igloo (2004)
09. Grameen /CLDDP	1999	07,000	01.32	06,000	09. Pran milk (2001)
10. Grameen-Danone	2007	01,000	00.03	-	19. Dairy Fresh (2012)
11. Rangpur Dairy	2007	08,000	02.08	07,000	11. Milk Fresh
12. Farm Fresh	2007	04,000	01.04	00,500	12. Cowhead Pure milk
13. Savar Dairy	1974	06,000	01.54	Govt. farm	13. PURA
Total milk collection/day		**387,000**	**100**	**284,500**	14. Ayran

It appears that the efficiency of dairy industry especially milk processing activities increased and industry became more progressive because of the advancement of new technology.[692] Table 23 shows that only three companies including Milk vita (52.08%), Aarong (20.83%) and Pran Dairy Ltd. (10.42%) have highest market share in comparison to other companies. Dairy industry in Bangladesh is faced by several constraints that include poor genotype, limited food availability, inadequate health care service, lack of cold chain, poor transportation, and unorganized marketing system.

Milk-vita

The first dairy plant with a capacity of 2000 liters per day was established at Lahirimohanpur (Sirajgonj) in 1946 with the target to sale milk products in Calcutta market that was within the easy rail communication system. After the partition, Eastern Milk Products Limited, a private company purchased this dairy plant in 1952. In 1965, the first milk producer's co-operative was

formed under the name Eastern Milk Producers' Co-operative Union Limited (EMPCUL). The nomenclature of the organization was changed to 'Bangladesh Milk Producers' Cooperative Union Limited' immediately after liberation by the Bangladesh Government in 1973 with keeping its brand name 'Milk-vita.' It possesses 52.08-63% market share of liquid milk, which provides various services to dairy farmers like milk collection facilities, veterinary medical services, AI services, balanced cattle feed, loan for cattle purchase and others services related to dairy farmers for increasing milk production and milking cow improvement.[693] Currently, Milk-

vita is the largest pioneering dairy cooperative venture in Bangladesh deals with about 350,000 liter / day liquid milk production, collection, processing and marketing with a diversified set of dairy products.[694]Milk production increases 5.98% per year where demand increases by about 10% due to an increase in purchasing capacity and food habit change of consumers in Bangladesh.[694]

BRAC Dairy

BRAC Dairy was established in 1998. It began as an income-generation sector to create a market for rural dairy farmers and provide them a profit-making platform. Currently, BRAC Dairy collects cows' milk from rural dairy farms to the 101 chilling centers and sells them in nationwide through its internal and external distributors and retail chains under the brand name Aarong Dairy. It has the processing capacity of 170,000 liters of milk per day and holds 20.83-24.00% of the national market share. Currently, this enterprise serves approximately 50,000 dairy farmers in the western region of Bangladesh including Khulna, Dhaka, Rajshahi and Rangpur) with over 1400 employees working under this umbrella.[695]

Pran Dairy (Pran Dairy Ltd.)

The Pran Dairy has established in 2001 as Pran Dairy, a sister concern of Pran Group which is the 3rdlargest dairy milk processor in Bangladesh has the capacity to collect 200,000 liters of milk daily from the existing five dairy hubs. The company has setup 101 milk collection and chilling centers, around 20 centers per hub to collect milk from nearly 12,000contract farmers having over 50,000 cows.[696,697]

Economics of dairy farming

The rank of the major cost items related to importance of milk production includes the concentrate feeds, green grass and labor cost.The major problems of milk production in the bathan areas are the rain and thunder storm, scorching sunshine and low prices of milk. This study has suggested that if the cattle could be sheltered in sheds and support price of milk be ensured, milk production in the bathan areas would be profitable enterprise.[698]

A dairy farm with 13 to 15 months calving interval, 24 months for age at puberty, 1.33 services per conception and 5.0 kg milk per day per cow have been reported economically profitable.[699] Research findings on the economics of dairy farming are reviewed (Table 24).

Table 24. Economics of rearing dairy cattle and management of dairy farming in Bangladesh

Years	Objectives	Major findings	References
1993	Assess economics of milk production	The economics of milk production in selected areas of Bangladesh has been reported	700
1994	Assess major problems of milk production in bathan areas	Rain and thunder storm, scorching sunshine and low milk price are the major problems. Animal shelter in shed and support milk price have been suggested for profitable bathan enterprise.	698
1994	To compare the cost and return of rearing native&	The benefit-cost ratio of milk/L has reported higher in cross-bred (1:1.33)than native (1: 1.04) cows. This study has recommended	701

1095	To compare the cost of rearing cross and native cows	The cost of rearing cross-bred cows has been reported to be higher than native cows but it is compensated by higher milk yield. Hence rearing of cross-bred cow has been advised in this study.	651
1995	To evaluate the economics of dairy farming	Overall balance : cost ratio has been reported as 1 : 1.03 which indicates that mini dairy farming is economically profitable.	702
1996	To assess the economic differences of rearing dairy breeds and areas	Rearing of exotic and their crosses dairy cows have been reported to be more profitable compared to indigenous cows. Dairy farming has also found more profitable in Dhaka city area than Rangpur.	703
1997	To find out the sector involvement of farmers	About 68% farmers are involved in crop and only 6.5% in livestock rearing and have suggested to utilize this data for development plan.	94
1997	To assess the economic profit of mini dairy farming system	Most of the mini dairy farmers have earned annual income ranged from Tk. 25,001 to 50,000. Some problems associated with mini dairy farming system have been reported and described.	623
1998	To detect the milk yield & economic status of rural dairy farm families	An average milk production in cow of the rural dairy farm families has reported as 256 ± 2.64 liter / lactation. Providing loan to the dairy farm families has been suggested to enhance milk production.	688
1999	To assess the rearing of livestock species and management practices	About 91.7% farmers rear cattle, 82.8% chicken and 71.3% ducks. About 19% farmers did not use any vaccines, 27% used vaccines and 38% have concerned with Vet and 22.4% income from livestock.	704
1999	To analyze the profitability of ideal dairy farm project financed by Krishi bank	The profitable status has been reported of all the dairy farms funded by Krishi bank and it has reported that the total cost of dairy farming decreased with the increase of farm size	705
1999	To analyze the profitability of ideal dairy farm project financed by Krishi bank	The dairy farms funded by Krishi bank have been reported to be marginally profitable with benefit-cost ration of 1.13.	706
2000	To identify the some economic traits of five genetic cows	It has been concluded that L × SL F1 cows found better for milking traits and L × Haryana F1 cows for reproduction traits than other crossbred (L × Friesian, L × Sindhi & Local) cows.	707
2000	To compare the economic benefit of dairy farming between two areas	The owners have earned an average of BDT 29.42 and BDT 29.34/ cow with 2.33 and 2.38 man-hours in two areas, respectively. It has suggested to increase more inputs and full time for dairy farms.	708
2000	To evaluate the fertility status of smallholder dairy cows	Delayed age at first calving, low milk yield, high production cost, low milk to concentrate feed ratio and poor reproductive perform-ances caused an average of BDT 39,493/- year in mini dairy farm.	709
2002	To assess the awareness of growing dairy farmers	Necessary awareness to utilize resources with efficiency which would enable to the growing farmers to obtain econo-micro-returns.	710
2003	To determine the non-sur-viability of subsidized & non-subsidized dairy farms	Overall 30.88% non-survivability of dairy farms due to (a) non-profi-tability, (b) scarcity of feed &fodder, (c) lack of Vet cares, (d) milk marketing problem and mortality of cows and calves.	711
2003	To detect the influence of loan on the activities on the dairy farms & production	Loan to the dairy farm owners has a positive impact on dairyindustry development as it caused to increase Number of lactating cows, milk production and gross income in dairy farms.	712

2004	To evaluate the economics of dairy farming at five milk pockets	Higher number of crossbred cows (4.58; 71%) are reared than local cows (1.87; 29.0%) with twice time higher milk yield in crossbred than local cows. Profit obtained ranged from 10,855to 2,23,444 with an average of 75,950/- taka depend on farm size.	713
2004	To analyze the impact of government's subsidy on the development of private dairy farms	Age at first calving, calving interval and dry period have beenreported to be significantly lower and lactation length significantly increased at post-subsidy than pre-subsidy dairy farms. Overallmilk production, fodder production and labor employment significantlyhigher in subsidized than non-subsidized dairy farms.	714
2009	Economics of dairy farming operated through milk supplying process through BRAC's milk supply chain	The annual average gross return and gross margin per cow have been reported to be Tk. 105097 and Tk. 39019, respectively with net return Tk. 30582/- Major problems faced by the dairy farmers are capital, feed, fodder and pasture land, breed, AI andveterinary service	715
2009	To evaluate the economics of smallholder dairy farming in Satkhira	The annual average milk production and net return per farm have been reported higher in member (7215.87 liter & Tk. 175670.30) with field fertility clinic than non-member (5206.52 liter & Tk 67611.51) farms.	716
2010	To compare the profitability of dairy farming between member and non-member of field fertility clinic	Total cost of raising a dairy cow has been estimated at TK. 142.04 and Tk. 158.21 / day for member and non-member farmers to FFC, respectively. All the selected variables except paddy straw had significant impact on milk production.	717
2010	To assess the economics based on rearing systems and dairy farm sizes	Intensive dairy farming system with large size produced higher milk yield with lower cost than extensive and traditional farming systems with high costs of milk production.	718
2010	A comparative evaluation on cost benefit analysis between rearing of cross-bred and native cows	The per day milk production has been reported as 1.86 liter in local cow whereas 5.94 liter in cross-bred cow and the income level from milk yields of crossbred cow recorded as 3.19 timeshigher than the local cow.	689
2014	To compare the livelihood status of GOV and NGO supported with self-managed dairy farms	Productivity and profitability of GOV and NGO supported dairy farming have been reported to be higher than the self-managed dairy farms due to intervention. Net return has reported higherwith GOV (Tk. 52601.8), followed by NGO (Tk.48819.1) andlowest with self-managed (Tk. 27194.5) dairy farms.	719
2016	To assess the 'one house and one farm' project	The household income, employment opportunities and capital of project farmers increased in compare to non-project farmers.	720
2016	To analyze the socio-economic factors that influence milk production in dairy cows	The socio-economic factors affecting milk production & OB WU (on-farm blue water use) have a highly linked with adaptation of efficient management tools to guide the dairy farmers to allocate water resources effectively for increasing milk production.	721
2016	To assess the farmers' input cost with respect to sustainable profit in dairy farming	Labor input cost has been reported as most important cost which effect sustainable profit compared to straw and other inputs. Higher sustainable profit in commercial than traditional farming.	722
2018	To explore the management and institutional factors associated with dairy farms profitability	Results showed that the dairy farm in is profitable business but it has been facing problems of farm operation and selling of milk. It would be required to overcome the problems of low income, unemployment and under nutrition of the country	685

2019	To assess the socio-econo-micfarm and technological aspects of dairy farms	The price of milk varied from region to region with higher in urban market. Results showed that 62.7%, 52.9% and 51.0% dairy farm families have smartphone, facebook and internet users, respectively. Technological based milk market linkage could be created.	723
2019	Economic analysis of dairy farming	Smallholder farms have owned av. 3.07 lactating cows consisting of 0.37 native and 2.70 crossbred cows. Native cow produces 1.9 & crossbred 6.48 liter/d. Crossbred provided higher economic benefit than native cows.	724

Economic analysis of dairy farms

Table 25shows the annual production cost of mini dairy farms and Table 26shows the overall livelihood status of GO and NGO supported dairy farmers' with self-managed farmers.

Table 25. Annual production cost and return of mini dairy farms.[725]

SN Item of expenditure	
A. Variable cost (VC): Overall, %	
1. Concentrate	35.19
2. Rice straw	11.46
3. Green grasses	07.17
4. Labor charge	23.64
5. Veterinary charge	01.64
6. Fodder cultivation	00.50
7. Transportation	02.68
8. Miscellaneous*	01.45
9. Interest on operating cost	03.28
Total variable cost	**86.99**
B. Fixed cost:	
1. Depression of cow-shed	00.66
2. Depression of cow	11.43
3. Depression of equipment	00.35
4. Interest on fixed capital	00.57
Total fixed cost	**13.01**
Total production cost (VC +FC)	**100**

C. Annual returns of mini dairy farms

SN Source	Overall, %
1.Sale of milk	69.43
2.Sale of ploughing	02.26
3.Sale of cow-dung	04.13
4.Sale of cattle	12.60
5. Calves & heifer	11.58
Gross return	100

- Crossbred (2.55) and native (0.65) cows
- Higher milk production in crossbred (5.66L/d) than native (2.23 L/d) cows
- Higher lactation period in crossbred (304 days) than native (210 days) cows.
- Benefit : Cost ratio = 1 : 1.03

- Overall benefit : cost ratio was 1 : 1.03 indicates that mini dairy farming is economically profitable in the rural areas of Bangladesh.

The profitability of 60 Ideal Milk Farm programs financed by Bangladesh Krishi Bank (BKB) in three selected districts (Mymensingh, Dhaka and Narayangonj) have been evaluated that the

total cost of dairy decreased with the increase of farm size.[705] It appears from another study that the BKB loan funded dairy farms are marginally profitable with benefit cost ratio 1.13.[706] Labor and concentrates constitute the major share in the cost components of maintenance of cows. Productivity and profitability of supported dairy farming was higher than the self-managed due to intervention.[719]

The profitability reported greater with cross-bred than with local bred animals (Table 27).[649,662-664,666,670,726,727] So, dairying should be encouraged with cross-bred cows in Bangladesh.[701] Native

Table 26. Overall livelihood status of Government (GO) and Non-government organization (NGO) supported dairy farmers' with self-managed farmers.[719]

SN	Parameters	Farm management status		
		Self	NGO	GO
	A. Cost items (%)			
01.	Labor cost	17.4	17.2	16.7
02.	Feed cost	53.4	55.4	55.1
03.	Veterinary cost	03.6	02.8	02.9
04.	Miscellaneous cost	01.7	01.6	01.7
05.	Interest on operating cost	04.6	04.6	04.6
06.	Total variable cost	80.7	81.7	80.9
07.	Housing	03.5	03.2	03.5
08.	Interest on capital invested	15.8	15.2	15.6
09.	Total fixed cost (TFC)	19.3	18.3	19.0
10.	**Total cost (TC)**	100	100	100
	B. Return items (%)			
1.	Milk	20.7	40.5	40.6
2.	Net charge in inventory	77.8	58.3	58.2
3.	Others	01.5	01.2	01.2
4.	**Gross return (GR)**	100	100	100
5.	Net return (NR)= GR-TC)	27194.5	48819.1	52601.8
6.	BCR (undiscounted)(GR/TC)	1.8	2.3	2.4

Conclusions

- The income of the dairy farms have been reported to be increased of Tk.25400.0 due to intervention.
- The labor, paddy straw, green grass and concentrate feed cost have been reported to have significant effect on gross returns from milk production for both the supported and self-managed farmers.
- There is a scope to improve the overall livelihood status of dairy farmers.

BCR = Benefit : Cost ratio
Total cost and return of dairy farming (Tk/dairy cow/year) [%]

Table 27. Comparison the cost and return of rearing between native and cross-bred cows[727]

SN	Parameters	Native cows Total Tk (%)	Cross-breed Total Tk (%)	SN	Parameters	Native cows Total Tk (%)	Cross-breed Total Tk (%)
	A. Cost items/day						
01.	Feed cost	19.01 (57.88)	44.42 (62.36)	08.	Other feed cost	00.01 (00.02)	00.02 (00.02)
02.	Paddy straw	13.96 (42.48)	18.67 (26.22)	09.	Labor cost	11.37 (34.61)	20.17 (28.32)
03.	Green grass	01.55 (04.72)	06.18 (08.68)	10.	Housing cost	00.29 (00.88)	00.43 (00.60)
04.	Oil cake	01.35 (04.12)	10.14 (14.23)	11.	Vet. cost	00.21 (00.63)	01.28 (01.80)
05.	Bran	01.79 (05.44)	06.26 (08.79)	12.	Capital cost	01.74 (05.29)	04.60 (06.46)
06.	Common salt	00.08 (00.24)	00.22 (00.31)	13.	Misc. cost	00.24 (00.72)	00.33 (00.46)
07.	Molasses	00.28 (00.85)	02.93 (04.12)		**Total cost**	**32.85 (100)**	**71.23 (100)**
	Return						
01.	Milk	51.24 (87.94)	210.00 (93.43)	04.	Calf	04.41 (07.57)	11.77 (05.24)
02.	Cow dung	02.22 (03.81)	02.89 (01.29)	05.	Total return	58.27 (100)	224.76 (100)
03.	Other uses	00.40 (00.69)	00.10 (00.04)		**06. Net return**	**25.42**	**153.53**

cows produced 0.63, 1.78 and 0.84 liters, whereas cross-bred cows produced 34.42, 10.00 and 4.75 liters per farm for large, medium and small farms, respectively.[725] However, the productive and reproductive performance of crossbred cows reported better than local cows.

To identify the development and production pattern of the smallholder dairy farmers of the

Milk-vita society shows that the collection of milk, number of active society and members, number and productivity of lactating cows improve year to year due to increase in extension activities and breeding policies of Milk-vita. But lactating cows per member (2.06) yet not increased indicates that the economic status of farmers remain unchanged.[655]Economic of dairy farming in Satkhira district has comparatively increased in terms of milk production and cash income in members of field fertility clinics (FFC) than non-member farms.[716,717]

The impact of the government subsidy on the development of private dairy farms has been evaluated on 200 pre-subsidized and 200 post-subsidized dairy farms in 6 divisions in Bangladesh.Overall milk production, fodder production and labor employment have significantly higher in subsidized than non-subsidized dairy farms in Bangladesh.[714]Most of the dairy farmers believe that dairy farming is a profitable enterprise and can be more profitable if Government gives support on feed cost, marketing, loan and dairy farm management training.

Research on reproductive and productive performance of dairy cattle

The dairy cattle improvement program hasbeen launched to improve native cattle for milk production by incorporation of both tropical (Sahiwal & Sindhi) and temperate (Holstein-Friesian & Jersey) breeds in Bangladesh. The productive and reproductive performances of different local, pure and crossbreds cattle have been partially reviewed in Bangladesh.[728,729]The reproductive performances of both the indigenous (90%) and crossbred (10%) cattle of Bangladesh have been reported to be poor, required average two services for conception, calving interval between 365 to 536 days and post-partum service period between 103 to 161 days.[729]Analysis of reports showed that the Holstein-Friesian crossbred cattle performed comparatively better than others crossbred.[728]Supplement of UMMB (@ 250g/head/day) has reported a positive effect on fertility of the local cows under village condition of Bangladesh.[397]Recently, the Field Fertility Clinic (FFC) services caused to increase the total milk production, total return and net return per headof cow which indicates the positive impact for dairy development.[717]The influence of season and month on first service conception rate[730] and age, parity and farming condition[731] in cattle have been reported.For accurate analysis of data, the definition of the productive and reproductive indices is required.[732]

- Birth weight- Live weight of calves recorded within 24 hours of birth.
- Growth rate- Weight gain per day
- Lactation length- Interval between first and last milking of a cow in the same lactation
- Lactation milk yield- Quantity of milk given by a cow over a lactation period
- Daily milk yield- Lactation milk yield divided by lactation length
- Age at puberty- Age at which heifer allowed for first service
- Weight at puberty- Weight at which heifer allowed for first service

- Age at first calving- Age at which heifer gave first calf.
- Service per conception- Average number of services required for each successful conception
- Post-partum anestrus period- Interval between date of a given calving and the date of first insemination after parturition
- Gestation length- Days between effective inseminations to concerned calving
- Calving interval-Days between two successive calving.

Reproductive performance of cattle (heifers and cows) is one of the most important factors that influence ranch profitability. Understanding the biological mechanisms associated with getting a cow or heifer bred can be a significant management tool for increasing realized income. The mean values of all the available published articles on productive and reproductive performances of different genotypes of cattle in Bangladesh have been reviewed and it appears that the mean values of these parameters varied greatly (Table 28a-d).

Table 28 (a).Comparison of the mean values of productive and reproductive traits in different genotypes of cattle

SN Parameters	SL	RS	HF	JS	AFS	AFS × PV
01.Age at puberty (days)	1143 (3)	1192.77 (3)	674.58 (2)	-	-	-
02.Length of estrus cycle (days)	21 (1)	22 (1)	20 (1)	-	-	-
03.Duration of estrus cycle (hr)	20 (1)	19 (1)	20 (1)	-	-	-
04.Age at 1st service (days)	1174.25(1)	-	659.33 (1)	-	-	849.0 (1)
05.Age at 1st calving (days)	1472 (3)	1468.4 (1)	939.33 (1)	792.00 (1)	-	-
06.Gestation period (days)	281.05 (6)	279.625	276.54	276 (1)	277.47 (3)	-
07.Post-partum anestrus period (d)	249.39 (2)	-	216.4 (1)	-	165.92 (3)	152.73 (1)
08.Calving interval (days)	523.59 (7)	489.62	486.03 (4)	487.65 (1)	478.5 (3)	441.42 (1)
09. Dry period (days)	152.93 (1)	-	-	-	-	-
10. Service per conception (No.)	1.59 (3)	-	1.78 (2)	2.01 (1)	1.48 (3)	1.52 (1)
11.Lactation length (days)	315.51 (4)	293.19 (3)	359.33 (2)	268.02 (1)	344.0 (1)	305.18 (1)
12.Lactation milk yield (Liter)	2076.87 (2)	1692.05 (2)	3399.28 (1)	-	-	2223.76 (1)
13.Av daily milk yield (L/d)	4.1 (1)	3.83 (1)	8.81 (2)	-	5.8 (1)	-

( ) = No. of reports analyzed - = No available report
SL= Sahiwal[518,733-740] RS = Red Shindi[518,733-738] HF = Holstein-Friesian[518,737,741,742]
JS = Jersey[738] AFS = Australian-Friesian-Sahiwal[739,740,743] AFS × PV = Pabna variety[744]

Table 28 (b).Comparison of the mean values of productive and reproductive traits in different genotypes of cattle

SN Parameters	RS × SL	HF × L	HF × SL	HF × RS	HF × PV	JS × L
01.Age at puberty (days)	1174.45 (2)	845.64 (19)	1072.79 (2)	1034.35 (2)	865.05 (3)	758.67 (9)
02.Length of estrus cycle (days)	22 (1)	22 (1)	-	20 (1)	-	21 (1)
03.Duration of estrus cycle (hr)	19 (1)	19 (1)	-	19 (1)	-	20 (1)
04.Age at 1st service (days)	-	994.12 (5)	-	-	27.5 M (1)	1037.2(2)
05.Age at 1st calving (days)	-	1219.5 (15)	1310.46 (3)	-	-	1588.59 (5)
06. Gestation period (days)	283 (1)	278 (18)	281.53 (6)	273 (1)	281.67 (2)	279.53 (13)
07. Post-partum anestrus period (d)	-	189.55 (13)	158.01 (5)	-	139.79 (2)	291.61 (10)
08.Calving interval (days)	455.36 (2)	434.16 (27)	518.09 (6)	445.57 (2)	420.89 (2)	459.18 (12)
09. Dry period (days)	-	122.63 (8)	-	-	-	79.83 (6)
10. Service per conception (No.)	-	1.63 (22)	1.85 (5)	-	1.33 (4)	1.55 (10)
11.Lactation length (days)	344.3 (1)	294.47 (27)	297.38 (3)	349.41 (1)	248.54 (4)	260.16 (15)
12.Lactation milk yield (Liter)	1325.49 (1)	1592.79 (14)	2263.76 (2)	1427.31 (1)	1850.17 (3)	1229.67
13.Peak daily milk yield	-	-	-	-	-	-
14.Av daily milk yield (L/d)	3.80 (1)	6.66 (19)	8.47 (3)	4.42 (1)	9.11 (2)	4.60 (9)

( ) = No. of reports analyzed - = No available report

RS × SL[518,736] HF × L[18,518,630,635,686,736-740,742,743,745-769] HF × SL[61,739,740,743,758,770,771]

HF × RS[518,736] HF × PV (Pabna variety)[39,744,771,772] JS × L[518,686,718,731,736,738,745-750,755-757,763,769,773-775]

Table 28 (c).Comparison of the mean values of productive & reproductive traits in different genotypes of cattle

SN Parameters	SL × L	RS × L	RS × PV	SL × PV	RCC
01.Age at puberty (days)	882.60 (15)	1077.43 (12)	1005.62 (1)	1037.85 (5)	961.33 (12)
02.Length of estrus cycle (days)	-	21 (1)	-	-	-
03.Duration of estrus cycle (hr)	-	20 (1)	-	-	-
04.Age at 1st service (days)	-	971.03 (3)	-	-	-
05.Age at 1st calving (days)	1388.90 (10)	1505.6 (10)	1416.62 (1)	-	1229.51 (9)
06.Gestation period (days)	280.79 (18)	279.18 (13)	283.87 (1)	282.37 (4)	280.88 (18)
07.Post-partum anestrus period (d)	114.90 (16)	142.45 (11)	-	124.43 (4)	89.51 (11)
08.Calving interval (days)	452.35 (19)	463.44 (15)	571.81 (1)	442.37 (2)	447.13 (18)
09. Dry period (days)	138.47 (7)	168.8 (4)	-	-	165.99 (3)
10. Service per conception (No.)	1.68 (18)	1.82 (12)	-	1.35 (5)	1.5 (16)
11.Lactation length (days)	276.40 (22)	269.02 (15)	317.97 (1)	224.86 (5)	243.96 (16)
12.Lactation milk yield (Liter)	158.73 (12)	1215.62 (7)	2116.91 (1)	1550.88 (4)	539.15 (12)
13.Av daily milk yield (L/d)	4.37 (18)	3.59 (12)	-	7.39 (4)	2.24 (13)

( ) = No. of reports analyzed - = No available report

SL × L[34,44,518,630,634,733,736,745-751,755-757,759-761,763,768-770,773-775] RS × L[44,518,630,733-736,745-753,755,756,759,761,768,769]

RS × PV[733-735] SL× PV[39,492,771,772,776] RCC[11,43,44,588,630,636,732-735,737,755-757,777-784]

Table 28 (d).Comparison of the mean values of productive and reproductive traits in different genotypes of cattle

SN Parameters	PV	DV	MV	NBG	DDC	CB	Local
01.Age at puberty (days = d)	1093.85 (4)	-	1013.4 (1)	869.1 (1)	572.4 (1)	1283.78 (4)	1028.98(17)
02. Length of estrus cycle (d)	21 (1)	-	-	-	-	-	22 (1)
03. Duration of estrus cycle (hr)	22 (1)	-	-	-	-	-	21 (1)
04. Age at 1st service (d)	-	-	-	-	-	-	2290 (6)
05.Age at 1st calving (d)	2323.9 (1)	-	1365.6 (1)	1190.7 (1)	-	1117.95 (3)	1355.77 (21)
06. Gestation period (d)	281.94 (7)	284.88 (1)	310.2 (1)*	280.8	275.8 (1)	281.73 (3)	281.76 (22)
07.Post-partum anestrus period (d)	135.16 (5)	-	70.26 (1)	109.72 (1)	-	227.5 (4)	130. 99 (23)
08.Calving interval (d)	462.61 (4)	524.0	399 (1)	441.94 (1)	-	456.2 (7)	464.18 (27)
09. Dry period (d)	228.2 (1)	-	72.6 (1)	180.0 (1)	190.0	104.33 (6)	171.26 (9)
10. Service per conception (No.)	1.37 (8)	-	1.3 (1)	1.36 (1)	1.62	2.13 (6)	1.52 (28)
11. Calving to1st service (d)	-	-	-	-	-	119.38 (3)	140.43 (7)
12.Highest milk production (L/d)	-	-	6.68 (1)	-	-	10.4 (2)	2.40 (2)
13.Lowest milk production (L/d)	-	-	-	-	-	2.92 (2)	0.72 (2)
14.Lactation length (days)	261.48 (9)	336.43 (1)	253.5 (1)	218.58 (1)	240 (1)	262.88 (9)	239.20 (35)
15.Milk yield (L/lactation)	1276.11 (6)	2205.43 (1)	1727.36 (1)	-	-	1290.69 (5)	669.61 (15)
16..Av daily milk yield (L/c/d)	4.27 (5)	-	6.8(1)	3.46 (1)	1.70 (1)	6.27 (8)	2.39 (32)

( ) = No. of reports analyzed - = No available report PV[39,44,492,518,630,733,734,771-773,785,786]

DV (Dhaka variety)[733,734] MV (Munshiganj variety)[787] NBG (North Bengal Grey)[14]
DDC (Dinajpur dwarf cattle)[12] NICB (Non-identified crossbred)[495,582,630,642,763,788-794]
Local (Indigenous, Native, Zebu, Non-descritive)[18,34,36-38,322,485,495,518,582,630,635,642,736-741,746,748,749,751,754,758-761, 763-767,774,788,791-803]

Age at puberty in heifers

Puberty is defined in heifers as the time when they first ovulate and show an estrus or heat period. Puberty is a period at which sexually organs functionally developed and animals become able to release the gametes by first ovulation.[804]Puberty is also defined as when ovulation is accompanied by visual signs of estrus and subsequent normal luteal function.[805]Although puberty and initiation of normal estrous cycle are complex events that require maturation of the hypothalamic-pituitary-ovarian axis, it has been well documented that nutrition, age and genetics are regulators of age at puberty.[805] Tables 28a-d show that the mean values of age at puberty in heifers varied from 572.4 days (19.08 months) in Dinajpur dwarf cattle to 1283.78 days (42.79 months) in non-descriptive crossbreds heifers. These mean age at puberty reported in different genotypes of heifers found highest in comparison to the reported standard values. Heifers must reach puberty by 13 to 14 months of age to calve as two years age, however it is influenced by age, weight, hormone, genetic (breed), nutrition and environment of heifers.[806] New modern hormonal technologies, proper management, housing, feeding system of the heifers can reduce the age of puberty and sexual maturity.[804]

Length of estrous cycle in cows

Estrus in cattle is commonly referred to as heat. The estrous cycle of the cow is the period from one estrus (heat) to the next estrus which is usually averages 21 days with a range of 18 to 24 days. Tables 28a-d show an average length of estrus cycle 20 days in Holstein-Friesian and HF × RS, 21 days in Sahiwal,JS × L, RS× L and Pabna variety, 22 days in Red Sindhi, RS × SL, HF × L crossbred cows.

Duration of estrus in cows

The average duration of standing heat is 15 to 18 hours but heat duration may vary from 8 to 30 hours in cows. Estrus is short in cow, with ovulation occurring 10 to 12 hours after the end of estrus. The best conception rates occur if AI is carried out in the middle to the end of standing estrus i.e.13 hours before to 8 hours before ovulation, about 30 hours after the onset of estrus. The average values on the duration of estrus in cows reported as 19 hours in Red Sindhi, HF × L, HF × RS, RS × SL, 20 hours in Sahiwal, HF, JS × L, RS × L 21 hours in local cows and 22 hours in Pabna variety (Table 28a-d).

Age at first service in heifers

Tables 26 a-d show that the mean values of the age at first service in heifers of different genotypes reported in Bangladesh varied widely from 659.33 days in HF to 2290 days in local non-descriptive heifers. However, the standard target age for the age at first service has been

suggested to 18 months, an age when heifers are expected to reach around 300kg for Holsteins and 275 kg for crossbreds.[807]

Age at first calving in heifers

The world cattle farming practice has adopted first breeding of heifers at 15 to 18 months of age with calving between 24.5 to 27.5 months as a model with optimum economic profit.[808]Analysis on the published reports on age at first calving in different genotypes shows comparatively lower age at first calving in AFS (792 days) and HF (939.33 days) than other

genotypes especially highest in Pabna variety (2323.9 days) (Table 28a-d). However, 24 months has been reported as optimum age at first calving and reduction of age at first calving to 24 months of age suggested to be an effective management practice.[809] An optimum range of age at first calving (AFC) on dairy farms appears to be 22 to 25 months inclusive. Lower and higher than this figure can bring lower first lactation 305 days and lifetime milk yields, lower fertility and lower chances of surviving to a second lactation.[810]The cost of raising a heifer to 24 months of age has been reported very high and letting them stay on farm in an unproductive state for more months costs more per animal in addition to reduced milk production.

Gestation period in cows

The length of the gestation period has interested farmers because a knowledge of the time to expect the birth of the calf enables proper preparation like drying off the cow and getting her in the proper physical condition for parturition and subsequent lactation. 'The period of development from the fertilization of the egg by the sperm cell until the birth of the fully developed offspring capable of independent existence outside the body of the mother is known as the period of gestation.'[811] Simply, gestation period is the time interval between fertilization of an egg and the birth of the young which begins at fertilization and ends with parturition.[812]Analyzed results reveals that the gestation period varies from 276 days in Jersey breed to 310.2 days (10.34 months) in Manikgonj variety of cows in Bangladesh (Table 28a-d).Gestation length is influenced by many factors like breeds of cows and bull, calf gender, single or multiple birth, the parity of the cow and fetal genotype but the breed of cow has the greatest influence on gestation length.[813] Increasing cow's age, male fetuses and growing fetus weight have been reported to contribute for prolonged gestation length in cows.[814]

Post-partum anestrus period (PPAP)

The PPAP refers to a condition where cows have not been observed or reported in estrus for several weeks after calving, often to the end of the voluntary (elective) waiting period in dairy cattlewhich is the time from calving to the subsequent estrus and conception.[815] To maintain a 365-day calving interval, cows need to conceive on average by 83 days (60 to 90 days) after calving with gestation length 282 days when the uterus undergoes involution and preparation for the next pregnancy. Comparatively short average PPAP have been reported in Munishigonj variety (70.26 days; single report) and Red Chittagong (89.51days; 11 reports) cows than other genotypes of cattle with especially highest PPAP in JS × Local crossbred (291.61 days) cows (Table 28a-d).The causes of the post-partum anestrus in cattle are often multifactorial but can be broadly categorized into physiological, nutritional, managerial, environmental and pathological

whereas suckling and nutrition (negative energy balance) are considered the most important.[815,816]

Calving interval

Dairy cattle production is characterized by cycles of calving, lactation including gestation and a dry period followed by the next calving. The term 'calving interval' refers to the period from one calving to the next calving from the same cow. The optimum calving interval seems to be somewhere between 12 and 14 months. There is general agreement that 12 months represents a

short calving interval based on pregnancy period of 280 days and a non-pregnancy period of 85 days.Comparatively highest calving interval have been reported in HF × SL (518.09 days) and RS × PV (571.81 days) crossbred cows than other genotypes especially found lowest in MV (399 days) in Bangladesh (Table 28a-d). However, the breed means for first calving interval across time ranged from 390 days for Jerseys to 407 days for Brown Swiss.[817]

Dry period in cows

The dry period is the period before calving that cows are not milked which is traditionally 6 to 8 weeks. The main functions of the dry period are to treat the cow with antibiotics in case of persistent sub-clinical mastitis, to allow the cow a rest period before birth of the next calf and to minimize milk yield in the next lactation. The udder of dairy cow requires a non-lactating or rest period, prior to calving in order to regenerate their mammary gland and optimize milk productionin the subsequent lactation. This phase of the lactation cycle is commonly referred to as the dry period. Analysis of the findings on dry period in the different genotypes of cows reveals lowest length of dry period in MV (72.6 days) and JS × L (79.83 days) crossbred cows in comparison to other genotypes (Table 28a-d). The dry period of the dairy cows lactation cycle ranges from 45 to 60 days in length.[818]Numerous studies demonstrated that a 60-day dry period is optimum and a dry period less than 40-day reduces milk yield in the subsequent lactation.[819]The cow and her udder are prepared for the next lactation during dry period, hence any abnormalities during the dry period will have a negative effect on the cow's health and milk production after calving. However, the dry period of 40 to 80 dry days provided maximum performance in Holstein cows.[819]

Number of services per conception (NSPC)

The NSPC is frequently used as an indicator of fertility and the optimum value is considered to range between 1.6 and 1.8 and NSPC around 2 is still acceptable.[820]Out of the 24 genotypes of cattle investigated for the NSPC reveals that except two genotypes JS (2.01) and non-descriptive crossbred (2.13) all the 22 genotypes required less than 2.0 NSPC (Table 28a-d). Responsible factors for NSPC are the quality and quantity of semen, accuracy of heat detection, time of insemination and skill of the inseminator, level of fertility, season of the year and environment factors. Factors like cattle breed, lactation number, AI number andsire breed are the most important factors to get maximum conception rateof the cows.[821]

Lactation length (LL) and lactation milk yield (LMY)

The standard LL of 305 days has been selected because this is approximately the normal lactation length of cows calving at interval of 12 months. However, in tropical regions, restricting the lactation records to 305 day would have less effective, as few cow's milk more than 305 days.[822]Analysis of findings on LL and LMY of the different genotypes of cows revealsthat the average highest LL of 359.33 daysin HF cows with highest LMY of 3399.28 liters and lowest LL foundin NBG cows (218.58 days), whereas the average lowest LMY reported in SL × L crossbred (158.73 liters) cows (Table 28a-d). When the results on LL and LMY analyzed based on the crossbred between Pabna varieties with different exotic genotypes found highest LMY in AFS × PV (2223.76 liter) in 305.18 LL (Table 28a-d). These findings

are in conformity with individual report of highest LMY reported in AFS × PV (1632 liters) in 282.80 days LL in comparison to PV (1503 liters), HF × PV (1619 liters), JS × PV (1517 liters) and SL × PV (1548) cows.[823]

Daily milk yield in different genotypes of cows

Tables 28a-d show that the comparatively highest average daily milk yield by HF (8.81 L/d) followed by AFS (5.8 L/d), SL (4.1 L/d) and RS (3.83 L/d) of the exotic breeds of cows. These analyzed findings are also in support the individual report of the CCBSDF where 11.57 liter/day milk yield reported in HF cow followed by AFS (4.68 liter/day).[824]The HF crossbred with PV produced highest daily average milk yield (9.11 L/d) in comparison to HF ×SL (8.47 L/d), HF × L (6.66 L/d) and HF × RS (4.42 L/d) whereas the non-descriptive crossbred produced milk 6.27 L/day (Table 26d). Among the local varieties of cows, highest average daily milk yield reported in MV (6.8 L/d) variety in comparison to other local varieties (Tables 28a-d). Comparatively highest daily milk yield has been reported in H × L (3.29 L/d) than JS × L (3.08L/d), SL × L (2.84 L/d), SD × L (2.99 L/d) and RCC (2.46 L/d).[756]

Seasonal influence on the occurrence of estrus in cows

Table 29shows that the estrus occurs throughout the year in all the seasons but higher in rainy season in comparison to other seasons in the Rajshahi Government Dairy Farm whereas it occurs at the similar percentage in the BLRI Cattle Breed-1, Savar. The seasonal variation on the occurrence of estrus with higher in summer than in winter which positively correlated with environmental temperature and insulation duration whereas negatively correlated with rainfall in Holstein cows have been reported elsewhere.[825]

Table 29.Seasonal influence on the occurrence of estrus and conception in indigenous cows maintained under farming conditions

	Rajshahi Government Dairy Farm (Study period 1986-1987)[826]			BLRI Cattle Breed-1 (BCB-1)2 (Study period 1992-2006)[485]		
SNSeason	No. of cows	Estrus No. (%)	Conceived No. (%)	SN	Season (month)	Estrus cows No. (%)
1. Winter (Dec-Feb)	71	42 (59.15)	20 (47.62)	1.	Winter (Oct-Jan)	384 (27.39)
2.Summer (March-May)	62	37 (59.68)	19 (51.35)	2.	Summer (Feb-May)	517 (36.88)
3. Rainy (June-August)	35	23 (65.71)	13 (56.52)	3.	Rainy (June-Sept)	501 (35.73)
4.Autumn (Sept-Nov)	26	09 (34.62)	06 (66.67)		-	
Overall	**194**	**111(57.22)**	**58 (52.25)**		**Overall**	**1402**

The influence of parities on productive and reproductive performance of native cows under farm condition have been reported.[827] There are some differences on daily milk yield, lactation length, birth weight of calves, post-partum anestrus period and gestation length but no differenceson the calving interval and number of services per conception have been reported in native cows.[827]

Genotype (breeds) has a significant effect on biological efficiencies of dairy cows.[475,828]Performance of the Holstein Friesian breed and its crosses with local cows especially PV and

MV has been reportedhighest productive performance among all the investigated genetic groups in Bangladesh. Among the cross-bred, the F2 and subsequent generations have reported inferior than the F1.[737]However, the pure exotic breeds especially HF has been reported not suitable in tropical environment in Bangladesh and moreover it requires low temperature, better feeding and management and less resistant to diseases and parasites. Accordingly cross-bred (HP × L) cows have been suggested to rear under Bangladesh environmental conditions.[829,830]

Estrus and pregnancy diagnosis in dairy cattle

The AI is the most viable option to produce pregnancies in dairy cows but implementation of a successful AI program on dairy cattle requires accurate and efficient detection of estrus. Several significant physiological changes have been reported to occur during the periestrual period that enables detection of estrual behavior and other correlated traits in cows. Some of these changes include physical activity, vaginal cytology and pH, electrical resistance of vaginal mucus and genital tissues, body temperatures, pulse and heart rates, blood flow, rumination time, pheromones, blood metabolites and hormones, milk yield and feed intake.[831,832]Cows are monitored traditionally for visual signs of estrus such as ‘standing to be mounted'by a herd mate but it is difficult to monitor several time in a day and identify when to inseminate.

Methods of estrus detection that are widely used on farms do not have good rates because the physiological and behavioral changes of the animals as well as the period of the duration of estrus cycle are being expressed in low intensity and short duration and even they are very variable and difficult to measure. Accordingly, the use of electronic methods have been suggested to improve estrus detection.[833]

Return to estrus from 18 to 24 days after AI is often considered by dairy farmers the easiest and least costly method for determining non-pregnancy in dairy cattle early post breeding. Estrus detection efficiency is estimated to be less than 50% dairy herds which is likely a result of the short duration of estrus behavior reported for lactating cows housed in concrete flooring in common housing system. Estrus cycle duration varies widely among lactating dairy cows from the standard 21-day interval and averaged around 24 days with a high degree of variabilityamong animals inseminated lactating dairy cows.

Pregnancy examinations are primarily used to identify pregnancy and non-pregnancy status of inseminated or mated females cattle, so that non-pregnant cows can be managed and reinseminated to reduce inter-insemination and calving intervals.Additional benefits are the detection of uterine or ovarian abnormalities, diagnosis of twins and others.[831]Rectal palpation,

ultrasonic diagnosis, progesterone diagnosis, early pregnancy factor diagnosis, diagnosis using pregnancy-associated glycoproteins, diagnosis using activity and temperature have been described.[831]Early pregnancy diagnosis is crucial to shortening the calving interval through enabling the farmers to identify open animals so as to treat and /or rebreed them at the earliest opportunity. However, several methods of pregnancy diagnosis are being practiced in bovine species, yet none qualifies as the ideal pregnancy diagnosis methods due to the inherent limitations of sensitivity, accuracy, specificity, speed and ease of performing the test.Table 30shows the summary on the research findings on the estrus and pregnancy diagnosis in cattle of Bangladesh.

Table 30. Estrus and pregnancy diagnosis in dairy cattle

Year	Research objectives	Major findings	References
1974	To evaluate the methods of diagnosis of pregnancy in dairy cows	Presence of keratinized epithelial cells in the mucus of cows has been suggested pregnancy but no such distinct results obtained with chemical tests of urine of pregnant animals.	834
1975	To detect estrus and pregnancy based on mucus examination	The presence of cornified epithelial cells in mucus has been reported as estrus in animals. The normal type of estrus could be detected by examination of the mucus before AI.	835
1987	To evaluate Dip-stick ELISA to detect estrus & pregnancy in dairy cows	Milk samples of 460 cows have been analyzed with Dip-stick ELISA (Progestassay® Pitman-Moore Inc, USA), of which 378 cows found estrus & AI and 304 cows became pregnant.	836
1987	To assess the serum cholesterol to detect reproductive status of dairy cattle	The serum cholesterol level of pregnant, lactating non-lactating cows showed significantly higher than calves and heifers but highly significantly decreased in cows with retained placenta.	837
1994	To detect true estrus and early pregnancy in zebu cows by using radioimmunoassay in milk & plasma	Estrus plasma and milk samples demonstrated low progesterone (0.99 and 2.02 mmol/L) in 91% and 90% cases, respectively. Progesterone assay at 24 days after estrus may be accurate for early diagnosis of pregnancy in zebu cows.	838
2017	To measure the vaginal electrical impedance (VEI) to detect estrus in dairy cows	Approximately 40% cows remained un-detected when they are in estrus. A satisfactory CR can be achieved only if the AI is performed at the correct time relative to ovulation.The VEI could be used to detect estrus but daily VEI valuesare required to confirm the stages of estrus cycle, correct time of AI and early pregnancy.	839
2017	To detect the electrical resistance of vaginal mucus (ER VM) during estrus to determine the best time of AI	The ERVM values up to 220 Ω during estrus has been reported to be the best for AI with higher CR than that of more than 220 Ω. The Draminski electrical heat detector has been suggested to use for proper detection of time of AI in cows.	840

Research on commercial dairy farms

The productive and reproductive performances of both the smallholder and commercial dairy farms have been analyzed (Tables 28a-d) and evaluated.[841-843] Analysis of data of 25 commercial dairy farms in the districts of Dhaka and Gazipur suggested that the dairy farmers have ample opportunities to increase output by using more of concentrate feed and labor inputs.[788,842] A survey of 30 commercial dairy farms in CTG showed that 57% farm owners belong to business class and the remaining 43% to different categories. Of the business categories, 53% considered dairying as a side-business whereas 47% considered it as a main business enterprise.[788]

Constraints of dairy farms

Dairy farming both private and commercial have been reported to be an important and have the potential to poverty alleviation, food security, improved family nutrition,income and

employment generation. However, inadequate veterinary medical services, scarcity of feed andfodder, high price of concentrates and drugs, unpredictable milk market, low milk price, lack of grazing land, long distance of AI center and low conception rate (CR), lack of credit facilities, natural hazards, calf mortality and diseases of dairy cattle and lack of extension services especially on technical knowledgehave been recognized as major constraints limiting dairy production in Bangladesh.[238,615,638,651,659]

The major constraints of the smallholder dairy farmers for rearing dairy cattle have also been reported in terms of percentage and rank basis(Table 31). In addition, problems of dairy farms have also been expressed as high problems (69.0%), medium problems (31.0%), scarcity of feeds and fodder (99.0%), disease problem (79.0%), calf rearing problem (42.0%) and inability to adopt AI (33.0%).[847]

Table 31. Major problems faced by the dairy farmers (farmers' opinion in %) in Bangladesh

SN Recorded problems of dairy farms	Ref-[238]	Ref-[651]	Ref-[638]	Ref-[844]	Ref-[631]	Ref-[845]	Ref-[846]
01.Diseases	+	-	94.0	-	-	-	-
02. Deficiency	-	-	78.0	-	-	-	-
03. Scarcity of feeds and fodder	89-100	54.0	72.0	+	90-100	80.0	89.29-100
04. Lack of knowledge to dairy farms	-	-	-	+	-	-	-
05. Inadequate veterinary services	64-92	86.0	-	+	58-95	66.67	-
06. Non-availability of grazing land	79-90	50.0	-	+	70-96	67.67	-
07. Non-availability of hybrid bulls	26-82	-	-	-	40-64	-	-
08. Non-availability of hybrid dairy cattle	76-85	-	-	-	-	45.00	-
09. Long distance of AI center	20-70	-	83.0	-	30-45	-	-
10. Low conception rates of AI	30-74	-	83.0	-	-	-	-
11. Lack of knowledge of disease	-	-	-	+	-	-	-
12. Inadequate complex loan facilities	31-62	34.0	-	+	-	-	-
13. Insurance system	-	-	39.0	-	-	-	-
14. Lack of training & extension services	24-56	-	-	+	27-50	47.00	-
15. Lack of capital	-	-	-	+	75-85	-	-
16. Non-organized milk marketing	83-96	-	11.0	+	40-60	-	-
17. Low milk yield	-	-	51.0	-	-	-	-
18. Low price of milk	-	84.0	-	-	-	-	-
19. Non-availability of milk processing	-	-	30.0	-	-	-	-
20.Natural hazards (rainfall, storm etc.)	-	44.0	14.0	-	-	-	-
21. Calf mortality	10-30	-	63.0	-	20-35	-	-
22. Adult cattle mortality	-	-	27.0	-	-	-	-
23. Non-availability of vaccine	-	-	72.0	-	-	-	-
24. Skilled labor	-	-	57.0	-	-	-	-
25. Security	-	-	44.0	-	-	-	-

+ = Recorded as problems

The loan provided to the dairy farmers have been reported to have a positive impact on the development of dairy industries especially to increase the number of dairy animals, milk production and labor employment.[712] It appears that only 6% farmers received services of AI, 32 for vaccination and 22% surgery and obstetrics services, however, the dairy farms located around Upazila headquarter received better service than locatedat long distance.[848]Improved

feeding technology, proper hygienic and sanitation program, proper treatment, sound breeding policy should be taken and more participation in management practices are necessary for increasing milk production as well as establishing dairy enterprises.[640]

Research findings on milk and milk products

Billions of people consume milk and milk products every day in the world. Milk is a composite physiological fluid of most complete food and dairy products are considered to be the most nutritious foods of all. Children and adolescents should be encouraged to consume milk and milk products because calcium of milk is required for bone development and maintenance.

Dairy industry in Bangladesh has been transforming from traditional substance to more market-oriented and enterprise-driven approach in the milk production system which would open the opportunity for dairy farmers to exploit the rising demand of milk and milk products at national level.[849] Bangladesh has milk production of 9.92 million tons in 2018[17] whereas the Integrated Dairy Research Network (IDRN) estimated for 2018 as 7.98 million tons.[850] The milk availability per capita is reported as 165.07 ml/day/head against the minimum requirement of 250 ml/day/head.[17] The self-sufficiency according to DLS is 64% while the same is 53% according to IDRN.[850] Only 9.0% of the total milk production is delivered to the processors and the remaining 91% is traded as informally.[850] The maximum milk production in 2030 will be 13.6 and 18.1 million ton as forecasted by the IDRN and DLS, respectively. Both data sources might be overestimated for the milk production which can be tested by taking backward validation and use appropriate methods and models for forward estimation which in turn will help for increasing the precision of the data.[851]

Milk production trend of Milk-vita through the year,[660] lactation curves of different cattle breeds[823] and lactation and stage difference in milk yield[852]have been reported from Bangladesh.

Seasonal influence has been recognized as one of the factor on milk production and milk fat content in dairy animals in Bangladesh. Higher milk production has been reported during January (40.94%) and February (41.13%) and lower for July (20.47%), August (17.84%), September (18.59%) and October (18.87%) in Baghabarighat milk shed area,[853]whereas highest milk production has been reported in the month of June and lowest in January, August, September and December in the Sree-Nagar Milk Shed area and these differences have been explained to be associated with the availability of forage.[854] The first month of lactation reported

as best milk producing period among the five months and the management system had positive association with milk composition of local Pabna cows.[42]

Composition of milk

The physiochemical properties of different packaged fluid milk,[855] effect of feeds on the composition of milk,[856] compositional profile of milk[857] and physical, chemical and microbiological quality of cattle and buffalo milk[858] have been reported from Bangladesh. Milk composition is subjected to change in response of genetics, breeding, feeding, number and stage of lactation and health status of the lactating animals.[859]Significantly higher fat, protein and total solids in milk of RCC have been reported in comparison with the milk of cross-bred (HF cross, Jersey cross & Sahiwal cross) cows,[860] even milk of RCC showed best data both from nutritional and technological aspects.[859]

The milk production and its composition in local cows have been reported as 1.5 liter/ day, fat 4.59%, SNF 8.91% and total solids 13.49% in early days[861] and differences between cow milk and buffalo milk has also been reported.[858]Recently, several reports have been published on different aspects on bovine milk composition milk (Table 32).

Table 32. Effects of breed on milk composition in cows

SNConstituents	SL × SD (n = 76) R[633, 860]	Sindhi (n = 19) R[633]	RCC (n = 60) R[633, 862,860,859]	HF × L (n = 45) R[859, 860,862]	J × L (n = 12) R[860]	Local (n = 15) R[859]
01.TMY, kg	1680.33(2)	1620.67	1630.46 (1)	-	-	-
02.Acidity, %	0.118 (1)	-	0.165 (1)	0.145 (1)	0.146	-
03.Specific gravity	1.028 (1)	-	1.029 (2)	1.029 (2)	1.032	-
04.Water, %	-	-	854.0 (1)	-	-	-
05.Total solids, %	13.16 (1)	-	14.40 (2)	12.1 (2)	14.2	-
06.SNF, %	8.46 (2)	8.480	8.35 (3)	8.02 (2)	9.57	-
07.Milk fat, %	4.10 (2)	4.709	6.05 (3)	4.28 (1)	5.20	-
08.Protein, %	3.92 (2)	3.767	4.04 (3)	3.11(1)	3.82	-
09.True protein (g/kg)	-	-	37.80 (1)	27.15 (1)	-	36.40
10.Casein (g/kg)	-	-	28.83 (1)	18.38 (1)	-	27.14
11.Whey protein (g/kg)	-	-	8.96 (1)	8.77 (1)	-	9.26
12.NPN (g/kg)	-	-	0.36 (1)	0.36 (1)	-	0.35
13.Lactose (g/kg)	-	-	52.65 (1)	45.95 (1)	-	50.55
14.Glucose (mg/kg)	-	-	20.62 (1)	7.55 (1)	-	20.45
15.Galactose (mg/kg)	-	-	57.35 (1)	42.69 (1)	-	58.43
16.Total minerals (g/kg)	-	-	8.53 (1)	7.17 (1)	-	8.43
17.Calcium (g/kg)	-	-	1.40 (1)	1.09 (1)	-	1.32
18.Phosphorus (g/kg)	-	-	1.14 (1)	0.81 (1)	-	1.08
19.Ca : P ratio	-	-	1.23 (1)	1.35 (1)	-	1.22
20.Magnesium (g/kg)	-	-	0.12 (1)	0.09 (1)	-	0.12
21.Sodium (g/kg)	-	-	0.40 (1)	0.48 (1)	-	0.40
22.Potassium (g/kg)	-	-	1.52 (1)	1.52 (1)	-	1.61
23.Manganese (g/kg)	-	-	0.06 (1)	0.06 (1)	-	0.06
24.Zinc (mg/kg)	-	-	5.03 (1)	3.49 (1)	-	4.78
25.Copper (mg/kg)	-	-	0.07 (1)	< 0.05 (1)	-	<0.05

SL × SD = Sahiwal × Sindhi RCC = Red Chittagong cattle HF × L = Holstein-Friesian × Local
J × L = Jersey × Local - = Data not available TMY = Total milk yield
SNF = Solid not fat NPN = Non-protein nitrogen R = Reference
n = No. of samples(cows) tested ( ) = No. of reports

The highest fat % has been reported in RC cows than Jersey and Sahiwal crosses and lowest in HF crosses cows. The highest protein value observed in RC cows and the lowest in HF crosses. Comparatively higher total solids (14.81% vs. 12.97) and fat (6.17% vs. 4.92%) have been reported in Pabna variety cows reared on station (BLRI) than rural community which might be due to concentrate supplement to cows maintained at BLRI station.[42]The physiological condition of the animals and quality of milk may be evaluated based on milk metabolites. Four

metabolites (α-keto glutaric, orotic, succinic and formic acid) in milk of Holstein cross cows, three in milk of RC cows (α-keto glutaric, succinic and uric acid) and two (citric and α-keto glutaric acid) in milk of indigenous cows have been reported.[863]All the animals species and breeds showed considerable variation regarding the major components in milk. RCC and Deshi cow's milk are more favorable because of their higher true protein, casein, lactose, and total mineral content. The indigenous cattle milk is more or less similar to RCC milk regarding all most all the milk components.

Evaluation of the quality of raw milk

Milk is one of the most complete nutritious foods for humans considered to be the 'ideal food' because it is rich in nutrients essential for growth and maintenance of a healthy life of all ages especiallymore importance for the infants.Due to presence of most of the nutrients for health in milk, it acts as an ideal growth medium for bacterial pathogens that cause spoilage of milk. The evaluation of the quality of milk mostly includes somatic cell count (SCC), micro-biological count (MC) and chemical composition mainly protein and fat contents.Milk from a healthy udder may be sterile or contains very low level of bacteria, usually 10^2 to 10^3 cfu/ml of milk but the addition of microbes due to contamination during milking process and growth will reduce the time required for milk to spoil. The udder and teat (udder interior & teat exterior), environment and the milking and milk handling equipment are the three main sources of microbes of contamination of raw milk. Most of the raw milk samples have been reported to be contaminated with bacteria associated with human health risk in Bangladesh.[864-866]Antibiotic resistance bacteria isolated (*Staphylococcus aureus*, *Escherichia coli*) from raw milk samples have been reported from Bangladesh.[867]The main sources of microbial contamination of raw milk are the infected udder and teat canal, surface of the teat skin, surrounding air, housing conditions, water supply, milker's hands and hygiene and equipment hygiene. The milking hygiene has been reported to have a significant effect on initial bacterial count of milk andwashing and disinfection of udder and milker's hands, and sanitary rinse of milking pails just before milking with calcium hypochloride solution (200 ppm Cl) significantly improved initial bacterial quality of milk.[868] Accordingly, the commercial and hygienic quality of raw milk determination is required prior to reception of raw milk for further processing.[869]Comparison of milk constituents

between market raw milk and milk from dairy farm (Table 33) and between local market raw milk and Milk-vita milk samples (Table 34) have been evaluated.

The quality of milk supplied by vendors in Mymensingh town reported inferior in comparison to milk produced in BAUDF.[870] Market milk samples had significantly higher % of water than the BAUDF milk samples, but total solid, solid-not-fat, fat, lactose and protein had also significantly lower in market milk than BAUDF milk samples.[871] The physical properties and chemical composition of milk supplied to the BAU campus from BAUDF reported to be superior to other suppliers in relation to the quality.[872] Raw milk samples of BAUDF found superior than the village sources of milk which may be due to maintaining better hygienic condition.[873]

Significantly lower all milk constituents of local market samples indicates that this market milk may be adulterated by adding water in it.[874] Milk collected from Baghabarighat dairy plant has reported to be superior than milk collected from other plants of Milk-vita.[877] The total solids, fat and protein contents of all the samples reported within the normal range except the milk fat

Table 33. Comparison of milk constituent between market milk and milk of dairy farms

SN Constituents	Market raw milk				Dairy farm raw milk				
	Mym R[870] (n=40)	? R[871] (?)	SH R[872] (?)	Farmers R[873] (80)*	BAUDF R[870] (n=40)	BAUDF R[871] (?)	BAUDF R[874a] (n=45)	BAUDF R[872] (?)	BAUDF R[873] (20)
01.Energy (Mj/kg)	2.47	-	-	-	3.38	-	-	-	-
02.Milk fat (g/kg)	30.4	-	-	-	47.0	-	-	-	-
03.Total solids (g/kg)	105.4	-	-	-	134.9	-	-	-	-
04.SNF (g/kg)	74.5	-	-	-	88.1	-	-	-	-
05. Acidity, %	-	0.14	0.16	-	-	0.15	0.16	0.15	-
06. Specific gravity	-	-	-	1.02635	-	-	1.031	-	1.0295
07. Water, %	-	89.95	88.72	-	-	86.21	86.33	87.73	-
08. Total solids, %	-	10.15	11.30	-	-	13.78	13.39	12.25	-
09. SNF, %	-	7.13	8.21	-	-	8.85	8.85	8.58	-
10. Milk fat, %	-	3.02	3.06	-	-	4.88	4.78	3.7	-
11. Lactose, %	-	3.78	2.86	-	-	4.66	4.64	-	-
12. Protein, %	-	2.34	-	-	-	3.51	3.57	-	-
13. Ash, %	-	0.60	-	-	-	0.71	0.71	-	-
14. TVC, CFU/ml	-	-	-	11,01979	-	-	-	-	8,33,333
15. TCC, CFU/ml	-	-	-	380.4376	-	-	-	-	317.38
16. TSC, CFU/ml	-	-	-	806.495	-	-	-	-	680.50

SH = Students' Halls (BAU) R = Reference - = Data not available ? = Samples numbers not available
*Four villages milk samples (Boira, Shuriakhali, Churkhai & Paglabazar)

Table 34. Comparison of milk constituent between Local market milk and Milk-vita milk samples

SN Constituents	Local market raw milk			Milk vita milk samples					
	MG (50) R[874b]	MY (?) R[875]	Sherpur (29)* R[876]	MCC (50) R[874]	MCC (30 R[877]	TCC (30) R[877]	TPP (30) R[877]	BDP (30) R[877]	Pabna (400) R[878]
01. Acidity, %	0.160	0.1708	0.147	0.156	0.150	0.135	0.145	0.159	0.1513
02.Specific gravity	1.022	1.0286	1.030	1.032	1.024	1.022	1.024	1.027	1.029
03.Water, %	-	-	-	-	-	-	-	-	-
04.TS, % / g/kg	105.0	122.65	29.44	136.0	11.48	10.78	10.72	12.91	13.123
05.SNF, % /g/kg	15.0	84.92	85.55	88.0	7.20	6.67	7.04	7.96	8.356
06.Milk fat, %/g/kg	30.0	37.73	43.89	47.5	4.28	4.10	3.68	4.95	4.788
07.Lactose, %	-	-	44.78	-	-	-	-	-	-
08.Protein, %,g/kg	-	33.98	35.34	-	-	-	-	-	-
09.Ash, % g/kg	-	6.92	5.44	-	-	-	-	-	-
10. TVC, CFU/ml	-	-	111.44×10^4	-	-	-	-	-	156750
11. TCC, CFU/ml	-	-	58.89	-	-	-	-	-	316.15

MG = Manikgonj MY = Mymensingh MCC = Manikgonj Chilling Center TCC= Tangail Chilling center
TPP = Takerhat Pasteurization Plant BDP = Baghabarighat Dairy Plant Ref-4! = Mean values of 5 centers
*Average values of three market samples

content collected from Shombhuganj bazzar (32.66g/kg) and Mymensingh Sador bazzar (30.66g/kg) which showed less than normal level (35.0g/kg).[875]Moderate level of TVC and TCC in raw milk collected from local market may be due to poor hygienic milking, improper cleaning of dairy utensils and unhygienic handling during marketing of raw milk.[876]The qualitative and

quantitative aspects of dairy milk collected at morning and evening have been reported to be varied with that the evening milk contained higher amount of fat (4.58 vs. 5.41 %), SNF (7.75 vs. 7.81 %) and TS (12.33 vs. 13.23) but yields have reported higher at morning (52.77%) than evening (47.24%) milking except fat content.[853]

Evaluation of the quality of pasteurized milk

Pasteurized milk is a dairy milk that is heated to a specific temperature and held at that temperature for a specific duration in order to kill the harmful bacteria that makes milk safe to drink before it is packaged and shipped to grocery stores.Pasteurized milk is produced byheating milk for a minimum time of 15 second at a temperature of 72 ^{0}C or 30 minutes at a temperature of 63 ^{0}C. Thepost-pasteurization contamination (PPC) of pasteurized fluid milk have been reported with bacteria that are able to grow at 6 ^{0}C. Several gram-negative bacteria when introduced as PPC can grow rapidly at refrigeration temperatures around 6 ^{0}C and spoilage that can be detected sensorially within 7 to 10 days of processing.[879]In Bangladesh, contradictory reports on the contamination of post-pasteurization of milk have been published, in which both the commercial pasteurized and UHT milk have been considered safe for human consumption within the mentioned expiry date[880] whereas high count of bacteria in both the raw and pasteurized milk[881,882]and the TVC varied from 35500 to 1150400 in the different commercial brands of pasteurized milk have been reported.[883]Low levels of fat, SNF and specific gravity in the different brands of pasteurized milk samples indicates water adulteration in pasteurized milk in Bangladesh. High bacterial count including the coliforms in pasteurized milk samples may cause significant public health hazard.[883]Table 35shows comparison of chemical composition between raw milk and pasteurized milk and Table 36shows the evaluation of liquid pasteurized milk marketed packaged cow milk.

Table 35. Comparison of chemical composition between raw milk and pasteurized milk[884]

SNConstituents	Raw milk samples (n=42)			Pasteurized milk samples (n = 42)		
	BAUDF	BAUSV	MDF (K)	Milk-vita	CCBS&DF	TDL
1.Milk fat (g/kg)	37.2	46.2	39.86	24.5	26.07	24.7
2.TS (g/kg)	126.29	143.20	124.41	109.11	109.59	109.14
3.Acidity (%)	0.14	0.17	0.14	0.15	0.14	0.15

BAUDF = BAU Dairy Farm BAUSA = BAU surrounding area MDF (K) = Mini Dairy Farm (Kewatkali)
TDL = Tulip Dairy Ltd.

The quality of milk marketed by Milk vita has been reported superior to other milk, whereas Aarong ranked second. Jahan was inferior quality in comparison to other packaged fluid milk.[885] Table 36 shows that the Milk vita brand pasteurized milk maintained standard levels for chemical and bacteriological quality as per BSTI standard.[886]Milk brand names used in abbreviated forms but not mentioned and reported that the different brands of Bangladeshi pasteurized milk did not maintain the standard and acceptable quality.[883]

Table 36. Evaluation of liquid pasteurized milk marketed packaged cow milk

SN Parameter	Milk-vita R[885]	Milk-vita R[886]	Aarong R[885]	Aarong R[886]	Tripti R[885]	Jahan R[885]	Rupali R[885]	Cowlac R[885]	Tatka R[886]	FramF R[886]	RDM R[886]
01. Sp. gr	1.029	-	1.027	-	1.023	1.018	1.026	1.025	-	-	-
02.pH	6.5	-	6.60	-	5.83	6.50	6.23	6.43	-	-	-
03.Acidity, %	0.17	0.166	0.15	0.157	0.15	0.09	0.15	0.14	0.136	0.141	0.169
04.Fat, %	3.53	3.51	3.10	3.41	3.54	3.30	3.70	3.36	3.06	2.26	3.33
05.Protein, %	3.39	4.07	3.46	4.03	3.14	3.08	3.56	3.18	4.14	4.14	4.10
06.Lactose, %	3.77	-	3.58	-	2.79	1.53	2.83	2.85	-	-	-
07.Ash, %	0.71	-	0.63	-	0.57	0.41	0.64	0.54	-	-	-
08.Water, %	88.51	-	89.49	-	90.16	91.89	89.47	90.37	-	-	-
09.SNF, %	7.96	8.13	7.61	8.11	6.96	5.01	6.42	6.67	8.54	8.15	8.02
10.Total solid, %	11.49	11.46	10.57	11.53	9.84	8.12	10.52	9.62	11.58	11.41	11.35
11.TCC/ml	280	10.0	360	15.00	1580	2760	1320	6780	12.80	14.40	13.40
12.TVC/ml	4.59	-	5.236	-	6.11	5.49	5.76	6.09	-	-	-
13. TSC (cfu/ml)*	-	5.4	-	6.4	-	-	-	-	5.3	6.3	6.8

*$\times 10^4$ Farm F= Farm Fresh RDM = RD Milk - = Data not available

Ultra-high temperature (UHT) milk

There are a wide variety of microbes have been reported to be contaminated the raw milk and milk products. Raw milk can be a source of many harmful pathogens, causing a number of diseases like brucellosis,campylobacteriosis, Q fever, salmonellosis, listeriosis, tuberculosis and others. To overcome this milk borne disease problem, milk is subjected to heat treatment of various intensities like pasteurization, sterilization and ultra-high temperature (UHT). The UHT processing of milk involves heating milk in a continuous process to high temperature of 135 to 150 ^{0}C (138 ^{0}C) for a few seconds (1-8 seconds) destroys all microbes present in milk as well as inactivates all the enzymes, cooling rapidly and aseptically packaging of milk in sterile containers, thus gives the milk a better shelf-life and commercially stable. The shelf life of UHT treated milk and dairy products at ambient temperature storage is 3 to 9 months.[887]Very limited works on the quality of existing UHT treated milk available in the local market have been conducted in Bangladesh (Table 37).

Table 37 shows that the Starship UHT chocolate milk better and more acceptable milk followed by Milkman.[888] Overall acceptability UHT milk supplied by Aarong reported better, followed by Farm Fresh. However, none of the samples meet the standards of whole milk in terms of total solids, solid-not-fat and fat contents. Therefore, it is recommended that the manufacturers should standardize the raw milk during processing.[889]

The UHT milk of Farm Fresh have been reported to be superior than Pran Dairy and Aarong Dairy because it contained higher Total solids (119.23 g / kg), fat (34.97 g / kg), lactose (43.23 g / kg) and ash (7.0g / kg).[889] The quality of UHT and pasteurized milk have been reported to be excellent with the respect of parameter studied.[890]

The chemical quality of raw milk collected from different sources reported superior to pasteurized milk.All the raw milk samples fulfills the normal chemical composition of milk but fat and total solids content of pasteurized milk samples reported below the normal range which implies that some portion of fat has been withdrawn from the pasteurized milk.It appears that

Table 37. Comparison of UHT milk marketed by different companies in BD

SNParameter	Aarong		Starship	Milkman	Pran dairy	Fram Fresh
	R[888]	R[889]	R[888]	R[888]	R[889]	R[889]
01. Flavor (50)	43.00	41.67	30.00	36.67	37.67	43.67
02.Consistency (30)	27.33	26.0	27.00	25.33	24.00	28.0
03. Color & appearance (20)	17.33	18.00	18.67	16.00	16.0	18.67
04. Specific gravity	-	1.028	-	-	1.027	1.029
05.Acidity	-	0.15	-	-	0.15	0.14
06.pH	6.53	-	6.53	6.54	-	-
07. Fat (g/kg)	17.00	34.63	17.33	20.67	34.73	34.97
08.SNF (g/kg)	123.73	84.40	124.73	123.20	82.30	84.27
09. Protein (g/kg)	32.37	34.07	32.97	32.57	32.77	33.93
10. CHO (g/kg)	83.50	-	84.33	82.50	-	-
11.Ash (g/kg)	7.87	6.73	7.43	8.13	6.73	07.00
12.TS (g/kg)	130.73	119.03	142.07	143.87	117.03	119.23
13.Lactose (g/kg)	-	43.60	-	-	42.80	43.23

the quality of pasteurized milk available in local markets is poor and consumers are not getting high quality milk.

Bacteriological and chemical evaluation of powder milk

The physical, chemical and bacteriological assessment of market dry milk have been evaluated in Bangladesh.[891-894] The TVC of powder milk varied from 200,000 to 4,30,000 /g of powder milk have been reported.[892]No significant variation of microbial population among the different brands of infant milk food but the sanitary quality of the commercial infant milk food samples reported lower than the suggested standards.[895] Out of 12 full cream powder milk samples tested, of which 11 (91.67%) contaminated with *E. coli* and 6 (50.00%) contaminated with *Staphylococcus aureus* in Bangladesh.[896] However, no bacterial contamination has been reported

in different commercial brands of powder milk that good sanitary measures have been adopted during processing and storage of milk.[897]

Table 38 shows a significant variation of bacterial population among the different brands of dry milk and the lower sanitary quality of the market dry milk samples suggests standard of International Commission in Microbiological Specification for Food (ICMSF). It appears that the considerably lower quality of the commercial sweetened condensed milk samples as per recommended standards of the ICMSF. Significant variations ($p<0.01$) in TVC have been reported among different brands of powder milk samples.

Preservation and adulteration of milk

The storage of raw milk are usually performed in refrigerator, adding plant leaves, adding chemicals, heat treated (boiling, pasteurization, UHT) for preservation. The limited production of milk leads the dairy personnel to adulterate milk with unhealthy liquor and other solid substances. The way of adulteration is occurred by unhygienic milking, inappropriate transport

Table 38. Bacterio-chemical evaluation of market powder milk in Bangladesh[891,893,898-900]

SN	Milk Brand	No. of samples tested	Microbial count /g LVC	TSC	TCC	DMC	Y& M	Chemical values pH	Acidity (%)	Fat (g%)	Protein (g%)	Ash (g%)	Lactose (g%)	Moisture g%)	SNF (g%)	TS (g%)
01.	Anchor	12	5.38	4.30	3.70	7.34	-	6.80	0.13	27.89	25.87	5.48	36.64	4.11	67.10	95.89
02.	Birch tree	12	5.36	4.15	3.41	7.32	-	-	-	-	-	-	-	-	-	-
03.	Dano	12	5.30	3.48	3.60	7.32	-	-	-	-	-	-	-	-	-	-
04.	Friesian	12	6.40	4.52	3.78	7.23	-	-	-	-	-	-	-	-	-	-
05.	Kanny	12	5.63	4.00	3.70	7.20	-	-	-	-	-	-	-	-	-	-
06.	Red cow	12	5.48	3.85	3.78	7.14	-	-	-	-	-	-	-	-	-	-
07	Blue cross	10	2.96	-	1.41	-	1.89	-	-	-	-	-	-	-	-	-
08	Lucky boy	10	2.99	-	1.45	-	1.93	-	-	-	-	-	-	-	-	-
09.	Blue bell	10	2.93	-	1.46	-	1.96	-	-	-	-	-	-	-	-	-
10.	Danish	10	2.89	-	1.36	-	1.86	-	-	-	-	-	-	-	-	-
11.	Blue crown	10	2.83	-	1.20	-	1.83	-	-	-	-	-	-	-	-	-
12.	Blue star	10	2.91	-	1.32	-	1.85	-	-	-	-	-	-	-	-	-
13.	Kwality	03	3.53	-	-	-	-	6.73	0.13	27.89	25.22	5.46	37.41	4.02	68.09	95.98
14.	Nido	03	3.60	-	-	-	-	6.70	0.13	27.83	26.04	5.48	37.31	3.37	68.81	96.63
15.	Diploma	03	3.49	-	-	-	-	6.73	0.11	27.26	25.65	5.35	37.22	4.49	68.26	95.51
16.	Farm land	03	3.96	-	-	-	-	6.70	0.14	26.20	26.55	5.35	37.62	4.31	69.49	95.69
17.	Starship	03	3.88	-	-	-	-	6.67	0.16	26.30	27.02	5.41	37.65	3.74	70.07	96.26

TVC = Total viable count SC = Staphylococcus count TCC= Total coliform count DMC = Direct Microscopic count
Y & M = Yeast and Mold != logarithms and in average g% = g/100g - = Data not available

system, germ favored storage and milk collector itself which creates milk contaminated.[901] The addition of water to increase volume of milk, thickening agents like starch, flour, skimmed milk powder, whey powder or other ingredients to counter the dilution and extend the solids content of the milk, vegetable oil, sugar cane or urea to compensate the fat, carbohydrate or protein content of diluted milk. Some chemicals like hydrogen peroxide, carbonates, bicarbonates, antibiotics, caustic soda and even the most lethal chemical formalin to increase the storage period of milk, ice to enhance the shelf life of milk, detergents to enhance the cosmetic nature of milk which diminishes foamy appearance and whitening of milk or calcium thioglycolate / potassium thioglycolate / calcium salts of thioglycolic acid and urea for whitening of milk and giving it a genuine look.[902]The quality of farm produced milk and rural milk have been reported to be deteriorated by middlemen due to adulteration with water which have been reported to be

68.0% and 54.0% of the milk samples of vendor supplied rural and vendor supplied farm milk and also added formalin preservatives respectively.[903]However, milk adulteration is a global concern and developing countries including Bangladesh are at higher risk associated with it due to lack of monitoring and policies that has been overlooked that can pose serious health hazard leading to fatal diseases.

Milk is being very easily adulterated throughout the world because demand and supply gap, perishable nature of milk, low purchasing capacity of customer and lack of suitable detection tests.[904] Adulterants in milk mainly include addition of vegetable protein, milk from different species, addition of whey and watering which are known as economically motivated adulteration which do not pose any serious health risk.[905] Adulterants in milk that having adverse health effects are urea, formalin, detergents, ammonium sulfate, boric acid, caustic soda, benzoic acid, salicylic acid, hydrogen peroxide, sugar and melamine. Cane sugar, starch, sulfate salts, urea and common salts are added to increase solid-not-fat (SNF). Melamine is added to increase protein content falsely.[906]Ammonium sulfate is added to increase the lactometer reading by maintaining

the density of diluted milk. Formalin, salicylic acid, benzoic acid and hydrogen peroxide act as preservatives and increase the shelf life of the milk.[907] Vegetable oil is added to increase non-milk fat in milk. Detergents are added to emulsify and dissolve the oil in water giving a frothy solution which is the desired characteristics of milk.[908]Table 39shows the summery of the research findings on preservatives and adulterants added to milk and milk products in Bangladesh.

Table 39. Research findings on evaluation of preservatives and adulterants addedto the milk and milk products

SN Products	Methods of preservation	Results	References
01. Ghee	Store at room temperature (RT)	Lab made ghee kept better than market ghee in aluminum container which has reported best, glass & plastic good, tinned and iron poor and earthen recorded as worst	909
02. Ghee	Tested by BSTI- BD	All the 10 tested ghee brands have been reported to be adulterated	910
03. Milk	Mixed morning milk with evening milk	Storage quality of milk reported better when milk stored with ice water than with or without water.	911
04. Milk	Heat treatment	Effect of heat treatment on shelf life of milk has been reported	912
05. Milk	Hydrogen peroxide (H_2O_2)	0.02 to 0.04% of hydrogen peroxide reported as the suitablelevel for milk preservation	913
06. Milk	Hydrogen peroxide (H_2O_2)	Six portions of milk have been preserved with 0.01%, 0.02%, 0.03%, 0.04%, 0.05% and 0.06% H_2O_2. Results showed that 0.04 to 0.05% H_2O_2 found enough to preserve milk sample up to 24 hrs	914
07. Milk	Hydrogen peroxide (H_2O_2)	H_2O_2 @ 0.02, 0.04, 0.06, 0.08, 0.10, 0.12 and 0.14% of 10% solution have been added to these seven groups ofMilk samples at RT (28-31 ^{0}C). The 0.14% H_2O_2 dilution has been recommended to use for preservation of raw milk	915
08. Milk	Banana leaf at RT	Acidity of milk dropped and it preserved milk taste, flavor and texture longer time than untreated raw milk	916
09. Milk	Banana, water hyacinth, bamboo, date palm and jack fruit leaves	Stored at RT (24-26 ^{0}C) and the texture (14 hrs), flavor (13.33 hrs), color (17.67 hrs), taste (13.33 hrs) and acidity (12.67 hrs) of milk samples preserved with banana leaf reported better than other leaf.	917
10. Milk	Sodium bicarbonate (0.10, 0.15 & 0.20%)	Stored at RT (32-34 ^{0}C) and reported that addition of 0.2% $NaHCO_3$ resulted optimum level for preserving milk up to 16 hours.	918
11. Milk	Sodium bicarbonate (0, 0.3, 0.4 & 0.5%)	Preserved at RT (28-30 ^{0}C) and reported that addition of 0.5% $NaHCO_3$ suggested enough to preserve raw milk up to 19 hours	919

14. Milk	Different containers	Effect of containers on the storage life of milk in winter season have been reported	922
15. Milk	Different containers – glass, tinned iron, plastic, aluminum, earthen and bronze at 12-20 ^{0}C and Sodium bicarbonate	Milk kept well in aluminum containers up to 10 hours but poorer in other containers and worst in earthen containers. Sodium bicarbonate @ 0.05 and 0.1% added milk kept well up to 16 hours and up to 20 hours with 0.15% based on acidity test. The Na_2CO_3 added milk has improved the keeping quality till 24 hours of storage in aluminum containers at 10-19 ^{0}C	923
16. Milk	Adulterants- starch test & formalin test of milk	Results showed that all the tested milk samples reported negative to starch test and formalin test of collected milk samples.	924
17..Milk	Water, powder milk and formalin	Water and milk powder have been added in raw milk. In addition, formalin detected in 75% milk samples in July and 50% in sept.	925
18. Raw milk & powder milk	Shelf-life of raw milk & Dano @ 140g/L water at RT & refrigerator	Raw milk and reconstituted powder milk have been reported to be acceptable up to 9.50 and 12.0 hours at RT (27-29 ^{0}C) and 12.67 23.67 days at refrigerator temperature (5-6 ^{0}C), respectively	926
19. Milk	Adulterants of milk	Different adulteration of milk have been reported	927
20. Milk	To evaluate contamination adulteration and preservative status	High fat content even after watering and presence of formalin in 8.0% milk samples of vendor rural milk. These adulterants and preservatives in milk may cause severe public health problems.	928
21. Milk	Adulteration	Detection of adulteration of milk	929
22. Milk	To detect the quality and adulteration of raw milk	The quality of milk varied from one goalas to another as well as dairy farmers. Adulteration tests found negative in all milk samples	930
23..Milk	To detect the mixed heated and raw milk	Turbidity index has been used successfully to detect the percentage of heated milk added to raw milk	931

It appears from Table 39that $NaHCO_3$ is the effective chemical for neutralizing the acids produced by acid producing bacteria and can be used as a short term preservation of milk under rural condition in Bangladesh where scientific cooling or pasteurization facilities are not available.

Some of the milk adulterants may produce severe public health disorders of which melamine can induce renal failure and death in infants.[932] Bothe peroxides and detergents in milk can cause gastro-enteritis. Excessive starch in the milk can cause diarrhea due to effects of undigested starch in colon and accumulated starch in the body may be fatal for diabetic patients.[908] Urea in the milk overburdens the kidneys as it have to filter out more urea content from the body.[933]

Preparation of milk products

Milk is an essential basal constituent of a wide range of milk products worldwide which include liquid milk, fermented milk, cheeses, butter and ghee, condensed milk, evaporated milk, dry milk or milk powder, cream, ice cream, whey products, yogurt, curd and casein. Manufacture of table cream from reconstituted milk,[934] low fat-milk in the household by gravity method,[935] manufacture of peda from sweetened condensed milk,[936]use of vegetable oil in manufacture of Khulna cheese from powdered milk,[937]comparison of quality of khejur gur sandesh with sandesh of different sweetmeat shops[938] and different varieties of sweets which are

prepared from milk and marketed by the different shopkeepers in Bangladesh (Table 40). Shopkeepers of different sweetmeat shops received raw milk from farmers (52.6%) and goalas (47.4%) and highest amount of whole milk has been reported to be required per unit production of rosomalai (21.0%) and ghee (18.0%) whereas the lowest amount in chomchom (9.0%) production.[939] A large varieties of sweetmeats are produced in different regions in Bangladesh but some sweetmeats which are famous in Bangladesh include (a) Porabari chomchom of Tangail (b) Monda of Muktagacha, (c) Bogurar doi, (d) Pyada and Rosomalai of Comilla, (e) Kacha golla of Natore, (f) Famtala sweetmeat (Jessore), (g) Malaikari of Faridpur and Dhaka for Amrti, Jillipi and Pranhara.[940]

Table 40. Recommended constituents and methods for preparation of different sweets from milk

SN Sweet	Constituents	Results	References
01. Butter	Sanitary & keeping qualities of butter	The sanitary and keeping qualities of butter made from raw and pasteurized cream of different ages at 0 ^{0}C and 5 ^{0}C	941
02. Chhana	Evaluation of different coagu-lants on the quality of chhana	Six types of coagulants comprising of sour whey (0.5%, 1.0% acidity, citric acid (0.5%, 1.0% acidity) and blend of sour whey and citric acids (0.5%, 1.0% acidity) have been evaluated of of which 1.0% sour whey as coagulants reported best.	942
03.Rosogolla	Fresh cow milk & powder milk	Commercial powder milk has been suggested to be used for the preparation of Rasogolla to complement the shortage supply of fresh cow milk	943
04. Rosogolla	Cow milk chhana and/or soy-chhana	Rosogolla prepared from only cow milk chhana and by mixing 10% soy-chhana stored for 16 days at RT, whereas 20% and 30% soy-chhana mixed with cow milk chhana stored for 12 and 19 days respectively for human consumption	944
05. Rosogolla	Cow milk chhana and/or soy-chhana	The combination of 10% soy chhana plus 90% cow milk chhana has been suggested to produce acceptable quality of protein rich rasogolla for human consumption	945
06. Rosogolla	Cow milk chhana buffalo milk chhana & mixed chhana	Results showed that rasogolla prepared from cow milk chhana gained the highest organoleptic score, whereas 50% CMC + 50% BMC produced rasogolla nearly similar to rasogolla of CMC	946
07. Rosogolla	Flour added in chhana	For both the physical and chemical properties of rossogolla, 5% flour has been suggested to add in chhana as a binder for making	947

09. Rosogolla	To assess the effect of conc of cooking and soaking sugar syrup on the quality of rosogolla	The chhana prepared by adding 1% citric acid in raw milk at 80 ^{0}C. The chhana obtained has been kneaded with 5% (w/w) wheat flour. The rosogolla prepared from 60 ^{0} Brix cooking syrup and 40 ^{0}Brix soaking syrup kept for 24 hours resulted in the best quality rosogolla	949
10. Rosogolla	To compare the rosogolla between Lab made and market rosogolla	Lab made rosogolla has been reported to be significantly better quality than market rosogolla. The proper method, proper composition of the ingredients and strict hygiene and sanitation measures should be followed that will give the consumer satisfaction	950
11. Rasogolla	To assess the nutriational quality of rosogolla collected from branded shop	TVC, coliform and fungal counts in all the tested samples have been reported higher than the maximum permissible level of BSTI standard. About 50% samples contained *Salmonella* spp. and *S. aureus* which have public health impact	951
12. Sandesh	Cardamom powder @ 0, 0.05, 0.10 & 0.15% as preservative	Results showed that all types of Sandesh prepared with different concentrations of cardamom powder reported with good qualities in terms of physical, chemical and microbiological content	952
13. Sandesh	Cardamom powder for self-life at RT	Addition of natural cardamom powder @ 0.10% has beenreported acceptable for the preparation of sandesh which has been shown more desirable aroma & increased self-life of sandesh up to 24 days	953
14. Sandesh	Cardamom powder @ 0, 0.05, 0.10, & 0.15% as preservative	Sandesh has been stored with adding different concentration of cardamom powder and stored at 23 ± 1.0 ^{0}C. Highest microbial growth has been inhibited with 0.15% cardamom powder and suggested to use as a preservative for sweetmeat to improve keeping quality	954
15. Rossomalai	Compare Milk-vita rosomalai with sweetmeat shops rossomalai	Physical, chemical and bacteriological examinations revealed that the rosomali of market sweetmeat shops reported inferior to the Milk-vita rossomali. Method of preparation of rossomalai has been described.	955
16. Rossomalai	Compare rossomalai between lab prepared & different sweetmeat shop rossomali	Physical, chemical and microbiological characteristics of rassomali prepared at lab and collected from differentof sweetmeat shop from five districts have been compared revealed that the quality of different district rossomali found inferior to lab made rossomali.	956
17. Rossomalai	Compared the quality of rossomali made	Physical, chemical and microbiological quality of rossomali have been evaluated. Physical examination revealed betterrossomali	957

19. Ingrain vough	Compare the quality between lab made and collected from market of Dinajpur district	Organoleptic, chemical analysis and bacteriological status of lab made and collected from three sweetmeat shop have been evaluated. Lab made Indrani vough has been reported as best in relation to bacterio-logical status but Sananda sweetmeat shop's product reported superior than other two sweetmeat shop products. Preparation method has been described.	959
20. Chamcham	Compare the cham-cham prepared with cow milk, buffalo milk & mixed milk	Examination of the quality of chamcham showed that chamcham prepared from buffalo milk reported superior to that of cow milkchamcham and 50% cow milk and 50% buffalo milk chamcham.Method of chamcham preparation has been described.	960

Rossomali

Rossomali is a royal sweet often served in weddings and eaten on special occasions. The dessert is called rossomali in Bengali language, ras malai in Hindi language and rasa malei in Odia language. It is believed to have originated somewhere in Eastern Indian sub-continent, presumably in Bangladesh, Indian state of Odisha and West Bengal region. (en.wikipedia.org/wiki/Ras_malai). It is a soft white round patties immersed in creamy, milky syrup flavored with cardamom, pistaios and saffron.

Method of Rossomalai preparation[955-957]

- Approximately 3.0 liters of raw milk should be collected, of which about 1.80 liter milk should be boiled in a stainless pan for five minutes for preparation of chhana and remaining 1.20 liter milk should be used for malai preparation.
- Theboiled milk (1.80 liter) should be cooled to 80^0C. Then the coagulant, sour whey (360 ml with 1.22% acidity) water should be added to the cooled milk for over 30 seconds allowing precipitating the milk curd (called chhana) until chhana separates.
- Whey is then removed from chhana through filtering cheese-cloth/ muslin cloth and water is expelled out leaving chhana inside the cloth.
- Then 1.0% (w/w) flour is added to the chhana and it is then grinded and kneaded to prepare chhana balls (small balls of 0.5-0.75 cm size) with a smooth surface without any visible sign of cracks.

- Concentrated sugar syrup (sugar : water = 1.5 :1) is then prepared and the solution is then heated to boiling.The small ball-shaped chhana put gently in the boiling sugar syrup and cooking for 20-30 minutes.Care should be taken that the balls never over crowded the pan and there is enough space for moving them freely.After swelling the colors of the balls are slightly darken, then the cooking should be finished.
- Then sweet balls should be cooked at room temperature and filtered from sugar syrup. At that time sweet balls became large size due to osmosis activity and weight increased more than three times (1-1.25 cm).
- The 1.20 liter of whole milk, 40 g sugar and 3 to 4 pieces of cardamom should be mixed in a pan and heated until the volume is reduced by 50%. When milk turned light brown color then malai is formed.
- Balls of chhana are then cooked in hot malai for 3 to 5 minutes, cooling to room temperature (about 25 ^{0}C) for 5-6 hours and it becomes ready for human consumption.

Rosogolla

The dessert is known as Rasagola in Odia and Rosogolla or Roshogolla in Bengali. Rasgulla is derived from the words 'ras' (juice) and 'gulla' (bal). Rosogolla is a sweet syrup cheese ball most popular in the regions of South Asia, manufactured from chhana which is obtained by heat and acid coagulation of milk.[949] It is one of the most delicious and nutritious among all sweetmeats due to its fairly high protein, fat, mineral especially Ca and P and also fat soluble vitamin A and D.[961]

Method of Rosogolla preparation[947-950]

The pre-requisite for producing excellent quality rosogolla is the availability of high-quality chhana together with the binding material, kneading and concentration of sugar syrup, cooking and soaking time. The correct concentrations of cooking sugar syrup is required for the body andtextural properties of rosogolla and its inappropriate concentration leads to cracked, flattened or even brushed rosogolla. Cooking is the process in which a soft and smooth body of chhana balls converts to a fluffy and fibrous network that provides spongy texture typical to rosogolla.

Materials

Cow milk 3.0 liter with 4.0% fat, food grade citric acid, soft wheat flour (ACI Pure), cane sugar and cardamom

Methods

Chhana preparation

- Fresh cow milk (3.0 liter) should be heated to boiling (95 ^{0}C) in a stainless steel pan for 10 minutes and then cool down up to 70-80^{0}C.
- The coagulants (fermented whey pH 4.2 or 1% citric acid) are then added at a temperature of 70 ^{0}C along with gentle stirring and the casein is then allowed to precipitate.
- The lumps (known as chhana) are then allowed to stay for half an hour for complete coagulation of chhana, as well as to cool down to room temperature (25-37^{0}C).
- Chhana is then separated from whey by filtering through a muslin cloth for 2 to 3 hours for the visible cessation of drainage of whey.

- When the loosely bound whey is completely drained out, the muslin cloth is tied together then the coagulum ishanging for about one and half an hour to complete drainage of whey.

Preparation of sugar syrup

The cooking and soaking sugar syrup @ 60 and 40^0 Brix concentrations have been reported to be most suitable for rosogolla making using admixture of 5% (w/w) wheat flour.[949]

Rosogolla preparation

- The chhana should be mixed with wheat flour (5.0% w/w)and kneaded properly to make uniform and smooth dough.
- The chhana dough isthen divided into small pieces of about 10g and rolled between the palms to obtain smooth balls without cracks.
- Cooking (@ 60) and soaking (@ 40) sugar syrup are prepared separately by dissolving the requisite amount of sugar in portable water. Heavy sugar syrup containing 5% sugar (sugar : water = 1 : 1) has also suggested. A 1.5 liter sugar solution is used for cooking and 1.0 liter for socking.
- Sugar solutions are then clarified by adding some quantity of raw milk during boiling and filtered through a muslin cloth.

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- The Chhana balls are then gently dropped into the boiling syrup contained in Karachi.
- After a few seconds, the foam is formed which covered the floating balls.
- The mild temperature is regulated as the balls are constantly covered with foam.
- Some quantity of water is then sprinkled during the continued boiling of sugar syrup to maintain the sugar syrup concentration.
- It is carefully watched that balls are not over crowded in the karahi and there is enough space for moving freely, especially when they swelled.
- The heat is controlled so that the balls are constantly covered with foam.
- After a regular interval, cool water is sprinkled for keeping the sugar syrup at a controlled density.
- Complete cooking of chhana balls is accompanied 20 to 30minutes.
- The balls are swollen to about double the original size.
- Finally, the balls are transferred to the clarified hot sugar syrup having 40% (sugar : water= 1 : 2) strength for soaking and 2 to 3 cardamom pieces are added to the sugar syrup and then cooled down to room temperature or below for 4 hours and ready for human consumption

Balish misti /Balish Rossogolla

Balish misti is one type of rossogulla famous sweet of Netrokona district. This misti is pillow-shaped and looks like a pillow as kheer is coated on the topof the sweet that is why it is called balish misti.

Method of preparation[948]

- Approximately 3.0 liters cow milk is boiled in a stainless steel pan for 10 minutes and thenis cooled at 70 ^{0}C.
- About 600 ml whey water is added in the 3 liters of the boiled milk at a temperature of 70 ^{0}C.
- Lumps of casein are formed as soon as the whey is added to the boiled milk, which is generally known as chhana.

- The contents are allowed to cool down at room temperature (about 25 ^{0}C) for 30 minutes and then the coagulum is transferred to a muslin cloth.
- When the loosely bound whey is completely drained out, the muslin cloth is tied together then the coagulum ishanging for about one and half an hour to complete drainage of whey.
- The coagulum is then carefully removed and weighed.
- The ingredients composition of Rassogolla preparation include chhana 590g + flour 75g, chhana 610g + flour 80g and chhana 595g + flour 75g can be used.
- Chhana and flour are weighed separately, mixed and kneaded.
- Then the kneaded mash should be converted into an oval shape with proper consistency to avoid the crack on the surface.
- About 3kg of sugar is dissolved in 2.5 liters of water in an iron pan and the solution is boiled.
- After some times of boiling the scum is labeled out for obtaining clean syrup.
- The syrup is kept in a suitable sized pan with a depth of 20 cm.
- The chhana of desired size (Balish) is made by hand.
- When all the Balish Rossogolla is made they are put gently in the boiling sugar syrup for cooking.

- Care should be taken that the newly prepared Rassogolla (Balish) are not over crowded in the pan and there is enough space for moving freely especially when they are swelled.
- The heat is so controlled that the rossogolla are constantly covered with foam.
- To control the density of the sugar syrup throughout the cooking period water is sprinkled at a regular interval.
- In 10-15 minutes Rossogolla are swelled and after 10 minutes of swelling the color of the Rossogolla become light are dark.
- Then the Rossogolla are allowed to stay for sometimes to become cool.
- After 3 hours Rossogolla are suitable for consumption.

Indrani vough

Indrani vough is a famous sweet of the district of Dinajpur. Description of this sweet is not available in the webpage and so far only one article has been published.[959]

Preparation of Indrani vough[959]

- Approximately 3 litersraw whole milk, 200g sugar, 20g flour and 240 ml sour whey are required for the preparation of Indrani vough.
- At first 1.70 liter cow milk should be heated to boil for five minutes into two separate iron pans. The milk should be cooled to 80 ^{0}C after boiling and sour whey should be added until chhana separates.
- The contents should be allowed to cool down at room temperature (25 ^{0}C), after 30 minutes the coagulum should be transferred to a muslin cloth and the cloth should be hung for about one hour for complete drainage of whey.
- Approximately 60g of chhana is usually obtained from 1.7 liter of fresh cow milk should be broken and kneaded with flour (5.5% by the weight of chhana) in order to obtain the desired body and texture.
- Rossogolla (disc shaped) should be made without the signs of cracks.

- Concentrated sugar syrup (sugar : water = 1.5 : 1) should be made and heated to boiling.
- Just after boiling the scum should be labeled out to obtain clear syrup.
- Then Rassogolla of chhana should be cooked in the boiling syrup for 8 to 10 minutes.
- For the preparation of malai 1.30 liter cow milk should be heated in a pan until 50% volume is reduced. The rossogolla is cooked in hot malai for 3 to 5 minutes.
- Then the Indrani vough is prepared and it is allowed to stay for sometimes to become cool.
- After 5 to 6 hours Indrani vough would be ready for consumption.

Cham cham

Chomchom, cham cham or chum chum is a traditional Bengali sweet, popular throughout the Indian sub-continent. This sweet comes in a variety of colors, mainly white, light pink, light yellow. The history of Porabari chamcham, an oval-shaped brownish variety of chomchom from Porabari in Tangail district in Bangladesh.

Requirements[960]

- Approximately 3.0 liter raw whole milk, sugar 2 kg to prepare sugar syrup, flour 40g (1.0% of weight chhana and sour whey 500 ml are required to make 1.5 kg Chamcham.

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- Out of the three liters milk, two liter milk is used for chhana preparation and one liter milk is used to Mawa preparation.

Preparation of Chhana

- Two liters of milk should be heated to boiling at 90 ^{0}C in stainless steel pan.
- The milk should be cooled to 80 ^{0}C after boiling and adding sour whey water at70 ^{0}C and the lumps of casein formed are allowed to stay for few minutes for complete of chhana. The contents should be allowed to cool down at room temperature (25-29 ^{0}C).
- After 30 minutes the chhana and whey mix should be transferred to a piece of muslin cloth.
- When whey will be completely drained out, the chhana should be hung for about one hour for complete drainage of whey.Then the Chhana should be carefully removed from the muslin cloth and weighed.

Preparation of Chamcham

- The mass of Chhana is then broken (grinding) and kneaded with wheat flour (1% of the volume of chhana) in order to obtain the desired body and texture.
- Small balls should be made without cracks.
- Concentrated sugar syrup (sugar : water = 1.5 : 1) should be made and heated to boiling.
- Just after boiling the scum isladled out to obtain a clear syrup.
- Then the balls of Chhana are cooked in the boiling sugar syrup for 40 to 45 minutes, then cooled to room temperature.

Preparation of Mawa

- Rest one liter milk should be boiled to dry for the preparation of mawa.
- Raw chamcham should be separated from sugar syrup, arranged on trays and mawa is then spread on the balls to garnish the chamcham.

Cheese

Cheese is a dairy product which is derived from milk and produced in wide ranges of flavors, textures and forms by coagulation of the milk protein casein. It comprises proteins and fat from milk, and milk is usually acidified and adding the enzymes of rennet (or bacterial enzymes with similar activity causes the milk proteins (casein) to coagulate. The solids (curd) are separated from the liquid (whey) and pressed into final form (Wikipedia).Table 41shows the research findings on cheese published from Bangladesh.

Table 41. Research findings on cheese preparation and its quality evaluation

Year	Constitutes	Results	Reference
1970	Dhaka cheese	Reported that about 1.2 million lbs of Dhaka cheeses are being supplied to Dhaka city from Austogram of Mymensingh district. Family profession has changed due to inadequate and high price of milk supply	962
1971	Cheese preparation method has been described	The commercial 'lactic' culture and Hensen's commercial rennet have been used for preparation of cheese. The cheese preparation method has been described.	963

1982	Combination of cultures with use of flour produce better quality cheese	*Streptococcus lactis* alone obtained the lowest average scores (86.94%) and cheese made with *S. lactis* + *Lactobacillus bulgaricus* and *S. lactis* + *L. bulgaricus* and *S. lactis* +*L. bulgaricus* + Leuconostoc obtained higher scores 93.17% and 94.33%, respectively.	964
1982	Rennet extract is prepared from abomasum ofslaughtered calves	Renate extract has been prepared using 10% sodium chloride solution with 6.0% boric acid as preservative. The extract has found to coagulate milk effectively at 30.5 ^{0}C.	965
1995	Preparation of Austogram cheese	Citric acid @ 850 ml/5 kg whole milk at 73 ^{0}C has been used to produce Austogram cheese. Firm curd thus formed sliced by knife, settled for 30 minutes and then 3% salt is added in the finish product, allowed to dry at RT for 24 hours, and could be stored up to 30 days at 21 ^{0}C	966
2004	Rennet is not available in local market and lactic, citric & tartaric acids& sour whey have been approved as coagulants	These acids and sour whey are used as coagulants for making cheese. Lactic acid produced the best quality cheese and citric acid 1-2% is widely used with desirable results. Milk is coagulated by means of lactic acid produced by bacteria or by rennet or both. Cheese keeps longer than fresh milk and is easier to transport. Method of preparation of cheese is described.	967
2005	Physical, chemical and bacteriological evaluation of Dhaka cheese	Low, medium and high salted Dhaka cheese have been evaluated on physical, chemical and bacteriological methods. Presence of high level of microbes in all the samples which indicate unsanitary condition. However, the medium-salted Dhaka cheese has the highest acceptability.	968
2008	Quality of cheddar cheese	Effect of hot ripening on the quality of cheddar cheese has been reported	969
2010	Evaluation of physical and chemical qualities of mozzarella cheese	The physical and taste scores of Mozzarella cheese made from cow and buffalo milk reported similar. Cheese made of buffalo milk had higher fatt, protein, ash and total solids than cheese made of cow milk.	970
2015	Effect of salting & salt conc in Dhaka cheese	Combination of 2% (w/w) salt stuffing and bringing showed significantly better distribution of salt followed by only bringing	971
2017	To standardize the desire level of papaya	Five groups of cheese have been prepared with 0.28g rennet, 5, 6, 7, and 8 drops papaya latex (PL). Cheese prepared from buffalo milk with 6 drops	972

Cheese making procedure of Austogram

- Cheese is prepared by producing curd from milk by adding crude rennet extract.
- This is obtained from the fourth stomach (abomasum) of cows and goats.
- The abomasum obtained from slaughter houses is washed and dried with sodium chloride and is kept till it is used.
- Before cheese making, this is soaked in water for at least 12 hours. This is locally known as 'maoa.'
- The raw milk is set with maoa and the coagulation takes place within an hour.

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- The curd is broken by hand or a bamboo knife and settled for a few minutes, then packed in a basket. The whey is pressed out by hand.
- For proper size and shape turning is made at certain intervals.
- When the curd is sufficiently dry after 24 hours, it is salted with sodium chloride.
- The salt is plugged into three centrally bored holes.
- The cheese is then ready for sale.

Analysis of cheese

- Five cheese samples of these manufacturers were collected and analyzed.
- These cheeses were found to contain 39.5% fat, 5.12% salt and 60.7% total solids.
- The TVC was 400,000,000 / g after incubating for 120 hours at 20 0C in plate count agar.
- The gram positive cocci constituted the predominant flora microorganisms

Methods of collection of rennet

- The abomasum of suckling slaughtered calves of different ages should be collected.
- The stomachs should be cleaned by rinsing in cold water and the adhering fats are needed to be removed mechanically.
- The mucous membrane of each stomach should be separated and cut into pieces of convenient size and then should be weighed in grams.
- The fresh cut pieces of each stomach should be added to 500 ml of 10% sodium chloride containing 6% boric acid as preservative and then macerated for 3 days in the refrigerator.
- After 3 days of maceration the samples should be filtered and the filtrates are collected and the keep in the refrigerator until the activity tests are made.
- The extraction should be repeated twice with the same sample of stomachs and filtrate should be collected after 3 days and 5 days respectively.
- All the successive collection of filtrate from each stomach should be pooled together and quantities obtained should be noted and store in the refrigerator.

- Six samples of rennet extracts obtained from different calves are tested first to find the desired concentration for suitable coagulation in milk.
- Each sample of rennet extract should be diluted with distilled water into 1:10, 1:20 and 1: 30 ratio.
- One ml portion of each dilution should be added to 10 ml portion of whole milk and then need to be incubated at 30.5 ^{0}C for half a minute and two minutes respectively in thermostatically controlled water bath.
- One the basis of rennet test for strength of rennet, the strongest rennet coagulates milk rapidly within one minute.
- Coagulation of milk in one minute is considered better for proper clotting of milk.

Some observation

- Milk samples which coagulated in 1 minute are considered to be the desirable strength for the coagulation of milk.
- If rennet extracts obtained from calves of early ages, i.e. 14 to 20 days or less are suitable for the quick clotting of milk.
- If the rennet extract is transferred from the sunlight to low temperature and keep there for a while, the activity of rennet extract might be regained.

- The cheese manufactured by using rennet extract prepared from the fourth stomach of calves of 14 to 25 days showed no flavor deteriorations but the cheese made from rennet extract of calves of 150 to 200 days gave a little bitter taste.
- Bitter taste in finished cheese indicates that the rennet extract obtained from the calves of 125 to 200 days, might contain more pepsin, good for the coagulation of milk.
- It appears that the quality of cheese depends on the nature of rennet extract used for preparation of cheese.

Preparation of cheeses[967]

- The cheeses are prepared by coagulating milk using lactic, citric and tartaric acid.
- Each 1.5 kg of milk is placed in three vats separately.
- The milk is heated to 85 ^{0}C and 2g coagulants per kg of milk are added.
- The milk stood for 40-45 minutes.
- When coagulation is completed the curd is cut into several pieces with a knife and left to settle for 25-30 minutes.
- The whey is separated by fine muslin and the resulting curd is put into a wooden box with addition of 1% salt. Then, it is kept in refrigerator for further study.

Preparation of cheese[963]

- Freshly drawn milk is supplied from BAUDF with acidity ranged from 0.16 to 0.18%
- The milk is then placed in two vats each containing 20 lb of milk for making two different blocks of cheese.
- The milk is heated by hot water supplied from a hot water tank.
- At 30-31 ^{0}C ‘lactic starter’ is added @ 4-5 oz for each 20 lb milk.
- The acidity is increased by 0.01-0.02% usually within 40-50 min.
- Hansen’s commercial rennet is added for coagulation.

- The milk is coagulated within 40-45 minutes and it is cut with a knife or broken by hands into smaller particles.
- The salt is added @ 3 oz / 20 lb of milk in two methods.
- In one bucket salting is done by sprinkling as the curds are hooped in a basket.
- In another, salt is plugged through centrally bored holes after 24 hours of hooping.

Preparation of cheese[970]

- Rennet and starter culture are collected from Classic Dairy Foods, beg Housing, Khagdohar, Mymensingh
- The milk is heated at 80 ^{0}C for 30 minutes and then cooled for about 45 minutes to 38-40 ^{0}C and a culture of thermophilic bacteria (5%) is then added.
- After 30 minutes, calcium chloride ($CaCl_2$) dissolved in water is slowly added at 0.5g/2.5 L of milk and after 15 minutes rennet dissolved in water is slowly added at 0.5 ml/2.5 L of milk.
- While adding $CaCl_2$ and rennet, milk is agitated by curd rake and ripened for about 40 to50 minutes for curd formation.
- When curd formation is completed it is cut into cubes by curd cutter and the temperature is raised to 45 ^{0}C, while stirring gently.

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- After 15 minutes the whey is removed from the curd using cheese cloth and put into a wooden cheese dice.
- The cheese is kept for 12 hours or one night in refrigerator and taken out and dipped into 25% salt solution for 30 to 40 minutes.
- The cheese is wiped with soft cloth and packed tightly with transparent polyethylene.
- Cheese thus prepared is defined as Mozzarella cheese and is stored in deep freeze.

Procedure of cheese preparation

- 2.5 liter milk is boiled at 81 ^{0}C and after cooling at 40 ^{0}C 0.03% calcium chloride is added and allowed to stand for 10 minutes.
- Then bacterial culture [generally 1% starter culture (sour dahi)] is added to the milk sample.
- After addition of starter culture, the milk sample mixed thoroughly.
- Ripening is taken for one hour at 40 ^{0}C.
- Lactic acid bacteria are responsible for turning lactose into lactic acid, thereby reducing the pH of the solution. When the pH is lowered, the protein is more easily precipitated.
- This is the vital for the production of cheese curds.
- At that time the milk is allowed to ripen for one hour up to reaches appropriate pH level.
- After the addition of starter culture 5,6 7,8 drops papaya latex (papain) and 0.28g rennet is added for coagulation of milk.
- After collection of fresh papaya from the garden washed with alcohol and punched with syringe and latex is collected drop by drop.
- The papaya latex served to coagulate the milk protein and formed curds.
- Required quantity of papaya latex (papain) is added to the sample by thoroughly mixing and allowed to stand for 3-4 hours to complete coagulation.

- The coagulated curd is cutted into small pieces like ¼ to 5/8 inch cubes using stainless steel wire knife for removing whey water from the curd and gaining appropriate pH.
- The curd is cooked at 46 ^{0}C for 20 minutes with stirred constantly.
- When most of the whey is drained out from the coagulated curd it is collected.
- When all of the curd is milled about 1% (by weight) salt is added.
- Then the curd is hooped and pressed into a stainless steel dices to form cheese block by forcing pressure.
- After collection of cheese it is kept in refrigerator for further use.
- It may be concluded that cheese from buffalo milk with 6 drops papaya latex (papain) had highest acceptability for preparation of desired quality cheese.

Ice cream

Ice cream is a frozen dairy food with mixture of milk, cream or butterfat, sugar and flavoring ingredients that has been frozen into a soft, creamy delight using special techniques. Hundreds of flavors have been devised, but most popular being vanilla, chocolate and strawberry.[973] Table 42 shows the research findings on ice cream in Bangladesh.

Table 42. Composition, microbial contamination and quality of ice-cream

Year	Parameters	Research findings	References
1983	Bacteriological status between commercial& lab made ice-cream	The TBC and TCC of commercial ice-cream varied from 92000 to 252000 CFU/g and 32 to 71 CFU/g, in comparison to an average of 49000 CFU/ml and 4 CFU/ml in lab made ice-cream, respectively. Ice-cream produced in the lab possessed more hygienic status thanthose produced commercially.	974
1984	Stabilizer of Ice-cream	The ice-cream made of stabilizer sodium alginate alone having 0.25% conc. reported best in respect of flavor, body texture & melt-down properties	975
1986	Quality between commercial& lab made ice-cream	The TVC, TCC, acidity % and fat % of market ice-cream varied from 92000 to 252000 CFU/g, 31-75 CFU/ g, 0.21 -0.26 % & 2.4-8.55% in comparison to 49000 CFU/g, 4 CFU/g, 0.16% and 12.0% in lab made ice-cream, respectively.	976
2000	Bacteriological status of market Ice-cream	TBC of Milk-vita, Igloo, Polar and Savoy ice-cream have been reported with an average of 3280, 3450, 15000 and 42460 CFU/ml respectively. TCC has been recorded in ice-cream of Polar (11.6 CFU/ml) and Savoy (28.0 CFU/ml) but not in Milk-vita and Igloo ice-cream.	977
2002	Sanitary quality of commercially produced ice cream	The average TBC (CFU/ml) of ice cream of Milk-vita (3280), Igloo (3450), Polar (15,000) and Savoy (42460) have been reported. Ice cream of Milk-vita and Polar reported negative for coliform and Staphylococcal count but other two ice cream reported positive.	978
2006	Evaluation of composition of ice-cream	The skim milk + 4% vegetable oil + 5% non-fat-dry milk have been reported to be produced the best quality ice-cream. The procedure of preparation is described.	979
2008	Evaluation of bacteriological quality of commercial ice-cream	The average TBC of Kwality, Igloo and Sub Zero ice cream have been reported to be 2×10^3, 3×10^3 and 4×10^3 cfu/g, respectively. Total coliform count of these ice-cream have been reported as 12, 18 and 32 cfu/g respectively. It appears that the coliform bacteria exceeded standard limits, which can cause serious human health problems	980

Procedure of ice-cream preparation

Method-A[973]

- ¾ cup white sugar, 1 cup heavy whipping cream, 2¼ cups milk and 2 teaspoons vanilla extract
- Stir sugar, cream and milk into a saucepan over low heat until sugar is dissolved.

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- Heat just until mix is hot and a small ring of foam appears around the edge
- Transfer cream mixture to a pourable container such as a large measuring cup. Stir in vanilla extract and chill mix thoroughly, at least 2 hours (overnight is best).
- Pour cold ice cream mix into an ice maker, turn on the machine and churn according to manufacturer's directions, 20 to 25 minutes.
- When ice cream is softy frozen, serve immediately or place a piece of plastic wrap directly on the cream and place in freezer to ripen 2 to 3 hours.

Method-B[979]

- Whole milk or skim milk, sugar (14%) and ice cream powder (2%) were mixed in a saucepan and heated up to boiling along with continuous string.
- The saucepan is taken out from the heater and allowed to cool down to room temperature.
- The mix is kept in the refrigerator at 4 ^{0}C for 24 hours.
- The cool mix is subjected to over-running for 45 minutes.
- After over-running the sample is poured in small cups and was transferred into deep freeze at -20 ^{0}C for hardening.

Dahi (Yoghurt)

Dahi is considered the oldest fermented milk product of Indian sub-continent and may be considered the western equivalent to yoghurt. Curd and dahi mean one and the same thing in the Indian sub-continent and both are made from milk and are fermented by adding healthy bacteria to the milk. Curd is prepared after curdling warm milk using some amount of curd or dahi. Dahi does not include milk coagulated by the addition of acids or milk enzymes. Traditionally, dahi is prepared by natural culturing of boiled and subsequently cooled milk resulting in variability in its

quality due to undefined starter cultures and uncontrolled fermentation.[983] Yoghurt is a fermented milk product prepared by addition of both *Streptococcus thermophiles* and *Lactobacillus bulgaris* as the starter culture because of their symbiotic relationship.[984] The function of the starter cultures is to ferment lactose (milk) sugar to produce lactic acid. The increase in lactic acid decreases pH and causes the milk to clot or form the soft gel that is characteristic of yoghurt. The fermentation of lactose also produces the flavor compounds that are characteristic of yoghurt. Functional properties of traditional dahi could be enhanced either by modification of basic milk, exopolysaccharide producing starter cultures, introduction of probiotic cultures and inclusion of diverse food additives like fruit juices, herbs and spices. Table 43 shows the preparation and evaluation of dahi which are locally produced in Bangladesh.

Table 43. Preparation and evaluation of yoghurt marketed in Bangladesh

Year	Research objectives	Summary of research results	References
1972	Bacteriological quality of dahi tested from five sweetmeat shop of Mymensingh town	These dahi has been reported to be contained wide varieties of bacteria with no uniformity. Higher proportion of lactobacilli has produced dahi which criticized for high acid taste and lacking desirable flavor. A ratio of two or more streptococci to one lactobacillus would give better results	985
1974	Preservation of starter culture at RT in different buffer solutions	Harvested and washed cells of starter culture have been preserved at RT in phosphate buffer pH 7.0, citrate buffer pH 6.8 and phosphate buffer with 20% glycerol. Phosphate buffer has reported to preserve the cells better than other two buffers	986
1975	Effect of adding skim milk powder with whole milk for preparation of yoghurt	Dahi made with 10 and 15% skim milk powder with mixed whole milk of cows and buffaloes have been reported an attractive appearance and hard consistency. Dahi with 10% added solids showed most liked body and appearance. Procedure of yoghurt preparation has been described	987
1986	Comparison of starter cultures between lab culture and market culture for the preparation of dahi	Lab culture contained *Streptococcus lactis* and *Lactobacillus bulgaricus* while the market culture which have procured from sweetmeat shop contained mostly lactobacillus and some contaminants like yeast and molds. Dahi prepared with lab pure culture has been reported better than that with market culture	988
1992	Effects of milk sources on the quality of fresh dahi	Milk powder, whole milk and skim milk have been used for preparation of dahi and their evaluation on score. Out of 100 total score, dahi made from powder milk showed 77.25%, whole milk 82.25% and skim milk 75.0%. Dehydrated at 50 ^{0}C dahi made from whole milk secured highest score	989
2000	Evaluation of five different types of dahi prepared with cow and buffalo milk alone and combination	Chemical quality of buffalo's milk dahi has been reported superior to other dahi but organoleptic score has significantly higher in buffalo : cow milk (50 : 50) dahi. General acceptability of buffalo : cow (50 : 50) milk dahi has been reported higher than that of other dahi samples. Procedure of dahi preparation is described.	990
2001	Yogurt prepared by adding jack fruit juice with milk	Addition of jack fruit juice increased the total solids content but decreased the protein, fat and ash content. Yeast cell reported higher in jack fruit yogurt than plain yogurt and 5% jack fruit juice yogurt has been suggested	991
2002	Comparison between market dahi samples	Results suggested that adulterated milk must be avoided in yogurt preparation and also to follow strict hygienic condition in order to	992

2004	Feasibility of using vegetable oil and powder milk with skim milk for dahi preparation	Six different types of dahi have been prepared from whole milk, skim milk and admixture of powder milk with different levels of vegetable oil. The addition of vegetable oil (soybean oil) @ 2-6% together with 5% non-fat dry milk (powder milk) have improved the quality of dahi. Method of dahi preparation has described	997
2004	Preparation & evaluation of single culture dahi prepared from whole milk with or without powder milk	Dahi prepared from whole milk with 5% powdered milk and 8.0% sugar scored the best for physical, chemical and microbiological qualities. Dahi prepared by using monoculture of *Lactobacillus acidophilus* has shown that easily be prepared in tropical environment	998
2005	Comparison of the dahi prepared from different species milk	Dahi prepared from cow milk has been reported superior than dahi prepared from buffalo or goat milk. Milk of all the three species of animals have shown mostly equal nutritive value	999
2005	Chemical and microbiological evaluation of traditional dahi	Highest TS content of Bogura dahi (38.24%) and lowest in Mymensingh dahi (29.82%) whereas highest fat (4.88%) and protein (4.74%) in Mymensingh dohi. Similar contents in Dhaka & Jamalpur dahi	1000
2006	Feasibility of using soya milk for the preparation of dahi	Results showed that 20% soya milk has been used for the preparation of dahi successfully which produced dahi nearly similar to the quality of buffalo milk	1001
2006	Microbial quality of yoghurt drinks	Microbial quality of fermented yoghurt drinks prepared from skim milk by adding different types of flavors and levels of sugar have been reported	1002
2007	Evaluate the shelf-life of normal and heat-treated dahi in RT and RFT	Shelf life of normal dahi has been reported to be good up to 2.3 days at RT (28.3 ^{0}C) and 7.3 days in RFT (5-6 ^{0}C) whereas up to 3.3 days and 38.3 days with heat-treated dahi, respectively.	1003
2007	Quality evaluation of market yoghurt	The yoghurt sold in the Chittagong metropolitan area in Bangladesh have been evaluated	1004
2008	Coconut milk added yoghurt	Preparation of yoghurt from cow milk adding of coconut milk has been reported	1005
2008	Evaluation of quality	The quality dahi prepared from different forms of commercial milk	1006

2011	Evaluation of the quality of commercial dahi of sweetmeat shops (Sylhet)	Dahi tested from the five major shops of Sylhet town showed that these dahi have not maintained the proper quality and contaminated with yeast and mold, however, the dahi of Fulkoli Brand found acceptable.	1011
2011	To evaluate qualitative characteristics of dahi prepared from non-fat-dry milk (NFDM) with vegetable oil	Dahi prepared from skim milk powder by adding vegetable oil (40g soybean oil) and 200g of skim milk powder per liter (20% NFDM + 4.0% vegetable oil + 5.0% gelatin) produced dahi similar to the quality of whole milk dahi.	1012
2011	To evaluate & compare the different market dahi	Commercial brands of dahi (Bogura, Bonoful, Arong, Muslim and Grameen soktee) have been evaluated as excellent to acceptable	1013
2012	Chemical and bacterio-logical quality evaluation of popular dahi of six distinct town	TBC (log cfu/g) and TCC (log cfu/g) have been found highest in dahi of Bogura (8.03 & 2.01) in comparison with Khulna (7.46 & 0.76), Barishal (5.76 & 1.20), Savar (6.45 & 0.76), Sylhet (7.13 & 0) and Comilla (6.97 & 0). Sugar and ash contents found very high but low fat content due to malpractices	1014
2012	Dahi has been prepared with 0, 5, 10 and 15% potato mash with storage	The addition of 5.0% potato mash in dahi has improved the storage quality that consumed up to 3 days at room temperature and 12 days at refrigerator temperature.	1015
2012	To prepare fruit yoghurt fortified with fruit juice of different fruits	The yoghurt fortified with 10% orange juice reported more acceptable than yoghurts prepared with strawberry and grape juice. Yoghurt with 5.0% fruit juice have also reported of acceptable in quality.	1016
2013	Preparation of dahi with mixed milk (whole cow milk + soy milk) and mango juice	Addition of 10% mango juice prepared a high quality low cost mango flavored soy milk dahi with high physical quality but somewhat deviation of chemical properties. The mango flavored soy based dahi found acceptable due to high price of milk. Procedure has described.	1017
2013	To assess the quality of yoghurt prepared from different forms of milk	Yoghurt has been prepared with whole milk, skim milk, powdered skim milk with added milk fat showed that the yoghurt from whole milk ranked the highest followed by others	1018
2013	To evaluate the quality	Significant difference in smell and taste, color and texture, protein,	1019

2014	Feasibility of using coconut milk by replacing skim milk for dahi preparation	Reconstituted skimmed milk replaced by 0, 10, 20 and 30% coconut milk to produce dahi. The replacement of 10% and 20% skimmed milk with coconut milk produced better dahi which enrich the nutritive value and comparatively cheaper. Preparation procedure has described	1022
2014	Evaluation of brand market yoghurt	Physical, chemical and microbiological evaluation of brand dahi of Bogura district have been reported	1023
2015	Dahi prepared by partial replacement of buffalo milk with soy milk	Four types of dahi have been prepared with 100% buffalo milk (BF), 50% BM + 25% soy milk (SA), 50% BM + 50% SM and 25% BM + 75% SM. Dahi made by a mixture by a mixture of 25% SM + 75% BM produced better results.	1024
2015	Chemical and microbio-logical evaluation of market dahi of four different bands	Yoghurt available in the local market appeared that the nutritional level has not been maintained. Coliform contamination recorded in all the four bands of yoghurt at a ranged between 6.66 to 54.66 cfu/ ml whereas only band yoghurt contained Salmonella contamination (2.0 cfu/ml).	1025
2015	To assess the microbio-logical quality of comer-cial yoghurt in Sylhet	Revealed that all the tested yoghurt samples exceeded the permissible limit ($\geq 10^7$ cfug^{-1} bacteria) for yoghurt. Of the chocolate, orange and fresh yoghurt, chocolate yoghurt has highly acceptable (8.69)	1026
2016	Feasibility of incorporating carrot juice in the yoghurt preparation with skim milk	Yoghurt prepared by incorporating 5% carrot juice reported best quality based on higher value of smell & taste, body & consistency, color and texture score.	1027
2016	Comparison of the quality of Netrokona market and lab made yoghurt	The quality of yoghurt samples collected from different sweetmeat shop of Netrokona district have been reported inferior qualities to yoghurt prepared in the lab based on physical, chemical and microbiological tests	1028
2016	Use of sodium alginate as stabilizer to improve the structural quality of sweet yoghurt	Yoghurt has been prepared with adding 0, 0.4%, 0.6%, 0.8% and 1.0% sodium alginate and reported that 0.6% produced effects as stabilizer to improve structural quality of yoghurt. It also enhanced the total solids, ash and protein content of yoghurt.	1029
2016	Quality assessment of	Yoghurt has been prepared with four different percentage of milk	1030

2016	To evaluate the qualities of yoghurt collected from different sources	The evaluation of physical, chemical and microbiological qualities of yoghurt collected from Bogura and Mymensingh districts showed that the Maharam Ali yoghurt and BAUDF yoghurt reported superior	1034
2017	Evaluation of yoghurt prepared from cow's and buffalo's skim milk with mango juice	Attractive color and pleasant mango flavor yoghurt has been prepared with cow skim milk and buffalo skim milk with addition of 10% mango juice. TBC has been reported higher in 10% mango juice yoghurt but it produced better yoghurt in terms of organo-leptic and chemical qualities	1035
2017	Comparison of mineral levels among powder milk, raw milk, ice-cream and yoghurt	Major minerals (Na, K, Ca, Mg & P) have been reported higher in powder milk, some found lower (Na, K & Ca) in raw milk and lowest levels of Mg and P in ice cream buy yoghurt and ice-cream contained intermediate levels of minerals	1036
2017	Compare the quality of commercial yoghurt of sweetmeat shop	Yoghurt of Bogura district has been reported best followed by Mymensingh and Tangail based on physical and microbiological quality	1037
2018	Investigation of microbio-logical quality of yoghurt collected from 10 districts	The level of TBC (1.72×10^7 to 3.64×10^8), TCC (1.02×10^2 to 4.51×10^2), total yeast and mold (2.0×10^2 to 9.4×10^3) counts in the yoghurt have been reported due to excessive contamination	1038
2018	Incorporation of carrot juice in dahi preparation	Results showed that the using of 15% carrot juice with whole milk has produced high quality fruit flavored dahi.	1039
2018	To develop lassi from sour dahi using different levels of sugar and 15% water	Results showed that good quality and nutritionally enriched lassi with more acceptability has been prepared from sour dahi using 15.0% sugar along with 15.0% water	1040

Procedure of dahi preparation[990]

- Buffalo and cow milk are mixed and boiled for 5 to 10 minutes in order to destroy the viable organisms that present in milk and reduced up to 10-15% of volume of milk.
- Sugar is then added to the milk @ 125 g / l of milk.
- The boiled milk is then cooled to body temperature (36.4 ^{0}C) and inoculated with desirable proportion (2-3%) of starter culture which can beused local market dahi.
- Culture is mixed thoroughly and after mixing it is sampled in plastic cups and keeps in the incubator having the temp (35-36 ^{0}C) until the complete coagulation (8 to 12 hours).
- After complete coagulation the dahi samples are stored at refrigerator until further use.

Method of preparation of fruit dahi[994]

- Whole milk is heated to boiling for about 20-30 minutes, non-fat milk powder is mixed with the whole milk in desired proportions (3%) before heating.
- The milk is stirred with spoon.
- Sugar is added to the milk @ 8.0% based on total amount of milk.
- After completion of heating milk is divided into five equal parts.
- Four different types of fruit juice namely mango, date palm, banana and apple juice is added to four cups except control (plain dahi).

- Fruit juice is added @ 10% based on total milk in the cups.
- The cups are incubated with culture.
- Heated milk is cooled to about 40 ^{0}C and inoculated with desirable proportion of cultures (2%).
- The samples are incubated at 37 ^{0}C until the complete coagulation of fruit's milk mixture.
- After 8-12 hours the complete coagulated fruit-milk mixture called fruit dahi are stored at refrigeration temperature.

Preparation of banana juice and different types of dahi[996]

- Mature ripe banana skin should be separated with the help of clean hand, the seed and black spotted are removed from banana fruit pulp.
- Then the banana pulp is blended and after completion of blending, the juice is filtered using clean cloth and then it is stored in the refrigerator until use.
- Whole milk is boiled in a pan for about 30-40 minutes to reduce 20-25% of its original volume.
- Sugar is added to the milk @ 10% during boiling.
- During heating milk is stirred thoroughly with the help of a stirrer.
- After desired heating, milk pan is taken out from the heater and allowed to cool.
- Banana juice is taken out from the refrigerator and kept in the room temperature for thawing.
- When the temperature of milk became about 40 ^{0}C then the milk is divided into four equal portions.
- Banana juice is then added into each portion of milk as: A: 10%, B: 20% and C : 30% and D: Plain (control).Different level of banana juice could be used successfully to prepare fruit dahi but also makes the product cheaper in comparison with plain (control) dahi.

Preparation of dahi[997]

- Whole milk collected for the preparation of dahi is heated to boil consistently until it reduced to 20-25% of the volume of milk.
- At the boiling of milk, sugar is added @ 8% of the total volume of milk.
- During heating, milk is stirred thoroughly with the help of stirrer,
- After desired heating, milk pan is taken out from the heater and allowed to cool down to near 42 ^{0}C and inoculated with 2% starter culture.
- After inoculation, warm milk of 42 ^{0}C is poured into several clean plastic cups that are boiled previously for maintaining their hygienic quality and kept undisturbed at an incubation temperature of 37 ^{0}C until coagulation.
- After complete coagulation (3.5-4 hours), the dahi samples are taken out of the incubator and stored in a refrigerator at about 5 ^{0}C for analytical purpose.
- All dahi used in this trial are prepared following the above way.
- Powdered milk is added with the skim milk before heating of milk.
- Similarly, vegetable oil i.e.soybean oil is mixed to the skim milk during heating of skim milk. Before adding, soybean oil is heated for neutralizing its odd flavor.

Methods of preparation of mango juice-soy milk dahi[1017]

Soy milk from soybean powder

- 1.0 kg whole soybean seed free from immature field damage and black spot are grinded in a soy flour mill.

- 125g powder is dissolved with 1liter of water by stirring.
- The soy milk is strained through a fine cloth to separate the residue.
- Soy milk is then boiled at 100 ^{0}C for 10-15 minutes with constant stirring.

Preparation of mango juice

- The mango fruit is washed by distilled water, skin is separated, seeds are removed and the fruit pulp is blended.
- After blending the juice is filtered by clean cloth and stored at refrigeration temperature (4 ^{0}C) until preparation of dahi.

Procedure of preparation of date palm brown sugar added dahi[1020]

- 2.5 liter of whole cow milk is boiled in an open pan called karahi for about 25 minutes in order to reduce the volume by 20%.
- The milk is then divided into 4 equal portions, 0.5 liter each.
- Date palm brown sugar is weighed at different levels 10%, 12% and 14% (weight/volume) of milk i.e. 50g (A), 60g (B), 70g (C) for each of 0.5 liter portion of milk.
- A standard 12% (60g for D) cane sugar as control.
- Date palm brown and cane sugar are added to each portion of hot >90 ^{0}C) milk and mixed well with a stirrer.
- The portions of milk are then cooled to 40 ^{0}C and 2% mixed starter culture is added to each portion.
- The portions are transferred into 100 ml cups and are incubated at 37 ^{0}C in an incubator for 5-6 hours.
- After coagulation, all the samples are put in a refrigerator at about 4 ^{0}C until tested.

Procedure of preparation of mango flavored dahi[1021]

- The collected whole milk is skimmed by an electric cream separator.
- Mango, sugar and starter culture are collected from local market.
- Ripened mangoes (*Mangifera indica*) are washed with clean water and skin is separated with the help of knife aseptically.
- The seeds are removed and mango pulps are blended.
- After blending, the juice was filtered with clean cloth (hot water washed).
- These kept in plastic containers and stored at freezing temperature (-20 ^{0}C) until preparation of dahi.
- Skim milk is heated to reduce about ¼ the of its original volume and sugar is added @12% during boiling. During heating, milk is stirred continuously with the help of a stirrer.
- After desired heating, milk pan is taken out from the heater and allowed to cool.
- When the temperature is about 40 ^{0}C, then milk is divided into four equal portions namely A, B, C and D and different types of dahi is prepared from each portion.
- Sample A served as control with mango juice and 5, 10, and 15% mango juice is added in group B, C and D respectively.
- Milk is inoculated with 2% starter culture and then distributed into plastic cups.
- The samples are incubated at 42 ^{0}C until the complete coagulation of dahi (7-8 hours).
- The dahi samples are stored at about 4 ^{0}C at refrigerator until judging.

Preparation of coconut milk dahi[1022]

- The edible portion (cellular endosperm) of coconut is shredded carefully to avoid the waste material.
- Two cups of warm water (250 ml) for every cup of coconut are used to prepare coconut milk.
- The coconut and water are blended with high pressure until the mixture is as smooth as possible.
- When the blending is completed then the coconut milk is filtered by a clean muslin cloth (hot water washed) and kept it in a beaker.
- When skimmed milk powder is dissolved with water then it may be defined as reconstituted skim milk.
- Skimmed milk powder is added @ 9g/100 ml (w/v) of warm water to prepare reconstituted skim milk.

Research on beef cattle production

There are more than 250 beef cattle breeds in the world and 60% of them are found in the USA.[1041]Currently, beef cattle production business are as popular as dairy production business. Some breeds have been around for centuries, while other have been developed in the last couple of decades by mixing older breeds like American Brahman.[1042]The beef cattle breeds of greatest prominence today originated in Britain (Herefords, Angus, beef Shorthorns and Galloways),USA (Black Angus, Beef Master& others), India (Brahman), France (Charolais, Limousin, Normandy), Switzerland (Simmental),South Africa (Afrikaner) and other countries.[1042]There is no any recognized beef breeds in Bangladesh, however, the male uncastrated native and cross-breed cattle are mainly used as a beef cattle.[435,1043]Recently, American Brahman semen has been

imported to develop beef cattle in Bangladesh. The American Brahman is a result of 266 and 22 females imported from India to USA between 1854 and 1926. Since then breed has been selectively bred for meat production, making it the ideal breed for meat production.[13]In comparison to other breeds the American Brahman is able to utilize low quality feed, withstand a wide range of temperatures and consistently maintain a higher feed to weight ratio than most other contemporaries.Overall this makes the breed ideal for meat production in Bangladesh when crossbred with local cattle.[1044-1046]

Native and crossbred uncastrated cattle of two to three years of age are mostly preferred by the butchers for their business whereas rearing of cattle are mainly based on rice straw with inadequate capital, training, feed stuff and fodder crops and marketing facilities.[1047]Recently Brahman beef cattle breed has introduced in research in Bangladesh and it has observed that 50% Brahman cross calves well performed live weight of 229.62kg at 12 months of age in comparison with 25% crosses with local cattle.[1044]The hearth girth (HG) around the chest and in combination of HG and body length (BL) can be used efficiently to predict live body weight in Brahman crossbred cattle.[1048]

The per capita intake of meat is only 8.6kg in humans Bangladesh against 42.1 kg for world and 32.2 kg of developing countries. Therefore, there is a need to develop market beef cattle of average >150 kg carcass weight by 24 months with an average FCR of < 6.5 under the farm feeding and management condition. An experiment has been conducted with imported frozen semen of beef breeds of Brahman, Simmental, Charolais and Limousin in native breeding cows,

of which Charolais × Local cows cross progeny had highest birth weight (27.5kg), followed by Brahman cross (24.1kg), Simmental cross (21.9kg), Limousin cross (19.8kg) and lowest in native calves (18.4kg). Among the five genotypes, cross-bred Simmental has performed as the best in terms of growth (297.3kg) performance up to 12 months of age.[1049]

Table 44shows the research findings on beef cattle production and marketing.

Table 42. Research findings on beef cattle production and marketing

Year	Main objectives	Major findings	References
2003	Beef cattle breeding	Genetic trends in the development of crossbreeding system in beef breeding has been reported.	1050
2004	Genotype × environment Interaction in beef bulls	There is a need for environmental-specific genetic evaluation and selection of beef bulls for commercial beef production	1051
2007	Cattle fattening practices	About 56.7% of the farmers used cattle of 2-3 years of age and 36.7% used 1-2 years age for fattening period of 3 to 6 months (60%) and 7-12 months (30%), respectively.	1052
2009	To assess the problems of beef cattle rearing and marketing	Cattle of 2-3 years are preferred age for slaughter and beef price is usually fluctuating. Rice straw is main feed but scarcity of feed and fodder crops, training, pasture land and marketing.	1047
2000	To assess the agribusiness of beef and beef products	Agribusiness of cattle, beef and beef products have been reported to be profitable and diversified uses of beef have been suggested.	1053
2015	To assess the status of beef cattle production	Cattle feed are mainly based on natural grasses and rice straw. Feed is the major challenge for farmers to rear beef cattle.	1054
2015	To predict the live weight of Brahman cross-bred cattle by using linear body measurements	The morphometric characterization of Brahman crossbred cattle and prediction equations based on heart girth around the chest (HG) or in combination of HG and body length (BL) have been reported to predict live weight of Brahman crossbred cattle.	1048

2017	To compare the live weight of different crossbred beef calves at birth and at 12 months of age	The birth and 12-m age live weight have been reported with Charolais cross (27.5 & 279.9 kg), Brahman (24.1kg & -), Simmental (21.9 & 297.3 kg), Limousin (19.8kg & 270.2kg) and Local (18.4kg & 194.7kg).	1049
2020	To evaluate the effect of sire and environment on growth performance of grade-2 Brahman calves	The sire and environment have reported to have significant effect on above growth traits at different ages of Brahman progeny which indicates that best sires in best environment can produce superior progeny.	1045
2020	Factors related to growth performance of Brahman graded calves	Improved feeding had positive impact on growth performance of Brahman growing bull calves. Growth performance had positively strong phenotypic correlation different growth traits and factors	1046

The higher birth weight, yearly weight and average daily gain of Brahman crossbred calves have been reported than that of indigenous and other crossbred calves.[564] It appears that these selected graded Brahman breeding bulls may generate a good opportunity to improve local cattle for beef purposes.

Care of the calf at birth

When calving time approaches, the cow should be watched closely for any complications. The newborn calf should begin to breathe shortly after the umbilical cord detached from dam. Mucus around the nostrils should be removed. Do not pound on the calf's chest or lift it by the rear legs since this can do more harm than good. Shortly after birth, the navel cord should be dipped with

a 7% tincture of iodine solution. The cow should be allowed to lick the calf after delivery. In cold weather or if the cow does not lick the calf, the calf should be dried with clean cloths. This practice not only dries the calf but stimulates the calf's blood circulation. Generally dairy calves are removed from their dam shortly after the dam has licked the calf clean, usually with one hour (http://www.ca.uky.edu).

Birth weight and growth of calves

Growth is defined as the mass increase in animal live weight and divided into two periods as pre-natal and post-natal growth. Both the pre-and post-natal growth are in equally significant but the breeders generally deal with post-natal growth of animals. Birth weight is an early and easy indicator of pre-natal growth, which is commonly used as an early selection criteria in cattle breeding. Table 45shows the analyzed mean values of birth weight of calves reported in different breeds and varieties of cattle.

The birth weight of calves is of critical importance to the dairy and beef cattle industry. Calves that are too small at birth may lack vigor, tolerance to cold-stress, resistance to pathogens or the ability to overcome parturition stresses during adaptation to extra-uterine life. Calves that are too large at birth may cause varying degrees dystocia, leading to increased birth asphyxia, metabolic and respiratory acidosis, depressed immunoglobulin in absorption and increased susceptibility to diseases.[1061]

Table 45. Analyzed mean values on the influence of breeds, gender and seasons on birth weight of calves

SN Breeds	Manage-ment	Gender (BW kg/calf) Male	Female	Overall mean	Seasons (BW kg/ calf) Summer	Rainy	Winter	Overall mean	Ref. No.
01. HF	Farm (F)	-	-	29.14 (92)	-	-	-	-	739, 1057
02. Sahiwal	Farm	-	-	20.52 (94)	-	-	-	-	739,1057
03. AFS	Farm	-	-	29.1 (86)	-	-	-	-	739
04. BC	SH	-	-	19.79 (624)	-	-	-	-	1044
05. Cross	F &SH	-	-	22.52 (598)	-	-	-	-	1057
06. RCC	F & SH	15.77 (232)	13.76 (208)	15.25 (1101)	14.34 (96)	13.98 (64)	13.98 (87)	14.10 (247)	A =
07. HF × L	F & SH	30.43 (79)	28.31 (65)	21.96 (910)	-	-	-	-	B =
08. SL×HF	SH	-	-	25.20 (153)	-	-	-	-	C =
09. HF×PV	SH	-	-	24.92 (361)	-	-	-	-	492
10. AFS×PV	F & SH	-	-	29.78 (515)	-	-	-	-	492
11. J × L	F & SH	-	-	17.39	-	-	-	-	D =
12. SL×L	F & SH	19.58 (20)	14.11 (17)	19.17 (348)	-	-	-	-	E =
13. SL× PV	SH	-	-	23.96 (659)	-	-	-	-	492
14. RS × PV	SH	18.34 (11)	17.73 (5)	18.04 (16)	-	-	-	-	735
15. SD x L	F & SM	18.38 (39)	17.55 (25)	17.25 (164)	-	-	-	-	F =
16. Pabna V	F & SH	20.61 (5)	19.76 (11)	21.49 (826)	-	-	-	-	G =
17. Local	SH	-	-	16.91 (399)	-	-	-	-	H =
18. Dhaka V	SH	32.98 (9)	29.2 (5)	31.09 (14)	-	-	-	-	735
19. MV	SH	-	-	14.83 (6)	-	-	-	-	58
20. NBGC	SH	-	-	18.35 (135)	-	-	-	-	58
21. DDC	SH	21.71 (14)	22.42 (12)	22.07 (26)	-	-	-	-	12
22. HF F2/ F3	Farm	-	-	25.72 (1476)	-	-	-	-	492,739

A= 42,43,58,635,732,735,756-758,777-779,782,783,967,1058
B = 635,739,745,747,754,756-758,761,766,1059,1060
E = 735,745,747,756-758,761,770
F = 735,747,756,761

C = 739,757,758,770
D = 745,747,754,756,757,758
G = 492, 735,785
H = 32,635,739,754,757,758,761,766,778

? = Not mentioned in the article
AFS = Australian-Friesian-Sahiwal
BC = Brahman cross
SH = Smallholder
RCC= Red Chittagong cattle
() = No. of observation
MV = Munshiganj variety
NBG = North Bengal Grey cattle
DDC = Dinajpur Dwarf cattle
RS = Red Sindhi
- = Data not available

Male calves, on average tend to be larger and higher birth weight than female calves(Table 45) because bovine males are larger than females and because male calves are often carried a few days longer than female calves of similar genetics, if a cow goes past her due date, she is likely to have a bull calves. If she calves a few days earlier, the calf is often a female calf.[1062] However, the birth weight can be affected by changing the rate of fetal growth or by changing length of gestation. Some breeds and family lines within breeds tend to have gestation lengths slightly shorter or longer than the average 283 days. Low birth weight cattle often have shorter-than-average gestation, and high birth weight cattle tend to have longer than average gestation. The fetus is growing fastest in the final stages, so several more days' gestation creates a larger calf. Study showed that each extra day of gestation amount to at least one pound more in the size or weight of the calf.[1062]

Environmental factors affecting growth rate include nutrition of the dam and environmental temperature. Overfeeding cows in late gestation increases risk for dystocia because of increased calf size and fat accumulation in the birth canal. Underfeeding to reduce birthweight is counter

productive, however, because of increased weakness and metabolic disease in underfed cows.The cow has poorer colostrum and won't pass adequate immunity to the newborn calf and this weak calf that is slower to get up, slower to suckle, and when it finally does suckle, it gets inadequate colostrum.No significant influence of season on birth weight of calves has been observed with these limited reports (Table 45). Calves born during rainy season reported approximately 10% heavier at birth than those born during the dry season elsewhere. It appears that the breed,gender and season of calving interaction have significant influence on birth weight of calves.

The RCC is a valuable indigenous cattle genetic resource of Bangladesh with many attributes better than other available indigenous types and varieties.[46]Table 45 shows that highest number of research reports (>16) on birth weight of RCC calves in comparison to other genotypes have been published from Bangladesh.The moderately high heritability of growth of RCC suggests that RCC selected for growth up to 24 months of age would show a quick response.[1058] An increasing trend in body weight from birth to 30 months of age with highest body weight gained at 30 months of age and then afterwards showed a gradual declining trend but no difference effects of management system (farm & field) on growth performance.[46]Although body weight and growth of RCC calves are very slow compared to crossbreds but comparatively higher other native cattle.[1063]

Calf management

Heifers are the future of the dairy herd and deserve to have the best management that incorporates all the latest research and management advice. Raising heifer calves is the second largest annual expense, approximately 20% of a dairy business's production cost after feed.

Heifers produce no income until they reach first lactation and no benefit until the second lactation. In the return, they will reply the investment through higher milk production and a longer productive life.[1064] Management of calves should be a good start with the first step in producing healthy, well grown replacement animals that are ready to enter the milking herd at 22 to 24 months of age.Starting calves off well is essential to minimizing death loss and improving health outcomes. Even when a calf survives a disease, negative economic impacts may occur, and it may never reach her full genetic potential.[1065]Calves treated with antibiotics have beenshown to produce less milk in their first lactation than calves that receive no treatment with antibiotic.[1065] This suggests to encourage farmers to look more to disease prevention than treatment of heifer calves. There are three targets to raise the desired number of healthy, fertile and productive heifers which include: (a) Keeping calf morbidity and mortality to a low level, (b) Maintaining good calf growth and (c) Maintaining good calf health. The goal of calf nutrition is to promote healthy, efficient and rapid growth through milk and to enhance rumen growth and function by initiating calf starter intake.

Colostrum management

Newborn calves have no innate immunity with immature immune system and depends on colostrum from its dam to initially acquire immunity through absorption of antibodies (IgG) which takes more than six months to fully mature immune system.The milk from the first milking following delivery is called true colostrum. After the first milking and for the next two and a half days, the cow's milk is called transition milk. True colostrum contains twice as much

dry matter and total solids, 2-3 times as many minerals and five times as much protein as whole milk (Table 46).[1066]Colostrum also contains various hormones and growth factors that are necessaryfor growth and development of the digestive tract. Colostrum is lower in lactose, thus decreasing the incidence of diarrhea.

Table 46. Comparison of composition of colostrum & milk of cows[1066]

SN	Constituents (%)	Milking after calving: Colostrum 1st	Transition milk 2nd	Transition milk 3rd	Whole milk	SN	Constituents (%)	Milking after calving: Colostrum 1st	Transition milk 2nd	Transition milk 3rd	Whole milk
1.	Total solids	23.9	17.9	14.1	12.9	2.	Fat	06.7	05.4	03.9	04.0
3.	Protein	14.0	08.4	05.1	03.1	4.	Lactose	02.7	03.9	04.4	05.0
5.	Minerals	01.1	01.0	00.8	00.7	6.	Calcium	00.26	00.15	00.15	00.13
7.	IgG (mg/ml)	32.0	25.0	15.0	00.6	8.	Vita-A (μg/dl)	295.0	190.0	113.0	34.0

Colostrum of the right quality and quantity given to the newborn calf at the right time which is the cornerstone of success for calf survival in any herd. It contains important nutrients like vitamins, minerals, energy and proteins, besides antibodies (IgG) and many other important substances. Colostrum is also called maternal derived antibodies (MDA) which are essential to protect the newborn for at least the first 2 to 4 months of life. There are five golden rules of colostrum feeding which include (a) Quickness (< 2 hours), (b) Quantity (10-15% BW), (c) Quality (>50g IgG/L), (d) Frequency (multiple) and (e) Cleanliness.[1067]

(a) Quick feeding of colostrum

The calf should get colostrum as quickly as possible after birth, because the ability of the intestine to absorb colostral Ab (IgG) into the blood is most efficient during the first 4-6 hours of life. At about 12 hours after birth the absorption of IgG is reduced by 50% and after 24 hours the calf can hardly absorb any IgG at all. Milk the cows as soon as possible after calving to assure adequate delivery of abs to the calf. If the cow is milked in late after delivery for the first time, abs content of colostrum will decrease by dilution.

(b)Quantity of colostrum

Colostrum is the key to calf survival and newborn calves must receive at least 3.0 to 4.0 liters (10-15% of the body weight) of colostrum within 2 hours of birth and 2-3 liters within six hours after birth depending on the live weight of calves. Protein, fat and sugars from colostrum help to increase the calf's metabolism and heat production. Moreover, colostrum intake facilitates the first feces (meconium). The colostral abs (IgG) are absorbed within 24 hours in bovine which help to protect the calf against infection for 3 to 4 weeks.The calf requires first 4 to 6 weeks times to develop own protective mechanism.

(c) Quality of colostrum

Only feed colostrum with at least 50g/liter of antibody (IgG) by testing with a Brix refractometer or colostrometer.Colostrum with < 50g/L IgG will not provide an adequate protection to the newborn calf.Colostrum should be given to the calf directly after milking the cow for the first

time.Fresh excess colostrum can be stored within one hour of collection in the refrigerator for up to 24 hours and in the freezer (-20 ^{0}C) for one year.Frozen colostrum should be thawed slowly in a hot water bath at a temperature of 50 ^{0}C.Colostrum should not be fed to calf from dam affected with mastitis, Johne's disease and Bovine virus diarrhea and other diseases.

(d) Frequency of colostrum feeding

The calf should receive multiple colostrum feedings by bottle during the first day of life.Teat feeding with a nipple bottle is best. Use a stomach tube if a calf is unable to bottle or is too weak to consume the full amount of colostrum

(e) Cleanliness

Strict hygiene standards for cleaning and sanitation should be maintained when milking a fresh cow. The udder as well as the milkers should be thoroughly cleaned.Unhygienecally collected colostrum can be contaminated and feeding of such colostrum may cause gastro-intestinal infection of newborn calf that may interfere absorption of colostral IgG in the intestine and even may cause enteritis.There is a need to test colostrum for bacteriological count to identify if improvements of colostrum hygiene are needed during collection and storage.Blood IgG antibody levels of calves should be checked to detect that the colostrum has been successfully absorbed to the calf.

Growth rate especially measure live weight at birth and then regularly should be monitored. Colostrum contains growth factors, hormones and other biologically active factors which positively impact the development of the digestive tract. Calves which do not intake and absorb adequate colostrum (IgG antibodies) have lower weight gain, increased risk for disease and death and decreased milk production during their first lactation.

Feeding of milk and milk replacer

The first 3 to 4 months of calf's life is a critical period and the feeding program at this time is important for rapid growth and development of baby calves and reducing death losses. Feeding of whole milk is expensive and milk replacers have been developed to reduce the amount of whole milk used raising calves. Traditionally, whole milk should be fed to calves at 10%of body weight that may be translated into feeding two liters of milk twice daily. Feeding of this two liter of milk does not provide sufficient energy to growing calves. Accordingly, feeding of 15% of calf body weight in whole milk or suitable milk replacer has been suggested. It is a legal requirement to feed calves under 28 days old at least two liquid milk feeds per day. The feeding of correct energy and volume of milk include improved health, growth rates, feed efficiency and lifetime milk performance. Thewaste milk including antibiotic treated milk, mastitic or high somatic cell count should not be fed to calves. Feeding of these types of waste milk can increase the risk of disease transmission and antibiotic resistance in the calf.The energy requirement of calves less than 3 weeks of age should be met through milk feeding and over 3 weeks of age through a combination of milk, calf starter and forage feeding.Calf should be fed milk at a temperature of 37-39 ^{0}C to ensure coagulation in the abomasum. To achieve this, milk should be heated to 40 ^{0}C which can also be applied to colostrum and transition milk. Pasteurized milk can also be fed to calf with no antibiotic residues.

Calf milk replacers (CMR)

A good quality CMR should be similar in chemical composition to whole milk. A good quality CMR will contain only milk derived protein (MDP) sources. It should contain the nutrients that calves can digest and in the right proportions. The CMR is generally formulated from by-products of dairy processing, together with animal fats plus added vitamins and minerals. Whole milk powder consists of mainly of 36-40% lactose, 30-40% fat and 28-32% milk protein of DM basis. The by-product of butter making is skim milk which consists mainly of lactose and all the milk proteins but it has only half the energy value of whole milk. Whey, the by-product of cheese making, consists only of lactose, albumin and globulin and is even lower in nutritive value.

The CMR should contain 20 to 27% crude protein and 16 to 20% fat to achieve optimum growth rate (> 900g/day) in early life. Protein sources can be either milk or plant or vegetable proteins. However, the MDP are important for the first 2 to 3 weeks of calf's life because calves aged up to 3 weeks can only digest MDP efficiently. The MDP sources include skim milk powder, whey powder and butter milk powder.Fiber is an indicator of protein quality and protein with less than 0.15% fiber contain milk or egg, whereas fiber levels over 0.20% indicate inclusion of plant proteins. All milk protein include dried whey protein concentrate, dried whey, dried whey product, skim milk, casein and sodium or calcium caseniate whereas alternative plant protein include soy protein isolate, protein modified soy flour, soy protein concentrate, soy flour, animal plasma, wheat gluten and pea protein. Digestibility and subsequent calf growth and feed efficiency are lower with vegetable proteins than with MDP. Soy protein products can contain a variety of anti-nutritional factors that further decrease the digestibility of growing calves.

The CMR should contain 10 to 25% crude fat with 18-20% fat content ideal. Review of research reports show that there is no benefit to feeding CMR with higher than 18% fat content. Calves less than two weeks old cannot digest non-milk fats as well as milk fats. Higher fat CMR may suppress concentrate intake, so may not be suited to systems requiring early weaning. Fat sources should be highly digestibleProtein sources are generally classified as either all milk or a portion coming from alternative proteins and preserved with an anti-oxidant. Fats commonly used include tallow, lard, palm and coconut oil. Tallow- a by-product of abattoir, is the most common fat to include because vegetable oils which contain high level of polyunsaturated fats, can cause scouring in calves. Tallow is preferred because it has a similar fatty acid composition to milk fat and is comparatively cheap.Coconut and palm oil have a similar digestibility to milk fat (about 96%).

Ash, vitamins and minerals in CMR should be added as per nutritional requirement and the ash content should not be higher than 8.0% with target ash content of 6.5 to 7.5%. The mineral and vitamins requirement of calves include as calcium 1.0%, phosphorus 0.7%, vitamin A 9,000 iu/kg, vitamin $D_3$600 iu/kg andvitamin E 50 iu/kg.

Calves may be started on a CMR when 2 to 4 days old, but the shift gradually from raw milk to CMR.Abrupt changes will increase the likelihood of nutritional scours and stress. Commercial CMR can be supplied as per direction of the manufacturer's recommendation. When the commercial CMR fed properly, high quality milk replacers will allow calf growth and performance equal or even greater than that attainable with whole milk. The preparation of CMR must be done with care, respecting concentration, water quality, hygiene of mixing and serving

equipment and mixing temperature.A typical milk replacer contains 70-80% milk solids, 17-20% animal and vegetable fats (e.g. tallow), 2% lecithin, traces of minerals (copper, zinc, manganese, cobalt, iron and iodine) and vitamins (A, D, B_{12}, K and E) with added antibiotics or antibacterial drugs.[1068]However, adding of antibiotic is discouraged in modernly managed calf rearing.[1066]

Advantages of CMR

- Advantages include ease of use, biosecurity and economic benefits
- Significantly improve the marketability and profitability of milk
- Grow more healthy calves and significantly reduces risk of disease e.g. Johne's disease, Bovine virus diarrhea and the cost of drugs and veterinary services
- Consistency of products when mixed correctly- less risk of digestive upsets and scours

Disadvantages of CMR

- Lower energy due to fat content compared to take over milk
- Products with plant-based proteins have a lower digestibility in calves less than 3 weeks of age.

Calf starter (Starter concentrate)

The newborn calf has a small undeveloped rumen and it does not contribute to digestion. The purpose of calf starter is to transition the calf from the milk-feeding period to the dry-feeding period. The intake of concentrate and water provide the rumen microbes with the nutrients they need to grow and multiply. Calf starter should be offered to calves starting at 3 days of age. After three weeks of eating starter concentrate, the rumen will have enough microbes to ferment the feed to supply the calf with energy.

Calf starter should be offered from day one and can be provided as a pellet or coarse feed and should be highly palatable to encourage early intake. The particle size of the starter concentrate should be 3 cm pellets and should be larger than 1.19 mm in diameter to avoid ruminal parakeratosis and bloat. It should not be powdery or dusty as this will reduce intake. Calf starter should provide around 18% crude protein to aid microbial growth and promote intake (Table 47).Calves eat only small amounts in the first two weeks but intake begins to increase measurably around 14 days of age.

Forage feed

Forages are good source of fiber which promotes the growth of the muscular layerof the rumen and helps maintain the health of the rumen lining.In addition to calf starter, good quality forage should be offered as early as day three. Feed racks and buckets should be located at a height that is suitable for calves and positioned so as to reduce possibility of soiling.

Water supply

Water accounts for 70-75% of a calf body weight and calves will perform best with fresh drinking water available to them from birth.Drinking water is required to support the rumen microbial population and promote good rumen development and function. Fresh water should be provided in addition to milk or milk replacer. Calves will drink 1.0 liter of water per day during the first week of life, increasing to nearly three times by 3-4 weeks of age.Providing drinking water in addition to milk replacer can increase growth by 38% and calf starter intake by 31%. Providing lukewarm water (16-18 ^{0}C) during cold weather may stimulate starter intake.

Table 47. Recommended nutrient composition for calf starter[1066]

SNNutrient	Amount	SNNutrient	Amount	SNNutrient	Amount
01. Crude protein, %	16-20	02.Calcium, %	0.7	03.Phosphorus, %	0.45
04. Potassium, %	0.65	05. Copper, ppm	10	06.Zinc (ppm)	40
07. Manganese. ppm	40	08. Cobalt, ppm	0.1	09.Selenium, ppm	0.3
10.Vit. A, iu/lb DM)	1818	11. Vit. D, iu/lb DM	270	12.Vitamin E iu/lb DM)	12

The newborn calf has rudimentary stomach and during the first weeks of life is considered a monogastric animals. The neonatal calf must receive the correct diet based not only in its nutritional requirement but also in what is required for rumen development and transition to a functional ruminant.Table 48shows the summary of the different experiments which have been conducted on milk replacers and calf starter with native and cross-bred calves for a period of 90 days.

Table 48. Calf rearing by using milk replacer and calf starter

Year	Research objective	Major findings	References
1968	Calcium and phosphorus supplement for the growth of calves	Calcium and phosphorus supplement have been reported to be required for growth and 2.0% level of steamed bone meal has reported superior to 1.0% for the purpose.	1069
1972	To evaluate a starter mixture in Sahiwal male calves	The starter mixture composed of 2 parts of Til oil cake and 1 part each of wheat bran and crushed khesehari. Starter mixture supplemented with Vitamin A 300 iu & D 1000 iu + TM-5 (1.5 lb/100lb) resulted higher average weekly LWG (4.4lb) than without Vitamin A + D (4.1lb) and without any TM-5 (3.7lb)	1070
1975	To evaluate four different formulation of calf starter	The average weekly LWG has reported significantly higher in calves fed starter mixture (SM) supplemented with TM-5 + Vit. A	1071

1987	To find out the effective starter mixture (SM) for crossbred calves up to one year of age	Six groups of cross-bred calves fed six different combination of SM to find the best effective one. Calves in Gr. A fed SM including wheat bran 45.45%, groundnut oil cake 45.45%, fish meal 13.63%, molasses 9.09%, steamed bone meal 1% and common salt 1.0% showed higher feeding value in terms of LWG (113.2kg).	1074
1987	To find out the effective composition of calf starter up to 90 days of age	Four different groups (A-D) of calves fed four different combination of calf starter mixture keeping Gr. A as control. Better performance has been reported in calves of control groupA (wheat bran 45%, til oil cake 33%, fish meal 20%, steamed bone meal 1% and common salt 1%) without adding shoti powder (Table ?).	1075
1988	To find out the milk replacers for crossbred calves for a period of 90 days with local ingredients	Five groups (A-E) of calves have been selected at birth and fed in five treatment groups separately. Each of the calf of all the groups have supplied colostrum for 4 days, wholemilk @ 0.5 kg/ 4.5 kg BW for two meals, 1.4 kg calf starter,and green grass (Napier & Para) but no milk replacer in Gr. A. Highest average LWG (2.55 kg/ week) has obtained in Gr. A fed without milk replacer than fed with milk replacer (1.63, 1.39, 1.31 and 1.61 kg/week).	1076
1990	To evaluate the six different formulations to find out the suitable starter mixture for cross-bred calves	Out of six starter mixture, mixture fed to Gr. A which include wheat bran 45.36%, ground-nut oil cake 45.36%, fish meal 13.61%, molasses 9.07% steamed bone meal 1.0% and common salt combination mixture has resulted weekly highest LWG 4.32 kg) than other groups.	1077
1992	To evaluate the three different calf starter mixture to determine the effective feeding regimesgrowth pattern of calves up to 3 months of age	All the three treatment groups (T-0, T-1 and T-2) have supplied similar feed ingredients including wheat bran 50%, rice bran 12%, khesari bran 30% and til oil cake 8%. In addition, calves of Gr T1 received 20% and T-2 received 40% leucaena leaf meal (g/d). Higher overall LWG (g/d) has been reported with T-0 group (278.58g) than T-1 (268.0g) and T-2 (273.3g).	1078
1993	Genetic potentiality of	The genetically potentiality of Jersey calves have been reported	1079

2011	Effect of feeding shoti based calf milk replacer	A trial research has been conducted under both on-station on-farm condition for the development of cost effective shoti based milk replacer	1082
2020	To evaluate plant sources to develop CMR based growth performance	The shoti and soybean based CMR have been reported to be maintained growth of calves compared to wheat based CMR and milk fed calves.	1083

Plagiarism 1072 & 1073

Composition of calf milk replacer with locally available ingredients

The primary nutrients in milk replacer are protein, fat, carbohydrates, vitamins and minerals. Table 49shows the composition of CMR with locally available ingredients.It appears from Table 47 that shoti and soybean based CMR better compare to wheat based CMR and even milk fed calves. Authors have suggested to use this CMR in the smallholder farms as well as commercial dairy farms and even suggested to utilize this formula for commercial production. However, the plant protein sources are highly discouraged to use for the preparation of CMR as these are associated with digestive disturbances within 3 weeks of age of calves.[1066]

Table 49. Composition of calf milk replacer (CMR)[1083]

T1 = Wheat based (n = 6)			T2= Shoti based (n = 6)			T3 = Soybean based (n = 6)		
SN	Ingredient	%	SN	Ingredient	%	SN	Ingredient	%
1.	Wheat flour	29.0	1.	Shoti powder	39.0	1.	Soy powder	08.0
2.	Soymeal	47.0	2.	Soymeal	50.0	2.	Soymeal	43.0
3.	Rice flour	13.0	3.	Soybean oil	09.0	3.	Rice flour	38.0
4.	Soybean oil	09.0	4.	DCP	01.0	4.	Soybean oil	09.0
5.	DCP	01.0	5.	Common salt	00.5	5.	DCP	01.0

T = Treatment group DCP = Dicalcium phosphate

The overall calf rearing scenario in Bangladesh is still remain in traditional practice in which more than 95% of dairy smallholder farmers overlook the scientific technology on calf management. Moreover, the smallholder and even commercial dairy farmers are permitted to rear their calves by the cows. Calves reared with their dam start grazing and ruminating at approximately three weeks of age and regularly graze with adult cattle at 4 to 6 months of age. These calves are mainly suffering from malnutrition followed by late rumen development, late maturity, late in estrus, decrease conception rate and low milk production that results in economic loss to the farmers. Commercial CMR has been manufactured and marketed in developed nations and even most of the developing countries but it has not yet been developed in Bangladesh.

Composition of calf starterwith locally available ingredients

The main purpose of feeding calf starter is to transition the calf from the liquid milk feeding period to the dry feeding period. Feeding of calf starter is very important to healthy rumen development, good body growth and successful weaning of the calf. Calves start consuming measurable amounts of solid feed at about 14 days of age and intake increases rapidly when milk rations are reduced or milk is withdrawn.[1084]

Calf starter is a balance concentrate mixture, comprising ground cereal grains, protein supplements, minerals and vitamins. Calf starter is usually supplied from the three days calf's age. Initially provide a handful of calf starter in a shallow bucket and then gradually increase the amount of calf starter as calves grow. Fresh calf starter and water supply should made available for optimal calf growth. Feeding calf starter andgood quality leguminous hay (fodder) from early life stimulates early development of rumen papillae which favors digestion of larger proportion of fodder at an early age.When calves are consuming 1 kg of calf starter a day for three consecutive days, the weaning process can begin.Table 50shows the composition of calf starter prepared with locally available ingredients in Bangladesh.

Table 50. Composition of Calf starter with locally available ingredients

Four formulae of an experiment[1075]						One formula of an experiment[1083]		
SN	Ingredient	A (C)	B	C	D	SN	Ingredient	%
1	Wheat bran	45	42	28	21	1.	Broken wheat	10.0
2	Til oil cake	33	31	40	42	2.	Wheat bran	40.0
3	Fish meal	20	20	20	20	3.	Khesari	24.0
4	Shoti powder	-	5	10	15	4.	Til oil cake	15.0
5	Steamed bone meal	1	1	1	1	5.	Fish meal	03.0
6	Common salt	1	1	1	1	6.	Soymeal	05.0
	Crude protein %	21.20	21.16	21.18	21.14	7.	Common salt	00.5
	Crude fibre %	07.08	06.54	06.05	06.56	8.	DCP	00.5

Different level of shoti (Indian Arrowroot: *Zodaria decumbens*) at 0,5,10 and 15 % used in a calf starter mixture fed calves up to 90 days of age. The performance of calves in terms of BW was better without shoti powder in control groups of calves.But the cost of feed /kg of grain was less when shoti was incorporated in the starter mixture.During the nursing period, the growth is significantly affected by calf genetics, birth weight, gender of calf, calving season, duration of nursing period, amount of milk or milk replacer intake, total starter intake, environmental temperature and care practices.[1085]

Navel disinfection

The umbilical cord of a newborn calf is a potential source of infection. During pregnancy, its main purpose is to attach the unborn calf to the dam to provide nutrients. Many blood vessels lead directly from the navel to a calf's organs. If bacteria enter, they have easy access to vital parts of the calf's body. Consequently, as soon as possible after birth, the navel should be dipped in a 7.0% iodine-based solution after proper removal of debris or straw on the navel cord, if any. If more than 5.0% of calves develop navel infections, the calving pen and calf facility may need some deep cleaning and navel disinfection may need to occur more quickly after birth. The navel should be examined regularly for about a week after birth. It should be dry, soft and not painful.

Public health and environment of livestock rearing

Livestock keeping at urbanized areas is increasing folds in rate now-a-days in Bangladesh. Urban livestock rearing practices has been reported to be associated with public health and environmental issues.[1086]

Culling of dairy cattle

Culling cattle is very important in any cattle operation because a producer gets rid of those animals that are inferior to the genetic qualities of the herd, those that are no longer productive and those that have no value being in the cow herd any more.[1087]

There are too many definitions have been used for the culling of dairy cattle. Some of them are: The culling is the removal of a live cow from the farm for immediate slaughter and sale is the

movement to another farm for future dairy purposes and assumed to exclude temporary ownership by traders who subsequently send animals for slaughter and mortality is the death of an animal on the farm whether euthanized or unassisted.Culling is the act of identifying and removing a cow from a herd and assuming a constant or expanding herd size, replacing the cow with another cow, often a first-lactation heifer.[1088] Culling is the departure of cows from the herd due to sale, slaughter or death which has been classified as voluntary or involuntary.[1089] Culling (exiting) is the departure of cows from the herd because of sale, slaughter, salvage or death.[1090] In most cases the cow that exits is replaced, thus replacement has been a useful synonym for the event. The term 'cull' refers to all cows that leave the dairy regardless of their destination or condition at departure. Some may object to including cows that are sold for dairy purposes as part of a general cull category, as the word 'cull' generally means to separate off for undesirable reasons.Cows removed from the herd is based on the destination of the cows after removal and these can be placed into three groups: (a) Dairy sale- sale in the context of culling means that the cow is sold alive to another dairy with the expressed goal of continuing to provide income, such as producing milk, calves, (b) Slaughter-Salvage- means that the cow left the dairy alive to be slaughtered for human consumption and (c) Death (died, dead)- means that the cow died on the dairy.[1090]

Cows that involuntary culling implies that cows are culled due to disease, injury, infertility or death whereas the voluntary culling implies low yield or cows surplus to herd requirement when animals are healthy and farmer has complete freedom of choice over which cows are removed from the herd. Culling has also been classified based on reasons as either biological or economic. Biological (forced) culls are those cows for which no possible productive feature exists, like

permanently sterile, irreparably injured, positive for tuberculosis and brucellosis, whereas economic mean that cow is removed because a replacement is expected to produce greater profit.[1091]

Reproduction (e.g., failure to conceive) has been recognized as the primary cause of culling, secondly production and thirdly mastitis in USA.[1092] Highest culling has been reported caused by infertility, followed by mastitis in Iran.[1091] Review of available inland literature reveals that only two articles on culling dairy cattle have been published based on breeds of cattle[1093] and age of cows[1094] from BAU Dairy Farm of Bangladesh (Table 51& 52).

A total of 238 animals have been culled, with annual culled rate 10.50, 7.98, 13.03, 7.56 and 60.92% in Pabna, Sahiwal, Sindhi, Red Chittagong and cross-bred cows respectively.Among all the breeds the highest percentages of culling rates reported in cross bred-cows (Table 51).The highest culling rate recorded in Pabna variety probably due to short lactation period and long calving interval.Red Chittagong cattle showed the second highest percentages in disposal for low production (22.2%). Highest culled rate caused by death due to parasitic diseases have been reported in crossbred (22.0%) in comparison to other breeds (Table 51). Mastitis has been highest in Sahiwal as the first cause for disposal of the animals. Tables 51 and 52 show highest culled rate of dairy cows due to parasitosis (22.0%), followed by pneumonia (13.10%), reproductive disorders (15.2%) and low milk production (8.3%). Table 52 shows that the highest culled rate has been reported in old aged cattle in comparison to other age groups. Dairy farmers should be encouraged to record and monitor disease events and reproductive performance and

use these information as the basis for management efforts aimed at reducing the need to replace cows.[1090]

Table 51. Etiology of culled dairy cows (n = 238) at BAUDF during the period from 1971-1983[1093]

SNEtiology for culling	Pabna	Sahiwal	Sindhi	Red CTG	Cross-bred
01.Low production	36.0	05.1	03.2	22.2	08.3
02.Reproductive disorders	12.0	10.5	16.1	16.7	15.2
03.Mastitis	0	15.9	13.2	0	03.4
04.Emaciation	04.0	05.3	03.2	11.1	04.8
05. Deformed body conformation	0	0	03.2	0	03.0
06.Udder trouble	0	0	0	0	0
07.Old age	16.0	26.3	22.6	27.8	03.4
08.Injury	0	0	0	0	00.7
09.Other reasons	0	0	06.4	0	11.0
10.Parasitic diseases	12.0	10.5	16.1	11.1	22.00
11.Pneumonia	0	05.3	06.4	05.6	13.1
12.Reproductive disorders	08.0	05.3	03.2	0	01.4
13.Bloat	0	0	03.2	0	00.7
14.Anthrax	0	05.3	0	0	02.1
15.Old age	08.0	10.5	09.7	05.6	00.7
16. Haemorrhagic septicemia	04.0	0	03.2	0	04.1
17.Other reasons	0	0	0	0	05.5

Table 52. Age-wise culling of cross-bred dairy cows at BAUDF during 1974-1983[1094]

SNCategories & Causes	Age of cows (years), No. %						
	Up to 3	>3- 4	>4-5	>5-6	>6-7	>7	Total
A. Sold							
1. Low production	-	-	-	25.0	08.9	19.6	12 (08.3)
2.Reproductive disorders	-	27.8	29.4	-	42.9	13.0	22 (15.2)
3.Mastitis	-	-	05.9	-	-	08.7	05 (03.4)
4.Emaciation	-	-	05.9	-	-	10.9	07 (04.8)
5. Deformed body conformation	07.2	05.6	-	12.5	-	-	05 (05.5)
6.Old age	-	-	-	-	-	10.9	05 (03.5)
7.Injury	-	-	-	-	-	02.2	02 (01.4)
8.Others	-	27.8	11.4	37.5	22.4	06.5	15 (10.3)
B. Dead							
1.Parasitosis	52.4	11.4	11.8	11.5	-	10.9	32 (22.0)
2.Pneumonia	33.3	16.7	-	12.5	09.5	-	19 (13.1)
3.Reproductive disorders	-	-	-	-	-	04.3	02 (01.4)
4.Blat	02.4	-	-	-	-	-	01 (00.7)
5.Anthrax	-	-	11.8	-	-	02.2	03 (02.1)
6.Old age	-	-	-	-	-	02.2	01 (00.7)
7.Haemorrhagic septicaemia	-	11.0	11.8	-	-	04.3	06 (04.1)
8.Others	04.7	-	11.4	-	16.3	04.3	08 (05.5)
Overall, %	**100**	**100**	**100**	**100**	**100**	**100**	**145**

Manure management and biogas production

Some definition and terminologies related to manure which include: **manure**- broadly refers to dung of farm animals and poultry, either sole or added with urine, waste water, feed waste, litter/bedding materials, **animal slurry** is the manure of feces, urine, waste water and sometimes feed residues and bedding materials, which contain variable moisture contents 90 to 95%, **bio-slurry** is the semisolid by-products from biogas plant after anaerobic digestion of manure, **composting** is a manure treatment system which can be used to produce a stabilized product that is free from odor, harmful coliforms and fly problems, and **biogas** which is produced through anaerobic digestion of biological materials including livestock manure. Farm animals annually produce about 151.3 million tons of fresh manure, of which 3.08 tons/ year is produced under Milk-vita areas and other commercial farms in Bangladesh. Traditional management system of manure is considered as waste that pollutes air, water and soil that poses a threat to public health. The cattle manure is usually managed as (a) solid storage (56.2%), (b) liquid slurry (1.65%), (c) burned fuel (37.3%) and (d) anaerobic digester (4.80%) in Bangladesh.[1095]

Livestock manure pollutes environment through emitting greenhouse gases (GHGs) estimated to be 9.5% of the total of livestock origin.[1096] It has been reported that 56.2 to 57.0% manure of large ruminants is kept in solid storage, 37.3 to 43.0% as burned fuel, 4.8% is used in anaerobic digestion and 1.65% is lost as liquid slurry.[1097] The total annual methane emission from manure is estimated to be 176.75 Gg and emission from cattle manure 87.85% in Bangladesh.[1097]The

cattle dung, poultry litter and town cattle market straw have been reported to produce biogas yields of 0.034, 0.030 and 0.142 m^3/kg with methane concentrations of 60%, 62% and 74% respectively.[1098]

Bangladesh remains for behind its neighbor countries in developing biogas as an alternative to conventional fuel. India has established 4.0 million biogas plants, 8.0 million in China and 80,000 in Nepal whereas it is only 10,000 in Bangladesh.[1099]Cattle dung available from 22 million large ruminants is nearly 0.22 million tons. One tone dung can produced 37 m^3 of biogas. Available cattle dung can produce 2.97×10^9 m^3 of gas which is equivalent to 1.52×10^6 ton kerosene or 3.04×10^6 tons of coal.[1100]

The dung is mixed with water in equal ratio and stored in a tank. After 10 to 12 days biogas is produced in the plant which is supplied to the ovens through plastic pipes.[1099]Biogas is a combustible gas produced by anaerobic digestion (AD) and fermentation of organic materials by the action of methanogenic bacteria in a wet process: the dung is mixed with water and left to ferment in an enclosed vessel. The resultant gas which is emitted is mainly composed of methane (60-70%) and carbon dioxide (30 to 40%)- a very similar composition to piped gas in towns, which is derived from fossil fuels. Methane based gas produces more heat than kerosene, fuel wood, charcoal and dung-cake.[1101]

Limited inland research reports on biogas production and management system has been published from Bangladesh.[1102-1104]An investigation study showed that 85% biogas plants are functioning at full capacity whereas 15% are not functioning at all in the district of Tangail.[1105]

A designed project has been suggested to produce 18 MW electricity and 72 ton bio-fertilizer annually from biogas in Bangladesh.[1106]Biogas technology is one of the best means to provide natural gas to the largest number of rural people which can provide them with pollution free, efficient energy for cooking and at the same time protect them from dung-bornediseases by giving them a clear environment.

Miscellaneous research findings

Design of an ideal stanchion dairy barn,[1107]participation of rural people in cattle management,[1108] non-genetic effects on birth weight,[1109]colostrum and transition milk,[1110]effect of parityon calving pattern,[1111] influence of season on birth,[1112] sex ratio of calves,[1113] genetic lift in the birth weight,[1114]growth curves of local × Jersey,[1115]body weight and milk yield,[1116]milk production trend and F1 crossbred cows of Milk-vita,[1117,1118]chemical and microbial qualities of morning and evening milk,[1119]lactationmilk record,[1120]milk yield and composition of RCC,[1121,1122]relationship of milk vein and milk production,[1123]nutritional content and bacteriological contamination and analysis of milk,[1124,1125,1126]evaluation of fermented milk-wheat flour,[1127]preparation of fermented beverage from whey-based watermelon,[1128]utilization of whey in fermented and non-fermented drinks,[1129]preservation of butter,[1130]lactic acid bacteria in dahi,[1131]limitation of crossbreeding,[1132]comparison of dairy traits of crossbred cows,[1133]variation of morphological features and growth of Pabna cattle,[1134]supplementation of fish meal on growth and reproductive performance,[1135] production of cowpea forage,[1136]maize fodder production,[1137]identification of naturally available forage species,[1138]importance of vitamin A in dairy cattle,[1139]productive and reproductive performance of dairy cows,[1140-1149]genetic and phenotypic parameter on fertility traits,[1150,1151]genotype and environment interaction in growth

trait,[1152]genetic evaluation of BLRI cattle,[1153]breeding soundness of stud bulls,[1154]evaluation of semen of Brahman bulls,[1155,1156]AI and pregnancy rate,[1157]suitability of temperature and tropical crossbred of cattle,[1158]cow fecesfor *in vitro* digestibility assay of forages,[1159,1160,1161]*in vitro*digestibility of hay,[1162]wheat bran supplementation in native bulls,[1163]feeding of urea-molassesstraw based diet,[1164,1165,1166]urea-molasses multi-nutrient blocks in rural cattle,[1167]lime treated rice straw,[1168]moringa oleifera leaf as protein supplement,[1169]frequency of feeding on growth and carcass characteristics,[1170]psychrophilic bacteria in dairy barns,[1171]livestock credit,[1172] profitability of loaneddairy farms,[1173,1174]livestock technology[1175] and biotechnology,[1176]matching technology in flood affected area,[1177]urine collecting devic,[1178] evaluation of milk urea nitrogen,[1179] manure yield by cattle and buffalo,[1180]preparation of hygienic compost,[1181]garbage waste induced heavy metals on roaming cattle,[1182]statistical analysis of some economic traits of cattle,[1183]indigenous knowledge on livestock practices,[1184]and quality of chocolate milk made of different source of fat and solid-not-fat.[1185]

Limitations due to inappropriate data and plagiarism

Review of inland published reports on cattle production, management and dairy products reveals that the repetition of research works have been practiced, moreover multiple articles have been published with same data or in duplicate in the same and different journals especially feeding practices of draught animals,[81,82]cow feces has been used as a source of microorganisms for *in vitro*[304] and *in vivo*[307,312] digestibility, reproductive parameters of L × HF

cows,[752,753] feeding schedule of different groups of calves from birth to 90 days of age[1072,1073] and same dairy farm data published as breed-wise[1093] and age-wise[1094] culling of dairy cattle in different journals. Authors, reviewers, editors, academicians, readers and science community need a more caution approach to deal these types of articles. This article at least would help to identify the future plagiarism on the submitted articles before publication in different journals.

CONCLUSIONS

The status of cattle breeds and varieties with their characteristics, productive and reproductive performances, feeds and fodder production, fattening of cattle and beef production and milk production and milk products, semen collection and crossbreeding by AI, economics of dairy farming and calf rearing with milk replacer and calf starter have been reviewed. It appears from this review that HF × L crossbred cows has been suggested for highest profit, feeding of German fodder for maximum milk production, AI at the mid-cycle (12 to 15 hours) for highest CR (80.36%) and higher birth weight in male calves than female calves.

ETHICAL APPROVAL

This review article does not contain any research studies with animals or human participants performed by the author. Therefore, ethical approval is not required for this review article.

CONFLICT OF INTEREST

The author declares that this review work was completed without any commercial or financial relationships that could be construed as a potential conflict of interest.

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REFERENCES

01. Samad MA (2017). Current status and challenges for globalization of veterinary medical education for the 'One Health' programme. *Revue Scientifique et TechniqueOffice International Epizootics* 36: 741-765 [doi: 20506/rst.36.3.2711]

02. Vaccaro L (2002). Dairy production in diverse regions-Latin America. Encyclopedia of Dairy Sciences. 2nd edn. Elsevier Ltd. Pp. 88-93 [doi: 10.1016/B978-0-12-374407-4.00127-8]

03. Jabbar MA (1980). Drought power shortage and mechanization of tillage in Bangladesh. *Bangladesh Journal of Agricultural Economics* 3: 1-26

04. Rashid MU, Rahman MR and Mammun ZA (2009). Use of cow as draught power in some selected areas of Bangladesh. *The Agriculturists* 7: 36-40 [doi: 10.3329/agric.v7i1.5251]

05. Rahman S, Begum IA and Alam MJ (2014). Livestock in Bangladesh: distribution, growth, performance and potential. *Livestock Research for Rural Development* 26, Article 173. Retrieved July 14, 2020, from http://www.Irrd.org/Irrd26/10/rahm26173.html

06. Nasim M, Ali MA, Wahiduzzaman M and Shamsuddin M (1964). Study on conception rate by first second and third insemination among East Pakistan cows with semen extended in egg-yolk-sodium-citrate diluent. *Agriculture Pakistan* 15 : 4.

07. Samad MA (2000). An overview of livestock research reports published during the twentieth century in Bangladesh. *Bangladesh Veterinary Journal* 34: 53-149

08. Samad MA (2019). A 50-year review on the prevalence of clinical diseases and disorders of cattle in Bangladesh. *Journal of Veterinary Medical and One Health* Research 1: 1-16 [doi: 10.36111/jvmohr.2019.1(1).0001]

09. Samad MA (2019). A systematic review of pre-clinical and clinical research reports on small ruminants published during the last six decades in the then East Pakistan and in Bangladesh. *Journal of Veterinary Medical and One Health Research* 1: 111-183 [doi: 10.36111/jvmohr.2019.1(1).0010]

10. Samad MA (2020). A systematic review of research findings on buffalo health and production published during the last six decades in Bangladesh. *Journal of Veterinary Medical and One Health Research*2 : 1-62 [doi: 10.36111/jvmohr.2020.2(1).0016]

11. Hossain MM, Bhuiyan AKFH, Faruque MO and Dev GK (2006). Characterization and distribution pattern of Red Chittagong cattle of Bangladesh. *Progressive Agriculture* 17 : 103-110

12. Begumu S, Miah AG, Mobarak H, Chowdhury A, Jemy A and Salma U (2015). Identification and characterization of dwarf cattle available in Dinajpur district. *Asian Journal of Medical and Biological Research* 1: 380-386

13. Hamid MA, Rahman A, Zaman MA and Hossain KM (2017). Cattle genetic resources and their conservation in Bangladesh. *Asian Journal of Animal Sciences* 11: 54-64 [doi: 10.3923/ajas.2017.54.64]

14. Al-Amin M, Nahar A, Bhuiyan AKFH and Faruque MO (2007). On farm characterization and present status of North Bengal grey (NBG) cattle in Bangladesh. *Animal Genetic Resources Informations* 40: 55-64

15. Hossen MJ, Hossain MS, Abedin MJ, Karim MR and Rume FI (2008). Animal production strategies in Southern region of Bangladesh. *The Agriculturists* 6 : 77-83

16. Hamid MA (2017-18). Livestock production systems and their distribution pattern in Bangladesh: A review. *Central Journal of Bangladesh Open University* 4: 1-11

17. DLS (2020). Livestock Economy at a Glance, DLS. dls.portal.gov.bd/sites/default/files/files/dls.portal.gov.bd/page/ee5f4621_fa3a_40ac_8bd9_898fb8ee4700/Livestock%20Economy%20at%20a%20a%20glance%20%20%282017-2018%29.pdf

18. Talukder MAI, Shahjahan M, Haque MN, Islam MS, Rahman SM, Yeasmin MN, Munira S, Habib MR, Salahuddin M, Billah MM and Miah MAH (2017). Socio-economic condition, cattle production and management system in a community at Pabna district of Bangladesh. *Research in Agriculture, Livestock and Fisheries* 4 : 181-185 [doi: 10.3329/ralf.v4i3.3509]

19. Talukder MAI, Shahjahan M, Habib MR, Billah MM, Salahuddin M, Munira S, Miah MAH, Rahman SM, Haque MN, Yeasmin MN, Islam MS, Ali MY and Kabir MH (2017). Living standard of farmers and cattle oriented marketing system in few rural areas at Pabna district in Bangladesh. *International Journal of Natural and Social Sciences* 4 : 65-69

20. Mamun-ur-Rashid M and Gao Q (2012). Rural women in livestock and fisheries production activities: an empirical study on some selected coastal villages in Bangladesh. *Asian Journal of Agriculture and Rural Development* 2 : 658-667

21. Paul SC and Saadullah M (1991). Role of women in homestead of small category in an area of Jessore. *Bangladesh Journal of Livestock Research and Rural Development* 2: 23-29

22. Quddus MA, Moniruzzaman M and Islam MA (1999). Participation of rural households in livestock production activities. *Bangladesh Journal of Animal Science* 28: 89-95

23. Joshi NR and Phillips RW (1953). Zebu cattle of Indian and Pakistan. FAO, Rome, Italy. ao.org/3/a-an469e.pdf

24. Naik SN (1978). Origin and domestication of zebu cattle (*Bos indicus*). *Journal of Human Evolution* 7 : 23-30 [doi: 10.1016/S0047-2484(78)80032-3]

25. Savalia KB, Ahlawat AR, Gamit VV, Parikh SS and Verma AD (2019). Recently recognized indigenous cattle breeds of India: A Review. *International Journal of Current Microbiology and Applied Sciences* 8 : 161-168 [doi: 10.20546/ijcmas.2019.812.024]

26. Madalena FE, Toledo-Alvarado H and Cala-Moreno N (2019). Animals that produce dairy foods: Bos indicus breeds and *Bos indicus*×*Bos taurus* crosses. In: Reference Module in Food Science. Elsevier BV. [doi: 10.1016/B978-0-100596-5.00619-3]

27. Srivastava AK, Patel JB, Ankuya KJ, Chauhan HD, Pawar MM and Gupta JP (2019). Conservation of indigenous cattle breeds. *Journal of Animal Research* 9 : 1-12 [doi: 10. 30954/2277-940X.01.2019.1]

28. Geer AVD (2008). *Bos indicus*, the zebu. In: Animals in Stone. Brill, pp. 119-141 [doi: 10.1163/9789047443568-007]

29. Sartori R, Drum JN and Prata AB (2019). Fertility and infertility in Bos indicus. In: Noakes et. Al. Veterinary Reproduction and Obstetrics, 10th edn. Elsevier Ltd. [doi: 10.1016/B978-0-7020-7233-8.00028-8]

30. Khan MJ, Peters KJ and Uddin MM (2009). Feeding strategy for improving dairy cattle productivity in small holder farm in Bangladesh. *Bangladesh Journal of Animal Science* 38 : 67-85

31. Islam F, Alam MP, Hossain MS, Leena SA, Islam MR and Hasan SMR (2016). Prospects and challenges of homestead cattle production in the villages of Capai Nawabganj district in Bangladesh. *International Journal of Agronomy and agricultural Research* 9: 44-50

32. Hossain MA, Khan MAS and Hashem MA (2017). Phenotypic and production performance of indigenous zebu cattle (Bos indicus) under hot and humid temperature in Mymensingh district. *International Journal of Natural and Social Sciences* 4 : 49-57

33. Bhuiyan AKFH, Hossain MM and Deb GK (2007). Indigenous cattle genetic resources of Bangladesh and a way forward to their development. *Bangladesh Journal of Progressive Science and Technology* 5: 105-112

34. Al-Amin M and Nahar A (2007). Productive and reproductive performance of non-descriptive (local) and crossbred dairy cows in coastal area of Bangladesh. *Asian Journal of Animal and Veterinary Advances* 2: 46-49 [doi: 10.3923/ajava.2007.46.49]

35. Hadiuzzaman M, Bhuiyan AKFH, Bhuiyan MSA and Habib MA (2010). Morphometric characteristics of Red Chittagong cattle in a nucleus herd. *Bangladesh Journal of Animal Science* 39 : 44-51

36. Koirala B, Alam MZ, Iqbal A and Bhuiyan AKFH (2011). Study on morphometric, productive and reproductive traits of native cattle at Sylhet district. *Journal of the Bangladesh Agricultural University* 9 : 85-89

37. Rahman MM, Hoque MA, Saha NG and Faruque MO (2013). Studies on management system and identification of the causes of genetic erosion of indigenous cattle in Mymensingh district. *Bangladesh Journal of Animal Science* 42 : 23-28

38. Rahman MM, Arafat Y, Jalil MA, Rasel IH, Ahmed S and Islam MA (2015). Morphometric, productive and reproductive characteristics of cattle at Magura district. *International Journal of Natural and Social Sciences* 2 : 113-117

39. Hoque MA, Amin MR and Hussen MS (1999). Dairy potential of Pabna cows and crossbreds with Sahiwal and Friesian and within and between breed sire effects. *Asian-Australasian Journal of Animal Sciences* 12 : 161-164

40. Talukder MAI, Shahjahan M, Islam MS and Munira S (2017). Diversity in morphology and pigmentation patterns of local Pabna cattle in Bangladesh. *Research in Agriculture, Livestock and Fisheries* 4 : 201-208

41. Sultana Z (2018). Animal breeding policies and strategies in Bangladesh. Chapter 2. Animal Breeding Policies and Strategies in South Asia. SAARC Agriculture Centre, Dhaka-1215, Bangladesh pp.6-27

42. Talukder MAI, Shahjahan M, Habib MR, Salahuddin MM, Rahman SM, Ali MY, Munira S, Miah MAH, Billah MM, Rahman S and Bhuiyan AKF (2019). Production and compositional studies of milk in local Pabna cows of Bangladesh. *Asian Journal of Medical and Biological Research* 5 : 48-51 [doi: 10.329/ajmbr.v5i1.41044]

43. Habib MA, Bhuiyan AKFH, Bhuiyan MSA and Khan AA (2003). Performance of Red Chittagong cattle in Bangladesh Agricultural University Dairy farm. *Bangladesh Journal of Animal Science* 32 : 101-108

44. Khan AA, Ali A, Husain SS and Bhuiyan AKFH (1999). Reproductive performances of different genetic group of cows under farm condition. *Bangladesh Journal of Animal Science* 28: 59-64

45. Sultana Z (2018). Animal breeding policies and strategies in Bangladesh. Chapter 2. Animal Breeding Policies and Strategies in South Asia. SAARC Agriculture Centre, Dhaka-1215, Bangladesh, pp.6-27

46. Nahar S, Islam AFMF, Hoque MA and Bhuiyan AKFH (2016). Animal performance of indigenous Red Chittagong cattle in Bangladesh. *Acta Scientiarum., Animal Sciences* 38: [doi: 10.4025/actasciaanimsci.v38i2.28718]

47. Hossain MS, Bhuiyan AKFH, Khan MJ, Habib MA and Reza MSA (2009). Performance of Red Chittagong cattle (RCC) using different feeding regimes. *Journal of Bangladesh Society of Agriculture Science and Technology* 6 : 13-16

48. Habib MA, Bhuiyan AKFH and Amin MR (2012). Genetic and phenotypic parameter on fertility traits of Red Chittagong cattle in Bangladesh. *Bangladesh Veterinarian* 29 : 78-89

49. Amin MR, Habib MA and Bhuiyan AKFH (2013). Reproductive potential of Red Chittagong cattle in Bangladesh. *Journal of Tropical Resources and Sustainable Science* 5 : 77-82

50. Hossain SMJ, Bhuiyan AKFH, Afroz MF, Kabir MA, Miraz MFH and Habib M (2018). Growth performance of Red Chittagong cattle based on phenotypic and genetic parameters. *International Journal of Animal Science* 2 : 1-6

51. Khan MSI, Rumi SI, Azgor MA, Karim MR and Biswas MAA (2008). Comparative study on the productive and reproductive performance of Red Chittagong and Red Chittagong cross cattle in Chittagong district of Bangladesh. *International Journal of Sustainable Agricultural Technology* 4 : 79-81

52. Rahman F, Alam MP, Hoque MA and Bhuiyan AKFH (2016). Genotype and environmental interaction in growth and milk yield traits of indigenous Red Chittagong cattle. *Journal of Bioscience and Agriculture Research* 11: 955-962 [doi: 10.18801/jbar.110216.117]

53. Afroz MA, Hoque MA, Habib MA, Carvalheria J and Bhuiyan AKMFH (2012). Estimation of adjustment factors for standardizing age and season corrected 305 day milk yield and estimation of heritability and repeatability of standardized milk yield of Red Chittagong cattle. *Indian Journal of Animal Science* 82 : 879-883

54. Al-Simul, Bhuiyan AKFH, Alam MK, Sarker MM and Rahman MM (2012). Feeding and management practices of Red Chittagong cattle in two selected upazilas of Chittagong district. *Bangladesh Journal of Animal Science* 41 : 35-40

55. Khan MKI, Miah G, Khatun MJ and Das A (2010). Economic values for different economic traits of Red Chittagong cow. *Indian Journal of Animal Science* 80 : 1138

56. Hossain SMJ, Bhuiyan AKFH, Haque KS, Akteruzzaman M, Sarker NR and Sultana N (2012). A socio-economic study on Red Chittagong cattle (RCC) farmers in selected upazillas of Chittagong district. *Bangladesh Journal of Livestock Research* 19 : 106-116

57. Sharmin J, Miah MAM and Bhuiyan AKFH (2010). Farmers' attitude towards the rearing of Red Chittagong cattle. *Bangladesh Journal of Extension Education* 22 : 119-125

58. Uzzaman MR, Bhuiyan MSA and Bhuiyan AKFH (2011). Phenotypic characterization and performances of Munshiganj cattle. *SAARC Journal of Agriculture* 9 :69-83

59. Bhuiyan AKFH (2014). Farm animal genetic resources in Bangladesh. SAARC Agriculture Centre, Dhaka. www.saarcagri.org

60. Rahman MM (1993). Rearing improved variety of cattle: Farmers' views. *Bangladesh Journal of Animal Science* 22 : 69-79

61. Miah G, Sohel MSH, Hossain MI, Shahjlal M, Hossain MS, Hossain MA and Islam KN (2018). Productive and reproductive potentialities of different groups of crossbred cows reared under different farming conditions. *Iranian Journal of Applied Animal Science* 8 : 201-206

62. Islam MN, Oliuzzaman M and Rahman MN (1995). Existing distribution pattern and rearing practices of indigenous cattle in some selected areas of Mymensingh district. *Bangladesh Journal of Training and Development* 8 : 94-98

63. ILRI (2004). Status, Trends, Utilization and Performance of FAnGR of Bangladesh. Consultancy Report of GEF-UNEP-ILRI FAnGR Asia Project, International Livestock Research Institute (ILRI), Kenya, pp. 1- 49

64. Beg MAS, Mannan MA, Khan MSR, Parvez MM and Ullah SM (2010). Morphometric characterization and present status of Red Chittagong cattle (RCC) in Chittagong district in Bangladesh. *International Journal of BioResearch* 1 : 11-14

65. Udo HM, Hermans C and Dawood F (1990). Comparison of two cattle production systems in Pabna district Bangladesh. *Tropical Animal Health and Production* 22: 247-259 [doi: 10.1007/BF02240408]

66. Natarajan A, Chander M and Bharathy N (2016). Relevance of draught cattle power and its future prospects in India: A review. *Agriculture Reviews* 37: 49-54

67. Hussain MD and Tareque AMM (1984). A study on the performance of draft animal in land preparation. *Bangladesh Veterinary Journal* 18: 37-41

68. Jabbar MA (1985). Potential of single animal ploughing in Bangladesh. *Bangladesh Journal of Agricultural Economics* 8: 53-61

69. Alam J (1987). Draught power shortage in Bangladesh. *Asian Profile* 15: 563-580

70. Hussain MD, Sarker MRI and Quasem MA (1987). An analysis of factors affecting harassing of draught power available from cattle. *Bangladesh Veterinary Journal* 21: 81-89

71. Mahbub ASM, Uddin MK, Matin MA, Hossain MM and Ahmed M (1990). System analysis of farm animal: A step for identification of draught power situation and its interaction with cropping systems at flat barind. *Bangladesh Journal of Animal Science* 19 : 159-169

72. Basher MA and Rahman ML (1991). Analysis of some farm assets in a selected area of Mymensingh district. *Bangladesh Journal of Animal Science* 20: 105-112

73. Islam AWM (1992). Draught animal power (DAP) in Bangladesh. International Information System for the Agricultural Science and Technology [agris.fao.org/agris-search/search.do?recordID=TH2002002089]

74. Sarker MAH, Bhuiyan MSR, Khondaker NA and Kutubi MAF (1992). Relationship between ownership pattern of draft animals and land holdings at plain and hill foot areas of Chittagong district. *Bangladesh Journal of Animal Science* 21: 111-117

75. Rahman A, Sayeed A and Alam J (1992). Economics of single ploughing in Bangladesh: Presentation of survey results. *Asian Australasian Journal of Animal Science* 5: 709-715 [doi: 10.5713/ajas.1992.709]

76. Rahman A, Sayeed A and Alam J (1992). Factors affecting the adaptation of single animal ploughing in Bangladesh. *Bangladesh Journal of Animal Science* 21: 97-103

77. Rahman A, Sayeed A and Alam J (1992). Productivity analysis of rice crop under single and double animal ploughing system in Bangladesh. *Bangladesh Journal of Agricultural Research* 17: 162-170

78. Rahman A, Ahmed F and Molla AR (1993). Prospect of adopting single animal ploughing in tillage operations in Bangladesh. *Bangladesh Journal of Animal Science* 22: 119-126

79. Bala BK, Satter MA and Biswas BK (1992). Utilization pattern of animal draft power and cow dung in Bangladesh. *Bioresource Technology* 41 : 1-8 [doi: 10.1016/0960-8524(92)90093-d]

80. Baset MA, Hossain MM and Saadullah M (1996). Relationship between land size and draught cattle ownership. *Bangladesh Journal of Training and Development* 9: 39-42

81. Baset MA, Hossain MM and Saadullah M (1996). Study of the feeding practices of draught cattle at village level. *Bangladesh Journal of Animal Science* 25: 7-12

82. Baset MA, Hossain MM and Saadullah M (1996). Study of the feeding practices of draught cattle at village level. *Progressive Agriculture* 7: 7-12

83. Baset MA, Hossain MM and Saadullah M (1997). Study of the draught cattle management systems at farmers level. *Bangladesh Journal of Animal Science* 26: 7-12

84. Islam MS, Akhter S and Hossain MM (2000). Cattle as a source of draught power in relation to land size. *Bangladesh Journal of Animal Science* 29: 21-26

85. Wangchuk K, Wangdi J and Mindu M (2018). Comparison and reliability of techniques to estimate live cattle body weight. *Journal of Applied Animal Research* 46 : 349-352 [doi: 10.1080/09712119.2017.1302876]

86. Islam MM, Ahmed N, Giasuddin M, Khan EH and Sarker NR (1994). Prediction of live weight of cattle by fitted regression lines. *Bangladesh Journal of Animal Science* 23: 127-132

87. Rashid MM, Hoque MA, Huque KS and Bhuiyan AKFH (2016). Prediction of live weight for Brahman crossbred cattle using linear body measurements in rural area. *Advances in Animal and Veterinary Science* 4 : 99-106

88. Khan MJ (2008). Best practices in animal feed production and management in Bangladesh. Sac.org.bd/archives/publications/best_practices.pdf

89. Kumar A, Singh VK, Narender and Kumar R (2014). Utilization of paddy straw as animal feed. *Forage Research* 40 : 154-158

90. Sheikh GG, Ganai AM, Reshi PA, Bilal S, Mir S and Masood D (2018). Improved paddy straw as ruminant feed: A review. *Agricultural Reviews* 39 : 137- 143 [doi: 10.18805/ag.R-1667]

91. Aquino D, Barrio AD, Trach NX, Hai NT, Khang DN, Toan NT and Hung NV (2019). Rice straw-based fodder for ruminants. Sustainable Rice Straw Management. pp.111-129

92. Khan MJ, Drochner W, Steingass H and Islam KMS (2008). Nutritive evaluation of some tree leaves from Bangladesh for feeding ruminant animals. *Indian Journal of Animal Science* 78: 1273-1277

93. Islam MZ, Islam MZ, Barman KK, Bari MS, Habib MR, Rashid MH and Islam MA (2020). Concentrate supplementation impact on the performances of extended transitional crossbred zebu cow. *Journal of Bangladesh Agricultural University* 18 : 117-123 [doi: 10.5455/JBAU.94751]

94. Rahman MM, Akhter S and Hossain MM (1997). Socio-economic aspects of the farmers for livestock keeping in Mymensingh town adjacent areas. *Progressive Agriculture* 8 : 153-157

95. Huque KS and Sarker NR (2014). Feeds and feeding of livestock in Bangladesh: performance, constraints and options forward. *Bangladesh Journal of Animal Science* 43 : 1-10

096. Rahman SMR, Sarker NR, Amin MR, Kamruzzaman M and Haque MR (2017). Identification of naturally available forage species and their feeding effect on dairy cows in different climatic vulnerable areas of Bangladesh. *Bangladesh Journal of Animal Science* 46 : 150-158

097. Momen MA and Rahman H (1968). Effect of different levels of nitrogen along with phosphorus and potasssic fertilizers on some mineral composition of pangola grass (Digitaria decumbens steet). *Animal Science Journal of Pakistan* 1: 1-9

098. Shamsuddin AM (1972-1973). Forage sorghum- A prospective fodder crop for Bangladesh. *Bangladesh Journal of Animal Science* 5-6: 1-4

099. Reza A, Quddoos A and Razzaque MA (1972-1973). Effect of nitrogen fertilization on the yield and nutritive values of Para grass. *Bangladesh Journal of Animal Science* 5-6 : 13-20

100. Islam MS and Sattar MA (1974). The yield response of pangola grass to N, P and K fertilizers. *Bangladesh Journal of Agricultural Sciences* 1 : 58-62

101. Bhuiya ZH, Islam MS and Sattar MA (1975). The yield response of para grass (*Brachiaria mutica*) to nitrogen, phosphorus and potash fertilizers. *Bangladesh Journal of Agricultural Sciences* 2 : 11-15

102. Akbar MA, Tareque AMM and Razzaque MA (1975-76). Studies on the effect of nitrogen fertilizer on yield, chemical composition and nutritive value of German grass (*Echinocloa crusgalli*). *Bangladesh Journal of Animal Science* 9-10 : 21-28

103. Kibria SS, Reza A and Razzaque MA (1975-1976). Effect of different doses of phosphorus fertilization on the yield, proximate composition and nutritive value of pangola grass. *Bangladesh Journal of Animal Science* 9-10 : 37-46

104. Mamun AA and Rahman MM (1986). Fodder production in the existing cropping system in Bangladesh. *Bangladesh Journal of Animal Science* 15: 69-76

105. Chowdhury AKMSH (1986). Effect of foliar application of mefluidide and PP333 on Tama Rye grass (Lolium species). *Bangladesh Journal of Animal Science* 15: 30-34

106. Ali SM. Talukder MN and Karim Z (1987). Effect of fertilizers, trace elements (Mo, Mn, B) and sulphur on growth characters and quality of German grass (*Echinocora crusgalli*). *Bangladesh Journal of Animal Science* 16: 37-42

107. Khandaker ZH and Islam MM (1988). Effect of nitrogen fertilization and stage of maturity on yield and quality of fodder maize (Zea mays). *Bangladesh Journal of Animal Science* 17 : 47-53

108. Satter MA, Ali MS and Haque MF (1990). Effect of phosphorus and sulphur on some quality components of wheat straw. *Bangladesh Journal of Animal Science* 19 : 53-61

109. Tareque AMM and Shajalal M (1990-1993). Effect of different levels of N-fertilizer on the yield, chemical composition and in vitro digestibility of maize fodder (*Zea mays*). *Bangladesh Veterinary Journal* 24-27 : 9-13

110. Khan M, Tareque AMM and Shahjalal M (1992). Effect of inoculation and nitrogen fertilization on yield, chemical composition, in vitro organic matter digestibility and energy content of cowpea (Vigna ungestibility) forage. *Indian Journal of Animal Nutrition* 9: 177-180

111. Torofder GS, Quyyum MA, Rahman MM, Maula G and Torofder IH (1992). Effect of plant thinning and leaf removal on the fodder and grain yield of maize. *Bangladesh Journal of Animal Science* 21: 59-63

112. Hasnath MA, Saadullah M and Samad MA (1992). Study on degradation of dry matter and crude protein of leguminous fodders. *Bangladesh Veterinarian* 9: 65-69

113. Kibria SS, Islam MR and Rahman MM (1993). Feasibility study on the production of different fodder crop in Bangladesh. *Bangladesh Journal of Animal Science* 22 : 25-33

114. Huque KS (1993). Effect of nitrogen fertilization on the yield and chemical composition of dal grass (Hymenachne pseudointerrupta). *Bangladesh Journal of Animal Science* 22 : 131-134

115. Rahman MM, Islam MR and Islam M (1993). Intercrop potential of maize (Zea mays L. cv. savari) in ipil-ipil (leucaena leucocephala cv. peru) based agroforestry hedgerows. *Bangladesh Journal of Livestock Research* 1 : 39-46

116. Islam MM, Yasmin L, Giasuddin M, Khan EH and Sarker NR (1993). Agronomic performance and feasibility of growing barseem (Trifolium alexandrinum) and oat (Avena sativa) as forage crops at Baghabari FRS site. *Bangladesh Journal of Livestock Research* 1 : 77-82

117. Rahman SME, Islam MA, Rahman MM and Oh DH (2008). Effect of cattle slurry on growth, biomass yield and chemical composition of maize fodder. *Asian Australasian Journal of Animal Science* 21 : 1592-1598

118. Khandaker ZH and Islam MM (1994). Structural carbohydrate, protein content and in vitro digestibility of oat (*Avena sativa*) forage at three stages of maturity. *Bangladesh Journal of Animal Science* 23 : 51-55

119. Mamun AA, Amin AKMR, Hossain SMA, Reza A and Islam N (1994). Feasibility of growing sorghum as fodder crop in Aus rice. *Bangladesh Journal of Animal Science* 23 : 67-74

120. Sarker NR, Giasuddin M, Islam MM, Rahman MM and Yasmin L (1994). Effects of intercropping, seedling rate and fertilizer on fodder production in the low lying area of Bangladesh. *Asian-Australasian Journal of Animal Sciences* 7 : 57-61

121. Khandaker ZH (1994). Effect of mixed cropping of maize (Zea mays) and cowpea (Vigna unguiculata) forage on fodder on forage yield, chemical composition and its in-vitro digestibility. *Indian Journal of Animal Nutrition* 11 : 55-57

122. Khandaker ZH and Islam MM (1994). Effect of stage of maturity on protein, cell wall constituents, nutrient digestibility and energy content of sun hemp (*Crolalaria juncea*) forage. *Bangladesh Journal of Agricultural Science* 21: 305-310

123. Khandaker ZH (1995). Chemical composition, organic matter digestibility and metabolizable energy content of oat (Avena sativa) forage at three different growth stages. *Progressive Agriculture* 6 : 123-126

124. Khan MJ, Tareque AMM and Islam MM (1995). Effect of nitrogen and phosphorus fertilization on maize fodder grown in various row widths and intra-row spacing. *Bangladesh Journal of Agricultural Sciences* 22 : 165-170

125. Shahjalal M, Selim ASM and Rahim A (1996). Effect of nitrogen fertilization on yield, chemical composition and in vitro digestibility of maize (Zea mays) and oat (*Avena sayiva*) fodders. *Bangladesh Journal of Animal Science* 25 : 65-72

126. Khan MJ, Shajalal M and Sarker AR (1996). Yield, chemical composition and nutritive value of oat (Avena saliva) fodder at different levels of nitrogen fertilizer. *Bangladesh Journal of Animal Science* 25 : 109-115

127. Khan RI, Alam MR and Ahmed M (1996). Yield of native grasses as influenced by seasons and nitrogen application. *Bangladesh Journal of Training and Development* 9 : 65-68

128. Shahjalal M, Khan MJ and Islam KMS (1996). Effect of Rhizobium inoculation and phosphate application on yield, chemical composition and nutritive value of sun hemp (Crotalaria juncea) forage in sheep. *Bangladesh Journal of Training and Development* 9 : 75-78

129. Rahman SMA, Begum J and Alam J (1996). Fodder production at Savar Dairy Farm: an economic analysis. *Asian-Australasian Journal of Animal Sciences* 9 : 411-420

130. Moholl M, Shahjalal M, Huque KS and Tareque AMM (1996). Nutritional evaluation of local grasses as feed for ruminants. *Bangladesh Journal of Animal Science* 25 : 57-64

131. Rahman MM, Moula MG, Begum S, Torofder GS and Salahuddin ABM (1997). Effect of sowing and cutting dates on the fodder yield of oat. Bangladesh Journal of Animal Science 26 (1-2): 21-24

132. Moula MG, Rahman MM, Biswas M and Ahmed A (1997). Effect of nitrogen rate and its time of application on the fodder yield of maize. Bangladesh Journal of Animal Science 26 (1-2): 45-49

133. Moula MG, Begum S and Ahmad A (1997). Plant thinning and leaf removal as influencing the grain and fodder yield of maize. Bangladesh Journal of Animal Science 26: 141-145

134. Karim MR, Islam F, Monin MA and Haque MN (1998). Intercropping of forage legumes in maize for fodder production. *Bangladesh Journal of Animal Science* 27 : 171-175

135. Khan RI, Alam MR and Amin MR (1999). Effect of season and fertilizer on species composition and nutritive value on native grasses. *Asian-Australasian Journal of Animal Sciences* 12 : 1222-1227

136. Khaleque MA, Kashem MA, Ahmed S and Hossain SMA (1999). Availability of green grass under different land type and land use systems in a haor village. Bangladesh Journal of Animal Science 28 : 53-58

137. Moula MG, Biswas M, Islam N and Miah AA (2000). Effect of rate and time of nitrogen application on the fodder and grain yield of triticale. *Bangladesh Journal of Animal Science* 29 : 119-125

138. Saha NK, Shahjalal M, Khan MJ and Al-Mamun M (2001). Evaluation of maize (*Zea mays*) and oat (*Avena sativa*) forages on the basis of biomass yield and nutritive value. *Progressive Agriculture* 12 : 175-181

139. Shahjalal M, Islam KMS and Tareque AMM (2001). Effect of maize-legume mixed cropping on yield and chemical composition. *Bangladesh Journal of Animal Science* 30 : 93-98

140. Huque KS, Rahman MM and Talukder AI (2001). Study on forage crop production on sloping land and in Bangladesh. *Asian-Australasian Journal of Animal Sciences* 14 : 956-959

141. Kabir F, Shajalal M, Chowdhury SA, Uddin MJ, Hasanuzzaman M and Miah G (2002). Yield and chemical composition of common roadside grasses available in Bangladesh. *On Line Journal of Biological Sciences* 2 : 364-365

142. Islam MR, Saha CK, Sarker NR, Jalil MA and Hasanuzzaman M (2003). Effect of variety on proportion of botanical fractions and nutritive value of different Napier grass (Pennisetum purpureum) and relationship between botanical fractions and nutritive value. *Asian-Australasian Journal of Animal Sciences* 16 : 837-842

143. Khan MSI, Hossain MM and Khan MAA (2004). Effect of compost and farmyard manure on zamboo fodder production. *Journal of the Bangladesh Agricultural University* 2 : 287-296

144. Sultana MN, Khan MJ, Khandaker ZH and Uddin MM (2005). Effects of Rhizobium inoculum and N-nitrogen fertilizer on biomass production of cowpea (Vigna unguiculata) forage at different stages of maturity. *Journal of the Bangladesh Agricultural University* 3 : 249-255

145. Sultana MN, Khan MJ, Khandaker ZH, Shahjalal M and Uddin MM (2005). Effect of Rhizobium inoculum and N-fertilizer on nutrient contents of cowpea (Vigna unguiculata) forage at various stages of maturity. *Bangladesh Journal of Animal Science* 34 : 93-102

146. Hannan MA, Asaduzzaman M, Deb GK and Rahman MF (2005). Effect of different sources of nitrogen on biomass yield, chemical composition, in-vitro organic matter digestibility and metabolizable energy content of dal grass (*Hymenachne amplexicaulis*). *Bangladesh Journal of Livestock Research* 12 : 66-76

147. Khan MJ, Shahjalal M, Haque ME and Hashem MA (2005). Effect of different sources and levels of nitrogen fertilizer on yield and nutrient contents of maize (Zea mays) forage. *Bangladesh Journal of Animal Science* 34 : 55-61

148. Uddin MM, Khandaker ZH and Sultana MN (2005). Effect of levels of nitrogen with or without phosphorus fertilizer on oat (Avena sativa) forage production harvested at various ages: i. Yield and nutrients content. *Bangladesh Journal of Animal Science* 34 : 63-71

149. Uddin MM, Khandaker ZH and Sultana MN (2005). Effect of levels of nitrogen with or without phosphorus fertilizer on oat (Avena sativa) forage production harvested at various ages: ii. Nutritive value and micro-mineral contents. *Bangladesh Journal of Animal Science* 34 : 73-81

150. Khaleduzzaman ABM, Islam N, Khandaker ZH and Akbar MA (2007), Effect of different doses of nitrogen and phosphorus fertilizer on yield and quality of Napier grass (*Pennisetum purpureum*). *Bangladesh Journal of Animal Science* 36 : 41-49

151. Islam MR, Rahman SME, Islam KMS and Chowdhury R (2008). Effect of the application of dried slurry on yield and chemical composition of maize fodder (*Zea mays*). *Bangladesh Journal of Animal Science* 37 : 52-57

152. Rahman SME, Islam MA, Rahman MM and Oh DH (2008). Effect of cattle slurry on growth, biomass yield and chemical composition of maize fodder. *Asian Australasian Journal of Animal Science* 21 : 1592-1598 [doi: 10.5713/ajas.2008.80190]

153. Tabassum N, Uddin MR and Gim Uhn-Soon (2008). Prospects of Triticale as fodder and feed in farming of Bangladesh. *Journal of Agricultural Science Chungnam National University, Korea* 35 : 101-118

154. Haque ME, Waddington SR, Sarker ZI, Sarker NR and Akteruzzaman M (2008). Production and promotion of triticale as a high quality fodder and feed in small-scale dairy farmers of Bangladesh. *Progressive Agriculture* 19 : 217-228 [doi: 10.3329/pa.v19i2.16964]

155. Biswas MAA, Kibria MG, Akter MM, Rashid MH and Islam MM (2009). Comparative economic profitability of Jumbo (Hybrid sorghum) and Napier (Pennisetum pur-pureum) grass and mustard-BR29-T Amon cropping pattern. *International Journal of Sustainable Agricultural Technology* 5 : 51-53

156. Islam MN, Alam MR, Kabir AKMA, Das NG and Khanduker MM (2010). Comparative study of yield, intake, chemical composition and nutritive values of gamma (Tripsacum dactyloides) oat (Avena sativa) and sorghum (*Sorghum bicolor*) forages. *Bangladesh Journal of Animal Science* 39 :67-74

157. Hasan MR, Akbar MA, Khandaker ZH and Rahman MM (2010). Effect of nitrogen fertilizer on yield contributing character, biomass yield and nutritive value of cowpea forage. *Bangladesh Journal of Animal Science* 39 : 83-88

158. Rahman MH, Rashid MH, Masum AKM and Hassan MN (2010). Effect of cow dung on biomass yield and nutrient composition of triticale fodder. *Bangladesh Journal of Progressive Science and Technology* 8 : 99-102

159. Roy PRS and Khandaker ZH (2010).Effect of phosphorus fertilizer on yield and nutritional value of sorghum (Sorghum bicolor) fodder at three cuttings. *Bangladesh Journal of Animal Science* 39 : 106-115

160. Islam R, Rahman SME, Rahman MM, Oh DH and Ra CS (2010). Effects of biogas slurry on the production and quality of maize fodder. *Turkish Journal of Agriculture and Forestry* 34: 91-99 [doi: 10.3906/tar-0902-44]

161. Zannat MK, Alam NR, Sarker NR, Huque KS, Khan MRI and Islam MA (2012). Comparative study on the biomass yield, chemical composition and in-sacco dry matter degradability of different cultivars of triticale fodder. *Bangladesh Journal of Animal Science* 41 : 24-28

162. Kanak AR, Khan MJ, Debi MR, Pikar MK and Ahtar M (2012). Nutritive value of three fodder species at different stages of maturity. *Bangladesh Journal of Animal Science* 41 : 90-95

163. Kanak AR, Khan MJ, Debi MR, Khandakar ZH and Pikar MK (2013). Comparison on biomass production of three fodder germplasms. *Bangladesh Journal of Animal Science* 42 : 35-39

164. Rahman MA, Hashem MA, Rahman MM, Rahman SME, Hossain MM, Azad MAK and Haque ME (2013). Comparison of struvite compost with other fertilizers on maize fodder production. *Journal of Environmental Science and Natural Resources* 6 : 227-231

165. Khatun MJ, Khan MKI and Shariar SMS (2014). Effect of various levels of nitrogen and phosphorus fertilizer with sheep and goat manure on morphology, yield and chemical composition of Jumbo fodder production. *Wayamba Journal of Animal Science* 6 : 910-920

166. Rahman MZ, Ali MY, Afroz MF, Karim MR and Talukder MAI (2015). Effect of intercropping on high yielding fodder production in bathan areas of Sirajgonj district. *Bangladesh Journal of Animal Science* 44 : 21-25

167. Alam MR, Hauqe MM, Sumi KR and Ali MM (2015). Proximate composition of para-grass (Brachiaria mutica) produced in integrated fish-fodder culture system. *Bangladesh Journal animal Science* 44 : 113-119

168. Rahman MZ, Ali MY, Sarker NR, Afroz MF, Al Rahman MO, Karim MR and Talukder MAI (2015). Effect of different types of organic manure on biomass yield, morphological characteristics and nutritive value of BLRI-4 in Baghabari milk shed area, Sirajgonj. *Asian Journal of Medical and Biological Research* 1 : 690-692

169. Hazary MEH, Bilkis T, Khandaker ZH, Akbar MA and Khaleduzzaman ABM (2015). Effect of nitrogen and phosphorus fertilizer on yield and nutritional quality of Jumbo grass (sorghum grass × Sudan grass). *Advances in Animal and Veterinary Sciences* 3 : 444-450 [doi: 10.14737/journal.aavs/2015/3.8.444.450]

170. Jalal N, Khan JM and Akbar MA (2016). Utility of farmers fallow lands for fodder production with high phenotypic growth and yield. *Pakistan Journal of Nutrition* 15 : 989-996

171. Islam R, Jalal N and Akbar MA (2016). Effect of seed rate and water level on production and chemical analysis of hydroponic fodder. *European Journal of Academics* 4 : 724-737

172. Kamal MT, Hashem MA, Sarker NR, Jahan R and Hossain MM (2016). Effects of organic manure on production performance and nutritive values of different Napier cultivars. *Journal of Bangladesh Society of Agriculture Science and Technology* 13 : 1-4

173. Islam MM, Khan MMH, Uddin MJ and Islam MJ (2017). Biomas and nutritional evaluation of German grass (Echinochloa polystachya) cultivated on floating bed. *Bangladesh Journal of Animal Science* 46 : 249-257

174. Islam MS, Sarker NR, Habib MA, Ali MY and Yeasmin T (2017). Effect of different soil types on growth and production of Napier-4 at the regional station of BLRI. *Asian Journal of Medical and Biological Research* 3 : 182-185

175. Sarker NR, Habib MA, Bashar MK, Amin MR, Tabassum F and Yeasmin D (2016). Feeds and forage availability, utilization and management practices for livestock in some selected coastal areas of Bangladesh. *Journal of Experimental Agriculture International* 14: 1-11 [1doi:10.9734/JEAI/2016/30396]

176. Sarker NR, Habib MA, Amin MR, Yeasmin S, Tabassum F and Yeasmin D (2017). Feeds and fodder dynamics in selected river basins of Bangladesh. *Bangladesh Journal of Animal Science* 46 : 206-214

177. Islam MS, Sarker NR, Ali MY, Habib MR, Billah MM, Miah MAH, Kabir MH and Shahjahan M (2017). Comparative study on fodder and rice production with the emphasis of economic profitability. *International Journal of Natural and Social Sciences* 4 : 1-5

aaa

178. Islam S, Begum J, Sarker NR and Khatun M (2017). Economics of fodder production for dairying in selected areas of Bangladesh. *Bangladesh Journal of Animal Science* 6 : 140-149

179. Islam MS, Sarker NR, Ali MY, Habib MA, Billah MM, Uddin MS and Habib MR (2018). Impact of loamy and sandy soils on productive and nutritive value of BLRI developed Napier-4 fodder at third cutting stage. *International Journal of Applied Research* 4: 20-23

180. FAO (2012). Balanced feeding for improving livestock productivity- increase in milk production and nutrient use efficiency and decrease in methane emission. By MR Garg. FAO Animal Production and Health Paper No. 173, Rome, Italy. Fao.org/3/i3014e/i3014e00.pdf

181. Miah MAH, Rahman MS, Rahmin QMF, Ahmed B and Watkins TD (1965). Utilization of molasses and urea-molasses as livestock feed in East Pakistan. Part II. *Pakistan Journal of Biological and Agricultural Sciences*8: 260

182. Tareque AMM and Quddas DA (1968). Determination of nutritive value of four forages in ruminants in East Pakistan. *Pakistan Journal of Veterinary Science* 2: 68-70

183. Rahman MS (1968). High concentrate in dairy and beef cattle feeding practice. *Pakistan Journal of Veterinary Science* 2: 17-24

184. Rahman MS (1968). Relative feeding values of meals or cake made from soybean, cotton seed, linseed and guar as protein supplements for dairy cattle. *Pakistan Journal of Veterinary Science* 2: 67-73

185. Quddoos A and Tareque AMM (1968). Investigation of the different methods of urea feeding in ruminant in East Pakistan. *Animal Science Journal of Pakistan* 1 : 167-172

186. Razzaque MA (1969). Methods on quantitative estimation rumen microbial protein synthesis. *Animal Science Journal of Pakistan* 1: 16-20

187. Islam MM and Quddos A (1972-73). Effect of partial replacement of vegetable protein by urea nitrogen on crude protein digestibility by ruminants. *Bangladesh Journal of Animal Science* 5-6: 43-50

188. Razzaque MA (1974-1975). Nitrogen- a limiting factor in animal nutrition. *Bangladesh Journal of Animal Science* 7-8: 63-71

189. Khan MJ, Rouf MA and Tareque AMM (1980). Studies on the chemical composition of three types of water hyacinth (Eichhornia crassipes) in Bangladesh. *Bangladesh Journal of Agriculture* 5: 167-172

190. Khan MJ, Razzaque MA and Tareque AMM (1981). Effect of feeding water hyacinth in combination on the growth of bullocks. *Bangladesh Journal of Agriculture* 6: 16-22

191. Reza A and Khan MJ (1981). Water-hyacinth (*Eichhomia crassipes*) as cattle feed. *Indian Journal of Animal Science* 57 : 702-706

192. Saadullah M, Haque M and Dolberg F (1982). Supplementation of alkali treated straw. *Tropical Animal Production* 7 : 187-190

193. Saadullah M, Haque M and Dolberg F (1982). Treated and untreated rice straw for growing cattle.*Tropical Animal Production* 7 : 20-25

194. Haque KZ, Rouf MA and Reza A (1982). A study on the effect of different levels and sources of nitrogen on dry matter and organic matter digestibility of German grass using in vitro technique. *Bangladesh Veterinary Journal* 16: 33-39

195. Mould F, Saadullah M, Haque M, Davis CH, Dolberg F and Orskov ER (1982). Investigation of some of the physiological factors influencing intake and digestion of rice straw by native cattle in Bangladesh. *Tropical Animal Health and Production* 7: 174-181

196. Mahatab SN, Ali A and Asaduzzaman AHM (1983). The nutritive value of bazar-napier (hybrid) grass in cattle. *ADAB News* 10: 34-37

197. Saadullah M (1986). Effect of urea-molasses with untreated 4% sodium hydroxide rice straw on the utilization of rumen microorganisms and ammonia concentration in the rumen *in vitro*. *Bangladesh Veterinary Journal* 20: 47-53

198. Aktar S, Saadullah M, Huq MA and Hossain MM (1987). Effect of different levels of urea and moisture on dry matter degradability of wheat straw by nylon bag technique. *Bangladesh Journal of Animal Science* 16 : 73-78

199. Huq MA and Saadullah M (1987). Ruminal dry matter and nitrogen degradability of common tree leaves and forages in Bangladesh. *Indian Journal of Animal Nutrition* 4 : 44-47

200. Rahman MM and Gheyasuddin S (1987). Study on the distribution of protein in various soluble fractions and the amino acid composition of shoti rhizome (*Curcuma zedoaria*). *Bangladesh Journal of Animal Science* 16: 94-97

201. Karim F, Akbar MA and Huque KS (1988). Effect of ensiling rice straw with poultry excreta and urea on its in vitro digestibility. *Bangladesh Journal of Agricultural Science* 15: 11-15

202. Khan MJ, Tareque AMM and Razzaque MA (1988). A study on the relationship between the content of nitrogen in water and water-hyacinth and its production in the earthen pots. *Bangladesh Veterinary Journal* 22 : 35-44

203. Hossain MD, Bulbul SM and Howlider MAR (1989). Proximate composition of some tree leaves vegetables and wastes in Bangladesh. *Bangladesh Veterinarian* 6: 40-43

204. Satter MA, Haque MF, Paul DC and Abedin MZ (1989). Matching technology generation with farmers need in a flood affected area: II. Studies on the effect of adjustment of ration on cattle health and milk production. *Bangladesh Journal of Animal Science* 18: 91-97

205. Saadullah M (1989). Treating wheat straw with animal urine. *Bangladesh Journal of Agricultural Sciences* 16 : 293-299

206. Kibria SS, Roxas DB and Ranjhan SK (1989). A ruminant feed based on water hyacinth: its nitrogen balance study. *Bangladesh Journal of Animal Science*18 ; 63-68

207. Kibria SS, Roxas DB, Castillo LS and Ranjhan SK (1989). Ensiled water hyacinth (Eichhornia crassipes Mart Solms) as ruminant feed. I. Physical and chemical characteristics of the silage. *Philippine Journal of Veterinary and Animal Science* 15: 30-41

208. Alam SM, Haque MF, Paul DC and Hussain MS (1991). Ownership pattern and feeding practices of livestock at the Jessore farming system research site. *Bangladesh Journal of Animal Science* 20: 75-82

209. Hossain MA, Hossain MB, Islam MB and Mannaf MA (1991). Feed, fodder and forage during normal and stress situation in the farming systems research site, Janokinathpur, Rangpur. *Bangladesh Journal of Animal Science* 20 : 83-89

210. Mahbub ASM, Ahmed M and Haque AKM (1991). Comparative performance of growing cattle using supplementary feed with water soaking and urea soaking rice straw at rural condition of Bangladesh. *Bangladesh Journal of Animal Science* 20 : 91-97

211. Mahbub ASM, Haq AKMZ and Rahman H (1991). Identification of feed and fodder situation and its impact on farm animal production at flat Barind area. *Bangladesh Journal of Animal Science* 20: 69-74

212. Islam M, Islam MR and Rahman MM (1991). Potential shrubs and tree fodder for smallholder livestock production in Bangladesh. *Asian Livestock* 16: 146-149

213. Akbar MA, Alam MS and Huq ME (1992). A study on yield, chemical composition and in vitro digestibility of different varieties of groundnut straw. *Bangladesh Veterinarian* 9: 37-40

214. Haque MM and Amin MR (1992). Feeds and feeding of livestock- a study at the farming system research site, Palima Tangail. *Bangladesh Journal of Animal Science* 21 : 5-10

215. Rahman MM, Islam MR, Rahman MM, Zaman MA and Malek MA (1992). Feeding system of large ruminants in rural Bangladesh. *Asian-Australasian Journal of Animal Science* 5 : 349-355

216. Mahatab SN, Ali A and Asaduzzaman A (1992). Note on nutrient utilization by cattle from jiga leaves. *Livestock Advisor* 17: 19-21

217. Ali MM and Tareque AMM (1992). Influence of Acacia pod and soybean meal on ruminal fermentation pattern and on serum mineral status in local bull calves. *Bangladesh Journal of Agricultural Sciences* 19: 311-316

218. Zamad MS, Saadullah M, Haque M and Dolberg F (1992). Effect of variety and lime treatment on the chemical composition and digestibility of paddy straw. *Bangladesh Journal of Agricultural Science* 19 : 149-150

219. Zaman MS and Sarker DRD (1993). Methods of predicting digestibility of barley straw treated with mixtures of calcium hydroxide and urea. *Bangladesh Journal of Agricultural Sciences* 20 : 381-386

220. Kibria SS, Islam MR and Saha CK (1993). Sugar cane tops can be ensiled. *Bangladesh Journal of Livestock Research* 1: 83-86

221. Sarker DRD, Islam MN, Rahman MS, Hamid MA and Hashem MA (1994). A study on the comparative digestive capacity of cattle and buffalo. *Bangladesh Journal of Animal Science* 23: 169-174

222. Biswas AR, Islam MM, Akbar MA and Khandaker ZH (1994). Effect of legume forage supplements on chemical composition, organic matter digestibility and energy contents of rice straw. *Progressive Agriculture* 5: 169-175

223. Hossain MA, Islam MF and Alam MS (1994-1998). Ownership pattern and feeding practices of livestock in the non-saline tidal floodplain area of Patuakhali district. *Bangladesh Journal of Livestock Research* 1-5: 150-160

224. Islam MM, Mili FJ, Khandaker ZH and Akbar MA (1994). Effects of moisture level and ensiling period on chemical composition and in vitro digestibility of urea treated rice straw. *Bangladesh Journal of Agricultural Sciences* 21 : 297-303

225. Chowdhury SA, Huque KS, Khatun M and Nahar Q (1995). Study on the use of algae as a substitute for oil cake for growing calves. *Livestock Research for Rural Development* 6(3): Article # 26. http://www.Irrd.org/Irrd6/3/2.htm

226. Chowdhury SA, Majid MA, Huque KS, Islam M and Rahman MM (1995). Effect of variety on yield and nutritive value of rice straw. *Asian-Australian Journal of Animal Science* 8 : 329-335

227. Islam M, Sarker NR, Islam MM and Yasmin L (1995). Feed and fodder availability in the Pabna milk shed area, Bangladesh. *Asian-Australasian Journal of Animal Sciences* 8 : 301-305

228. Mansur AA, Anwar ABMN and Rashid MH (1995). Farmers' problem concentration in roughage feeds and feeding of cattle. *Bangladesh Journal of Animal Science* 24 : 145-151

229. Islam MM, Giasuddin M, Sarker NP and Yasmin L (1995). Feeding pattern of ruminant at Baghabari milk shed area. *Bangladesh Journal of Animal Science* 24 : 153-160

230. Khandaker ZH, Islam MM and Khan AA (1995). Effect of replacement of wheat bran by rice polish on nutrient intake and growth of bull calves. *Bangladesh Journal of Animal Science* 24 : 165-172

231. Huque KS, Talukder AMM and Akbar MA (1995). Effect of drying temperature and collection procedures of rumen inoculum on digestibility in vitro and metabolisable energy contents of grasses. *Bangladesh Journal of Agricultural Sciences* 22: 1-6

232. Zaman MA, Rahman MM, Islam MR and Rahman MM (1996). Feeding practices of large ruminants in Bangladesh. *Bangladesh Veterinarian* 13 : 27-28

233. Huque KS and Chowdhury SA (1997). Study on supplementing effects on feeding systems of molasses and urea on methane and microbial nitrogen production in the rumen and growth performances of bulls fed a straw diet. *Asian-Australasian Journal of Animal Sciences* 10 : 35-46

234. Chowdhury SA and Huque KS (1996). Study on the development of a technique for preserving straw under wet condition in Bangladesh. *Asian-Australian Journal of Animal Science* 9 : 91-99

235. Chowdhury SA and Huque KS (1996). Effect of urea on wet rice straw for preserving its keeping quality and nutritive value in cattle diets. *Asian-Australian Journal of Animal Sciences* 9 : 181-187

236. Chowdhury SA, Huque KS and Haque ME (1996). Straw preservation under wet condition during monsoon in Bangladesh: Effect of preserving wet straw with urea on its keeping quality and nutritive value in cattle when fed alone or supplemented with concentrates. *Asian-Australasian Journal of Animal Sciences* 9 : 319-329

237. Khandaker ZH and Tareque AMM (1996). Studies on protein degradabilities of feedstuffs in Bangladesh. *Asian Australasian Journal of Animal Science* 9: 637-642 [doi: 10.5713/ajas.1996.637]

238. Khan MS, Islam MN, Rahman MM and Ali MB (1997). Socio-economic aspects of private dairy farm in Bangladesh. *Progressive Agriculture* 8: 235-238

239. Khan MJ and Shahjalal M (1997). Effect of partial replacement of rice bran by dried cow-dung on growth and nutrient utilization in growing bull calves. *Bangladesh Journal of Agricultural Sciences* 24: 155-160

240. Hauqe KS, Tareque AMM and Zaman MA (1997). Chemical analysis of nutritive values of fruit wastes. *Bangladesh Veterinary Journal* 31: 54-56

241. Khatun MJ, Akbar MA and Shahjalal M (1998). A study on degradability of different protein supplements.*Progressive Agriculture* 9 : 241-245

242. Khan MJ, Shahjalal M and Rashid MM (1998). Effect of replacing Til oil cake by poultry excreta on growth and nutrient utilization in growing bull calves. *Asian Australasian Journal of Animal Science* 11: 385-390 [doi: 10.5713/ajas.1998/385]

243. Reza A (1998). The energy role of cattle in the Bangladesh agro-ecosystem. *Ecological Engineering* 10: 221-226

244. Chowdhury SA (1999). Effect of graded levels of mustard oil cake supplementation on intake, nutrient digestibility, microbial N of adult connulated native (Bos indicus) bulls fed rice straw. *Asian-Australasian Journal of Animal Sciences* 12 : 715-722

245. Chowdhury AS (1999). Biodigester effluent as protein supplement for indigenous (Bos indicus) growing bulls. *Livestock Research for Rural Development* 11 (2): Article # 13. http://www.Irrd.org/Irrd11/2/chow112.htm

246. Khandaker ZH and Tareque AMM (1999). Rumen fermentation pattern in indigenous cattle fed rice straw-based diet with varying levels of rumen degradable protein (RDP) from urea. *Indian Journal of Animal Nutrition* 16 : 349-353

247. Khan MJ, Scaife JR and Hovell FD (1999). The effect of different sources of urease enzyme on the nutritive value of wheat straw treated with urea as a source of ammonia. *Asian-Australasian Journal of animal Science* 12 : 1063-1069 [doi: 10.5713/ajas.1999.1063]

248. Habib M, Akbar MA, Choudhury KA and Ali MS (2000). Degradation of dietary protein from different sources in the rumen. *Bangladesh Journal of Animal Science* 29: 127-134

249. Saadullah M, Hossain MM, Hossain MS and Kamaruddin KM (2001). Livestock feeds and fodder availability in different locations of Bangladesh. *Bangladesh Veterinarian* 18 : 33-40

250. Islam MR, Rahman MM, Rahman MM and Zaman MA (2002). Effect of agro-ecological zones, farm category and season on feeds and feeding of large ruminants in rural Bangladesh. *Asian-Australasian Journal of Animal Sciences* 15 : 643-649

251. Amin MR (2002). Phenylalanine, tyrosine and aromatic acids in the rumen fluids of goat, sheep and cattle. *Bangladesh Journal Animal Science* 31 : 9-17

252. Khaleduzzaman ABM and Khandaker ZH (2002). Effect of feeding different levels of rumen degradable protein on growth and nutrient utilization in indigenous bull calves. *Bangladesh Journal of Animal Science* 31 : 19-26

253. Khan MJ, Steingass H and Drochner W (2002). Nutritional evaluation of some aquatic plants for animal feeding. *Bangladesh Journal of Agricultural Sciences* 29: 317-324

254. Bhuiyan A, Akbar MA and Hossain ME (2003). Nutritive value of damp rice straw and its feeding effect on aflatoxin transmission into cow milk. *Pakistan Journal of Nutrition* 2 : 153-158

255. Zaman MA, Rahman MM, Islam MR, Hossain MK and Khan KA (2003). Available feeds and the quantities fed to the large ruminants in different areas of Bangladesh. *Journal of Biological Sciences* 3 : 898-902 [doi: 10.3923/jbs.2003.898.902]

256. Khan MSI, Rahman MM, Rahman SME, Hossain MM and Khan AA (2004). A comparative study of feed intake, feces outgo, digestibility and body weight gain between Red Chittagong and Holstein-Frisian cross cows during pregnancy. *Bangladesh Journal of Animal Science* 33 : 43-49

257. Kabir AKMA, Alam MR and Amin MR (2004). Effect of tannins on organic matter digestibility and metabolizable energy content in three leguminous leaves. *Progressive Agriculture* 15 : 53-59

258. Mohanta NGD, Begum M and Singha AK (2006-2007). Effect of urease enzyme, molasses, dhaincha and Ipil Ipil leaves on the nutritive value of urea treated straw. *Bangladesh Journal of Training and Development* 19-20 : 101-109

259. Shamsuddin M, Alam MM, Hossein MS, Goodger WJ, Bari FY, Ahmed TU, Hossain MM and Khan AHMSI (2007). Participatory rural appraisal to identify needs and prospects of market-oriented dairy industries in Bangladesh.*Tropical Animal Health and Production* 39 : 567-581

260. Rahman MM, Khandaker ZH and Khaleduzzaman ABM (2008). The bioavailability of phosphorus from bone meal and triple super phosphate and its effects on indigenous growing cattle. *Bangladesh Journal of Animal Science* 37 : 58-65

261. Bostami ABMR, Khan RI, Amin MR, Sarker NR, Pervage S and Hasan K (2008).Effect of addition of molasses and period of preservation on physical and nutritional properties of Maize stover silage. *Bangladesh Journal of Animal Science* 37 : 42-51

262. Khan MJ, Hannan MA, Islam S and Islam MN (2008). Effect of different nitrogen sources on yield, chemical composition and nutritive value of dal grass (*Hymenachne amplexicaulis*). *Bangladesh Veterinarian* 25 : 75-81

263. Malek MA, Khan MJ and Islam KMS (2008). Nutritive at value of rice straw as affected by ensiling with urea and urease sources at various moisture levels. *Indian Journal of Animal Science* 78: 182-185

264. Malek MA, Khan MJ and Islam KMS (2008). Nutritional improvement of ensiled rice straw through supplementation of urea, molasses, soybean seed meal and aquatic plants. *Indian Journal of Animal Science* 78: 1404-1407

265. Rahman MM, Akbar MA, Islam KMS, Khaleduzzaman ABM and Bostami ABMR (2009). Nutrient digestibility and growth rate of bull calves fed rice straw treated with wood ash extract. *Bangladesh Journal of Animal Science* 38 : 42-52

266. Islam S, Khan MJ and Islam MN (2009). Effect of feeding wilted water hyacinth (Eichhornia crassipes) on the performance of growing cattle. *Indian Journal of Animal Science* 79 : 494-498

267. Rahman MM, Alam MR, Amin MR and Das NG (2010). Comparative study of the nutritive values of the different varieties of rice straw. *Bangladesh Journal of Animal Science* 39 : 75-82

268. Simul AI, Bhuiyan AKFH, Alam MK, Sarkar MM and Rahman MM (2012). Feeding and management practices of Red Chittagong cattle in two selected upazillas of Chittagong district. *Bangladesh Journal of Animal Science* 41 : 35-40

269. Chakma S, Rahman MM, Islam P, Awal MA, Roy UK and Haq MR (2012). Arsenic in rice and rice straw. *Bangladesh Veterinarian* 29 : 1-6

270. Khandaker ZH, Uddin MM, Sultana MN and Peters KJ (2012). Effect of rumen degradable protein (RDP) supplementation on intake, digestibility and microbial protein synthesis of cattle in a straw-based diet in Bangladesh. *Tropical Animal Health and Production* 44: 791-800 [doi: 10.1007/s11250-011-9969-z]

271. Kibria SS, Islam MR and Saha CK (1991). Development of straw based ration for feeding ruminants. *Asian-Australasian Journal of Animal Sciences* 4 : 235-240

272. Hossain ME, Sikder H, Kabir MH and Sarma SM (2015). Nutritive value of water hyacinth (Eichhornia crassipes). *Online Journal of Animal and Feed Research* 5 : 40-44

273. Uddin MJ, Khandaker ZH and Khan MJ (2015). Nutritive values and chemical composition of foliages, grass and herbs using in vitro technique. *ISESCO Journal of Science and Technology*11 : 35-43

274. Amin R, Sarker NR, Ali MY, Hashem MA and Khatun MM (2016). Study on cutting intervals on biomass yield, nutritive value and their oxalate content of different high yielding napier (P. purpureum) cultivars. *Asian Australasian Journal of Bioscience and Biotechnology* 1 : 100-107

275. Sarker D, Redoy MRA, Sarker NC, Kamal MT and Al-Mamun M (2016). Effect of used rice straw of mushroom cultivation on growth performance and plasma metabolites in beef cattle. *Bangladesh Journal of Animal Science* 45 (3): 40-45 [doi: 10.3329/bjas.v45i3.31044]

276. Jahan R, Amin R, Sarker NR and Kamal MT (2018). Feeding effects of total mixed ration on rumen metabolic profile in cattle. *Bangladesh Journal of Animal Science* 47: 35-39

277. Sarker LR, Khan RI and Rahman MM (2018). Ensiling of wet rice straw using biogas slurry and molasses in monsoon of Bangladesh. *Journal of Animal Sciences and Livestock Production* 2 No.1:1: [doi: 10.21767/2577-0594.100012]

278. Haque M, Davis C, Saadullah M and Dolberg F (1982). Performance of cattle fed treated paddy straw with animal urine as a source of ammonia. *Tropical Animal Health and Production* 6: 150-157

279. Sarker DRD, Rahman MS, Huq MA and Samad MA (1984). Voluntary dry matter consumption and its influence on growth performance in different breeds of cattle and buffalo. *Bangladesh Journal of Animal Science* 13: 42-47

280. Shahjalal M and Islam MM (1986). Studies on the utilization of sugar cane bagasse by the growing bull calves. *Bangladesh Journal of Animal Science* 15: 12-16

281. Shahjalal M, Islam MM and Tareque AMM (1986). Studies on the voluntary intake of bagasse and its digestibility by nylon bag technique. *Bangladesh Journal of Animal Science* 15 : 23-29

282. Haque KS and Akbar MA (1986). Effect of supplementation of Leucaena leucocephala leaf meal to rice straw with poultry excreta or urea on its digestibility in vitro. *Bangladesh Veterinary Journal* 20 : 65-71

283. Akhtar S, Sadullah M, Hossain MM and Huq MA (1988). Effect of urea, moisture level and treatment time on the crude protein content of wheat straw. *Bangladesh Veterinary Journal* 22 : 19-22

284. Sarker DRD, Zaman MM, Islam MN and Wadud A (1988). Dry matter consumption and body weight gains in breeds of cattle and buffalo heifers. *Bangladesh Journal of Agricultural Sciences* 15 : 255-257

285. Haque KS and Akbar MA (1988). Effect of addition Leucaena leucocephala to rice straw ensiled with poultry excreta and/or urea on its in vitro digestibility. *Bangladesh Journal of Agricultural Sciences* 15: 21-25

286. Mukammeluddin A, Tareque AMM, Bhuiyan MRH and Gheyasuddin S (1989). Effects of urea supplemented, urea treated and urine treated rice straw on the growth and serum transaminase activities of calves. *Bangladesh Veterinarian* 6 : 18-22

287. Zaman MS (1990). Effect of calcium hydroxide on urea hydrolysis and nitrogen content of urea treated straw. *Bangladesh Journal of Agricultural Sciences* 17 : 59-63

288. Satter MA, Haque MF, Paul DC and Abedin MZ (1991). Matching technology generation with farmers' need in a flood affected area: III. Migrating livestock feed crisis with the use of dried maize stoker. *Bangladesh Journal of Animal Science* 20: 1-8

289. Kibria SS, Islam MR and Saha CK (1991). Development of straw based ration for feeding ruminants. *Asian Australasian Journal of Animal Science* 4: 235-240

290. Khan MAS, Jabber MA, Akbar MA and Topps JH (1991). Leucaena leucocephala as an alternative protein supplement to fish meal for lactating cows in Bangladesh. *Animal Production* 52: 594

291. Khandaker ZH and Reza A (1993). Effect of urea feeding on the fattening of local emaciated cattle of Bangladesh. *Bangladesh Journal of Animal Science* 22 : 101-106

292. Ali MA, Wadud A, Rahman MS, Hasan N and Sarker DRD (1993). Effects of Napier, Para and German grasses on growth performance of cross-bred calves. *Bangladesh Veterinarian* 10 : 30-32

293. Sarker DRD, Hamid MA and Beg MAH (1993). Water hyacinth as a supplement for urea treated rice straw. *Bangladesh Veterinarian* 10 : 33-36

294. Rashid MA, Islam MM and Akbar MA (1994). Different techniques of straw treatment and their effects on feeding value and growth rate of local bull calves. *Bangladesh Journal of Training and Development* 7 : 81-86

295. Islam MM, Khandaer ZH, Abedin G and Akbar MA (1994). Effect of feeding urea treated and urea supplemented rice straw on the performance of heifers. *Bangladesh Journal of Animal Science* 23: 7-13

296. Khan MAS and Rahman MM (1994). Replacement of fishmeal by Leucaena leucocephala on the performance of local dairy calves of Bangladesh. *Bangladesh Journal of Animal Science* 23: 43-49

297. Hashem MA, Talukder MJR, Akhter S and Saadullah M (1994). Effects of urea-molasses block supplementation on the eating and rumination behavior in fistulated cows. *Bangladesh Veterinary Journal* 28 (1-4): 71-74

298. Huque KS, Jalil MA, Islam MR, Talukder MAI and Islam M (1994-1998). Assessment of factors related to farmers acceptance of urea feeding technologies at sustainable level. *Bangladesh Journal of Livestock Research* 1-5: 63-71

299. Hossain KM, McMeniman NP, Dowsett KF, Jillella D and Knott LM (1994-1998). The effects of dietary crude protein, urea solutions and uterine urea concentrations upon sperm motility and survival. *Bangladesh Journal of Livestock Research* 1-5: 72-91

300. Khan MAS (1995). Replacement of fish meal by *Leucaena leucocephala* on the performance of local dairy calves of Bangladesh. *Annalesde Zootechnie* 44: 360

301. Saadullah M, Sarker DRD, Akhter S, Hashem MA, Samad MA and Islam S (1995). Carcass weight and gut contents of bull calves fed urea treated rice straw and fish meal. *Bangladesh Journal of Agricultural Sciences* 22 : 57-61

302. Islam MM, Khandaker ZH, Akbar MA and Hannan MA (1995). Effect of different methods of protein replacement by urea nitrogen on growing bull calves. *Bangladesh Journal of Agricultural Sciences* 22 : 15-19

303. Hashem MA, Akhter S, Hossain MM, Islam MS and Saadullah M (1995). Urea-molasses block supplementation on intake and ruminal fermentation characteristics in cattle. *Bangladesh Journal of Animal Science* 24 : 27-33

304. Akhter S (1995). Cow faeces as a source of microorganisms for in vitro digestibility assay: effect of stages at different faecal concentrations and incubation periods. *Bangladesh Journal of Animal Science* 24: 103-109

305. Hossain MS, Hossain MM, Hashem MA and Ali RN (1996). Transfer of feeding technology to promote cattle production of village level. *Bangladesh Journal of Animal Science* 25 : 51-56

306. Begum J, Reza A, Islam MR, Rahman MM and Zaman MS (1996). Effect of supplementation of different levels of tea waste on the performance of growing calves. *Asian-Australasian Journal of Animal Sciences* 9: 175-179

307. Akhter S, Owen E and Hossain MM (1996). Use of cow faeces at different times after being voided as a source of microorganisms in vivo digestibility assays of forages. *Asian Australasian Journal of Animal Science* 9: 371-374

308. Chowdhury SA (1997). Effect of low levels of leucaena foliage supplementation on intake, nutrient digestibility and microbial N yield in cattle fed rice straw alone. *Asian-Australasian Journal of Animal Sciences* 10 : 265-273

309. Khandaker ZH and Tareque AMM (1997). Effect of rumen degradable protein (RDP) in straw based ration on purine derivatives excretion and microbial nitrogen supply in cattle. *Asian-Australasian Journal of Animal Sciences* 10 : 364-370

310. Chowdhury SA (1997). Effect of graded levels of rice mill feed (RMF) supplementation on intake, nutrient digestibility, microbial N yield and growth rate of native (*Bos indicus*) bulls fed rice straw alone. *Asian-Australasian Journal of Animal Sciences* 10 : 445-454

311. Chowdhury SA and Huque KS (1997). Effect of graded levels of green grass supplementation on nutrient digestibility, rumen fermentation and microbial nitrogen production in cattle fed rice straw alone. *Asian-Australasian Journal of Animal Sciences* 10 : 460-470

312. Akhter S and Hossain MM (1998). Cow faeces in in-vitro digestibility assays of forages. *Asian Australasian Journal of Animal Science* 11: 51-53

313. Rahman MM, Akter S and Hossain MM (1998). The availability of livestock feeds and feeding practices followed by the farmers of some areas of Mymensingh district. *Bangladesh Journal of Animal Science* 27 : 119-126

314. Rahman MJ, Reza A and Shahjalal M (1998). Effect of wheat bran and rice polish on the performance of growing bull calves. *Bangladesh Journal of Animal Science* 27 : 157-162

315. Chowdhury SA and Huque KS (1998). Effect of molasses or rice gruel inclusion to urea supplemented rice straw on its intake, nutrient digestibilities, microbial N yield, N balance and growth rate of native (Bos indicus) growing bulls. *Asian-Australasian Journal of Animal Sciences* 11 : 145-151

316. Khatun MJ, Akbar MA, Shahjalal M and Khan MKI (1999). Comparison of different protein supplements on growth and nutrient utilization in bull calves. *Bangladesh Journal of Animal Science* 28 : 141-147

317. Begum N, Khan MJ and Islam KMS (2000). Feeding rations containing road side grass, maize silage or water hyacinth in bull calves. *Pakistan Journal of Biological Science* 3: 1730-1732

318. Miah AG, Ali ML, Salma U, Khan MAS and Islam MN (2000). Effect of pre and post-partum supplementation of cows with urea molasses multinutrient blocks (UMMB) on the performance of their calves. *Pakistan Journal of Biological Sciences* 3 : 1092-1093

319. Parvez MS, Shahjalal M and Akbar MA (2001). Effect of different levels of energy and protein on growth and nutrient utilization in local bull calves. *Bangladesh Journal of Animal Science* 30 : 107-113

320. Hamid MA and Rahman MS (2001). Effect of urea treated rice straw on feed intake and growth of crossbred calves. *Bangladesh Journal of Training and Development* 14 : 83-88

321. Haque ME, Akbar MA, Khandaker ZH and Habib M (2001). Effects of supplementing bypass protein and energy to straw-based diets on growth and nutrient utilization by indigenous zebu calves. *Bangladesh Veterinarian* 18 : 41-48

322. Alam MGS, Ghosh A, Mondal AK and Akbar MA (2001). Supplementation and puberty of zebu calves of Bangladesh. *Bangladesh Veterinarian* 18 : 1-8

323. Chowdhury SA (2001). Effect of graded levels of cottonseed cake supplementation on intake, nutrient digestibility, microbial N yield of growing native (Bos indicus) bulls fed rice straw. *Asian-Australasian Journal of Animal Sciences* 14 : 326-332

324. Mahbub ASM and Uddin MK (2001). Effect of replacement of green grass by water hyacinth (Eichhornia crassipes) in the ration of indigenous heifer under farmer's condition. *Bangladesh Journal of Animal Science* 30 : 9-13

325. Baset MA, Rahman MM, Ali ML, Mahbub ASM and Haque MN (2002). Effect of urea molasses straw (UMS) on the performance of steers (local zebu cattle) with supplementation of wheat bran. *Pakistan Journal of Biological Sciences* 5 : 807-808

326. Khandaker ZH and Uddin MM (2002). Nutritional evaluation of locally available feedstuffs in Bangladesh. *Indian Journal of animal Nutrition* 19 : 110-115

327. Ahmed S, Khan MJ, Shahjalal M and Islam KMS (2002). Effects of feeding urea and soybean meal-treated rice straw on digestibility of feed nutrients and growth performance of bull calves. *Asian Australasian Journal of Animal Sciences* 15 : 522-527

328. Khan MJ, Steingass H and Drochner W (2002). Evaluation of some aquatic plants from Bangladesh through mineral composition, in-vitro gas production and in situ degradation measurements. *Asian-Australasian Journal of Animal Science* 15 : 537-542 [doi: 10.5713/ajas.2002.537]

329. Kyum MK, Rahman ME, Islam MR, Khan MSI and Sultana A (2003). A study on the growth performance of crossbred growing bull calves fed by supplementing molasses with straw based diet and conventional concentrates. *Online Journal of Biological Science* 3 : 26-31

330. Habib M and Akbar MA (2005). Influence of protein source on bacterial population and fermentation products in the rumen of cattle. *Journal of Animal and Veterinary Advances* 4 : 937-941

331. Khan MSI, Saiful IM, Goto M and Islam MN (2005). Effect of different dietary energy levels on the performance of crossbred dairy heifers. *Journal of the Bangladesh Society of Agricultural Science and Technology* 2 : 81-84

332. Islam MR, Miah G, Huque KS, Akter S, Rahman MM and Islam MZ (2005). Comparative performances of cattle and buffalo calves on nutrient intake, digestibility and growth fed on maize silage and concentrated mixture. *Bangladesh Journal of Livestock Research* 12 : 21-32

333. Huque KS and Sultana N (2007). Review on feeding, nutrition and growth efficiency of native male cattle of Bangladesh and comparison with feedlot beef animals. *Bangladesh Journal of Animal Science* 36 :113-135

334. Huque KS, Sultana N, Rahman MZ and Hossain SMJ (2007). Effect of age on feed utilization for growth performances and carcass quality in native bulls. *Progressive Agriculture* 18: 107-116

335. Islam MA, Wadud A, Khan MAS, Matubbar A and Siddiki MSR (2007). Effect of feeding urea molasses block on the performance of heifer under farm condition. *Journal of the Bangladesh Society for Agricultural Science and Technology* 4 : 237-241

336. Mallick NC, Hasan K and Khandaker ZH (2007). Effect of supplemental copper on the nutrient utilization and copper status of indigenous bull calves. *Bangladesh Journal of Animal Science* 36 : 50-56

337. Rahman MM, Alam MR, Amin MR and Rahman MM (2007). Nutritive values of four leguminous tree foliages. *Bangladesh Journal of Animal Science* 36 : 57-61

338. Barua S, Khan MJ, Bhuiyan AKFH, Islam MN and Islam SS (2008). Supplementation of concentrate with different levels of protein on nutrient intake, digestibility and growth of Red Chittagong heifers. *Bangladesh Journal of Animal Science* 37 : 10-16

339. Rahman MA, Khondaker ZH and Khaleduzzaman ABM (2009). Bioavailability of phosphorus and its effect on the nutrient utilization in cattle. *Bangladesh Journal of Animal Science* 38 : 33-41

340. Ali MF, Rashid MH, Masum AKM and Islam MN (2010). Effect of urea molasses block (UMB) on the growth performance of Red Chittagong and Holstein-Friesian crossbred bull calves. *Bangladesh Journal of Progressive Science and Technology* 8 : 89-92

341. Ferdous S, Masum AKM, Khan MAS and Islam MA (2010). Comparative study of the performance of buffalo calves and cow calves by feeding urea molasses block with straw based diet. *Journal of the Bangladesh Agricultural University* 8 : 87-90

342. Akter A and Khandaker ZH (2010). Triple super phosphate as a source of phosphorus in the diet of growing bull. *Bangladesh Journal of Animal Science* 39 : 89-90

343. Hossain MM, Khan MJ and Akbar MA (2010). Nutrient digestibility and growth of local bull calves as affected by feeding urea and urease enzyme sources treated rice straw. *Bangladesh Journal of Animal Science* 39 : 97-105

344. Islam SS, Khan MJ, Bhuiyan AKFH, Islam MN and Barua S (2010). The value of protein-rich supplements on the performance of Red Chittagong heifers (Bos indicus) fed urea molasses straw-based diet. *Tropical Animal Health and Production* 42 : 1505-1511

345. Alam SM, Haque MF, Paul DC and Hussain MS (1991). Ownership pattern and feeding practices of livestock at the Jessore farming system research site. *Bangladesh Journal Animal Science* 20 : 75-82

346. Islam S, Hoque MA, Khondoker MAMY, Saha NG and Akhtar A (2013). Estimation of effect of breeding bulls and genetic parameters on early growth performance of calves at farm and field levels. *Bangladesh Journal of Animal Science* 42 : 81-88

347. Akter M, Khan MJ, Akbar MA and Asaduzzaman M (2013). Improving quality of rice straw through treatment with urea and midden soil for large animals. *Bangladesh Journal of Animal Science* 42 : 29-34

348. Khatun H, Khan RI and Moniruzzaman M (2013). Preparation of wastage with poultry droppings and oat forage (Avena sativa) as a feed for cattle. *Journal of Environmental Science and Natural Resources* 6 : 233-237

349. Uddin ME, Yesmin S, Khan MAS and Rashid MH (2013). Effect of particle size of para grass and maize grain on intake, digestibility and growth performance of crossbred heifers. *Bangladesh Journal of Progressive Science and Technology* 11: 71-74

350. Hasanuzzaman M, Akter N, Begum MR, Alam M, Yeasmin T and Sarker MS (2014). Study on effect of rice gruel on growth performance of cattle. *Wayamba Journal of Animal Science* 7 : 1051-1058

351. Uddin MJ, Huque KS, Chowdhury SA and Khandaker ZH (2015). A repeated drench with soybean oil improves growth and feed conversion of beef cattle fed rice straw supplemented with urea

molasses. *Livestock Research for Rural Development* 27 (2): Art. 23. http://www.lrrd.org/lrrd27/2/uddi27023.html

352. Rashid MM, Hoque MA, Huque KS and Bhuiyan AKFH (2015). Effect of concentrate feeding on the cost effective growth performance of F1 Local x Brahman bulls in Bangladesh. *Livestock Research for Rural Development* 27 (5). Art. # 100. http://lrrd.org/lrrd27/5/rash27100.htm

353. Hossain MS, Miah MY, Khandaker ZH and Islam F (2015). Effect of different level of matikalai (Vigna mungo) hay supplementation to straw-based diets on feed intake, digestibility and growth rate of indigenous cattle. *Livestock Research for Rural Development* 27 (2): Art. 21. http://lrrd.or/lrrd27/2/hoss27021.html

354. Rahman MSA, Bhuiyan MSA and Bhuiyan AKFH (2015). Effects of genetic and non-genetic factors on growth traits of high yielding dairy seed calves and genetic parameter estimates. *Journal of Advanced Veterinary and Animal Research* 2 : 450-457 [doi: 10.5455/javar.2015.b116]

355. Sarker MAH, Khan MAH, Rashid MH and Islam MH (2016). Effect of Azadirachta indica and Annona reticulata leaf as natural anthelmintic and their effects on performances of zebu cow under subsistence farming condition in Bangladesh. *International Journal of Pharmaceutical, Chemical and Biological Sciences* 6 : 16-21

356. Akhter MN, Islam MR, Habib MR, Rashid MH and Khandaker ZH (2017). Effect of energy and protein supplementation on growth and nutrient requirement estimation in cross-bred bull calf. *Bangladesh Journal of Animal Science* 46 : 179-187

357. Islam MS, Habib MR, Islam MA and Rashid MH (2019). Effect of protein concentrate supplementation based diet on growth and nutritional status in dairy heifers. *Journal of Bangladesh Agricultural University* 17 : 45-49 [doi: 10.3329/jbau.v17i1.40662]

258. Amin MR (2002). Phenylalanine, tyrosine and aromatic acids in the rumen fluids of goat, sheep and cattle. *Bangladesh Journal Animal Science* 31 : 9-17

359. Dey NG and Rahman MS (1969). Limited roughage in dairy cattle feeding practice. *Animal Science Journal of Pakistan* 2 : 49-55

360. Rahman MS and Saha GC (1974-1975). Voluntary roughage intake and its economic influence in terms of milk production in different breeds of cattle and buffaloes. *Bangladesh Journal of Animal Science* 7-8 : 23-28

361. Khan MAS and Rahman MS (1980). Influence of German (Echinocloa crusgalli), Napier (*Penisetum purpureum*) and Para (*Brachiaria mutica*) grasses on milk production. *Bangladesh Veterinary Journal* 14 : 17-23

362. Ahmed TU, Mannan AKMA, Rahman MS and Hoque M (1982). Study on the urea treated rice straw in milk production. *Bangladesh Journal of Animal Science* 11 : 20-27

363. Husain SMI, Islam MN, Hasan MN, Mannan AKMA and Wadud A (1984). Effect of feeding urea-treated and untreated rice straw on fat, solids-not-fat and total solids content of milk of Pabna cows. *Bangladesh Journal of Animal Science* 13 : 25-30

364. Khan MAS, Akbar MA, Mannan AKMA and Hossain SMI (1987). Influence of different levels of fishmeal on the quantity and quality of milk produced from crossbred cows in early lactation. *Bangladesh Veterinary Journal* 21 : 71-79

365. Reza A (1988). Replacement of conventional forage by water-hyacinth in the ration of milch cow. *Bangladesh Journal of Animal Science* 17: 85-92

366. Khan MAS, Akbar MA, Mannan AKMA, Husain SMI and Hasnath MA (1990). Influence of different levels of fishmeal on the performances of crossbred cows during late lactation. *Bangladesh Journal of Animal Science* 19 : 71-80

367. Khan MAS, Bain SK, Akbar MA and Chowdhury SA (1990). Study on the effect of feeding urea treated rice straw supplemented with different levels of fishmeal as bypass protein in early lactating dairy cows. *Bangladesh Journal of Animal Science* 19 : 119-130

368. Sarker NR, Saadullah M, Huq MA, Hossain B and Begum D (1990). Effect of urea supplementation on feed intake and milk production in indigenous cows. *Bangladesh Veterinarian* 7 : 85-88

369. Talukder MAI, Husain SMI, Islam MN and Amin MR (1990). Effects of urea treated and untreated rice straw on milk quality. *Progressive Agriculture* 1 : 13-17

370. Talukder MAI, Islam MN and Husain SMI (1990). Effects of urea treated and untreated rice straw with undegradable protein on voluntary feed intake, milk yield and body weight changes of indigenous cows. *Bangladesh Journal of Agricultural Science* 19: 89-97

371. Hossain MS, Alam MS and Hossain SMM (1991). Farm level production, disposal and marketing of milk in Bangladesh. *Bangladesh Journal of Training and Development* 4 : 77-87

372. Khan MAS, Dolberg F and Akbar MA (1992). Effect of fishmeal and wheat bran diet on the performance of local lactating cows in Bangladesh. *Bangladesh Journal of Animal Science* 21 : 37-42

373. Sarker RN, Saadullah M, Huq MA and Begum D (1992). Effect of feeding untreated and ammoniated rice straw supplemented with or without urea molasses block lick on performance of lactating cows. *Bangladesh Veterinary Journal* 23: 103-108

374. Alam J, Sayeed A and Rahman A (1993). Straw based ration for dairy cows: an economic analysis. *Bangladesh Journal of Livestock Research* 1 : 87-92

375. Wadud A, Nasiruddin M, Islam MN, Masuduzzaman M and Sarker DRD (1993). Measurement of urea in milk of dairy animals. *Bangladesh Veterinarian* 10 : 25-29

376. Islam MN, Talukder MAI, Hussain SMI and Akhter S (1994). Effects of urea treated rice straw on the energy value of milk. *Bangladesh Veterinarian* 11 : 38-40

377. Saadullah M, Sarker DRD, Huq MA, Samad A and Islam S (1994). Study on the effect of replacement of wheat bran by urea molasses block lick in straw based diet on the performance of draught cows. *Bangladesh Journal of Animal Science* 23 : 163-168

378. Matin MA and Bhuiyan AKFH (1994). Effect of genetic and non-genetic factors of milk yield and birth weight of pure and crossbred dairy cattle in Bangladesh. *Bangladesh Journal of Animal Science* 23 : 57-65

379. Islam M and Huque KS (1995). On farm evaluation of urea molasses straw (UMS) feeding to lactating cows. *Asian-Australasian Journal of Animal Sciences* 8 : 523-527

380. Islam M, Sarker NR and Islam MM (1995). Effect of feeding legume forage with straw supplementation on milk production at Pabna milk shed area. *Asian-Australasian Journal of Animal Sciences* 8 : 107-111

381. Islam MS, Mannan AKMA and Zaman MM (1996). Effect of different levels of fishmeal with urea treated rice straw on growth and maturity of heifers. *Bangladesh Journal of Training and Development* 9 : 79-82

382. Rahman MT, Zaman MM and Islam MN (1996). Lactation stage and order on milk yield of half-bred Sindhi cows. *Bangladesh Journal of Training and Development* 9: 71-74

383. Huque KS, Jalil MA and Islam M (1996). Milk production potentialities of native and cross-bred cows at farmers level and prospect of small dairying in Bangladesh. *Bangladesh Journal of Training and Development* 9 : 83-87

384. Miah AG, Salma U, Khan AS and Islam MN (2000). Effects of urea-molasses multi-nutrients-blocks on the reproductive performance of indigenous (zebu) cows. *Progressive Agriculture* 10 : 75-78

385. Rahman MM, Ali CMH and Islam MN (1999). Replacing concentrate by molasses and urea in different proportion on dairy cows. *Bangladesh Journal of Training and Development* 12 : 181-184

386. Rafiq K, Mostofa M, Awal MA and Hossain MM (2000). Effect of medicated block licks on the performance of indigenous dairy cows of Bangladesh. *Asian-Australasian Journal of Animal Sciences* 13: 774-780

387. Miah AG, Salma U, Khan MAS and Ali ML (2000). Effects of urea-molasses multi-nutrients-blocks on the reproductive performance of indigenous cows. *Bangladesh Journal of Animal Science* 29 : 135-142

388. Chowdhury MAR, Khan MAS, Islam MN and Kabir AKMA (2001). Effects of supplementation of urea molasses block on the performance of cross-bred cows under smallholder farm condition. *Progressive Agriculture* 12 : 169-174

389. Islam MN, Debnath GK, Wadud MA and Chanda T (2001). Supplementary feeding on the performance on indigenous cows. *Bangladesh Journal of Animal Science* 30 : 21-26

390. Wadud R, Rahman MM, Islam MN, Rashid MH and Hossain B (2001). The effect of feeding mustard and sesame oil cake on milk yield and body weight changes of dairy cows. *Bangladesh Journal of Animal Science* 30 : 171-174

391. Ali M, Sarker NR, Islam MR and Ali ML (2002). Effect of legume forage (Vigna mungo) supplementation with rice straw based diet on the production performance of lactating cows. *Bangladesh Journal of Livestock Research* 9 : 8-16

392. Hossain MS, Haque MN, Aziz SA, Mazumder MS, Ali ML and M-E-Elahi ATM (2002). Effect of urea molasses straw on the productive and reproductive performance of indigenous cows under the village conditions of Bangladesh. *Pakistan Journal of Biological Sciences* 5 : 997-999

393. Khan MAA, Islam MN, Khan MAS and Akbar MA (2002). Effect of restricted and ad libitum feeding during late pregnancy on the performance of crossbred cows and their calves. *Asian-Australasian Journal of Animal Sciences* 15 : 1267-1273 [doi: 10.5713/ajas.2002.1267]

394. Akter Y, Akbar MA, Shahjalal M and Ahmed TU (2003). Supplementation of straw-based diets with urea molasses block containing antiparasitic drug to improve milk production of dairy cows. *Bangladesh Journal of Animal Science* 32 : 91-100

395. Debnath GK, Kober AKMH, Chanda T, Hoque MA and Halim MA (2003). Effect of supplementary concentrate feeding on milk production, quality and body weight changes of Red Chittagong cows and their calves under village management condition. *Pakistan Journal of Biological Sciences* 6 : 945-947 [doi: 10.3923/pjbs.2003.945.947]

396. Chowdhury MAR, Siddiki MSR, Khan MAS, Islam MN and Ahmed S (2004). Effect of feeding urea molasses block on postpartum reproductive performance of crossbred dairy cows under small holder farm condition. *Bangladesh Journal of Animal Science* 33 : 93-100

397. Mazed MA, Islam MS, Islam MA, Khan MAS and Islam MN (2004). Effect of feeding urea molasses multinutrient block (UMMB) on productive performance of indigenous cows under village condition of Bangladesh. *Bangladesh Journal of Animal Science* 33 : 11-19

398. Mazed MA, Islam MS, Rahman MM, Islam MA and Kadir MA (2004). Effect of urea molasses multi-nutrient block on the reproductive performance of indigenous cows under the village condition of Bangladesh. *Pakistan Journal of Biological Sciences* 7: 1257-1261

399. Akter Y, Akbar MA, Shahjalal M and Ahmed TU (2004). Effect of urea molasses multi-nutrient blocks supplementation of dairy cows fed rice straw and green grasses on milk yield, composition, live weight gain of cows and calves and feed intake. *Pakistan Journal of Biological Sciences* 7 : 1523-1525

400. Khan MAA, Islam MN, Khan MAS and Akbar MA (2004). Effects of feeding high and low energy levels during late pregnancy on performance of cross-bred dairy cows and their calves. *Asian-Australasian Journal of Animal Sciences* 17 : 947-953

401. Siddiki MSR, Khan MAS, Islam MN and Ahmed S (2005). Effects of supplementing urea molasses block with straw-based diet on productive and reproductive performance of crossbred dairy cows of Bangladesh. *Journal of the Bangladesh Society of Agricultural Science and Technology* 2 : 137-140

402. Chowdhury MAR, Khan MAS, Islam MN, Kabir AKMA and Rahman ABMM (2005). Supplementation of straw based diet with urea molasses block to improve milk yield, growth and reproductive efficiency of cross-bred dairy cows. *Bangladesh Journal of Animal Science* 34 : 131-136

403. Hassan MR, Wadud A, Akbar MA, Huda MS and Uddin MJ (2006). Effect of feeding poultry droppings by partial replacement of wheat bran on milk yield and composition. *Bangladesh Journal of Animal Science* 35 : 42-46

404. Alam MGS, Azam MSU and Khan MJ (2006). Supplementation with urea and molasses and body weight, milk yield and onset of ovarian cyclicity in cows. *Journal of Reproduction and Development* 52 : 529-535

405. Khan AR, Raha SK and Weindlmaier H (2006-2007). Technical efficiency of dairy operations in Bangladesh- A stochastic frontier analysis. *Bangladesh Journal of Training and Development* 19-20: 47-59

406. Singha AK and Siddiki MSR (2007). Drenching with oil for increased protein availability for increasing milk production of dairy cow. *Bangladesh Journal of Environmental Science* 13: 167-170

407. Alam MGS, Rahman MA, Khatun M and Ahmed JU (2009). Feed supplementation and weight change, milk yield and post-partum oestrus in Deshi cows. *Bangladesh Veterinarian* 26 : 39-47

408. Kamal MM, Labal DMH and Khaleduzzaman ABM (2009). Supplementation of maize-based concentrates and milk production in indigenous cows. *Bangladesh Veterinarian* 26 : 48-53

409. Habib MA, Hossain MS and Bhuiyan AKFH (2009). Impact of urea-based diets on production of Red Chittagong cattle. *Bangladesh Veterinarian* 26 : 74-79

410. Alam MM and Sarder MJU (2010). Effects of nutrition on production and reproduction of dairy cows in Bangladesh. *Bangladesh Veterinarian* 27 : 8-17

411. Biswas MAA, Hoque MN, Kibria MG, Rashid MH and Akhter MM (2010). Field trial and demonstration of urea molasses straw technology of feeding lactating animals. *Bangladesh Research Journal* 3 : 1129-1132

412. Sharmin MM, Khan MAS, Islam MN and Islam MA (2010). Effect of supplementation of micro-nutrients on the performance of dairy cows. *Bangladesh Journal of Animal Science* 39 :151-155

413. Das NG, Huque KS, Alam MR, Sultana N and Amanullah SM (2010). Effects of oxalate intake on calcium and phosphorus balance in bulls fed napier silage (*Pennisetum purpureum*). *Bangladesh Journal of Animal Science* 39 : 58-66

414. Sarker MSK, Islam MA, Huque KS, Sarker NR, Hossain MM and Bhuiyan AA (2012). Effect of genotype and lactation on milk urea nitrogen, blood urea nitrogen and milk composition of dairy cows. *Bangladesh Journal of Livestock Research* 19 : 74-84

415. Sarker NR, Huque KS and Asaduzzaman M (2012). Study on feeding effect of dietary protein sources of on blood or milk urea nitrogen in native cows. *Bangladesh Journal of Livestock Research* 19 : 85-96

416. Rahman MZ, Ali MY, Huque KS and Talukder MAI (2014). Effect of di-calcium phosphate on calcium balance and body condition score of dairy cows fed Napier grass. *Bangladesh Journal of Animal Science* 43 : 197-201

417. Rahman MZ, Ali MY, Sarker NR, Afroz MF, Rahman MOA and Karim MR (2015). Effect of modified feeding practice on milk production of cross bred dairy cows in Baghabari milk shed area, Sirajgonj. *Asian Journal of Medical and Biological Research* 1 : 254-258

418. Shoshe NZ, Baset MA, Islam MT, Matin SMA and Abdullah-Al-Mahmud M (2015). Effects of herd, season and days in milk on milk urea nitrogen of crossbred dairy cows in Sylhet. *Research in Agriculture, Livestock and Fisheries* 2 : 287-292

419. Yeasmin D, Islam N, Sarker NR, Huda N, Habib A and Tabassum F (2017). An exertion of enhance milk yield of native Pabna cattle through using different types of calcium salt of fatty acid. *SAARC Journal of Agriculture* 15 : 137-146

420. Howlader MMR, Hasan MMI, Atikuzzaman M,. Paul S and Begum (2017). Impact of dietary restriction on follicular waves in cattle with particular reference to anestrous. *Bangladesh Journal of Veterinary Medicine* 15 : 27-32

421. Asaduzzaman M, Amin MR, Sarker NR and Huque KS (2018). Production potential of lactating Red Chittagong cows due to improved feeding in small-scale dairy farm. *Progressive Agriculture* 29 : 147-157

422. Asaduzzaman M, Amin MR, Sarker NR and Huque KS (2018). Study on on-farm prenatal nutritional status of Red Chittagong cows in selected breeding habit of Satkania Upazila of Chittagong district of Bangladesh. *Journal of Agriculture, Forestry and Fisheries* 6 : 155-160 [doi: 10.11648/j.aff.20170605.12]

423. Habib MR, Rashid MH, Islam MA, Majumder S, Islam KMS, Ahmed S, Alam MS and Vergas-Bello-Perez E (2018). Influence of green grass-based diets on growth and reproductive performance in dairy heifers. *Tropical Animal Health and Production* [doi: 10. 1007/s11250-018-1514-x]

424. Haque MA, Aziz MN, Akbar MA, Rahman MS and Paikar MK (2018). Effect of different types of silage on milk production of dairy cows. *International Journal of Natural and Social Sciences* 5 : 71-81

425. Prima NZ, Khan MAS, Habib MR and Islam MA (2018). Effect of pre-partum and post-partum concentrate supplementation on milk yield and quality, calf birth weight and post-partum heat period of Holstein Friesian crossbred cows. *Fundamental and Applied Agriculture* 3 : 579-585 [doi: 10.5455/faa.297521]

426. Sarker NR, Yeasmin D, Habib MA and Tabassum F (2019). Feeding effect of total mixed ration on milk yield, nutrient intake, digestibility and rumen environment in Red Chittagong cattle. *Asian Journal of Medical and Biological Research* 5: 71-77 [doi: 10.3329/ajmbr.v5i1.41048]

427. Butler WR (1998). Effect of protein nutrition on ovarian and uterine physiology in dairy cattle. *Journal of Dairy Science* 81: 2533-2539

428. Dubey DK and Hnanasekar R (2008). Heat stress in dairy animals: causes, consequences and possible solutions. en.engormix.com/dairy-cattle/articles/heat-stress-in-dairy-animals-t34200.htm

429. Rahman MS (1967). Climatological factors influencing dairy cattle performance. *Pakistan Journal of Veterinary Science* 1: 151

430. Al Reyad M, Sarker MAH, Uddin ME, Habib R and Harun-ur-Rashid M (2016). Effect of heat stress on milk production and its composition of Holstein-Friesian cross-bred dairy cows. *Asian Journal of Medical and Biological Research* 2 : 190-195

431. Rakib MT, Hassan MM, Al-Faruq A, Erfan R, Baurua SR, Faruk MO, Hasanuzzaman M, Chowdhury S and Alam M (2016). Effect of transport on physical and haematological status of cattle in Bangladesh. *Journal of Animal Health and Production* 4 : 78-86 [doi: 10.14737/journal.jahp/2015/4.3.78.86]

432. Chanda T, Debnath GK, Khan KI, Rahman MM and Chanda GC (2017). Impact of heat stress on milk yield and composition in early lactation of Holstein Friesian crossbred cattle. *Bangladesh Journal of Animal Science* 46 : 192-197

433. Alam M, Hasanuzzaman M, Hassan MM, Rakib TM, Hossain ME, Rashid MH, Sayeed MA, Philips LB and Hoque MA (2018). Assessment of transport stress on cattle travelling a long distance (648 km) from Jessore (Indian border) to Chittagong, Bangladesh. *Veterinary Record Open* 5(1): [doi: 10.1136/vetreco-2017-000248]

434. Ahmed M, Hossain MM and Akhter S (2002). Cattle fattening as income generating activity by the farmers. *Bangladesh Journal of Animal Science* 31 : 83-90

435. Baset MA, Rahman MM, Islam MS, Ara A and Kabir ASM (2003). Beef cattle production in Bangladesh- A review. *Online Journal of Biological Sciences* 3 : 8-25

436. Al-Mamun A, Islam SS, Islam MS and Billah MM (2019). Problems and prospects of small scale beef cattle fattening program in a selected area of Bangladesh. *International Journal of Science and Research* 8 : 833-837 [doi: 10.21275/ART20198135]

437. Quddoos A and Tareque AMM (1969). Effect of urea feeding in ruminants in different combination of feed ingredients. *Animal Science Journal of Pakistan* 2 : 7-15

438. Mandal NA and Rahman MS (1977). Effect of synthetic hormone on growth performance in Sahiwal male calves. *Bangladesh Journal of Agricultural Sciences* 4 : 175-178

439. Saadullah M, Haque M and Dolberg F (1982). Treated and untreated rice straw for growing cattle. *Tropical Animal Production* 7: 20-25

440. Haque M, Davis CH, Saadullah M and Dolberg F (1983). A note on the performance of cattle fed treated paddy straw with animal urine as a source of ammonia. *Tropical Animal Production* 8 : 276-278

441. Islam MM and Razzaque MA (1986). Feasibility of beef production from local cattle in Bangladesh. *Bangladesh Journal of Animal Science* 15 : 80-84

442. Hossain MM (1986). Study of cattle fattening program by landless and youth. *Bangladesh Journal of Animal Science* 15 : 85-88

443. Tareque AMM (1986). Value of green grass supplementation in rice straw based ration for local growing cattle in Bangladesh. *Bangladesh Journal of Agricultural Sciences* 13 : 115-120

444. Tareque AMM (1986). Utilization of banana plant with leaves by Bangladeshi bull calves. *Bangladesh Veterinary Journal* 20 : 33-38

445. Parveen K, Tareque AMM, Akbar MA and Khan MJ (1990-1993). Effects of protein levels on the performance of fattening local bull calves. *Bangladesh Veterinary Journal* 24-27 : 29-38

446. Huq ASMA, Islam MR and Dham SC (1993). A case study on the differential management practices for rearing up cattle herds in the saline prone areas of Patuakhali district. *Bangladesh Journal of Animal Science* 22 : 61-68

447. Kibria SS, Islam MR and Shaha CK (1993). Performance of cross-bred animals fed with straw based ration under different feeding methods. *Bangladesh Journal of Livestock Research* 1 : 31-38

448. Hashem MA, Moniruzzaman M, Akhter S and Hossain MM (1999). Cattle fattening by rural farmers in different districts of Bangladesh. *Bangladesh Journal of Animal Science* 28 : 81-88

449. Rahman ME, Hossain MM, Majumder S and Samad MA (2001). Cattle fattening with urea molasses straw and its effect on intake, growth and digestibility. *Bangladesh Journal of Animal Science* 30 : 99-105

450. Hossain MM, Saadullah M and Miah MN (2004). Effect of urea molasses straw on growth performance of cattle. *Bangladesh Journal of Animal Science* 33 : 67-77

451. Rahman MM, Hossain Mm, Azad MAK and Khan MSI (2004). Effect of feed supplements on cattle fattening by the rural farmers. *Bangladesh Journal of Animal Science* 33 (1-2): 51-60

452. Azad MAK, Hossain MM and Khan MSI (2004). Cost and returns of on-farm cattle fattening by rural farmers. *Journal of the Bangladesh Society for Agricultural Science and Technology* 1 : 133-136

453. Kamruzzaman M, Khan MJ and Shahjalal M (2005). Feeding of urea supplemented and urea ensiled straw with or without soybean meal on nutrients digestibility and growth performance of bull calves. *Bangladesh Journal of Animal Science* 34 : 45-53

454. Rahman MM, Khandaker ZH and Rahman MA (2005). Effect of phosphorus supplementation on feed utilization and growth performance of growing bull. *Bangladesh Journal of Animal Science* 34 : 83-92

455. Khan M, Hossain MM and Khan MAA (2006). Supplementing Metafos and Biomix-DB as growth promoters on the performance of bull calves. *Journal of the Bangladesh Agricultural University* 4 : 83-90

456. Begum AA, Hossain MM, Khan M, Rahman MM and Rahman SME (2007). Cattle fattening practices of selected farmers in Panchagarh district. *Bangladesh Journal of Animal Science* 36: 62-72

457. Rahman MA, Alam AMMN and Shahjalal M (2009). Supplementation of urea-molasses-straw based diet with different level of concentrate for fattening of emaciated bulls. *Pakistan Journal of Biological Sciences* 12 : 970-975

458. Ahmed T, Hashem MA, Khan M, Rahman MF and Hossain MM (2010). Factors related to small scale cattle fattening in rural areas of Bangladesh. *Bangladesh Journal of Animal Science* 39 : 116-124

459. Sarker MK, Amin MR, Harun-ur-Rashid M and Kabir AKMA (2010). Growth performance of Red Chittagong and Holstein crossbred bull calves using growth promoter. *Journal of the Bangladesh Agricultural University* 8 : 83-86

460. Sarma PK and Ahmed JU (2011). An economic study of small scale cattle fattening enterprise of Rajbari district. *Journal of the Bangladesh Agricultural University* 9 : 141-146 [doi: 10.3329/jbau.v9i1.8756]

461. Islam MH, Hashem MA, Hossain MM, Islam MS, Rana MS and Habibullah M (2012). Present status on the use of anabolic steroids and feed additives in small scale cattle fattening in Bangladesh. *Progressive Agriculture* 23 : 1-13

462. Rahman Z, Hossain MM and Hashem MA (2012). Factors related to small scale beef fattening programs in Dinajpur district of Bangladesh. *Progressive Agriculture* 23 : 33-38

463. Khan MS, Bashar MK, Akbar MA and Huque KS (2014). Feeding practices and compositional verification of the constituents of growth promoters for cattle fattening in Bangladesh. *Bangladesh Journal of Animal Science* 43 :142-146

464. Amin MR, Rahman MH, Talukder M, Asgar MA, Paul AK and Mollah ML (2016). Poverty alleviation of destitute women and poor farmers in Barisal district of Bangladesh through beef fattening. *Asian Journal of Medical and Biological Research* 2 : 48-54

465. Hossain MD, Hossain MM, Khan M, Kamal MT and Hashem MA (2016). Organic beef cattle production pattern at Shahjadpur upazilla of Sirajgonj district in Bangladesh. *Bangladesh Journal of Animal Science* 45: 25-30

466. Sultana N, Huque KS, Rahman MZ and Das NG (2017). Effect of age on feed efficiency and carcass yield characteristics of indigenous bull. *Bangladesh Journal of Animal Science* 46 : 17-23

467. Hossain MA, Islam MS and Hashem MA (2018). Phenotypic and productive traits of kurbani bulls as livelihood changes of farmers during Eid-ul-Azha in Mymensingh district. *International Journal of Natural and Social Sciences* 5 : 44-51

468. Saha NG, Akter QS, Chowdhury MRH, Tareq KMA and Fouzder SK (2018). Effect of urea molasses straw on beef fattening at rural areas in Chattogram district. *International Journal of Natural and Social Sciences* 5 : 9-15

469. Kamal MT, Hashem MA, Al-Mamun M, Hossain MM and Razzaque MA (2019). Study of cattle in fattening system in selected region of Bangladesh. *SAARC Journal of Agriculture* 17: 105-118 [doi: 10.3329/sja.v17i1.42765]

470. Karim R, Islam MN, Uddin MM and Hossain MM (2020). Livelihood improvement of farmers through cattle fattening of Mymensingh district: A socio-economic study. *Journal of Agriculture, Food and Environment* 1 : 1-9

471. Kiplagat SK, Limo MK and Kosgey IS (2012). Genetic improvement of livestock for milk production. *IntechOpen* [doi: 10.5772/50761]

472. MLA (2019). Cattle genetics. Meat & Livestock Australia Limited ABN 39081678364. mbfp.mla.com.au/Cattle-genetics#

473. MOFL (2007). National Livestock Development Policy. Ministry of Fisheries and Livestock (MOFL), Government of the Peoples' Republic of Bangladesh, Dhaka

474. Bhuiyan AKFH (2014). Farm animal genetic resources in Bangladesh: Diversity, conservation and management. SAARC Agriculture Centre. www.saarcagri.org. pp 4-74

475. Islam SKMA, Hoque MA, Alam MR, Hassan MM and Rahman MA (2006). A cross-sectional study on production performance of stall fed dairy cattle at Central Cattle Breeding Station (CCBS), Savar, Dhaka, Bangladesh. *Bangladesh Journal of Veterinary Medicine* 4 : 61-63

476. Iqbal A, Bhuiyan AKFH and Bhuiyan MSA (2007). Estimation of genetic trends for some economic traits in dairy cattle. *Bangladesh Journal of Animal Science* 36 : 1-8

477. Haque MA, Amin MR and Hussen MS (1997). Breeding profiles of Sahiwal bulls and native cows in dairy pocket of Bangladesh. *Bangladesh Journal of Animal Science* 26 : 147-153

478. Hossain KB, Takayaniagi S, Miyake T, Bhuiyan AKFH and Sasaki Y (2002). Statistical genetic studies on cattle breeding for dairy productivity in Bangladesh. I. Genetic improvement for milk performance of local cattle populations. *Asian Australasian Journal of Animal Science* 15 : 627-632 [doi: 10.5713/ajas.2002.627]

479. Hossain KB, Takayaniagi S, Miyake T, Bhuiyan AKFH and Sasaki Y (2002). Statistical genetic studies on cattle breeding for dairy productivity in Bangladesh. II. Estimation of reciprocal and heterosis effects and optimum cross breeding system between the local and exotic breeds for milk performance. *Asian Australasian Journal of Animal Science* 15 : 777-782 [doi: 10.5713/ajas/2002.777]

480. Habib MA, Bhuiyan AKFH and Bhuiyan MSA (2003). Estimation of heterosis for some quantitative traits in dairy cattle. *Bangladesh Journal of Genetic Biotechnology* 4 : 31-34

481. Bhuiyan MSA, Hanotte O and Bhuiyan AKFH (2005). Genetic diversity of Red Chittagong cattle of Bangladesh using microsatellite markers. *Progressive Agriculture* 16 : 141-148

482. Pervage S, Khandoker MAMY, Uddin MJ, Bostami ABMR and Mondal A (2007). Evaluation of bovine cumulus-oocyte-complexes in view of in vitro nuclear maturation and fertilization. *Bangladesh Journal of Animal Science* 36 : 16-23

483. Bhuiyan MSA, Bhuiyan AKFH, Yoon DH, Jeon JT, Park CS and Lee JH (2007). Mitochondrial DNA diversity and origin of Red Chittagong cattle. *Asian Australasian Journal of Animal Science* 20 : 1478-1484 [doi: 10.5713/ajas.2007.1478]

484. Ashraf A, Bhuiyan AKFH, Tapio M and Khatun MR (2008). Genetic diversity studies of North Bengal Grey cattle of Bangladesh based on microsatellite markers. *South Asian Journal of Agriculture* 3 : 47-50

485. Deb GK, Mufti MMR, Mostari MP and Huque KS (2008). Reproductive efficiency of BLRI cattle breed-1 at farm condition. *Progressive Agriculture* 19 : 85-92

486. Rabeya T, Bhuiyan AKFH, Habib MA and Hossain MS (2009). Phenotypic and genetic parameters for growth traits in Red Chittagong cattle of Bangladesh. *Journal of Bangladesh Agricultural University* 7 : 265-271

487. Mufti MMR, Mostari MP, Deb GK, Nahar K and Huque KS (2009). Genetic diversity of Red Chittagong cattle using randomly applied polymorphic DNA markers. *American Journal of Animal and Veterinary Science* 4 : 1-5

488. Hadiuzzaman M, Bhuiyan AKMFH and Habib MA (2010). Inbreeding of Red Chittagong cattle in a nucleus breeding herd. *Bangladesh Veterinarian* 27 : 43-45

489. Quddus MA and Amin MR (2010). Constraints of native cattle genetic resource conservation and features of breeding system in representative areas of Bangladesh. *Journal of Bangladesh Agricultural University* 8 : 113-120

490. Aktar S, Bhuiyan AFH, Saha NG and Hoque MA (2011). Effect of bull performance on progeny early growth and genetic relationships between bull and progeny traits. *Bangladesh Journal of Animal Science* 40 : 1-7

491. Habib MA, Bhuiyan AKFH and Amin MR (2012). Estimation of regression factors for extending part lactation milk yield records of Red Chittagong cattle (RCC) in Bangladesh. *International Research Journal of Applied Life Science* 1 : 78-83

492. Hossen MS, Hossain SS, Bhuiyan AKFH, Hoque MA and Amin MR (2012). Genetic trends of some important dairy traits of crossbred cows at Baghabarighat milk shed area in Bangladesh. *Bangladesh Journal of Animal Science* 41 : 67-73

493. Hossen MS, Hossain SS, Bhuiyan AKFH, Hoque MA and Talukder MAS (2012). Sire evaluation of milk producers' co-operative union limited of Bangladesh. *Bangladesh Journal of Animal Science*41 : 74-78

494. Habib MA, Bhuiyan AKFH, Amin MR and Khan MAS (2013). Seasonal index and breeding efficiency of Red Chittagong cattle in Bangladesh. *Journal of Tropical Resources and Sustainable Science* 1 : 55-61

495. Siddiquee NU, Rahman SMA, Bhuiyan MSA, Rahman AKMA, Amin MR and Bhuiyan AKFH (2013). Practice, preference and performance of cattle under peri-urban dairy management system in Mymensingh. *Bangladesh Journal of Animal Science* 42 : 89-95

496. Das A, Miah G, Gupta MD and Khan KI (2013). Genetic parameters of Holstein crossbred on commercial dairy farms in Chittagong, Bangladesh. *Indian Journal of Animal Research* 47 : 327-330

497. Bhuiyan AKFH, Rashid MM, Khan RA, Habib MA, Bhuiyan MSA and Faiz MA (2015). Progeny tested bull production for dairy cattle development in Bangladesh. *Bangladesh Journal of Animal Science* 44 : 106-112

498. Fatematuzzohora M, Haque MA, Islam MR, Hoque MA and Ali MY (2016). Evaluation of reproductive performance of indigenous cows using Brahman cross-bred bull in a participatory breeding program. *Asian Australasian Journal of Bioscience and Biotechnology* 1: 173-181

499. Habib MA, Bhuiyan AKFH, Amin MR and Khan MS (2019). Comparison of different models for estimation of standardized 300 day milk yield from 15 test day interval records of Red Chittagong cattle in Bangladesh. *Asian Australasian Journal Bioscience and Biotechnology* 4 : 67-73

500. Ferdous F, Choudhury MP, Faruque MO, Hossain MM and Bhuiyan AKFH (2019). Genetic evaluation of Red Chittagong cattle in Bangladesh. *SAARC Journal of Agriculture* 17 : 141-154 [doi: 10.3329/sja.v17i2.45301]

501. Mahbubul M, Khandokar MAMY, Islam MR and Hoque MA (2020). Estimation of genetic parameters for growth traits in Brahman crossbred cattle of Bangladesh. *Journal of Bangladesh Agricultural University* 18: 421-427

502. Sorensen MK, Norberg E, Pedersen J and Christensen LG (2008). Crossbreeding in dairy cattle: A Danish perspective. *Journal of Dairy Science* 91 : 4116-4128 [doi: 10.3168/jds.2008-1273]

503. Hamid MA and Hossain KM (2014). Role of private sector in the development of dairy industry in Bangladesh. *Livestock Research for Rural Development* 26 (10): Art. # 79 http://lrrd.org/lrrd/26/10/hami26179.htm

504. Barua P (2006). Analytical documentation of the artificial insemination programme of BRAC. BRAC Research Report. bigd.bracu.ac.bd/wp-content/uploads/2020/03/Analytical-Documentation-of-the- Artificial_Insemination-Program-of-BRAC.pdf

505. BRAC (2016). BRAC artificial insemination. brac.net/brac-enterprises/item/879-brac-artificial-insemination

506. Haque M (1968). Effect of energy intake on reproductive performance of dairy bulls. *Animal Science Journal of Pakistan* 1 : 14-16

507. Haque M (1968). Repeatability of semen characteristics of yearly beef bulls. *Animal Science Journal of Pakistan* 1 : 34-38

508. Nasim M, Rahman MM, Zaman MW and Shamsuddin M (1969). Study on conception rate by artificial insemination among cows of different psychic conditions. *Animal Science Journal of Pakistan*2 : 56-59

509. Nasim M, Rahman MM, Zaman MW and Shamsuddin M (1971). Study on conception rate by artificial insemination among cows of different psychic conditions. *Animal Science Journal of Pakistan* 4 : 48-51

510. Ali SZ and Hoque M (1974). A study on the preservation of bovine semen at room temperature. *Bangladesh Journal of Agricultural Sciences* 1 : 78-82

511. Islam ABMM (1975-76). Assessment of dairy sires by contemporary comparisons. *Bangladesh Journal of animal Science* 9-10: 59-70

512. Majid MA and Islam ABMM (1982). Phenotypic variation in size of spermatozoa in different breeds of cattle, sheep and goat. *Bangladesh Veterinary Journal* 16 : 41-46

513. Ali SZ (1982). A study on separation of X and Y chromosome bearing spermatozoa by centrifugation method. *Indian Veterinary Journal* 59 : 713-715

514. Hussain SS, Ali A, Mostafa KG and Bhuiyan AKFH (1985). Effect of season on semen characteristics of cross-bred bulls under field conditions. *Bangladesh Journal of Animal Science*14 : 18-22

515. Hussain SS, Ali A and Amin MR (1990). Efficiency of soybean milk and egg-yolk citrate diluents on preservation and conception rate of bull semen. *Bangladesh Veterinarian* 7 : 89-92

516. Das SC, Ahmed JU and Alam MGS (1990-1993). Conception rate in zebu cows with frozen Sahiwal semen. *Bangladesh Veterinary Journal* 24-27 : 39-43

517. Ahmed JU, Shamsuddin M and Alam MGS (1992). Effects of seasons on fertility in the zebu cattle of Bangladesh. *Bangladesh Journal of Training and Development* 5 : 85-93

518. Rahman MF, Islam MS, Hossain MA, Prodhan MAM and Rahman A (1993).Reproductive patterns of different breeds of cows in Bangladesh. *Bangladesh Journal of Livestock Research* 1 : 19-24

519. Ahmed JU, Shamsuddin M and Alam MGS (1993). Breeding soundness of bull used for artificial insemination in Bangladesh. *Bangladesh Journal of Agricultural Sciences* 20 : 225-232

520. Alam J, Akteruzzaman M, Rahman A and Sayeed MA (1993). The cost of semen production and the rate of conception for artificial insemination in cattle. *Asia-Australasian Journal of Animal Sciences* 6 : 13-17

521. Kibria SS, Nahar TN, Mia MM and Talukder AI (1994-1998). Effect of genetic group, season and age of bull on semen characteristics. *Bangladesh Journal of Livestock Research* 1-5 : 92-102

522. Alam J, Sayeed MA, Rahman SMA, Ahmed Z, Kabir M and Aktaruzzaman M (1994-1998). Prospect of artificial insemination programme in Bangladesh. *Bangladesh Journal of Livestock Research* 1-5: 135-149

523. Mahbub-E-Elahi ATM, Majid MA, Prodhan MAM and Nahar TN (1994-1998). An evaluation of artificial insemination with frozen semen in Manikgonj Milk shed area. *Bangladesh Journal of Livestock Research* 1-5: 194-198

524. Mia MM, Islam MS, Hashem MA, Howlider MAR and Hossain MS (1996). Phenotypic correlations among different semen characteristics of some pure and crossbred cattle in Bangladesh. *Progressive Agriculture* 7 : 189-192

525. Hoque MA, Amin MR and Hussen MS (1997). Breeding profiles of Sahiwal bulls and native cows in a dairy pocket of Bangladesh. *Bangladesh Journal of Animal Science* 26: 147-153

526. Bhuiyan MMU, Shamsuddin M and Alam MGS (1997). Seminal vesiculitis in bulls used in routine artificial insemination. *Bangladesh Journal of Animal Science* 26: 51-57

527. Bhuiyan MMU and Shamsuddin M (1998). Bull sperm morphology in context of ambient temperature during semen collection. *Bangladesh Veterinary Journal* 32 : 33-39

528. Bhuiyan MMU and Shamsuddin M (1998). Some factors affecting the quality of liquid semen used in cattle artificial insemination. *Bangladesh Veterinary Journal* 32 : 112-117

529. Sufian MKNB, Hasnath MR and Bhuiyan AKFH (1998). Analysis of various factors determining cow fertility in the artificial insemination services. *Bangladesh Journal of Animal Science* 27 : 31-40

530. Quddus MA and Rahman MM (1998). Attitude by the rural farmers towards artificial insemination services in Bangladesh. *Bangladesh Journal of Animal Science* 27 : 83-92

531. Bhuiyan MMU and Shamsuddin M (1999). Quality of imported and native frozen semen used in artificial insemination programmes in Bangladesh. *Bangladesh Veterinarian* 16 : 1-5

532. Bhuiyan MMU, Shamsuddin M and Galloway D (1999). Identification of poor fertility bulls in AI programmes. *Bangladesh Veterinarian* 16 : 67-71

533. Islam MH, Bhuiyan MMU and Alam MGS (1999). Qualitative changes of frozen bull semen under field condition in Bangladesh. *Bangladesh Veterinarian* 16 : 86-90

534. Zaman MA and Rouf MA (1999). Effect of season, age, parity, farming condition and month on service per conception of cattle. *Bangladesh Journal of Animal Science* 28 : 65-71

535. Debnath C, Ali SZ and Ali A (2001). Measurements of spermatozoa in different breeds of cattle and goats. *Bangladesh Journal of Animal Science* 30 : 165-170

536. Haque MN, Islam ABMM, Bhuiyan AKFH, Aziz SA and Kibria MG (2001). Phenotypic variation and repeatability of semen characteristics of bulls. *Pakistan Journal of Biological Sciences* 4 : 1418-1420

537. Sarder MJU (2001). Individual bull and season factors affecting semen production used for artificial insemination. *Bangladesh Veterinary Journal* 35 : 19-24

538. Das AK, Ali MY, Islam MA, Hira AK and Ali SZ (2002). Fertility of cow in using locally produced chilled and imported frozen semen. *Pakistan Journal of Biological Sciences* 5 : 215-217

539. Hoque MA, Baik DH, Hussen MS and Rahman MS (2002). Effect of breeding groups and environment on conception rate in Pabna and its crossbred cows of Bangladesh. *Pakistan Journal of Biological Sciences* 5 : 612-615

540. Sarder MJU (2002). Influence of age and season on body weight, scrotal circumference and libido of Sahiwal bulls used for artificial insemination in Bangladesh. *Bangladesh Veterinary Journal* 36 : 75-80

541. Hoque MA, Salim HM, Debnath GK, Rahman MA and Saifuddin AKM (2003). A study to evaluate the artificial insemination (AI) success rate in cattle population based on three years record among different sub-centers of Chittagong and Cox's Bazar district of Bangladesh. *Pakistan Journal of Biological Sciences* 6 : 105-111

542. Sarder MJU (2003). Studies on semen characteristics of some Friesian cross and Sahiwal bulls for artificial insemination. *Pakistan Journal of Biological Sciences* 6 : 566-570

543. Haque MN, Islam ABMM, Bhuiyan AKFH and Rahman MM (2003). Effects of breeds and age of bulls on semen characteristics used in artificial insemination in Bangladesh. *Bangladesh Veterinarian* 20 : 136-142

544. Asad L, Husain SS, Rahman MGM, Khandoker MAMY, Hossain ME and Rahman MZ (2004). Genetic and non-genetic factors affecting the semen quality of bulls. *Pakistan Journal of Biological Sciences* 7 : 1903-1907

545. Azmal SA, Amin MR, Khatun R, Islam MS, Mostari MP and Goswami PC (2004). Relative merits of homo and heterospermic bull semen in respect of preservation quality. *Pakistan Journal of Biological Sciences* 7 : 1908-1911

546. Azmal SA, Amin MR, Goswami PC, Mostari MP, Islam MS and Khatun R (2004). Relative merits of homo and heterospermic bull semen in respect of fertility. *Pakistan Journal of Biological Sciences* 7 : 1912-1917

547. Mostari MP, Rahman MGM, Khandoker MAMY and Husain SS (2004). Evaluation of bulls based on semen quality and herd fertility. *Pakistan Journal of Biological Sciences* 7 : 2177-2181

548. Sarder MJU (2004). Morphological sperm abnormalities of different breeds of AI bull and its impact on conception rate of cows in AI programme. *Bangladesh Journal of Veterinary Medicin*e 2 : 129-135

549. Salim HM, Halim MA, Akter N and Rashid MH (2004). Evaluation of adaptation status of artificial insemination technique on dairy cattle at farmers level. *Pakistan Journal of Biological Sciences* 7 : 674-678

550. Alam MGS, Yeasmin S, Bari FY and Mishra B (2005). The effect of duration of preservation on the quality of chilled bull semen. *Bangladesh Veterinarian* 22 : 16-22

551. Talukder MAS, Islam MR, Khandoker MAMY, Afroz S and Rahman MGM (2005). Studies on semen characteristics of different crossbred bulls. *Bangladesh Journal of Animal Science* 34 : 11-16

552. Sarder MJU (2005). Study on dimensional characteristics of different breeds of bull spermatozoa. *Journal of Animal and Veterinary Advances* 4 : 755-760

553. Sarder MJU (2006). Comparative study on reproductive performance of cross-bred dairy cows at greater Rajshahi district. *Journal of Animal and Veterinary Advances* 5: 679-685

554. Sarder MJU (2007). Effects of breed and season on phenotypic traits of bulls used for artificial insemination in Bangladesh. *Bangladesh Veterinarian* 24 : 98-109

555. Nasrin S, Amin MR and Alam MK (2007). Evaluation of semen and non-return rate of bulls in artificial insemination center. *Bangladesh Journal of Animal Science* 37 : 1-7

556. Miazi OF, Hossain ME, Hossain MA, Halim MA and Islam MM (2007). Adaptation condition of rural farmers toward artificial insemination in Sirajganj district of Bangladesh. *International Journal of Sustainable Agricultural Technology* 3 : 107-112

557. Arefin T, Bhuiyan AKFH, Khondokar MAMY, Habib MA and Das S (2008). Evaluation of frozen semen of Red Chittagong cattle (RCC). *Molecular Biology and Technology Journal* 6 : 66-69

558. Nasin S, Amin MR and Alam MK (2008). Evaluation of semen and non-return rate of bulls in artificial insemination (AI) center. *Bangladesh Journal of Animal Science* 37: 1-7

559. Shaha SP, Alam MGS, Khatun M and Ahmed JU (2008). Breeding soundness of stud bulls. *Bangladesh Veterinarian* 25 : 51-61

560. Latif MA, Ahmed JU, Bhuiyan MMU and Shamsuddin M (2009). Relationship between scrotal circumference and semen parameters in crossbred bulls. *Bangladesh Veterinarian* 26 : 61-67

561. Jabbar MA, Husain SS, Islam SMF, Amin MR, Khandaker MAMY, Bhuiyan AKFH, Ali SZ and Faruque O (2010). Stakeholder perspectives on breeding strategy and choice of breeds for livestock development in Bangladesh. *Bangladesh Journal of Animal Science* 39 : 20-43

562. Paul AK, Alam MGS and Shamsuddin M (2011). Factors that limit first service pregnancy rate in cows at char management of Bangladesh. *Livestock Research for Rural Development* 23 (3): Art. 57. http://www.lrrd.org/lrrd/23/3/paul23057.htm

563. Hossain ME, Khatun MM, Islam MM and Miazi OF (2012). Semen characteristics of breeding bulls at the Central Cattle Breeding and Dairy Farm of Bangladesh. *Bangladesh Journal of Animal Science* 41: 1-5

564. Haque MM, Hoque MA, Saha NG, Bhuiyan AKFH, Hossain MM and Hossain MA (2012). Selection of Brahman crossbred breeding bulls based on phenotypic performance. *Bangladesh Journal of Animal Science* 41 : 60-66

565. Habib MA, Bhuiyan AKFH, Amin MR and Khan MAS (2012). Estimation of breeding values of cows based on test day and 305 day milk yield for the genetic evaluation of Red Chittagong cattle in Bangladesh. *Journal of Bioentrepreneurship* 2: 28-32

566. Jha PK, Paul AK, Rahman MB, Tanjim M, Bari FY and Alam MGS (2013). Improvement of preservation quality of chilled bull semen using α-tocopherol as an antioxidant. *Journal of Embryo Transfer* 28 : 31-39

567. Uddin MM, Sultana MN, Van Huylenbroek G and Peters KJ (2014). Artificial insemination services under different institutional framework in Bangladesh. *Bangladesh Journal of Animal Science* 43 : 166-174

568. Khatun MA, Bari FY, Alam MS, Ali MR and Sarker PK (2014). Post AI conception rate in cattle at Rajarhat, Kurigram, Bangladesh. *Wayamba Journal of Animal Science* 7 : 845-854

569. Sharifuzzaman, Jalil MA, Barman SC, Matin MA, Rokonuzzaman M and Haque MA (2015). Comparative study on conception rate in indigenous and cross-bred cows after artificial insemination. *International Journal of Natural and Social Sciences* 2 : 9-12

570. Hossain MM, Bhuiyan MMU, Rahman MM and Juyena NS (2015). Factors influencing the rates of pregnancy, calving and peri-parturient disorders in heifers at selected char areas of Bangladesh. *Bangladesh Veterinarian* 32 : 65-72

571. Paul AK, Mandal AK, Chowdhury MMR, Mitra PK, Samad MA, Maruf AA, Rahman MM, Hossain MB, Noman AA, Tarafder MM and Bonaparte N (2015). First service influencing factors for pregnancy rate in dairy cows of Bangladesh. *International Journal of Natural and Social Sciences* 2 : 64-69

572. Rashid MM, Hoque MA, Huque KS and Bhuiyan AKFH (2015). Effect of semen collection frequency and scrotal circumference on semen quality parameters in Brahman × Local crossbred bulls. *Advance Animals and Veterinary Sciences* 3 : 677-684 [doi: 10.14737/journal.aavs/2015/3.12.677.684]

573. Bilkis T, Khan MKI, Das A, Miazi OF, Momin MM and Hazary MEH (2016). Artificial insemination practices and factors affecting conception rate of dairy cows in the commercial dairy farms. *International Journal of Science, Environment and Technology* 5 : 2689-2700

574. Hossain DMN, Talukder M, Begum MK and Paul AK (2016). Determination of factors that affect the pregnancy rate of cows after artificial insemination at Monirampur Upazila of Jessore district of Bangladesh. *Journal of Embryo Transfer* 31 : 349-353

575. Bhuiyan MSA, Bhuiyan AKFH, Lee JH and Lee SH (2017). Community based livestock breeding programs in Bangladesh: Present status and challenges. *Journal of Animal Breeding and Genetics* 1: 77-84 [doi: 10.12972/jabng.20170009]

576. Islam MR, Husain SS, Hoque MA, Talukder MK, Rahman MS and Ali MY (2017). Computer assisted sperm analysis of Brahman crossbred breeding bull semen. *Bangladesh Journal of Animal Science* 46 : 1-9

577. Islam MM, Apu AS, Hoque SAM, Ali MY and Karmaker S (2018). Comparative study on the libido, semen quality and fertility of Brahman cross, Holstein Frisian cross and Red Chittagong breeding bulls. *Bangladesh Journal of Animal Science* 47 : 61-67 [doi: 10.3329/bjas.v47i2.40236]

578. Hasan MM, Islam MR, Husain SS and Apu AS (2020). Frozen semen quality and fertility of imported pure Holstein Friesian and Sahiwal breeding bulls in Bangladesh. *Asian Australasian Journal of Bioscience and Biotechnology* 5 : 33-41

579. Islam MR, Husain SS, Talukder MKU and Rahman MS (2020). Evaluation of semen parameters of Brahman graded bull compared to Holstein graded and local bulls using computer assisted sperm analyzer. *Journal of Bangladesh Agricultural University* 18 : 442-448 [doi: 10.5455/JBAU.81689]

580. Mazumder A, Hoque MJ, Kundu AK and Afrin S (2020). Farmer's challenges in adopting artificial insemination of cattle in Bangladesh. *Journal of Fisheries, Livestock and Veterinary Science* 1 : 10-17 [doi: 10.18801/jfvs.010120.02]

581. Begum M, Begum J, Majumder MKH, Hasan MM, Hossain MS and Islam F. (2017). Milk production performances of crossbred cattle at the villages of Jamalpur district in Bangladesh. *Research in Agriculture, Livestock and Fisheries* 4 : 91-98

582. Hossain MM, Alam MM, Rashid MM, Asaduzzaman M and Rahman MM (2005). Small scale dairy farming practice in a selective area of Bangladesh. *Pakistan Journal of Nutrition* 4 : 215-221

583. Rashid MM, Roy BC, Asaduzzaman M and Alam MM (2007). Study of the dairy cattle management systems at farmer's level in Jessore district of Bangladesh. *Pakistan Journal of Nutrition* 6 : 155-158

584. Howlader MMR, Mian MF, Kamal AHM, Prodhan MAH and Rahman MF (1997). Conception rate of Pabna cows and heifers bred under artificial insemination and natural service. *Asian-Australasian Journal of Animal Sciences* 10 : 329-332

585. Shamsuddin M (1995). Fertility trend and status of estrus detection in the bovine under the farm conditions in Bangladesh. *Bangladesh Veterinary Journal* 29 : 9-16

586. Miah AG, Salma U and Hossain MM (2004). Factors influencing conception rate of local and crossbred cows in Bangladesh. *International Journal of Agriculture and Biology* 6 : 797-801

587. Mufti MMR, Alam MK, Sarker MS, Bostami ABMR and DasNG (2010). Study on factors affecting the conception rate in Red Chittagong cows. *Bangladesh Journal of Animal Science* 39 : 52-57

588. Das S, Bhuiyan AKFH, Begum N, Habib MA and Arefin T (2010). Fertility and parasitic infestation of Red Chittagong cattle. *Bangladesh Veterinarian* 27 : 74-81

589. Siddiqui MAR, Das ZC, Bhattacharjee J, Rahman MM, Islam MM, Haque MA, Parrish JJ and Shamsuddin M (2012). Factors affecting the first service conception rate of cows in smallholder dairy farms in Bangladesh. *Reproduction of Domestic Animals* 48 : 500-505 [doi: 10.1111/rda.12114]

590. Ghosh T, Paul AK, Talukder AK, Alam MGS and Bari FY (2012). Use of two estrus synchronization protocols and their success on pregnancy in zebu and crossbred heifers at char areas of Bangladesh. *Journal of Embryo Transfer* 27 : 223-228

591. Haque MN, Gofur MR, Asaduzzaman KM and Bhuiyan MMU (2015). Factors limiting the pregnancy rates in artificially inseminated cows in Bangladesh. *International Journal of Dairy Science* 10 : 278-278 [doi: 10.3923/ijds.2015.278.287]

592. Miah AG, Moniruzzaman M, Mobarak MH, Bari AKMA and Salma U (2015). Factors influenced the conception rate of dairy cattle at first service in char areas of northern part of Bangladesh. *Journal of Science and Technology* 13: 104-111

593. Biswas S, Kar J, Sen A, Mohanto N and Nath SK (2017). Success of estrus synchronization and artificial insemination in cattle among the NGO supported farmers at char area in Bangladesh. *International Journal of Advances Research and Biological Sciences* 4 : 166-170 [doi: 10.22192/ijarbs.2017.04.05.018]

594. Hamid SA and Kamruzzaman SM (2017). Effects of GnRH on conception rate at the time of artificial insemination in crossbred dairy cows. *International Journal of Animal Science and Technology* 1 : 19-34 [doi: 10.11648/j.ijast.20170101.14]

595. Kabir MH, Rahman MM, Hasan MR, Das D, Shahariar MS, Das S, Khatun MS and Sarder MJU (2018). Improvement of conception rate in cows through assessment of semen used for artificial insemination program at Government and private sector. *SSRG International Journal of Veterinary Science* 4 : 1-5

596. Howlader MMR, Rahman MM, Hossain MG and Hai MA (2019). Factors affecting conception rate of dairy cows following artificial insemination in selected area at Sirajgonj district of Bangladesh. *Biomedical Journal of Scientific and Technical Research* 13 (2): [doi: 10.26717/BJSTR.2019.13.002386]

597. Islam MT, Bhuiyan MJS, Juyena NS and Bhuiyan MMU (2019). Post-artificial insemination conception rate of a Brahman bull in selected areas of Bangladesh. *Bangladesh Journal of Veterinary Medicine* 17 : 61-69 [doi: 10.33109/bjvmjj19fam4]

598. Rahman MM (2019). A report on comparison between the DLS and BRAC AI performance in Sylhet region, Bangladesh. *Journal of Dairy, Veterinary and Animal Research* 8 : 65-69 [doi: 10.15406/jdvar.2019.08.00244]

599. Shamsuddin M (1995). Fertility trend and status of estrus detection in the bovine under the farm conditions in Bangladesh. *Bangladesh Veterinary Journal* 29 : 9-16

600. Willett EL, Black WG, Stone NH and Buckner PJ (1951). Successful transplantation of a fertilized bovine ovum. *Science* 113, 247

601. Betteridge KJ (1981). An historical look at embryo transfer. *Journal of Reproduction and Fertility* 62: 1-13

602. Mapletoft RJ (2013). History and perspective on bovine embryo transfer. *Animal Reproduction* 10: 168-173

603. Troxel TR (2020). Embryo transfer in cattle. Uaex.edu/publications/PsF/FSA-3119.pdf

604. Hussain SS and Mostafa KG (1982). A review on the role of estrus synchronization as a method of increasing animal production in Bangladesh. *Bangladesh Journal of Animal Science* 11: 1-7

605. Khan AHMSI, Hossein MS, Siddiqui MAR, Shamsuddin M, Bhuiyan MMU and Kamaruddin KM (2000). Dose-specific effects of pregnant mare serum gonadotropin on the embryo production in Bangladeshi zebu cows. *Bangladesh Veterinarian* 17 : 67-73

606. Rahman MGM, Goswami PC, Khandoker MAMY, Tareq KMA and Ali SZ (2003). Collection of bovine cumulus-oocyte-complexes(COCs) from slaughter house ovaries in Bangladesh. *Pakistan Journal of Biological Sciences* 6 : 2054-2057

607. Ali SM, Khandoker MAMY, Afroz MA and Bhuiyan AKFH (2012). Ovarian response to different dose levels of follicle stimulating hormone (FSH) in different genotypes of Bangladeshi cattle. *Asian-Australasian Journal of Animal Science* 25 : 52-58

608. Deb GK, Dey SR, Nahar TN, Khan MYA and Rahman MM (2016). In vitro production of bovine blastocyst with oocyte collected from abattoir ovary. *Bangladesh Journal of Animal Science* 45 : 31-35

609. Khandoker MAMY, Atiqah NF and Arini N (2016). Effect of ovarian types and collection techniques on the number of follicles and quality of cumulus-oocyte-complexes in cow. *Bangladesh Journal of Animal Science* 45 : 10-16

610. Choudhury SM, Bhuiyan MMU, Rahman MM, Rahman MM, Sharif MN, Bhattachacharjee J, Bari FY and Juyena NS (2017). Comparison between two cryo-devices for verification of immature oocytes of indigenous zebu cows in Bangladesh. *Journal of Embryo Transfer* 32 : 311-317

611. Rahman MM, Morshed SMN, Juyenna NS and Bhuiyan MMU (2018). Determination of an effective media and its hormone and protein supplementation for in vitro maturation of oocytes of indigenous zebu cows. *Bangladesh Journal of Veterinary Medicine* 16 : 45-51

612. Haque SAMA (2007). Bangladesh: Social gains from dairy development. fao.org/3/i0588e/l0588E03.htm

613. Anon. (2020). The role of dairy farm in the livestock sector of Bangladesh. assignmentpoint.com/business/management/the-role-of-dairy-farm-in-the-livestock-sector-of-bangladesh.html

614. Ali MA and Anwar ABMN (1987). Cattle problem confrontation of the farmers in a union of Mymensingh. *Bangladesh Journal of Extension and Education* 2: 41-49

615. Khan MS, Islam MN and Hashem MA (1998). Problems associated with establishing dairy farms in private sector. *Bangladesh Journal of Training and Development* 11 : 207-212

616. Khan ABMKI, Baset MA and Fouzder SK (2010). Study on management and production system of small scale dairy farm in a selective rural area of Bangladesh. *Journal of Science Foundation* 8 : 13-23 [doi: 10.3329/jsf.v8i1-2.14615]

617. Uddin MN, Uddin MB, Al-Mamun M, Hassan MM and Khan MMH (2012). Small scale dairy farming for livelihoods of rural farmers: constraint and prospect in Bangladesh. *Journal of Animal Science Advances* 2 : 543-550

618. Imtiaz MA and Rana S (2014). Problems faced by the small scale dairy owners in receiving Veterinary services in selected areas of Chittagong. *Bangladesh Journal of Veterinary Medicine* 12: 63-65

619. DLS (2013). Annual Report on Livestock 2013. Division of Livestock Statistics, Ministry of Fisheries and Livestock, Farm Gate, Dhaka, Bangladesh

620. Banglapedia (2014). Cattle. En.banglapedia.org/index.php?title=Cattle#

621. Uddin MM, Sultana MN, Ndambi OA, Alqaisi O, Hemme T and Peters KJ (2011). Milk production trends and dairy development in Bangladesh. *Outlook on Agriculture* 40 : 263-272 [doi: 10.105367/oa.2011.0056]

622. Islam KMA, Uddin MM, Sultana MN, Assaduzzaman M and Islam MN (2010). Distribution pattern and management practices of cross-bred dairy cows in cooperative dairy production system in Bangladesh. *Livestock Research for Rural Development* 22 (12). Art. 219. http://www.Irrd.org/lrrd22/12/ amin22219.htm

623. Jabbar MA, Sarker SMMU and Baset MA (1997). An economic analysis of dairy cow rearing in two villages of Pabna district. *Bangladesh Journal of Animal Science* 26 : 125-132

624. Miah MIA and Begum R (1994). Fluid milk marketing in selected areas of Sadar Thana of Mymensingh district. *Bangladesh Journal of Animal Science* 23 : 103-109

625. Ali MH and Chowdhury SK (1996). Some aspects of dairy cooperatives under Baghabari Milk-vita area of Sirajganj district. *Bangladesh Journal of Animal Science* 25 : 99-108

626. Islam MR, Asaduzzaman MU and Begum J (1992). Women's role in livestock raising in Bangladesh. *Asian Livestock* 17: 41-45

627. Islam MH, Rahman AKMM, Hashem MA and Hossain SMI (1999). Women's participation in dairying. *Bangladesh Journal of Animal Science* 28 : 21-27

628. Hamid MA, Zaharaby AKM, Islam KMS, Hossain SMI and Sultana N (2006). Women's role in dairying: A rural development perspective. *Bangladesh Journal of Animal Science* 35: 47-52

629. Miazi OF, Hossain MB and Hasan MM (2007). Productive and reproductive performance of crossbred and indigenous dairy cows under rural conditions in Comilla, Bangladesh. *University Journal of Zoology, Rajshahi University* 26: 67-70 [doi: 10.3329/ujzru.v26i0.702]

630. Huque KS (2014). A performance profile of dairying in Bangladesh- programs, policies and way forwards. *Bangladesh Journal of Animal Science* 43: 81-103

631. Asaduzzaman M, Wadud A and Miah G (2003). Smallholder dairy production system and its impact on the livelihood of smallholders in Bogura districts. *Bangladesh Journal of Livestock Research* 10 : 37-43

632. Rashid MM, Roy BC, Asaduzzaman M and Alam MM (2007). Study of the dairy cattle management systems at farmer's level in Jessore district of Bangladesh. *Pakistan Journal of Nutrition* 6 : 155-158

633. Zaman MM, Haque MR, Adyl FMM, Hossain MS and Saha NG (1999). Study on the effect of lactation order number and different breeds on the milk yield, SNF, milk fat and milk proteins. *Progressive Agriculture* 10: 47-50

634. Azam MA, Khan MKI and Das A (2012). Adaptability and survivability of different crossbreds cattle under commercial dairy farming conditions in Chittagong area. *International Journal of Natural Sciences* 2 : 67-70

635. Khan MKI, Miah G, Huque KS, Khatun MJ and Das A (2012). Economic and genetic evaluations of different dairy cattle breeds under rural conditions in Bangladesh. Livestock Research for Rural Development 24 (1): Art. # 20. http://www.lrrd.org/lrrd24/1/khan24020.htm

636. Khan MKI, Huque KS, Miah G and Khatun MJ (2012). Studies on genetic gains and karyotype of Red Chittagong cattle in Bangladesh. *Research Opinions in Animal and Veterinary Sciences* 2 : 490-493

637. Saadullah M (2000). Animal based smallholding farms in developing countries with special reference to Bangladesh. *Journal of International Development and Cooperation* 6: 23-33 [doi: 10.15027114304]

638. Khan MS, Islam MN and Hashem MA (1998). Problems associated with establishing dairy farms in private sector. *Bangladesh Journal of Training and Development* 11: 207-212

639. Chowdhury MSI, Husain SMI, Khan MAS and Islam MR (2001). Participation of rural youth in dairy enterprise in some selected areas of Bangladesh. *Bangladesh Journal of Animal Science* 30 : 75-83

640. Rabbani MS, Alam MM, Ali MY, Rahman SMR and Saha BK (2004). Participation of rural people in dairy enterprise in a selected area of Bangladesh. *Pakistan Journal of Nutrition* 3 : 29-34

641. Kober AKMH, Sikder N and Debnath GK (2007). Present status and prospectus of small scale dairy farming in the selected areas of Bangladesh. *International Journal of Sustainable Agricultural Research and Developmen*t 5 : 390-394

642. Kober AKMH, Bari MS, Nath BK and Chakma J (2014). Small scale dairy cattle management in hilly district of Bangladesh. *Advances in Agriculture, Sciences and Engineering Research* 4 : 1445-1452

643. Datta AK, Haider MZ and Ghosh SK (2019). Economic analysis of dairy farming in Bangladesh. *Tropical Animal Health and Production* 51: 55-64 [doi: 10.1007/s11250-018-1659-7]

644. Jabbar MA and Raha SK (1984). Consumption pattern of milk and milk products in Bangladesh. *Bangladesh Journal of Agricultural Economics* 7: 29-44

645. Roy BK, Huque KS, Islam MR, Hasanuzzaman M and Rahman MM (2002). Consumption pattern of milk and milk products among different income levels in some selected areas of Bangladesh. *Pakistan Journal of Nutrition* 1 : 282-

646. Uddin MM, Van Huytenbroeck G, Hagedom K, Sultana MM and Peters KJ (2010). Institutional and organizational issues in livestock service delivery in Bangladesh. *Quarterly Journal of International Agriculture* 49 : 111-125

647. Parveen K and Hossain SMA (1994). Feeding practices and milk yield in rural cows. *Bangladesh Veterinary Journal* 28 : 63-66

648. Ashrafuzzaman AKM and Rahman MH (1994). Cow milk production efficiency in a selected area of Bangladesh. *Bangladesh Journal of Animal Science* 23: 139-147

649. Alam J, Akteruzzaman M, Rahman A and Ahmed Z (1994). Comparative performance of local and crossbred cows in Bangladesh. *Indian Journal of Dairy Science* 47 : 112-117

650. Jalil MA, Sarker NR, Paul DC and Khan AA (1995). Status of existing husbandry practices of dairy cattle at Manikganj, Bangladesh. *Bangladesh Journal of Animal Science* 24 : 71-80

651. Ashrafuzzaman AKM and Rahman MH (1995). Status and economic efficiency of milk production: A study in two villages. *Journal of Rural Development* 25: 75-88

652. Bhuiyan AKFH, Amin MR and Faruque MO (1995). Dairy merit of cows at Sylhet Government Fairy farm. *Bangladesh Veterinary Journal* 29 : 57-61

653. Majid MA, Talukder AI and Zahiruddin M (1996). Productive performance of purebreds, F1, F2 and F3 generations cows reared in Central Cattle Breeding and Dairy Farm of Bangladesh. *Asian-Australasian Journal of Animal Sciences* 9 : 461-464

654. Hamid MA, Husain SMI, Khan MKI, Islam MN and Biswas MAA (2000). Skin thickness in relation to milk production of crossbred cows. *Pakistan Journal of Biological Sciences* 3 : 1525-1529

655. Islam KMS, Azad MAK and Hossain SMJ (2001). Milk production profile in Baghabarighat Milk Shed area of Bangladesh. *Pakistan Journal of Biological Sciences* 4 : 912-915

656. Khan MS, Islam MN, Hashem MA and Sultana Z (2001). Milk production performance of indigenous and cross-bred cows of private dairy farm. *Bangladesh Journal of Animal Science* 30 : 15-19

657. Islam MR, Husain SMI, Islam MN and Bhuiyan MM (2001). Importance of udder characteristics in selecting cross-bred dairy cows on milk yield. *Bangladesh Journal of Animal Science* 30 : 55-59

658. Hoque MA and Hussen MS (2001). Genetics of lactation of Pabna and its crosses with Sahiwal and Friesian. *Indian Journal of Animal Science* 71: 80-82

659. Huque KS, Rahman MM and Islam MR (2002). Farming characteristics of cooperative dairy production systems in Bangladesh. *Bangladesh Journal of Livestock Research* 9 : 17-19

660. Azad MAK, Hasanuzzaman M, Miah G and Roy BK (2002). Milk production trend of Milk vita throughout the year. *Pakistan Journal of Nutrition* 1 : 236-240

661. Kadir MA, Rahman MM, Islam MS, Hossain MI and Islam MN (2003). Relation of milk vein measurements with milk production in indigenous dairy cows. *Bangladesh Journal of Animal Science* 32 : 139-144

662. Asaduzzaman M and Miah G (2004). A comparative performance of crossbred and indigenous dairy cows under smallholder dairy farming condition. *Bangladesh Open University Journal of Agriculture and Rural Development* 7: 12-18

663. Asaduzzaman M and Miah G (2005). Comparative performance of crossbred and indigenous dairy cows under smallholder dairy farming condition. *Journal of Agriculture and Rural Development* 3 : 143-145

664. Ali MH, Islam MN, Khan MAS and Islam MN (2005). Performances of different crossbred and indigenous dairy cows at Takerhat milk shed area under the Bangladesh milk producers' cooperative union limited (milk vita) of Bangladesh. *Journal of the Bangladesh Society of Agricultural Science and Technology* 2 : 137-140

665. Kadir MA, Khan MSI, Rahman MM, Rahman ME, Jahan SS and Rabbani MS (2005). Udder shape and teat measurements and their relation with milk production in indigenous dairy cows. *Bangladesh Journal of Progressive Science and Technology* 3 : 115-118

666. Islam MN, Islam MN, Wadud A, and Ali MH (2005). Economic benefits of rearing indigenous and crossbred dairy cows under smallholder dairy farming system. *Journal of the Bangladesh Society of Agricultural Science and Technology* 2 : 145-149

667. Shamsuddin M, Goodger WJ, Hossein MS, Azizunnesa, Bennett T and Nordlund K (2006). A survey to identify economic opportunities for smallholder dairy farms in Bangladesh. *Tropical Animal Health and Production* 38 : 131-140

668. Azad MA, Hasanuzzaman M, Azizunnesa, Shil GC abs Barik MA (2007). Milk production trend, milk quality and seasonal effect on it at Baghabarighat Milk Shed Area, Bangladesh. *Pakistan Journal of Nutrition* 6: 363-365

669. Hasanuzzaman M, Biswas MAA, Uddin MM, Shil GC and Akter B (2007). Milk production trend of Takerhat milk shed area of milk-vita around the year. *International Journal of Sustainable Agricultural Technology* 3 : 55-60

670. Apu AS, Hussain SS, Khandoker MAMY, Rahman AHMS, Islam MR and Kabir AFMA (2008). Productive and reproductive potentials of indigenous and crossbred dairy cows under farm condition. *International Journal of Bioresearch* 5 : 26-32

671. Reza MSA, Bhuiyan AKFH, Habib MA and Rabeya T (2008). Evaluation of Red Chittagong cows based on test day milk production. *Progressive Agriculture* 19 : 101-109

672. Alam MR, Khan MKI and Khanom J (2009). Prediction of lactation milk yield from test day records using Wood model. *Wayamba Journal of Animal Science* 1 : 18-19 [

673. Ahmad S, Hossain FMA and Islam N (2011). Effects of lactation number and different stage of lactation on milk yield of indigenous and crossbred cows in Bangladesh. *International Journal of Natural Sciences* 1 : 31-34

674. Islam MR, Hasan MN, Masum AKM, Khan MAS and Rahman MF (2011). Study on the milk yield of different genotypes of dairy cows. *International Journal of BioResearch* 1(6): 7-9

675. Khan MKI and Mazumder J (2011). Economic selection index using different milk production traits of Holstein and its crossbreds. *Turkish Journal of Veterinary and Animal Sciences* 35 : 255-261

676. Baset MA, Huque KS, Sarker NR, Hossain MM and Islam MN (2012). Effect of season, genotype and lactation on milk yield and composition of local and crossbred dairy cows reared under different feed base region. *Bangladesh Journal of Livestock Research* 19 : 50-65

677. Quddus MA (2012). Adoptation of dairy farming technologies by small farm holders: practices and constraints. *Bangladesh Journal of Animal Science* 41: 124-135

678. Ghosh S and Khan MKI (2014). Identification of the suitable milk recording protocol for small-scale dairy production. *International Journal of Dairy Science* 9 : 124-131 [doi.3923/ijds.2014.124.131]

679. Hossain ME, Chanda T, Debnath GK, Hassan MM and Haque MA (2014). Influence of dietary energy and protein intake on yield and composition of milk in crossbred dairy cows. *Iranian Journal of Applied Animal Science* 4 : 687-692

680. Hossain ME, Chanda T, Debnath GK, Hassan MM, Shikatand MA and Haque MA (2015). Influence of body condition score on yield and composition of milk in crossbred dairy cows. *Iranian Journal of Applied Animal Science* 5 : 309-315

681. Saha SN, Alam MGS, Shamsuddin M and Khatun M (2015). Effects of breeds, management system, milk yield and body weight on onset of post-partum ovarian cyclicity in cows. *Bangladesh Veterinarian* 32: 27-34 [doi: 10.3329/bvet.v32i1.29254]

682. Rahman MO, Hassan MN, Siddiki MSR, Habib MR and Rana MS (2016). Evaluation of morning and evening milk of Holstein Friesian cross cows collected from Bangladesh Agricultural University Dairy Farm. *Asian Australasian Journal of Bioscience and Biotechnology* 1 : 255-260

683. Zaman MA, Ara A and Haque MN (2016). Effect of season on production and quality of milk of crossbred dairy cows at Sylhet district government dairy farm in Bangladesh. *Bangladesh Journal of Animal Science* 45 : 52-57

684. Khan MKI, Blair HT, Lopez-Vilalobos N and Johnson PL (2005). Productive, reproductive and economic performance of dairy cattle in Bangladesh. *Proceeding of the Association for the Advancement of Animal Breeding and Genetics* 16: 124-127

685. Barua S, Alam MJ, Rahman MM, Farid MS and Koiry S (2018). Selected factors associated with dairy farms profitability of Chittagong district in Bangladesh. *Asian Research Journal of Arts and Social Sciences* 7 : 1-12 [doi: 10.9734/ARJASS/2018/43222]

686. Islam MS, Akhtar A, Hossain MA, Rahman MF and Hossain SS (2018). Lifetime productivity and repeatability estimation of selected traits of crossbred cows in Savar Dairy Farm. *Progressive Agriculture* 29 : 168-177

687. Islam MS, Akbar MA, Khan MJ, Habib MR, Ali MY and Islam MA (2018). Effect of adding additives on silage quality and milk production of lactating crossbred cows. *Asian-Australasian Journal of Bioscience and Biotechnology* 3 : 40-44

688. Islam A, Wadud A, Rabbani MG and Hossain B (1998). Rearing practices and milk production of dairy cattle in Thakurgaon district. *Bangladesh Journal of Animal Science* 27 : 177-181

689. Islam MM, Topader AH and Rob A (2010). Comparative study on the cost benefit between indigenous and cross bred cows reared in rural area of Dinajpur district. *Bangladesh Journal of Animal Science* 39 : 191-196

690. Muntasir B (2019). Local milk industry: A revolution in white. dhakatribune.com/business/2019/10/13/local-milk-industry-makes-huge-strides

691. Khan AR, Raha SK and Weindlmaier H (2005). Market performance of milk processing enterprise in Bangladesh. *Bangladesh Journal of Training and Development* 18 : 93-100

692. Khan AR, Raha SK and Weindlmaier (2006-2007). Market structure of dairy industry in Bangladesh- An empirical analysis at milk processing level. *Bangladesh Journal of Training and Development* 19-20: 61-70

693. Zaedi MS, Demura K, Yamamoto Y, Sawauchi D, Masuda K and Nakatani T (2009). Dairy industry in Bangladesh and structures of Milk-vita. *The Review of Agricultural Economics* 64: 169-180

694. Azad MAK (2018). Milk vita cooperative dairying: A legendary era in Bangladesh, 'Water Microbiology, Water Sustainability and Reuse Technologies. December 3-4, 2018, Chicago, USA [longdom.org/conference-abstracts-files/2476-2059-64-018-010.pdf]

695. BRAC (2014). BRAC Dairy. Brac.net/sites/default/files/Dairy_June_2014.pdf

696. Bhuiyan AH (2019). Pran eyes doubling milk collection by 2025. today.thefinancialexpress.com.bd/trade-market

697. Pran (2020). Pran Dairy. Pranfoods.net/brands/dairy

698. Rahman MM and Akteruzzaman M (1994). Economics of milk production in the bathan areas of Bangladesh. *Bangladesh Journal of Agricultural Sciences* 21 : 25-31

699. Azizunnesa BC, Sutradhar M, Hasanuzzaman M, Azad MAK and Kumar S (2008). Management vs productive and reproductive performances of dairy farm. *Pakistan Journal of Nutrition* 7 : 408-411

700. Rahman MM, Rahman MH and Kutubi AF (1993). Economics of milk production in selected areas of Mymensingh district. *Bangladesh Journal of Animal Science* 22: 13-24

701. Sayeed MA, Rahman SMA, Alam J and Begum J (1994). Economics of milk production in Dhaka district – A case for Savar Thana. *Asian-Australasian Journal of Animal Sciences* 7 :49-55

702. Alam J, Yasmin F, Sayeed MA and Rahman SMA (1995). Economics of mini-dairy farms in selected areas of Bangladesh. Asian-Australasian Journal of Animal Sciences 8 (1): 17-22

703. Rabbani R, Rahman MH, Zaman S and Mondal RA (1996). Economic return from milk production in Bangladesh. *Progressive Agriculture* 7 : 117-121

704. Quddus MA and Akhter S (1999). Factors affecting livestock farming in rural areas. *Progressive Agriculture* 10 : 99-102

705. Rahman MM, Jabbar MA, Rahman MM and Rahman MS (1999). Profitability analysis of ideal milk farm financed by Bangladesh Krishi Bank in some selected areas of Bangladesh. *Bangladesh Journal of Animal Science* 28 : 29-35

706. Alam J, Haque ABMM, Rahman MM and Sarker (1999). Profitability of loance dairy farms in selected areas of Bangladesh. *Bangladesh Journal of Animal Science* 28: 37-45

707. Ashraf A, Islam SS, Islam ABMM and Ali SZ (2000). A study of some economic traits of indigenous cattle and their cross breeds in Southern Bangladesh. *Asian-Australasian Journal of Animal Sciences* 13 : 1189-1192

708. Rahman MS, Miah MAM and Rahman MH (2000). Dairy cow rearing efficiency in income and employment: A study of two areas of Bangladesh. *Bangladesh Journal of Animal Science* 29 : 11-20

709. Hossain MK, Hossain MS, Bari FY, Shamsuddin M and Paul RK (2001). Economics of fertility management of small holding dairy farms. *Bangladesh Veterinarian* 18 : 83-88

710. Samad MA, Alam MJ and Alam MS (2002). Management dynamics and resources use efficiency of cattle raising in Bangladesh. *Bangladesh Journal of Animal Science* 31 : 107-117

711. Rahman SMA, Alam J and Rahman MM (2003). Study on the non-survivability status of subsidized and non-subsidized dairy farms in Bangladesh. *Bangladesh Journal of Animal Science* 32 : 27-38

712. Rahman SMA, Kabir MH and Rahman MM (2003). Economics of dairy industry under institutional dairy loan programme in Bangladesh. *Bangladesh Journal of Livestock Research* 10 : 22-26

713. Huque KS, Rahman MM and Islam MR (2004). Economics of dairying under co-operative dairy production system in selected milk pocket areas of Bangladesh. *Bangladesh Journal of Livestock Research* 11 : 20-30

714. Rahman SMA, Alam J and Rahman MM (2004). Impact of government's subsidy on private dairy farms in Bangladesh. *Bangladesh Journal of Livestock Research* 11 : 86-97

715. Mandate GK, Mandal MAS and Rahman MS (2009). Production and marketing of milk in some selected areas of Sirajganj district. *Bangladesh Journal of Agricultural Economics* 32: 105-115

716. Sikder MSI, Akteruzzaman M, Parveen S and Shamsuddin M (2009). Economics of community dairy farming in Satkhira district. *Bangladesh Journal of Animal Science* 38 : 164-169

717. Islam MS, Sikder MSI, Hossain MM, Akteruzzaman M and Shamsuddin M (2010). Impact of field fertility clinic on dairy production in peri-urban areas of Chittagong district. *Bangladesh Journal of Animal Science* 39 :183-190

718. Uddin MM, Sultana MN, Ndambi OA, Hemme T and Peters KJ (2010). A farm economic analysis in different dairy production systems in Bangladesh. Livestock Research for Rural Development 22 (7): Art. # 122. http://www.lrrd.org/lrrd22/7/uddi22122.htm

719. Uddin MT, Akhi K, Begum J, Islam MS and Khatun MM (2014). A socioeconomic analysis of GO-NGO versus self-managed dairy farming in two districts of Bangladesh. *Bangladesh Journal of Animal Science* 43 : 232-241

720. Uddin MT and Jannat A (2016). Farmers' livelihood through 'one house one farm' approach in selected areas of Mymensingh district of Bangladesh. *SAARC Journal of Agriculture* 14 : 90-106

721. Sultana MN, Uddin MM and Peters KJ (2016). Socio-economic determinants of milk production in Bangladesh: an implication on on-farm water use. *Livestock Research for Rural Development* 28 : Art. #1. http://www.lrrd.org/lrrd28/1/sult28001.html

722. Rashid MMO, Anik AR and Kamruzzaman M (2016). Profit elasticity of livestock farming in Bangladesh. *Wayamba Journal of Animal Science* 8 : 1321-1326

723. Dipu SMMA, Begum MR and Sultana S (2019). Socio-economic, farm and technological characteristics of the peri-urban small and marginal dairy farmers of Chittagong metro area, Bangladesh. *SAARC Journal of Agriculture* 17 : 77-91 [doi: 10.3329/sja.v17i1.42763]

724. Datta AK, Haider MZ and Ghosh SK (2019). Economic analysis of dairy farming in Bangladesh. *Tropical Animal Health and Production* 51: 55-64 [doi:10.1007/s11250-018-1659-7]

725. Alam J, Yasmin F, Sayeed MA and Rahman SMA (1995). Economics of mini dairy farms in selected areas of Bangladesh. *Asian Australasian Journal of Animal Science* 8: 17-22

726. Kabir MH and Talukder RK (1999). Economics of small scale dairy farming in Bangladesh under the government support programme. *Asian-Australasian Journal of Animal Sciences* 12 (3): 429-434

727. Mondal RK, Sen S and Rayhan SJ (2010). A comparative economic analysis of local breed and cross breed milk cow on a selected area of Bangladesh. *Journal of Scientific Foundation* 8 : 23-29

728. Shahjahan M (2017). Genetic admixture and performance diversity of high yielding dairy cows surrounding the Baghabari Milk Vita areas of Bangladesh. *Asian Journal of Medical and Biomedical Research* 3 : 127-133

729. Kamal MM (2010). A review on cattle reproduction in Bangladesh. *International Journal of Dairy Science* 5 : 245-252 [doi: 10.3923/ijds.2010.245.252]

730. Zaman MA and Rouf MA (2007). Influence of season and month on first service conception rate of cattle. *Journal of Science Foundation* 5 : 55-58

731. Zaman MA and Alam MJ (2008). Study on first service conception rate of cows influenced by age, parity and farming condition. *Bangladesh Journal of Progressive Science and Technology* 5 : 425-428

732. Mostari MP, Huque KS, Hasanat MS and Gulshan Z (2007). Productive and reproductive efficiency of Red Chittagong cattle under farm condition. *Progressive Agriculture* 18 : 109-114

733. Ghose SC, Haque M, Rahman M and Saadullah M (1977). A comparative study of age at first calving, gestation period and calving interval of different breeds of cattle. *Bangladesh Veterinary Journal* 11 : 9-14

734. Ghose SC, Haque M, Rahman M and Saadullah M (1980). A comparative study of lactation period and milk yield of different breeds of cattle. *Indian Veterinary Journal* 57 : 1009-1014

735. Ghose SC, Haque M, Saadullah M and Rahman MM (1981). A comparative study on the birth weight and age at sexual maturity of different breeds of cattle. *Bangladesh Veterinary Journal* 15 : 45-49

736. Rahman MF, Ahmed N and Ahmed AR (1987). A comparative study on some productive and reproductive performances of dairy cows at Savar Dairy Cattle Improvement Farm. *Bangladesh Veterinary Journal* 21 : 55-61

737. Majid MA, Nahar TN, Talukder AI and Rahman MA (1994-1998). Reproductive performance of purebred, F1, F2 and F3 cows raised in Savar Dairy Farm. *Bangladesh Journal of Livestock Research* 1-5: 53-62

738. Sultana R and Bhuiyan AKFH (1997). Quantitative analysis of the reproductive potentialities of different genotypes of cattle in Bangladesh. *Bangladesh Journal of Agricultural Sciences* 24 : 55-58

739. Rahman M, Islam MAS, Khan MN, Islam MN, and Sarker MSK (2001). Genetic differences in the performance of local, pure and crossbred cow. *Bangladesh Journal of Animal Science* 30 : 155-164

740. Uddin MM, Islam MN, Hassan MN and Ahmed S (2004). Reproductive performances of different genetic groups of dairy cows under ideal management condition. *Journal of the Bangladesh Agricultural University* 2 : 99-102

741. Hirooka H and Bhuiyan AKFH (1995). Additive and heterosis effects on milk yield and birth weight from crossbreeding experiments between Holstein and the local breed in Bangladesh. *Asian-Australian Journal of Animal Sciences* 8 : 295-300

742. Bhuiyan SA, Ali A, Bhuiyan AKFH and Bhuiyan MM (2000). Genetic and phenotypic parameters of some economic traits in dairy cows. *Bangladesh Journal of Animal Science* 29 : 143-152

743. Kabir F and Kisku JJ (2013). Reproductive performance of different crossbred cows of Bangladesh. *African Journal of Agricultural Research* 8 : 723-726

744. Hossen MS, Hossain SS, Bhuiyan AKFH, Hoque MA and Talukder MAS (2012). Comparison of some important dairy traits of crossbred cows at Baghabarighat milk shed areas of Bangladesh. *Bangladesh Journal of Animal Science* 41 : 13-18

745. Nahar N, Mostofa KG and Amin MR (1989). A comparative study on the performance of F1 crossbred cows. *Bangladesh Journal of Animal Science* 18 : 55-62

746. Jahan MKI, Chowdhury MMR, Nahar SMZH and Rahman MF (1990). Performances of local and cross-bred cows in farm condition. *Bangladesh Veterinarian* 7 : 48-49

747. Nahar TN, Islam M and Hasnath MA (1992). A comparative study on the performance of F1 crossbred cows under farm conditions. *Asian-Australian Journal of Animal Sciences* 5 : 435-438

748. Sarder MJU, Shamsuddin M, Bhuiyan MMU and Rahman MA (1997). Individual cow as determinant of the fertility and productivity in mini dairy farms. *Bangladesh Veterinary Journal* 31 : 91-98

749. Sarder MJU and Islam MK (2001). Effects of genetic group and parity of cows on reproductive parameters in mini-dairy farms. *Progressive Agriculture* 12 : 121-125

750. Alam MR, Bhuiyan MER, Rahman MA, Myenuddin M and Ahmad N (2001). Reproductive and productive performances of indigenous and cross-bred dairy cows in some selected farms. *Progressive Agriculture* 12 : 137-140

751. Kober AKMH, Debnath GK, Chanda GC, Chanda T and Amin MR (2003). Economic traits of different dairy cows under village condition. *Pakistan Journal of Biological Sciences* 6 : 902-904

752. Islam MS, Mazed MA, Rahman MM, Islam MA, and Kadir MA (2004). A study on some productive parameters of local x Friesian upgraded dairy cows. *Journal of Animal and Veterinary Advances* 3 : 560-563

753. Islam MS, Mazed MA, Islam MA, Kadir MA and Rahman MM (2004). A study on some reproductive parameters of Local x Frisian upgraded dairy cows. *Journal of Animal and Veterinary Advances* 3 : 717-721

754. Deb GK, Bhuiyan AKFH and Hossain MM (2005). Estimation of genetic parameters for economic traits in dairy cattle. *Bangladesh Journal of Animal Science* 34 : 17-26

755. Talukder MAS, Khandoker MAMY, Rahman MGM, Islam MR and Khan MAA (2005). Reproductive problems of cows at Bangladesh Agricultural University Dairy Farm and possible remedies. *Pakistan Journal of Biological Science* 8 : 1561-1567

756. Mondal SC, Alam MM, Rashid MM, Ali MY and Hossain MM (2005). Comparative study on the productive and reproductive performance of different dairy genotypes reared in Bangladesh Agricultural University Dairy Farm. *Pakistan Journal of Nutrition* 4 : 222-225

757. Munim T, Husain SS, Hoque MA and Khandoker MAMY (2006). Genetic and non-genetic effects on productive and reproductive traits of different groups of cows. *Bangladesh Journal of Animal Science* 35 : 1-12

758. Munim T, Husain SS, Hoque MA and Khandoker MAMY (2006). Estimation of heritability for productive and reproductive traits in different genetic groups of cows. *Progressive Agriculture* 17 : 111-119

759. Uddin MK, Wadud A, Begum D, Siddiki MSR and Rashid MH (2008). Productive and reproductive performance of indigenous and cross-bred cattle in Comilla district. *Bangladesh Journal of Animal Science* 37 : 39-43

760. Alam MM, Sarder MJU, Ferdousi Z and Rahman MM (2008). Productive and reproductive performance of dairy cattle in Char areas of Bangladesh. *Bangladesh Veterinarian* 25 : 68-74 [doi: 10.3329/bvet.v25i2.4620]

761. Rokonuzzaman M, Hassan MR, Islam S and Sultana S (2009). Productive and reproductive performance of crossbred and indigenous dairy cows under smallholder farming system. *Journal of the Bangladesh Agricultural University* 7 : 69-72

762. Das A, Gupta MD, Khan MKI and Miah G (2011). Effect of non-genetic factors on the productive and reproductive traits of Friesian crossbred dairy cows. *Wayamba Journal of Animal Science*: 62-64 [1297506172.pdf]

763. Paul AK, Maruf A, Jha PK and Alam MGS (2013). Reproductive performance of crossbred and indigenous (Deshi) dairy cows under rural context at Sirajgonj district of Bangladesh. *Journal of Embryo Transfer* 28 : 319-324

764. Mamun MJA, Khan MAS, Sarker MAH and Islam MN (2015). Productive and reproductive performance of Holstein Friesian cross-bred and indigenous cow under small holder farming system. *Bangladesh Journal of Animal Science* 44 : 166-170

765. Khoda MS, Sarker NR, Bhuiyan AKFH and Bhuiyan MSA (2015). Evaluation of productive and reproductive performances of crossbred and deshi dairy genotypes in Bangladesh. *International Journal of Natural and Social Sciences* 2 : 6-13

766. Rahman MH, Ali MY, Juyena NS and Bari FY (2017). Evaluation of productive and reproductive performances of local and cross-bred cows in Manikgonj district of Bangladesh. *Asian Journal of Medical and Biological Research* 3 : 330-334

767. Hauque M, Jahan M, Rahman MM, Islam J and Ahmed N (2011). A comparative study on some productive and reproductive performance of different cross-bred and indigenous dairy cows in Satkhira district. *Bangladesh Veterinary Journal* 45 : 1-10

768. Hasan MK, Rahamn MA, Mahbub ASM, Belal SA and Ahmed T (2014). Performance of different crossbred cattle at Comilla district of Bangladesh. *Journal of Sylhet Agricultural University* 1: 161-167

769. Sultana N, Rashid MM and Hossain SMJ (2001). A comparative study on productive and reproductive performance of different crossbred and indigenous dairy cows under small scale dairy farm conditions. *Pakistan Journal of Biological Sciences* 4 : 1036-1037

770. Goni MO, Rahman MGM, Islam MR, Khandoker AMMY and Talukder MAS (2005). Reproductive and productive performance of different dairy breeds at Baghabarighat milk producer's co-operative union limited. *Bangladesh Journal of Animal Science* 34 : 27-36

771. Das PK, Ali SZ, Islam ABMM and Roy BK (2003). A comparative study of productive and reproductive performance and estimates of heritability for economic traits in different genetic groups of cattle available at Baghabarighat milk pocket area of Bangladesh. *Journal of Biological Sciences* 3: 726-740 [doi: 10.3923/jbs.2003.726.740]

772. Khan MKI and Khatun MJ (1998). Performances of F1 crossbred cows at Baghabari Ghat Milk shed area. *Bangladesh Journal of Animal Science* 27 : 183-186

773. Khan AA, Amin MR, Howlider MAR and Hussain SMI (1991). Successive reproductive and milk yield performance in dairy cows. *Bangladesh Journal of Training and Development* 4: 31-37

774. Talukder MSU, Haque MN, Hossain MI, Aziz SA and Rahman MR (2001). Effect of different genotypes on milk yield and reproductive performance of cows. *Pakistan Journal of Biological Sciences* 4 : 1421-1424

775. Haque MN, Haque MR, Parvin A and Hussain MM (2011). Productive and reproductive performance of different crossbred cattle at Sylhet Govt Dairy Farm. *Progressive Agriculture* 22 : 47-54

776. Islam SS and Bhuiyan AKFM (1997). Performance of crossbred Sahiwal at the Pabna milk shed area in Bangladesh. *Asian-Australian Journal of Animal Sciences* 10 : 581-586

777. Khan MKI, Huque KS, Miah AG and Khatun MJ (2000). Study on the performance of Red Chittagong cows under different production system. *Pakistan Journal of Biological Sciences* 3 : 318-319 [doi: 10.3923/pjbs.2000.318.319]

778. Akter S, Huque KS, Jalil MA, Munzur MM and Miah G (2002). Study on productive and reproductive performance and breeding method of Red Chittagong cow under rural condition in different regions of Bangladesh. *Bangladesh Journal of Livestock Research* 9 : 1-7

779. Alam M, Bhuiyan AKFH, Ali A and Mamun A (2007). Genetic analysis of birth weight and milk production of RCC of Bangladesh. *Bangladesh Journal of Animal Science* 36 : 24-32

780. Habib MA, Bhuiyan AKFH and Amin MR (2010). Reproductive performance of Red Chittagong cattle in a nucleus herd. *Bangladesh Journal of Animal Science* 39 : 9-19

781. Habib MA, Afroz MA and Bhuiyan AKFH (2010). Lactation performance of Red Chittagong cattle and effects of environment factors. *Bangladesh Veterinarian* 27 : 18-25

782. Hasanuzzaman M, Hossaim ME, Islam MM, Begum MR, Chowdhury S and Hossain MZ (2012). Performance of Red Chittagong cattle in some selected areas of Chittagong district of Bangladesh. *Bangladesh Journal of Animal Science* 41 : 29-34

783. Badruzzaman ATM, Rahman MA, Hossen F and Nasrin SL (2014). Reproductive and productive performances of Red Chittagong cattle under rural condition in Chittagong district of Bangladesh. *Annals of Veterinary and Animal Science* 1 : 166-170

784. Azizunnesa BC, Sutradhar M, Hasanuzzaman M, Miazi OF, Aktaruzzaman M and Faruk MO (2010). Study on the productive and reproductive performances of Red Chittagong cow at rural areas in Chittagong. *University Journal of Zoology Rajshahi University* 28: 27-31

785. Roy BK, Wadud MN, Islam MN, Miah G and Das PK (2005). Effects of parity on milk yield and reproductive performance of Pabna cows. *Bangladesh Veterinarian* 22 : 83-91

786. Talukder MAI, Shahjahan M, Salahuddin M, Munira S, Miah MAH, Habib MR, Billah MM, Rahman SM, Haque MN, Yeasmin MN, Islam MS, Ali MY and Kabir MH (2018). Cattle production scenario in few rural areas at Pabna district of Bangladesh. *International Journal of Natural and Social Sciences* 5 : 1-67

787. Uzzaman MR, Bhuiyan MSA and Bhuiyan AKFH (2011). Phenotypic characterization and performances of Munshiganj cattle. *SAARC Journal of Agriculture* 9 :69-83

788. Faruk MSA, Islam SKMA, Alam M, Deb A and Chanda GC (2005). Husbandry practices of dairy farming at Chittagong sub-urban area. *International Journal of Natural Sciences* 5 : 59-65

789. Alam MGS and Ghos A (1988). Reproductive performance in cows: its relation to parity and season. *Bangladesh Veterinary Journal* 22 : 51-61

790. Ghosh A, Alam MGS, Yeasmin F and Barman L (1992). Reproductive performance of cross-bred zebu cows. *Bangladesh Veterinarian* 9 : 92-97

791. Rahman MM, Islam MN, Rahman MM and Dev A (1998). Productive and reproductive performances of indigenous and crossbred dairy cows under village management condition. *Progressive Agriculture* 9 : 95-100

792. Barman BK, Rahman MA, Paul TK, Murshed MM, Ali MS and Debnath GK (1998). Economic assessment of productive and reproductive status of dairying in selected areas of Kushtia. *Progressive Agriculture* 9 : 145-150

793. Ali MH, Khan MAS, Islam MN, Khan MKI, Rashid MM and Khatun MJ (2000). Comparative performance study on the crossbred and indigenous cows under small holder dairy farming. *Pakistan Journal of Biological Sciences* 3 : 795-798

794. Ali MH, Miah AG, Ali ML, Salma U, Khan MAS and Islam MN (2000). A comparative study on the performance of crossbred and indigenous (zebu) cows under the small holder dairy farming condition in Gaibandha district. *Pakistan Journal of Biological Sciences* 3 : 1080-1082

795. Mia AS and Ali KM (1971). Evaluation of reproductive status of bovine (Bos indicus) females in absence of breeding records. *Bangladesh Journal of Animal Science* 4 : 17-22

796. Rahman MA, Alam MGS, Ahmed JU and Das SC (1995). An assessment on reproductive status of zebu heifers and cows in Tangail milk shed area. *Bangladesh Veterinary Journal* 29 : 17-24

797. Sarder MJU (2001). Reproductive and productive performances of indigenous cows. *Bangladesh Veterinarian* 18 : 123-129

798. Haque MN, Aziz SA, Chanda SS, Hossain MI and Baset MA (2002). A study of the milking and reproductive performances of indigenous cattle at urban area of Bangladesh. *Pakistan Journal of Biological Sciences* 5 : 97-100

799. Nahar TN, Islam MR, Zaman MS and Kibria SS (1995). Performance of native cows under farm conditions. *Asian-Australasian Journal of Animal Sciences* 8 : 219-221

800. Islam SS, Asraf A and Islam ABMM (2000). A study on the milking and reproductive performances of grazing indigenous cattle at semi-urban areas of Bangladesh. *Asian-Australasian Journal of Animal Sciences* 13 : 837-841

801. Islam F, Bari FY and Alam GS (2014). Reproductive performances and management effects on productions of indigenous dairy cows raised at Char areas in Northern Bangladesh. *GSTF Journal of Veterinary Science* 10.7603/s40871-015-0007-x

802. Khan MAS and Hossain MA (1994). A baseline study on the production performance of local cows for the development of supplementation strategies in Bangladesh. *Bangladesh Journal of Animal Science* 23: 179-183

803. Hossain MA, Hashem MA and Khan MAS (2016). A basic study on production performance of local cows under a typical village condition of Mymensingh district. *Journal of Environmental Science and Natural Resources* 9 : 115-120

804. Gupta SK, Singh P, Shinde KP, Lone SA, Kumar N and Kumar A (2016). Strategies for attaining early puberty in cattle and buffalo: A Review: *Agricultural Review* 37: 160-167 [doi: 10.18805/ar.v37i2.10741]

805. Perry GA (2016). Factors affecting puberty in replacement beef heifers. *Theriogenology* 86: 373-378 [doi: 10.1016/j.theriogenology.2016-04-051]

806. Estill CT (2017). Initiation of puberty in heifers. veteriankey.com/initation-of-puberty-in-heifers/

807. Watanabe K, Lewis B, Mlewah TB and Tetsuka M (2017). Age at first calving and factors influencing it in dairy heifers kept by smallholder farmers in Southern Malawi. *Journal of the Association for Research in Otolaryngology (JARO)*51: 357-362

808. Penev T, Vasilev N, Stankov K, Mitev J and Kirov V (2014). Impact of heifer age at first breeding and first calving on some parameters of economic effectiveness at dairy cattle farms. *International Journal of Current Microbiology and Applied Sciences* 3: 772-778

809. Nilforooshan MA and Edriss MA (2004). Effect of age at first calving on some productive and longevity traits in Iranian Holsteins of the Isfahan Province. *Journal of Dairy Science* 87: 2130-2135 [doi: 10.3168/ids.S0022-0302(04)70032-6]

810. Steele M (2020). Age at first calving in dairy cows which months do you aim for to maximize productivity. *Veterinary Evidence* 5:[doi: 10.18849/ve.v5il.248]

811. Knott JC (1931). A study of the gestation period of Holstein-Friesian cows. *Journal of Dairy Science* 15: 87-98

812. Felix SU (2018). Conception and gestation in domestic animals and various factors influencing them: A Review. *Journal of Dairy and Veterinary Sciences* 5: [doi: 10.19080/JDVS2018.05.555656]

813. Jackson GG (2013). Overview of prolonged gestation in cattle and sheep. MSD Veterinary Manual, Merck & Co., Inc, USA

814. Nogalski Z and Piwczynski D (2012). Association of length of pregnancy with other reproductive traits in dairy cattle. *Asian-Australasian Journal of Animal Science* 25: 22-27 [doi: 10.5713/ajas.2011.11084]

815. Ambrose DJ (2017). Post-partum anestrus and its management in dairy cattle. veterinankey.com/

816. Endecott R (2015). Post-partum interval and fertility. drovers.com/article/post-partum-interval-and-fertility

817. Hare L, Norman HD and Wright JR (2006). Trends in calving ages and calving intervals for dairy cattle breeds in the United States. *Journal of Dairy Science* 89: 365-370 [doi: 10.3168/jds.S0022-0302(06)72102-6]

818. Nickerson SC (2020). Importance of dry cow management in the control of mastitis. dairy-cattle.extension.org/importance-mastitis

819. Boujenane (2019). Factors affecting the dry period length and its effect on milk production and composition in subsequent lactation of Holstein cows. *Iranian Journal of Applied Animal Science* 9: 229-234

820. Siatka K, Sawa A, Krezel-Czopek S, Piwczynski D and Bogucki M (2017). Effect of some factors on number of services per conception in dairy cows. *Journal of Veterinary Science and Technology* 8: [doi: 10.4172/2157-7579.1000465]

821. Potdar VV, Bhave K, Gaundare Y, Awasthi IR and Khadse JR (2016). Factors influencing conception rate of local and crossbred cows. *IOSR Journal of Agriculture and Veterinary Science* 9: 51-54

822. Syrstad O (1991). Milk yield and lactation length in tropical cattle. fao.org/3/u9550Tos.htm#

823. Khan MKI, Blair HT, Lopez-Vilalobos N (2012). Lactation curves of different cattle breeds under cooperative dairying conditions in Bangladesh. *Journal of Applied Animal Research* 40: 179-185

824. Islam MS, Akhtar A, Hossain MA, Rahman MF and Hossain SS (2017). Reproductive performance and repeatability estimation of some traits of crossbred cows in Savar Dairy Farm. *Journal of Environmental Science and Natural Resources* 10: 87-94

825. Bulbul B and Ataman MB (2009). The effect of some seasonal conditions on oestrus occurrence in cows. *Archiv Tierzucht* 52: 459-465

826. Ghosh A, Alam MGS, Pandit KK and Kamaruddin KM (1988). Seasonality of post-partum reproductive performance of indigenous cows of Bangladesh. *Bangladesh Veterinarian* 5 : 73-75

827. Rahman MM and Haque MN (2001). Productive and reproductive performances of native cows under farm conditions. Journal of Biological Sciences 1 : 1085-1087 [doi: 10.3923/jbs.2001.1085.1087]

828. Khaton R, Sarder MJU and Gofur MR (2015). Biometrical studies of reproductive organs of dairy cows of different genotypes in Bangladesh. *Asian Journal of Animal Sciences* 9: 388-395 [doi: 10.3923/ajas.2015.388.395]

829. Rahman MM, Gofur MR, Rahman MS, Bari FY and Juyena NS (2016). Effect of genotype on reproductive and productive performances of dairy cows under rural context in Bangladesh. *International Journal of Livestock Research* 6: 9-24 [doi: 10.5455/ijlr.20160412082206]

830. Islam A, Ahmed ABMT, Hasan M, Shuvo MA, Islam MR, Rahman MM, Hossain MM and Islam KM (2017). Productive and reproductive performance of different breed and crossbreds dairy cattle at Central Cattle Breeding and Dairy Farm, Savar, Dhaka, Bangladesh. *International Journal of Natural Sciences* 6: 148-153

831. Stevenson JS and Britt JH (2017). A 100-year Review: Practical female reproductive management. *Journal of Dairy Science* 100: 10292-10313 [doiL 10.3168/jds.2017-12959]

832. Balhara AK, Gupta M, Singh S, Mohanty AK and Singh I (2013). Early pregnancy diagnosis in bovines: Current status and future directions. *The Scientific World Journal*. Article ID 958540 [doi: 10.1155/2013/958540]

833. Marques LR, Almeida JVN, Marques TC, Guimaraes KC, Pain TD and Leao KM (2020). Estrus detection and reproductive performance of dairy cows.: Review. *Research Society and Development* 9: e243974063 [doi: 10.33448/rsd-v9i7.4063]

834. Hussain SS and Hasnath MA (1974-1975). Physical and chemical tests for early pregnancy diagnosis of cows, ewes and does. *Bangladesh Journal of Animal Science* 7-8 : 56-62

835. Hussain SS, Hasnath MA and Islam ABMM (1975-1976). To study the change in the vaginal mucus at stages of estrus cycle in cows, ewes and does. *Bangladesh Journal of Animal Science* 9-10 : 1-3

836. Rahman MF and Ahmad N (1987). Detection of estrus and pregnancy in cows from milk progesterone concentration. *Bangladesh Journal of Animal Science* 16 : 32-36

837. Bhuiya MRH and Hossain MA (1987). Effects of age, sex, breed, pregnancy, lactation and disease on total serum cholesterol levels in dairy cattle. *Bangladesh Journal of Animal Science* 16 : 43-48

838. Alam MGS and Ghosh A (1994). Plasma and milk progesterone concentrations and early pregnancy in zebu cows. *Asian-Australasian Journal of Animal Science* 7 : 131-136

839. Malakar S, Juyena NS, Paul S, Hasan MM, Bhattacharjee J, Mollah HR and Islam MR (2017). Monitoring vaginal electrical impedance in crossbred cows during post-partum period. *Asian Journal of Medicine and Biological Research* 3 : 221-225

840. Ahmed M, Chowdhury MK, Rahman MM, Bhattacharjee J and Bhuiyan MMU (2017). Relationship of electrical resistance of vaginal mucus during oestrus with post-AI pregnancy in cows. *Bangladesh Journal of Veterinary Medicine* 15 : 113-117

841. Hossain SMJ, Bhuiyan AKFH, Haque KS, Sarker NR, Sultana N and Alam MK (2011). Productive and reproductive potential of Red Chittagong cattle (RCC) under in-situ and ex-situ conditions. *Bangladesh Journal of Livestock Research* 18 : 7-13

842. Sikder MKI, Alam MJ and Azad MAS (2001). Profitability and resource use efficiency of commercial dairy farms in Dhaka and Gazipur district. *Bangladesh Journal of Animal Science* 30 : 115-122

843. Mojumder MLO, Ahemd JU, Bhuiyan MMU, Hasan MJ and Ali MS (2015). Evaluation of reproductive health status in government and commercial dairy herds of Bangladesh. *Asian Journal of Medical and Biological Research* 1 : 31-38

844. Faruque MG (2002). Problem confrontation of the farmers in managing dairy cattle. *Bangladesh Journal of Animal Science* 31 : 59-67

845. Mian MRU, Halim MA and Jabbar MA (2001). Economics of dairy farming under livestock credit programme of BKB in a selected are of Mymensingh district. *Bangladesh Journal of Training and Development* 14 : 89-98

846. Raheed MG, Islam MS, Salam MA and Hossain MM (2006). Problems and opinions of the dairy farms owners using indigenous knowledge for profitable dairy farming in Rajshahi district. *Bangladesh Journal of Animal Science* 35 : 65-74

847. Anwar ABMN, Rahman MM and Islam MN (1987). Problem confrontation by Modhupur farmers in adopting artificial insemination. *Bangladesh Journal of Animal Science* 16 : 84-93

848. Rahman MH and Rana S (2014). Animal health services: extent of availability in some selected rural areas of Bangladesh. *Bangladesh Journal of Veterinary Medicine* 12 : 173-177

849. Uddin MM, Hemme T, Ndambi OA and Khan MJ (2017). Impact of dairy support services and strategies on reduction of cost of milk production in different dairy production systems in Bangladesh: Implications for rural livelihood improvement. *Asian Journal of Poverty Studies* 3 : 95-104

850. IFCN (2019). Dairy report for better understanding of milk production worldwide. IFCN-the Dairy Research Network, University of Kiel, Germany. www.ifcndairy.org

851. Uddin MM, Akter A, Khaleduzzaman ABM and Sultana MN (2020). Forecasting milk production in Bangladesh toward achieving self-sufficiency. *Livestock Research for Rural Development* 32(5): Article 81. Lrrd.org/lrrd32/5/moham32081.html

852. Rahman MI, Zaman MM and Islam MN (1996). Lactation and stage difference in milk yield of half bred Sindhi cows. *Bangladesh Journal of Training and Development* 9: 71-74

853. Islam KMS (2001). Quality and amount of morning and evening milk of the Bangladesh Baghabarighat Milk Shed area throughout the year. *Asia Australasian Journal of Animal Sciences* 14 : 92-95

854. Hasanuzzaman M, Azad MAK, Barik MA and Rahman MZ (2002). Milk fat production trend and effect of season on it at Sree-nagor Milk Shed area under Milk-vita throughout the year. *Pakistan Journal of Nutrition* 1 : 231-233

855. Asaduzzaman M, Islam MN, Masum AKM, Khan MAS and Amanullah M (2011). Physiochemical properties of different packaged fluid milk available in Bangladesh. *Bangladesh Journal of Progressive Science and Technology* 9 : 161-164

856. Hussain M, Siddique MHR, Hossain A and Rahman MS (1977). Effect of feeds on the composition of milk of indigenous cows of Bangladesh. *Bangladesh Journal of Agriculture* 1: 100

857. Islam KMS (2001). Compositional profile of milk round the year at Baghabarighat milk shed area of Bangladesh. *Indian Journal of Animal Science* 71: 989-991

858. Islam MN, Rahman MM, Ali ML, Hassan MN and Islam MN (2001). Physical, chemical and microbiological qualities of cow's and buffalo's milk. *Bangladesh Journal of Animal Science* 30 : 27-33

859. Islam MA, Alam MK, Islam MN, Khan MAS, Ekeberg D, Rukke EO and Vegarud GE (2014). Principal milk components in buffalo, Holstein cross, indigenous cattle and Red Chittagong cattle from Bangladesh. *Asian Australasian Journal of Animal Sciences* 27 : 886-897

860. Islam MR, Hassan MN, Siddiki MSR, Khan MAS and Islam MA (2008). Determination of quality of milk from different genotype of dairy cows. *Bangladesh Journal of Animal Science* 37 : 53-56

861. Hossain MA, Mannan AKMA and Rahman MS (1969). Average percentage of fat, total solids and solids-not-fat contents of local cow's milk and the variations of milk fat percentage with the stage of lactation, milk yield and number of lactation. *Animal Science Journal of Pakistan* 2 : 37-48

862. Haider N and Kober AKMH (2006). Nutritional content and bacteriological contamination of milk of Red Chittagong and Holstein-Friesian crossbred cows. *Bangladesh Veterinarian* 23 : 47-52

863. Islam MA, Uddin ME, Jahan R, Wadud A and Sarker MM (2013). Metabolites in the milk of buffalo, Holstein cross, indigenous and Red Chittagong cattle of Bangladesh. *Bangladesh Journal of Animal Science* 42 : 152-157

864. Chanda GC, Uddin GMN, Deb A, Bilkis T, Chowdhury S and Uddin MB (2008). Microbiological profile of the traditionally collected industrial raw milk from the milk pocket zones of Bangladesh. *Bangladesh Journal of Microbiology* 25 : 17-20

865. Das S, Debnath GK, Chanda T, Alim MA and Sarker S (2010). A study on quality of milk from farm to shop in Chittagong metropolitan area. *International Journal of Animal and Fisheries Sciences* 3: 252-256

866. Islam MA, Rashid MH, Ahmed S and Masum AKM (2016). Quality evaluation of raw milk collected from local markets of Madhupur upazila of Tangail district. *Fundamentals and Applied Agriculture* 1 : 70-74

867. Talukder M and Ahmed HMM (2016). Determination of antibiotics sensitivity profiles of bacteria isolated from raw milk. *Asian Journal of Medical and Biological Research* 2 : 396-401

868. Islam MA, Islam MN, Khan MAS, Rashid MH and Obaidullah SM (2009). Effect of different hygienic condition during milking on bacterial count of cows' milk. *Bangladesh Journal of Animal Science* 38 : 108-114

869. Bilkis T, Islam MM, Sumy MC, Mandal MNA and Uddin GMN (2013). Rapid estimation of quality of raw milk for its suitability for further processing in the dairy industries of Bangladesh. International *Journal of Dairy Science* 8 : 1-11 [doi: 10.3923/ijds.2013.1.11]

870. Islam MN (1990). A study on the gross energy value of milk. *Bangladesh Journal of Animal Science* 19 : 81-87

871. Islam MN, Hossain SMI and Mannan AKMA (1984). Studies on the physical and chemical qualities of market milk in Mymensingh town (Bangladesh). *Bangladesh Journal of Animal Science* 13 : 52-56

872. Islam MN, Ali MS, Kober AKMH and Amin MR (2002). Quality of milk consumed by residential people of Bangladesh Agricultural University Campus, Mymensingh. *Bangladesh Veterinarian* 19 : 29-33

873. Khan MTG, Zinnah MA, Siddique MP, Rashid MHA, Islam MA and Choudhury KA (2008). Physical and microbiological qualities of raw milk collected from Bangladesh Agricultural University Dairy farm and the surrounding villages. *Bangladesh Journal of Veterinary Medicine* 6 : 217-221

874. (a) Islam MN, Hussain MN, Hussain SMI, Zaman MM and Sarker DRD (1985). Studies on the physical and chemical qualities of fluid milk produced at BAU Dairy Farm. *Bangladesh Journal of Animal Science* 14: 62-66

874. (b) Islam MN, Islam KMA, Wadud A and Hassan MN (1992). Studies on the quality of milk available in surrounding local markets of Manikganj milk chilling center and Milk-Vita Manikganj. Bangladesh *Journal of Animal Science* 21 : 65-70

875. Uddin MS, Habib MR, Islam MA, Afrin S and Rashid MH (2016). Quality of raw milk collected from Mymensingh town in Bangladesh. *Bangladesh Journal of Animal Science* 45 : 73-78

876. Hasan T and Rakib RH (2016). Physiochemical and microbiological quality assessment and detection of adulteration of raw milk available in Nakla Upazila, Sherpur, Bangladesh. *SAARC Journal of Agriculture* 14 : 46-217

877. Rahman AKMM, Zaman MM, Husain SMI and Khan MAS (1995). Physical and chemical qualities of milk collected from different plants of Milk-vita. *Bangladesh Journal of Animal Science* 24 : 119-125

878. Azad MAK, Hassan MN, Rashid MH, Islam MN and Alam SMK (2001). Chemical and microbiological quality of milk collected from milk producing societies of Milk vita. *Bangladesh Journal of Animal Science* 30 : 43-48

879. Martin NH, Boor KJ and Wiedmann M (2018). Symposium review: Effect of post-pasteurization contamination on fluid milk quality. *Journal of Dairy Science* 101 : 861-870 [doi: 10.3168/jds.2017-13339]

880. Banik SK, Das KK and Uddin MA (2014). Microbiological quality analysis of raw, pasteurized, UHT milk samples collected from different locations in Bangladesh. *Standford Journal of Microbiology* 4: 5-8

881. Rahman MM, Rahman MH, Ali MH and Hassan MN (1998). Bacteria in relation to sanitary quality of pasteurized milk in plant and commercial storage. *Bangladesh Journal of Animal Science* 27: 145-150

882. Hasan MA, Islam MA, Mahmud MS, Uddin ASMA and Ahmed S (2015). Microbial analysis of raw and pasteurized milk from selected areas of Dinajpur, Bangladesh. *Asian Journal of Medical and Biological Research*1 : 292-296 [doi: 10.3329/ajmbr.v1i2.25624]

883. Ahmed S, Zim AFMIU, Rahman S, Ghosh S, Chhetri A and Ali MS (2019). Quality and safety assessment of Bangladeshi pasteurized milk. *Journal of Food Quality and Hazards Control* 6: 25-29 [doi: 10.18502/jfqhc.6.1.455]jfqhc.6.1.455]

884. Rashid MH, Hasan MN and Khan MAS (1999). A comparative study on the chemical quality of raw and pasteurized milk. *Bangladesh Journal of Animal Science* 28 : 149-153

885. Rahman MS, Islam MN, Hossain MN and Sarker EA (2000). Quality of packaged fluid milk available in retail market of Mymensingh town. *Bangladesh Journal of Animal Science* 29 : 163-172

886. Saha S and Ara A (2012). Chemical and microbiological evaluation of pasteurized milk available in Sylhet city of Bangladesh. *The Agriculturists* 10 : 104-108

887. Datta N (2018). UHT treatment of milk and dairy products. *Journal of Advances in Dairy Research* 6:1 [doi: 10.4172/2329-888X.1000e133]

888. Sabbir MA, Habib R, Rashid MH and Imam MF (2015). Quality of ultra-high temperature treated chocolate milk manufactured in Bangladesh. *Bangladesh Journal of Animal Science* 44 : 128-131

889. Arafat MY, Habib R, Siddiki MSR and Imam MF (2015). Quality of ultra-high temperature treated milk available in Gazipur and Mymensingh of Bangladesh. *Bangladesh Journal of Animal Science* 44 : 132-136

890. Karmaker A, Das PC and Iqbal A (2020). Quality assessment of different commercial and local milk available in the local markets of selected area of Bangladesh. *Journal of Advanced Veterinary and Animal Research* 7 : 26-33 [doi: 10.5455/javar.2020.g389]

891. Rahman MM, Hasan MN, Rahman MM and Mannan AKMA (1987). Investigations on the microbial assessment and the quality of commercial spray-dried milk. *Bangladesh Journal of Animal Science* 16 : 19-26

892. Rahman MM, Hasan MN, Rahman MM and Mannan AKM (1988). Microbiological quality of commercial spray dried milk sampled from Bangladesh. *Asian Journal of Dairy Research* 7: 199-202

893. Rahman MM, Hassan MN, Mannan AKMA and Rahman MM (1991). Physical, chemical and bacteriological assessments of market dry milk. *Bangladesh Journal of Agricultural Science* 18: 119-122

894. Roy MK, Islam MN, Akter M and Asaduzzaman M (2012). Determination of quality of milk powder available in local market of Bangladesh. *Bangladesh Journal of Progressive Science and Technology* 10 : 155-158

895. Jahan SS, Hassan MN, Rahman MM and Hossain ZMA (2006). Physical, chemical and microbiological qualities of infant milk food available in local market. *Bangladesh Journal of Animal Science* 35 : 59-64

896. Afroz H, Sultana F, Fakruddin M, Kamrunnahar, Khan ZUM and Datta S (2013). Isolation of Escherichia coli and Staphylococcus aureus from full cream powder milk sold under market conditions at Dhaka, Bangladesh and their antibiotic susceptibility. *Journal of Advance Science Research* 4: 27-31

897. Siddique MNA, Islam MN, Habib MR, Rashid MH, Islam MA and Afrin S (2017). Evaluation of the quality of sweetened condensed milk of different brands available in local markets of Bangladesh. *International Journal of Natural and social Sciences* 4 : 64-70

898. Mia MAR, Hassan MN, Islam MN and Rahman MM (1998). Microbial association of commercial sweetened condensed milk. *Bangladesh Journal of Animal Science* 27 : 71-76

899. Kajal MFI, Rashid MH, Uddin ME and Zaman MR (2012). Qualities of full-cream powdered milk of different brands available in retail markets of Bangladesh. *Bangladesh Journal of Animal Science* 1 : 106-111

900. Kajal MFI, Wadud A, Islam MN and Sarma PK (2012). Evaluation of some chemical parameters of powder milk available in Mymensingh town. *Journal of the Bangladesh Agricultural University* 10 : 95-100

901. Tasci F (2011). Microbiological and chemical properties of raw milk consumed in Burdur. *Journal of Animal and Veterinary Advances* 10 : 635-641

902. Walker GP, Dunshea FR and Doyle PT (2004). Effect of nutrition and management on the production and composition of milk and protein. *Australian Journal of Agriculture* 55 : 1009-1028

903. Debnath GK, Kober AKMH, Chanda T, Chanda GC and Bari MS (2014). A comparative study on the quality of available brand and non-brand fluid milk consumed by the people of Chittagong city of Bangladesh. *International Journal of Natural Sciences* 4 : 16-20

904. Kamthania M, Saxena J, Saxena K and Sharma DK (2014). Methods of detection and remedial measures. *International Journal of Engineering Technologies Research* 1: 15-20

905. Azad T and Ahmed S (2016). Common milk adulteration and their detection techniques. *International Journal of Food Contamination* 3: 22 [doi: 10.1186/s40550-016-0045-3]

906. Liu Y, Todd EED, Zhang Q, Shi JR and Liu XJ (2012). Recent developments in the detection of melamine. *Journal of Zhejiang University of Science B* (Biomed & Biotechnol) 13 : 525-532

907. Singh P and Gandhi N (2015). Milk preservatives and adulterants: processing, regulatory and safety issues. *Food Reviews International* 31 : 236-261

908. Singuluri H and Sukumaran M (2014). Milk adulteration in Hyderabad, India- a comparative study on the levels of different adulterants present in milk. *Journal of Chromatograph Separate Techquine* 5: 212

909. Islam MN, Mannan AKMA and Hussain M (1982). Studies on the keeping quality of ghee. *Bangladesh Journal of Animal Science* 11 : 28-35

910. DS (2008). Ghee of 10 BSTI- certified brands found adulterated. thedailystar.net/news-detail-66453

911. Wadud A, Rahman MM and Islam Mn (1992). Evaluation of keeping quality of morning milk mixed with evening milk as determined by acidity and organoleptic tests. *Bangladesh Veterinarian* 9: 1-6

912. Matubbar A, Islam MN, Wadud A, Islam MA and Hussain MA (2007). Effect of heat treatment on shelf life of milk. *Journal of the Bangladesh Society of Agricultural Science and Technology* 4 : 189-192

913. Hossain MS, Islam MN, Mannan AKMA and Hussain SMI (1989). Studies on the preservation of milk with hydrogen peroxide. *Bangladesh Journal of Animal Science* 18 : 75-80

914. Saha BK, Ali MY, Chakraborty M, Islam Z and Hira AK (2003). Study on the preservation of raw milk with hydrogen peroxide (H2O2) for rural dairy farmers. *Pakistan Journal of Nutrition* 2 : 36-42

915. Arefin S, Sarker MAH, Islam MA, Harun-ur-Rashid M and Islam MN (2017). Use of hydrogen peroxide (H_2O_2) in raw cow's milk preservation. *Journal of Advanced Veterinary and Animal Research* 4 : 371-377

916. Biswas AKMAA, Hassan MN, Hossain MM and Islam MN (1998). Effect of banana (Musa sapientum) leaf on the keeping quality of raw milk. *Bangladesh Journal of Animal Science* 27 : 163-169

917. Khan MRI, Wadud A, Rashid MH, Islam MN and Begum R (2000). Effects of different types of green leaves on keeping quality of raw milk under rural conditions in Bangladesh. *Progressive Agriculture* 11 : 163-166

918. Hamid MA, Islam MN and Hossain MA (2003). Effect of sodium bicarbonate on the keeping quality of milk. *Journal of the Bangladesh Agricultural University* 1 : 71-79

919. Rahman MM, Islam MN, Harun-ur-Rashid M and Masum AKM (2018). Effects of sodium bicarbonate on milk preservation. *Research in Agriculture, Livestock and Fisheries* 5 : 75-85

920. Islam MN, Ara A and Islam MN (2003). Effects of refrigeration on keeping quality of raw and pasteurized milk during storage. *Bangladesh Veterinarian* 20 : 19-24

921. Chanda T, Debnath GK, Hossain ME, Islam MA and Begum MK (2012). Adulteration of raw milk in the rural areas of Barisal district of Bangladesh. *Bangladesh Journal of Animal Science* 1 : 112-115

922. Hamid MA, Islam MN, Hussain MA and Alam A (2007). Effect of containers on the storage life of milk in winter season. *Bangladesh Journal of Environmental Science* 13 : 101-104

923. Rahman MM, Islam MN, Siddiquee and Habib MA (2012). Keeping quality of cow milk in different containers with or without sodium bicarbonate. *Bangladesh Veterinarian* 29 : 90-95

924. Islam MA, Rashid MH, Kajal MFI and Alam MS (2013). Quality of milk available at local markets of Muktagacha upazilla in Mymensingh district. *Journal of Bangladesh Agricultural University* 11 : 119-124

925. Debnath GK, Chanda T, Talukder S and Akhter M (2012). Detection of adulterants and preservatives added to incoming fluid milk from rural to Chittagong metropolitan areas. *Bangladesh Journal of Veterinary and Animal Science* 1: 55-64

926. Kar S, Rahman MM and Islam MN (2017). Shelf life of raw and reconstituted milk at room and refrigeration temperature. *International Journal of Natural and Social Sciences* 4 : 24-32

927. Hossain SK, Husain SMI, Zaman MM, Khan MAS and Islam MN (1995). Detection of adulteration of milk. *Progressive Agriculture* 6: 15-20

928. Kober AKMH, Bari MS, Morshed S and Momin MM (2015). Evaluation of nutritional quality, contamination, adulteration and preservation quality of different sources of milk. *Bangladesh Journal of Veterinary and Animal Sciences* 3: 25-29

929. Zaman MM, Hossain SK, Hussain SMI, Sarker AR, Islam MN and Khan MAS (1995). Detection of adulteration of milk. *Progressive Agriculture* 6 : 15-20

930. Rahman A, Habib MR, Ali MY, Islam MA and Rashid MH (2017). Physico-chemical analysis and detection of adulteration in raw milk collected from goalas of different places of sadar upazila in Mymensingh district. *Research in Agriculture, Livestock and Fisheries* 4 : 99-106 [doi: 10.3329/ralf.v4i2.33721]

931. Rakib MRH, Habib R, Hassan MN, Imam MF and Hassan MN (2014). Development of turbidity index as field method to detect mixing of heated milk with raw milk. *Bangladesh Journal of Animal Science* 43 : 123-127

932. Domingo E, Tirelli AA, Nunes CA, Guerreiro MC and Pinto SM (2014). Melamine detection in milk using vibrational spectroscopy and chemometrics analysis: A review. *Food Research International* 60: 31-39

933. Kandpal SD, Srivastava AK and Negi KS (2012). Estimation of quality of raw milk (open & branded) by milk adulteration testing kit. *Indian Journal of Community Health* 24:3

934. Habib R, Islam MN, Khan MAS and Habib MA (2006). Manufacture of table cream from reconstituted milk. *Journal of Bangladesh Society of Agricultural Science and Technology* 3 : 21-24

935. Habib R, Islam MN, Khan MAS and Habib MA (2006). Production of low fat-milk in the household by gravity method. *Journal of Bangladesh Society of Agricultural Science and Technology* 3: 29-32

936. Habib R, Islam MN, Khan MAS and Habib MA (2006). Manufacture of peda from sweetened condensed milk. *Journal of Bangladesh Society of Agricultural Science and Technology* 3 : 181-184

937. Mukhtaruzzaman M (1994). The use of vegetable oil in manufacture of Khulna cheese from powdered milk. *Bangladesh Veterinarian* 11: 45-49

938. Tila RJ, Wadud A, Islam MA, Sayedutunnesha and Matubbar A (2008). Comparative study on the quality of khejur (Phoenix sylvestris) gur sandesh manufactured in the laboratory and different sweetmeat shops of Jessore district. *Journal of the Bangladesh Society for Agricultural Science and Technology* 5 : 69-72

939. Ahmed ABMK, Habib MR, Afrin S, Islam MA and Harun-ur-Rashid M (2016). Uses of milk in sweetmeat shops and consumer preferences to milk products at Mymensingh municipality in Bangladesh. *Asian Journal of Medicine and Biological Research* 2 : 266-273 [doi: 10.3329/ajmbr.v2i2.29070]

940. Banglapedia (2015). Sweetmeats. En.banglapedia.org/index.php?title=Sweetmeats

941. Mannan AKMA, Saha J, Rahman MS and Miah MAH (1983). Studies on the sanitary and keeping qualities of butter made from raw and pasteurized cream of different ages at the storage temperature of ^{0}C and 5 ^{0}C. *Bangladesh Journal of Animal Science* 12 : 25-31

942. Begum J, Islam MN, Rashid MH, Hassan MN, Islam MZ and Siddiki MSR (2019). Effect of coagulants on the yield and quality of Chhana and Rasogolla. *Asian Journal of Dairy and Food Research* 38 : 186-190 [doi: 10.18805/ajdfr.DR-139]

943. Parvin S, Hassan MN and Rahman MM (2001). Comparative study on the production of rasogolla from fresh cow milk and commercial powder milk. *Bangladesh Journal of Animal Science* 30 : 143-147

944. Chandha T, Islam MN, Debnath GK and Kabir MJ (2001). Studies on the storage life and keeping quality of rasogolla at room temperature. *Bangladesh Journal of Animal Science* 30 : 149-154

945. Chanda T, Islam MN, Debnath GK, Kober AKMH and Chanda GC (2002). Preparation of rasogolla from different proportionate mixture of cow's milk and soy-milk curd. *Bangladesh Journal of Animal Science* 31 : 99-106

946. Haque A, Alam MJ, Hasanuzzaman M, Islam MN and Azad MAK (2003). Comparison of rasogolla made from fresh cow milk, fresh buffalo milk and mixture of cow and buffalo milk. *Pakistan Journal of Nutrition* 2 : 296-299

947. Basak S, Hassan MN, Uddin MJ and Iqbal A (2007). Quality of rasogolla prepared from cow's milk with the addition of different levels of flour. *Bangladesh Journal of Animal Science* 36 : 105-112

948. Rahman MF, Islam MN, Hasan MN, Siddiki MSR and Naznin F (2010). Comparison of the rossogolla (balish) prepared in the laboratory and collected from market of Netrokona district. *Bangladesh Journal of Animal Science* 39 : 134-143

949. Begum J, Islam MN, Rashid MH, Islam MZ and Siddiki MSR (2020). Effects of different concentrations of cooking and soaking sugar syrup on the physic-chemical quality of Rasogolla. *Journal of Dairy and Veterinary Science* 14 : 77-81

950. Tarafdar SU, Pramanik MAH, Basak B, Rahman MS and Biswas SK (2002). A comparative study on the quality of rasogolla made in laboratory and collected from local markets of Mymensingh, Bangladesh. *Pakistan Journal of Nutrition* 1 : 156-160 [doi: 10.3923/pjn.2002.156.160]

951. Prodhan UK, Alam MJ, Sultana A, Harun-Ar-Rashid M, Das T, Akter N and Rahman MM (2017). Quality assessment of sweetmeat (rosogolla) of Dhaka and Tangail region of Bangladesh. *Journal of Environmental Science, Toxicology and Food Technology* 11 : 6-11 [doi: 10.9790/2402-1107010611]

952. Kober AKMH, Islam MN and Debnath GK (2002). Physical, chemical and microbiological qualities of Sandesh (milk sweet). *Bangladesh Veterinarian* 19 : 23-28

953. Kober AKMH, Islam MN and Amin MR (2003). Effects of cardamom on self-life of Sandesh (milk sweet) at room temperature. *Bangladesh Veterinarian* 20 : 64-71

954. Kober AKMH, Islam MN and Hassan MN (2006). Effects of cardamom (Elettaria cardamomum) as preservative of sandesh (Chana sweet). *Bangladesh Veterinarian* 23 : 42-GK 46

955. Islam MZ, Rahman SMR, Alam MM and Mannan AKMA (2003). Manufacture of rasomalai and its quality attributes: An indigenous milk sweetmeat of Bangladesh. *Pakistan Journal of Nutrition* 2: 300-304

956. Yasmin S, Wadud A, Islam MN and Hasan T (2005). Study on the quality of the rasomalai manufactured in laboratory and sweetmeat shops of different districts of Bangladesh. *Journal of the Bangladesh Agricultural University* 3 : 71-76

957. Sayedatunnesha, Wadud A, Islam MN, Islam MA and Hossain MA (2008). Comparative study of the quality of Rasomali manufactured from cow and buffalo milk. *Bangladesh Journal of Animal Science* 37 : 57-62

958. Islam MN, Parvin F, Hossain MS, Wadud A, Siddiki MSR and Khan MS (2015). Replacement of cow milk chhana with soy chhana in the preparation of rasomlai. *Bangladesh Journal of Animal Science* 44 : 59-63

959. Rasul M, Hassan MN, Khan MAS, Sharmin MM and Islam MA (2013). Comparative study of Indrani vough manufactured in the laboratory and collected from sweet shops of Dinajpur district. *Bangladesh Journal of Animal Science* 42 : 71-75

960. Haque MA, Rashid MH, Kajal MFI and Istiak MS (2012). Comparison of chamcham manufactured from cow milk and buffalo milk. *Journal of Bangladesh Agricultural University* 10 : 255-260

961. Prajapati PS, Chavan RS, Jana A and Chavan SR (2011). Rasogolla- Ambrosia of Indian: A Review. *Beverage and Food World* 45: 27-30

962. Miah AH and Quddus A(1970). Standards and standardization in the manufacture of Dacca cheese-I. A. Standards of Commercial Dacca cheese. *Animal Science Journal of Pakistan* 3 : 33-38

963. Miah AH and Quddus MA (1971). Standards and standardization in the manufacture of Dacca cheese-II. B. Effect of manufacturing. *Animal Science Journal of Pakistan* 4 : 23-31

964. Miah AH, Chanda GC and Hasan N (1982). Effect of different starter cultures on the quality of Dhaka cheese. *Bangladesh Journal of Agricultural Sciences* 9 : 225-235

965. Mannan AKMA, Hoque Z and Rahman MS (1982). Study on the manufacturer of rennet extracts obtained from the fourth stomach of young calves of different ages. *Bangladesh Journal of Animal Science* 11 : 47-51

966. Zaman MM (1995). Effect of citric acid in milk on cured formation and manufacture of Austogram cheese. *Progressive Agriculture* 6: 57-60

967. Azam G, Kamruzzaman M and Islam MN (2004). A comparison of the different coagulants for making cheese. *Bangladesh Veterinarian* 21 : 114-118

968. Habib R and Hassan MN (2005). Quality of Dhaka cheese available in Dhaka city markets. *Bangladesh Journal of Animal Science* 34 : 111-119

969. Hossain N, Hassan N, Islam MN, Islam MA and Matubbar A (2008). Effect of hot ripening on the quality of cheddar cheese. *Bangladesh Journal of Progressive Science and Technology* 6 : 341-344

970. Mijan MA, Haque MA, Habib MA and Wadud MA (2010). Evaluation of quality of mozzarella cheese. *Bangladesh Veterinarian* 27 : 36-42

971. Habib R (2015). Effect of salting method on salt concentration in Dhaka cheese. *Progressive Agriculture* 26 : 79-84

972. Rana MS, Hoque MR, Rahman MO, Habib R and Siddiki MSR (2017). Papaya (Carica papaya) latex- an alternative to rennet for cottage cheese preparation. *Journal of Advanced Veterinary and Animal Research* 4 : 249-254

973. John C (2020). How to make vanilla ice crème.allrecipes.com/recipe/233928/how-to-make-vanilla-ice-cream/

974. Khan MAK, Mannan AKMA, Rahman MM and Hassan MN (1983). Study on the bacteriological quality of commercially produced ice-cream in Bangladesh. *Bangladesh Veterinary Journal* 17 : 51-55

975. Mannan AKMA, Islam MA, Miah MAH and Rahman MS (1984). Effect of various stabilizing agents on the properties of ice cream. *Bangladesh Journal of Animal Science* 13: 15-24

976. Khan MAK, Mannan AKMA and Rahman MF (1986). Studies on the quality of market ice cream in Bangladesh. *Bangladesh Journal of Animal Science* 15: 11-16

977. Rahman MM, Rahman GI, Mahbub-E-Elahi ATM, Rahman MM, Ali MR and Rahman MA (2000-2001). Sanitary quality of commercially produced ice cream sold in retail stores. *Bangladesh Journal of Livestock Researc*h 7-8 (1-2): 7-11

978. Mahbub-E-Elahi ATM, Habib S, Rahman MM, Rahman GI and Bhuiyan MJU (2002). Sanitary quality of commercially produced ice cream sold in the retail stores. *Pakistan Journal of Nutrition* 1: 93-94

979. Uddin MJ, Hassan MN, Wadud A, Siddiki MSR and Hassan MR (2006). The manufacture of ice cream from skim milk with the addition of vegetable oil and different levels of non-fat dry milk. *Bangladesh Journal of Animal Science* 35 : 53-58

980. Hossain MT and Kober AKMH (2008). Microbiological quality of ice cream available in Chittagong. *Bangladesh Journal of Microbiology* 25 : 135-136

981. Akter S and Ahmed S (2012). Bacterial analysis of different types of ice creams from Dhaka city. *Bangladesh Journal of Microbiology* 29 : 41-43

982. Rahman T, Sharma BC and Islam MN (2015). Microbiological profiling of ice cream samples sold in the retail shops in Dhaka city. *Bangladesh Journal of Microbiology* 32 : 45-48

983. Sarker S and Sur M (2017). Augmentation of biofunctionality of dahi. *International Journal of Dairy Science* 12: 243-253

984. Aryana KJ and Olson DW (2017). A 100-year review: yogurt and other cultured dairy products. *Journal of Dairy Science* 100: 9987-10013 [doi: 10.3168/jds.2017-12981]

985. Hassan N and Miah AH (1972-73). A study on starter cultures for the manufacturer of dahi. *Bangladesh Journal of Animal Science* 5-6 : 5-11

986. Miah AH and Pramanik SC (1974-75). Study on the inhibition and preservation of starter culture. *Bangladesh Journal of Animal Science* 7-8 : 14-22

0987. Hassan N and Miah AH (1975-76). Effect of added milk solids-not-fat on the characteristics of dahi II. *Bangladesh Journal of Animal Science* 9-10 : 73-76

0988. Islam MN, Hassan MN, Mannan AKMA and Husain SMI (1986). Influences of laboratory and market cultures on the constituents of milk during fermentation. *Bangladesh Veterinary Journal* 20 : 23-24

0989. Dev A, Hasan MN and Islam MN (1992). A study on the utilization of skim milk and skim milk powder in the form of dahi. *Bangladesh Journal of Animal Science* 21 : 89-95

0990. Chakraborty M, Islam MN, Rashid MH and Mannan AKMA (2000). Dahi from different proportions of cow's and buffalo's milk. *Bangladesh Journal of Animal Science* 29 : 61-68

0991. Rahman MR, Rashid MH, Islam MN, Hasan MN and Hasan S (2001). Utilization of Jack fruit juice in the manufacturer of yoghurt. *Online Journal of Biological Science* 1 : 880-882

0992. Ali MY, Islam MA, Alam MJ and Islam MN (2002). Quality of yoghurt (dahi) made in laboratory and available in the market of Mymensingh town in Bangladesh. *Pakistan Journal of Biological Sciences* 5 : 343-345

0993. Kamruzzaman M, Islam MN, Rahman MM, Parvin S and Rahman MF (2002). Evaporation rate of moisture from dahi (yogurt) during storage at refrigerated condition. *Pakistan Journal of Nutrition* 1 : 209-211

0994. Mustafa MHH, Hassan MN and Islam MN (2002). Preparation of fruit dahi by using seasonal fruits available in local market. *Bangladesh Journal of Animal Science* 31 : 129-138

0995. Hassan MN, Islam MN and Hasan MN (2002). Preparation of dahi by using seasonal fruits available in local markets. *Bangladesh Journal of Animal Science*31: 129-138

0996. Kamruzzaman M, Islam MN, Rashid MN and Rahman MN (2003). Replacement of whole milk with banana juice for manufacture of fruit dahi. *Bangladesh Veterinarian* 20 : 128-135

0997. Munzur MM, Islam MN, Akhter S and Islam MR (2004). Effect of different levels of vegetable oil for the manufacture of dahi from skim milk. *Asian Australasian Journal of Animal Sciences* 17 : 1019-1-25

0998. Habib R, Hassan MN, Khan MAS, Islam MN and Hasan T (2004). Preparation of dahi from cow milk and powdered milk by using single bacterial culture of Lactobacillus acidophilus. *Bangladesh Journal of Animal Science* 33 : 101-110

0999. Alam SMK, Munzur MM, Akhter S and Wadud A (2005). A comparative study on the quality of yoghurt prepared from cow, buffalo and goat milk. *SAARC Journal of Agriculture* 3: 1-5

1000. Harun-ur-Rashid M and Miyamoto TM (2005). Quality evaluation of traditional fermented milk dahi in Bangladesh. *Milk Science* 54: 29-36

1001. Sultana MN, Wadud A, Islam MN and Uddin MJ (2006). Study on the quality of dahi prepared from buffalo milk with the addition of different levels of soya milk. *Journal of the Bangladesh Agricultural University* 4 : 111-116

1002. Ahmed S, Uddin MM, Siddiki MSR, Hassan MN and Islam MN (2006). Microbial qualities of fermented yoghurt drinks manufactured from skim milk by adding different types of flavors and levels of sugar. *Journal of the Bangladesh Society of Agricultural Sciences and Technology* 3 : 173-176

1003. Shaheen SMS, Uddin MJ, Islam MN and Sarker MM (2007). Thermal effect on keeping quality of yoghurt (dahi). *Journal of the Bangladesh Agricultural University* 5 : 345-352

1004. Kober AKMH, Mannan MA, Debnath GK and Akhter S (2007). Quality evaluation of yoghurt sold in Chittagong metropolitan area in Bangladesh. *International Journal of Sustainable Agricultural Technology* 3 : 41-46

1005. Hossain MA, Wadud A, Khan MAS, Islam MA and matubbar A (2008). Preparation of dahi from cow milk adding of coconut milk. *Bangladesh Journal of Progressive Science and Technology* 6: 354-348

1006. Islam MA, Wadud A, Khan MAS, Islam MA and Matubbar A (2008). Study on the quality of dahi prepared from different forms of commercial milk. *Bangladesh Journal of Progressive Science and Technology* 6 : 441-444

1007. Shekh L, Wadud A, Islam MA, Rahman SME, Sarker MM, Ding T, Choi JH and Oh DH (2009). Study on the quality of market dahi compared to laboratory made dahi. *Journal of Food Hygiene and Safety* 24 : 318-323

1008. Akter N, Nahar A, Islam MN, and Al-Amin M (2010). Effects of different level of starter culture and sugar on manufacturing characteristics of misti dahi (sweet yoghurt). *Journal of the Bangladesh Agricultural University* 8 : 245-252

1009. Bhuiyan AI, Wadud A, Nahar A and Al-Amin M (2010). Effects of different approaches on the quality of dahi. *Journal of the Bangladesh Agricultural University* 8 : 233-238

1010. Islam MN, Akhter F, Masum AKM, Khan MAS and Asaduzzaman M (2010). Preparation of Dahi for diabetic patient. *Bangladesh Journal of Animal Science* 39 : 144-150

1011. Dey S, Iqbal A, Ara A and Rashid MH (2011). Evaluation of the quality of dahi available in Sylhet metropolitan city. *Journal of the Bangladesh Agricultural University* 9 : 79-83

1012. Begum J, Nahar A, Islam MN and Rahman MM (2011). Qualitative characteristics of dahi prepared from non-fat-dry milk fortified with vegetable oil. *Bangladesh Research Publication Journal* 6 : 35-92

1013. Chowdhury NA, Paramanik K and Zaman W (2011). Study on the quality assessment of curd (dahi)locally available in Bangladesh market. *World Journal of Food Dairy Science* 6 : 15-20

1014. Sarkar MM, Nahar TN, Alam MK, Rahman MM, Rashid MH and Islam MA (2012). Chemical and bacteriological quality of popular Dahi available in some selected areas of Bangladesh. *Bangladesh Journal of Animal Science* 41 : 47-51

1015. Amin MR, Islam MN, Habib MA and Islam F (2012). Shelf-life of dahi (yogurt) with or without potato mash. *Bangladesh Veterinarian* 29 : 22-30

1016. Hossain MN, Farruddin M and Islam MN (2012). Development of fruit dahi (yoghurt) fortified with strawberry, orange and grapes juice. *American Journal of Food Technology* 7 : 562-570 [doi: 10.3923/ajft.2012.562.570]

1017. Rakhi TA, Islam MN, Hoque SAM and Rahman MM (2013). Development of mango flavored soy dahi. *Bangladesh Journal of Animal Science* 42 : 44-48

1018. Uddin MR, Mazed MA, Islam MS, Hasan N and Khan MAS (2013). Comparative study on the dahi-prepared from whole milk, skim milk, reconstituted milk and recombined milk. *Journal of Environmental Science and Natural Resources* 6 : 261-266

1019. Rahman MA, Islam MN, Khan MAS, Sharmin MM and Islam MA (2013). Quality evaluation of dahi (curd) made in the laboratory and collected from local markets of Mymensingh district in Bangladesh. *Journal of Science and Technology* 11: 128-132

1020. Hossain AA, Habib R, Islam MN and Rakib MRH (2014). Use of date-palm (Phoenix dactylifera L.) brown sugar as a sweetener for making dahi. *Bangladesh Journal of Animal Science* 43 : 62-67

1021. Kabir MA, Rashid MH, Hassan MN, Afroz MF and Miraz FH (2014). Manufacture of dahi from skim milk adding mango juice. *Bangladesh Journal of Animal Science* 43 : 128-131

1022. Saha SR, Islam MN, Sheekh AL and Siddiki MSR (2014). Dahi manufacturing from reconstituted skim milk partially replaced by coconut milk. *Bangladesh Journal of Animal Science* 43 : 218-223

1023. Islam MR, Bari MS, Chanda GC, Rahman MM and Kibria ASMG (2014). Physical, chemical and microbiological parameters of brand dahi available in Bogura, Bangladesh. *Advances in Agriculture, Sciences and Engineering Research* 4 : 1750-1759

1024. Islam MN, Hossain MS, Rashid MH, Siddiki MSR, Khan MS and Parvin F (2015). Preparation of dahi from buffalo milk and blends with soy milk. *Bangladesh Journal of Animal Science* 44 : 137-142

1025. Bari MS, Islam S. Mahmud MH, Ali MS and Khan MSI (2015). Chemical and microbiological evaluation of yoghurt available in the market of Bangladesh. *Wayamba Journal of Animal Science* 7 : 1119-1123

1026. Hossain AYMZ, Shaheb MR, Ahmed S and Sarker A (2015). Studies on the microbial quality of yoghurts in Sylhet city and preparation of new flavored yoghurts. *American Journal of Food Science and Nutrition Research* 2 : 172-179

1027. Islam MN, Muzahid AAM, Habib R, Mazed MA and Salam MA (2016). Preparation of dahi from skim milk with different level of carrot juice. *Bangladesh Journal of Animal Science* 45 : 36-43

1028. Ahmed S, Islam MN, Rashid MH, Islam MM and Masum AKM (2016). Evaluation of dahi collected from Netrokona district in Bangladesh. *Bangladesh Journal of Animal Science* 45 : 60-65

1029. Islam MN, Arefin S, Sarker MAH, Akhter S and Habib R (2016). Feasibility of using sodium alginate for improving structural quality of sweet dahi. *Bangladesh Journal of Animal Science* 45 : 66-72

1030. Yesmin M, Rakib MRH, Hossain AA, Khan A and Islam MN (2016). Determination of appropriate level of fat in milk for the production of good quality dahi. *Asian Journal of Medical and Biological Research* 2 : 253-258

1031. Zohra FT, Islam MN, Siddiki MSR, Habib MR and Afrin S (2016). Effect of different levels of water on qualitative characteristics of Lassi prepared from reconstituted milk. *Bangladesh Journal of Animal Science* 45 : 46-51

1032. Rakib MRH, Yesmin M, Hemayet MA, Kabir MA and Islam MN (2016). Effect of fortification of skim milk with coconut milk on the proximate composition and manufacture of dahi, a traditional sweet curd. *Asian Journal of Medicine and Biological Research* 2 : 247-252

1033. Islam MN, Khan A, Masum AKM and Habib R (2016). Partial replacement of skim milk for preparation of dahi. *Fundamentals and Applied Agriculture* 1 : 12-16

1034. Afrin S, Habib MR, Islam MA and Rashid MH (2016). Physical, chemical and microbiological qualities of dahi collected from Bogura and Mymensingh district of Bangladesh. *Asian Australasian Journal of Bioscience and Biotechnology* 1 : 134-140

1035. Biswas SR, Kibria S, Habib MR, Siddiki MSR and Harun-ur-Rashid M (2017). Preparation of dahi from cow and buffalo skim milk with addition of mango (*Mangifera indica*) juice. *Asian Journal of Medicine and Biological Research* 3 : 191-197

1036. Kibria S, Masum AKM, Islam MA and Harun-ur-Rashid M (2017). Mineral profiles of powdered milk, yogurt, ice cream and raw milk. *Asian Journal of Medical and Biological Research* 3 : 294-297

1037. Islam M, Fakir MAH, Rahman MA and Choudhury KA (2017). Comparative assessment of dahi (yogurt) collected from different areas of Bangladesh. *International Journal of Natural and Social Sciences* 4 : 17-25

1038. Matin A, Banik T, Badsha MR, Hossain A, Haque MM and Ahmad M (2018). Microbiological quality analysis of yoghurt in some selected areas of Bangladesh. *International Journal of Natural and Social Sciences* 5 : 82-86

1039. Sarker MT, Prabakusumua AS and Islam MS (2018). Dahi (curd) preparation from milk with different levels of carrot (Dacus carota) juice. *MOJ Food Processing and Technology* 6 : 66-71 [doi: 10.15406/mojfpt.2018.06.00146]

1040. Moazzem MS, Islam MN, Masum AKM and Habib MR (2018). Effect of different levels of sugar on qualitative characteristics of lassi prepared from sour dahi. *Fundamentals and Applied Agriculture* 3 : 434-439

1041. Folio3 (2018). What are some famous beef cattle breeds?- All you need to know. Animalcare.folio3.com/beef-cattle-breeds/

1042. Cook R (2020). Cattle breeds by origin of country. Beef2live.com/story-cattle-breeds-origin-country-89-104667

1043. Baset MA, Rahman MM, Islam MS, Das GB and Ara A (2002). Beef cattle production in Bangladesh- A Review. *Online Journal of Biological Sciences* 2: 429-435 [doi: 10.3923/jbs.2002.429.435]

1044. Haque MA, Fatematuzzohora M, Hoque MA and Ali MY (2016). Evaluation of growth performance of Brahman calves to local environment of Bangladesh. *Asian Journal of Medical and Biological Research* 2: 259-265

1045. Shejuty KN, Papry KN, Hussain SS and Hoque MA (2020). Effect of sire and environment on growth performance of grade-2 Brahman calves. *Journal of Bangladesh Agricultural University* 18: 456-467

1046. Papry KN, Shejuty SF, Bhuiyan AKFH and Hoque MA (2020). Growth performance of graded Brahman calves in selected areas of Mymensingh district. *Journal of Bangladesh Agricultural University* 18: 435-441 [doi: 10.5455/JBAU.73448]

1047. Rahman MA, Hossain MM, Azad MAK and Akhter S (2009). Factors affecting beef cattle production from farmers to consumers. *Bangladesh Journal of Environmental Science* 17: 182-187

1048. Rashid MM, Hoque MA, Huque KS, Talukder MAI and Bhuiyan AKFH (2015). Morphometric characterization of Brahman crossbred cattle and prediction of live weight using linear body measurements. *Asian Journal of Medical and Biological Research* 1: 569-577 [doi: 10.3329/ajmbr.v1i3.26480]

1049. Mostari MP, Khan MYA, Roy BK, Hossain SMJ and Huque KS (2017). Growth performance of yearling F1 progeny of different crossbred beef cattle. *Bangladesh Journal of Animal Science* 46 : 82-87

1050. Bhuiyan AKFH, Dieti G and Klautschek G (2003). Genetic trends in the development of crossbreeding system in beef breeding. *Journal of Bangladesh Agricultural University* 1 : 49-61

1051. Bhuiyan AKFH, Dieti G and Klautschek G (2004). The genetic development of sire, dam and progeny and genotype × environment interaction in a beef breeding system. *Asian Australasian Journal of Animal Science* 17 : 13-17

1052. Begum MAA, Hossain MM, Khan M, Rahman MM and Rahman SME (2007). Cattle fattening practices of selected farmers in Panchagarh district. *Bangladesh Journal of Animal Science* 36 : 62-72

1053. Sabur SA, Alam MJ and Halim MA (2000). An agribusiness study on beef and beef products in Dhaka city. *Bangladesh Journal of Animal Science* 29 : 35-46

1054. Rashid MMO and Kamruzzaman M (2015). Economics of beef cattle production in selected areas of Bangladesh. *Wayamba Journal of Animal Science* 7 : 1232-1238

1055. Rashid MM, Huque KS, Hoque MA, Sarker NR and Bhuiyan AKFH (2015). Effect of concentrate to roughage ratio on cost effective growth performance of Brahman crossbred calves. *Journal of Agricultural Science and Technology* 5: 286-295 [doi: 10.17265/2161-6256/2015.04.00]

1056. Rashid MM, Hoque MA, Huque KS and Bhuiyan AKFH (2016). Genotype × environment interactions in growth performance of Brahman crossbred cattle in Bangladesh. *Asian Journal of Animal Sciences* 10: 68-76 [doi: 10.3923/ajas.2016.68.76]

1057. Matin MA, Bhuiyan AKFH and Samad MA (1993). Genetic and non-genetic factors affecting birth weight of pure and crossbred dairy cattle. *Bangladesh Veterinarian* 10 : 1-5

1058. Afroz MA, Hoque MA and Bhuiyan AKMFH (2011). Estimation of heritability for growth traits of Red Chittagong cattle in a nucleus herd. *Bangladesh Veterinarian* 28 : 39-46

1059. Hossain MS, Rashid MHO, Sarker SC, Trisha AA, Sumon MRA, Majumder MKH and Islam F (2016). Growth performances and husbandry practices of Holstein-Friesian × local crossbred calves in the villages of Pabna and Natore districts in Bangladesh. *Bangladesh Journal of Progressive Science and Technology* 14: 28-31

1060. Rahman SMA, Bhuiyan SA and Bhuiyan AKFH (2015). Effects of genetic and non-genetic factors on growth traits of high yielding dairy seed calves and genetic parameter estimates. *Journal of Advances Veterinary and Animal Research* 2 : 450-457

1061. Holland MD and Odde KG (1992). Factors affecting calf birth weight: A Review. *Theriogenology* 38: 769-798 [doi: 10.1016/0093-691x(92)90155-k]

1062. Thomas HS (2014). Factors affecting birth weight in calves.progressivecattle.com/topics/ reproduction/factors-affecting-birthweight-in-calves

1063. Hossain SMJ, Bhuiyan AKFH, Afroz MF, Kabir MA, Miraz MFH and Habib M (2018). Growth performance of Red Chittagong cattle based on phenotypic and genetic parameters. *International Journal of Animal Science* 2 : 1-6

1064. AHDB (2020). Calf management. Media.ahdb.org.uk/media/default/imported%20publication%20Docs/calfManagement_180629_WEB.pdf

1065. Oliveira MS and Stone AE (2018). Dairy calf management from birth to weaning. Extension.msstate.edu/sites/default/files/publications/publications/p3274.pdf

1066. Foley JA and Otterby DE (1978). Availability, storage, treatment, composition and feeding value of surplus colostrum: A Review. *Journal of Dairy Science* 61: 1033-1060

1067. DeLaval (2020). Calf management lifetime productivity starts when the calf is born. Delavalcorporate.com/globalassets/category-pages/delaval-calf-care-and-management-booklet.pdf

1068. CSIRO (2000). Calf milk replacers- CSIRO Publishing. www.publish.csiro.au>ebook> 9780643107427_Chapter4PDF

1069. Mursheduzzaman M and Rahman MS (1968). Bone meal in calf rations. *Animal Science Journal of Pakistan* 1 : 52-56

1070. Rahman MS and Hussain SMI (1972-1973). Relative feeding and economic value of different feed additives in growing ration of Sahiwal bull calves. 1. Effect of TM-5 with or without vitamins A & D combined. *Bangladesh Journal of Animal Science* 5-6 : 21-29

1071. Rahman MS and Hussain SMI (1975-76). Relative feeding and economic values of different feed additives in fattening ration of Sahiwal bull calves. II. Effect of TM-5 with vitamin A alone and vitamin A and D combined. *Bangladesh Journal of Animal Science* 9-10: 47-53

1072. Wadud A and Rahman MS (1978). Performance of baby calves fed milk replacers comprising of locally available ingredients. *Bangladesh Veterinary Journal* 12 : 16-26

1073. Wadud A, Zaman MM, Samad MA and Hussain SMI (1985). Effect of whole milk and different milk replacers in calf raising. *Bangladesh Journal of Animal Science* 14 : 13-17

1074. Zaman MM, Rahman MS, Akbar MA and Samad MA (1987). Comparative feeding values of different calf starter combinations up to one year of age of calves. *Bangladesh Journal of Agricultural Sciences* 14 : 17-20

1075. Khan MAS, Rahman MS, Mannan AKMA and Hussain SMI (1987). Influence of different levels of Shoti (*Zeodaria decumbens*) used in the formulation of calf starter. *Bangladesh Journal of Animal Science* 16 : 27-31

1076. Rahman F, Rahman MS, Wadud A and Hussain SMI (1988). Study on growth performance of baby calves as influenced by milk replacers. *Bangladesh Journal of Agricultural Sciences* 15 : 189-192

1077. Zaman MM, Wadud A, Sarker DRD, Samad MA and Hashem MA (1990-1993). Comparative study on the starter mixture for calves up to six months of age. *Bangladesh Veterinary Journal* 24-27 : 99-104

1078. Rahman MM, Islam MR and Zaman MS (1992). Study on the feeding regimes and growth pattern of pre-ruminant Pabna zebu calves. *Asian Australasian Journal of Animal Sciences* 5 : 659-664

1079. Mannan MA, Islam MN, Sarker DRD, Husain SMI and Talukder MAI (1993). Study on some growth parameters of crossbred calves. *Bangladesh Veterinarian* 10 : 43-47

1080. Mukhtaruzzaman M and Hashem MA (1994). Study on the growth performance of crossbred dairy calves fed different calf-starter. *Bangladesh Veterinarian* 11 : 50-54

1081. Masum AKM, Islam MN and Khan MAS (2009). Utilization of soymilk as milk replacer for calves. *Bangladesh Journal of Animal Science* 38 :102-107

1082. Roy A, Sarker NR, Huque KS and Roy BK (2011). Effect of feeding shoti based milk replacer to calves under on-farm and on-station conditions. *Bangladesh Journal of Livestock Research* 18: 26-34

1083. Roy BK, Sarker NR, Alam MK and Huque KS (2020). Growth performance of calves fed sshoti, wheat and soybean based milk replacers. pdfs.semanticscholar.org/ac7b/2a8789c27d9188e6d06089cd0f328992d809.pdf

1084. Kertz AF, Hill TM, Quigley JD, Heinrichs AJ, Linn JG and Drackley JK (2017). A 100-year Review: Calf nutrition and management. *Journal of Dairy Science* 100: 10151-10172 [doi: 10.3168/ids.2017-13062]

1085. Yaylak E, Orhan H and Daskaya A (2015). Some environmental factors affecting birth weight, weaning weight and daily live weight gain of Holstein calves. *Turkish Journal of Agriculture-Food Science and Technology* 3: 617-622

1086. Alam MN, Kabir AKMA, Sakib MN and Azad MS (2016). Impact of livestock rearing practices on public health and environmental issues in selected municipality areas of Bangladesh. *Bangladesh Journal of Animal Science* 45 : 44-51

1087. Lindquist K (2019). How to cull cattle. Wikihow.com/Cull-Cattle

1088. Hadley GL, Wolf CA and Harsh SB (2006). Dairy cattle culling patterns, explanations and implications. *Journal of Dairy Science* 89: 2286-2296 [doi: 10.3168/jds.S0022-0302(06)72300-1]

1089. Dohoo IR and Dijkhuizen AA (1993). Techniques involved in making dairy cow culling decisions. *Compodium on Continuing Educationfor the Practising Veterinarian* 15: 515-519

1090. Fetrow J, Nordlund KV and Norman HD (2006). Invited review: Culling: nomenclature, definitions and recommendations. *Journal of Dairy Science* 89 : 1896-1905 [doi: 10.3138/jds.S0022-0302(06)72257-3]

1091. Ansari-Lari M, Mohebbi-Fani M and Rowshan-Ghasrodashti A (2012). Causes of culling in dairy cows and its relation to age at culling and interval from calving in Shiraz, Southern Iran.*Veterinary Research Forum* 3: 233-237

1092. Bascom SS and Young AJ (1998). A summary of the reasons why farmers cull cows. *Journal of Dairy Science* 81: 2299-2305

1093. Hussain SMI, Wadud A, Mannan AKMA, Hassan MN and Islam MN (1983). Culling pattern among different breeds of cows at the Bangladesh Agricultural University Dairy Farm. *Bangladesh Veterinary Journal* 17 : 75-78

1094. Wadud A, Hussain SMI, Samad MA and Shil RN (1985). Reason for disposal and age specific disposal rates of cross bred cows in BAU dairy farm. *Bangladesh Journal of Animal Science* 14: 13-17

1095. GOB (2015). Draft national integrated livestock manure management (ILMM) policy. Ministry of Fisheries and Livestock, GOB

1096. Geber PJ, Steinfield H, Henderson B, Mottel A, Opio C, Dijkman J, Falcucci A and Tempio G (2013). Tackling climate change through livestock: A global assessment of emission and mitigation opportunities. FAO, Rome.

1097. Huque KS, Khanam JS, Amanullah SM, Huda N, Bashar MK, Vellinga T, Fielding M and Hicks K (2017). Study on existing livestock manure management practices in Bangladesh. *Current Journal of Applied Science and Technology* 22: 1-10 [doi: 10.9734/CJAST/2017/34675]

1098. Rahman KM, Harder MK and Woodard R (2018).Energy yield potentials from the anaerobic digestion of common animal manure in Bangladesh. *Energy and Environment* 29 : 1-16 [doi: 10.1177//0958305X18776614]

1099. Khan S (2019). The need and prospect of promoting biogas in the country. thefinalcialexpress.com.bd/views/the- need-and-prospect-of-promoting-biogas- in- the-country-1569686636

1100. Energypedia (2015). Biogas technology in Bangladesh. energypedia.info/wiki/Biogas_Technology_in_Bangladesh

1101. Rouf MA (2008). Studies on smoke opacity of different type of diesel vehicles in Dhaka city. *Bangladesh Journal of Scientific and Industrial Research* 4: 559-570

1102. Bosu SK, Rashid MA and Rahman MH (1993). Effect of mechanical mixing on biogas generation. *Bangladesh Journal of Animal Science* 22: 93-99

1103. Kabir H and Khan M (2010). Using the metafrontier approach for estimating technical efficiency and technological gaps of biogas plants under different regions in Bangladesh. *Bangladesh Research Publication Journal* 4 : 31-40

1104. Uddin ME, Larson RA and Wattiaux MA (2020). Effects of dairy cow breed and dietary forage on greenhouse gas emissions from manure during storage and after field application. *Journal of Cleaner Production* 270: 122461 [doi: 10.1016/jclepro.2020.12246]

1105. Nessa A, Pimpi SK and Akand K (2014). Status of biogas production in Tangail district, Bangladesh. *Journal of Environmental Science and Natural Resources* 7: 81-85

1106. Shahrul IM, Hasan MF, Mamun MAA, and Malek ABMA (2007). Prospect of biogas plant in the rural area of Bangladesh. *Engineering e-Transaction* 2: 31-37

1107. Wali WM (1986). Design of an ideal stanchion type commercial dairy barn for Bangladesh. *Bangladesh Journal of Animal Science* 15: 62-68

1108. Rahman MM, Habib S, Kadir MA, Islam MM and Islam MS (2002). Participation of rural people in cattle management practices in a selected area of Bangladesh. *Journal of Animal and Veterinary Advances* 1 : 196-199

1109. Habib MA, Bhuiyan AKFH and Amin MR (2009). Birth weight and its non-genetic effect in Red Chittagong cattle (RCC) in a closed nucleus herd. *International Journal of Biological Research* 1: 35-39

1110. Obaidullah SM, Islam MN, Bhuiyan AKFH, Apu AS, Rahman AHMS and Islam MA (2008). Changes in the composition of colostrum of Red Chittagong cows from calving to transition in milk. *International Journal of Bioresearch* 4 : 19-24

1111. Islam MR, Zaman MS, Nahar TN and Kibria SS (1990). The effect of parity on calving pattern of zebu cows. *Bangladesh Veterinarian* 7 : 43-44

1112. Ali ML, Hasnath MR, Uddin M and Islam N (1999). Influence of season of birth on calving frequency and sex ratio in cattle. *Bangladesh Journal of Animal Science* 28 : 129-132

1113. Wadud A, Ali ML, Islam MN and Mannan AKMA (1990). Sex ratio of calves under farm condition in Bangladesh. *Bangladesh Veterinarian* 7 : 109-110

1114. Bhuiyan AKFH (1995). Genetic lift in the birth weight of local cattle resulting from nucleus bull selection programme. *Bangladesh Journal of Animal Science* 24 : 1-6

1115. Hussain SMI, Mannan AKMA, Ahmed MF and Mostafa KG (1983). Study on the behavior of growth curves of local × Jersey grade 1. *Bangladesh Journal of Animal Science* 12: 55-59

1116. Ahmed R, Zaharaby AKM, Islam KMS, Khan MAS, Mannan AKMA and Kamruzzaman M (2008). Seasonal variations of body weight and milk yield of deshi and crossbred cows. *Bangladesh Journal of Progressive Science and Technology* 6: 177-180

1117. Azad MAK, Hasanuzzaman M, Miah G and Roy BK (2002). Milk production trend of Milk vita throughout the year. *Pakistan Journal of Nutrition* 1 : 236-240

1118. Hossain MM, Apu AS, Rahman AHMS, Mondal A and Mondal MA (2008). Performance evaluation of different F1 crossbred dairy cows under rural condition in Milk-vita area of Nilphamari district. *Journal of the Bangladesh Society for Agricultural Science and Technology* 5 : 15-18

1119. Akter S, Galib MAA, Kabir H, Nath SK, Afrin K and Karker MS (2015). Chemical and microbial qualities of morning and evening milk collected from selected dairy farms in Chittagong city of Bangladesh. *Bangladesh Journal of Animal Science* 44 : 171-175

1120. Habib MA, Bhuiyan AKFH and Amin MR (2012). Adoptation of ratio factors for extending part lactation milk records for Red Chittagong cattle in Bangladesh. *International Research Journal of Applied Life Science* 1 : 56-63

1121. Mamun A, Hossain ME, Bhuiyan AKFH, Islam MN and Alam M (2008). Yield and chemical composition of milk of Red Chittagong cow under farming condition. *International Journal of Sustainable Agricultural Technology* 4 : 70-75

1122. Hossain SMJ, Afros MF, Bhuiyan AKFH and Habib MA (2018). Milk production performance of Red Chittagong cattle based on phenotypic and genetic parameters. *Global Advanced Research Journal of Agricultural Science* 7 : 110-117

1123. Kudir A, Rahman MM, Islam MS, Hossain MI and Islam MN (2003). Relationship of milk vein measurements with milk production in indigenous dairy cows. *Bangladesh Journal of Animal Science* 32 : 138-144

1124. Halder N and Kober AKMH (2006). Nutritional content and bacteriological contamination of milk of red Chittagong and Holstein-Friesian crossbred cows. *Bangladesh Veterinarian* 23: 47-52

1125. Banik SK, Das KK and Uddin MA (2014). Microbiological quality analysis of raw, pasteurized, UHT milk samples collected from different locations in Bangladesh. *Stanford Journal of Microbiology* 4 : 5-8

1126. Uddin MA, Motazzim-ul-Haque HM and Noor R (2011). Isolation and identification of pathogenic Escherichia coli, Klebsiella spp. and Staphylococcus spp. in raw milk samples collected from different areas of Dhaka city, Bangladesh. *Stamford Journal of Microbiology* 1: 19-23

1127. Begum JA, Shamsuddin M, Islam MS and Helaluddin AHM (1975-76). Feasibility study on fermented milk-what flour combination. *Bangladesh Journal of Animal Science* 9-10: 55-58

1128. Begum T, Islam MZ, Siddiki MSR, Habib R and Rashid MH (2019). Preparation of fermented beverage from Whey-based watermelon (Citrullus lanatus) juice. *Asian Journal of Dairy and Food Research* 38 : 301-306 [doi: 10.18805/ajdfr.DR-150]

1129. Rahman MM and Hasan MN (1998). Utilization of whey in the form of fermented and non-fermented drinks. *Bangladesh Journal of Animal Science* 27: 57-63

1130. Hussain SMI, Islam MN, Hasan MN, Zaman MM and Wadud A (1985). Studies on the preservation of butter by using indigenous methods. *Bangladesh Journal of Animal Science* 14 : 23-27

1131. Masud T, Sultana K and Shah MA (1991). Incidence of lactic acid bacteria isolated from indigenous dahi. *Asian-Australasian Journal of Animal Science* 4: 329-331

1132. Jabbar MA and Ali SZ (2007). The limitations of cross breeding for improvement of cattle in Bangladesh. *Oxford Agranian Studies* 17 : 29-56

1133. Hussen MS, Hussain SS, Bhuiyan AKFH, Hoque MA and Talukder MAS (2012). Comparison of some important dairy traits of crossbred cows at Baghabarighat milk shed area of Bangladesh. *Bangladesh Journal of Animal Science* 41: 13-18

1134. Talukder MAS, Shahjahan M, Munia S, Rahman SM, Ali MY, Salauddin M, Miah ABH, Billah MM, Habib MR and Bhuiyan AKFH (2019). Variation of morphological features and growth trials in half sib baby calves of Pabna cattle in Bangladesh. *Asian Journal of Medical and Biological Research* 5: 52-55 [doi: 10.3329/ajmbr.v5i141045]

1135. Alam MS, Rashid MH, Uddin ME and Asaduzzaman M (2012). Effect of supplementation of fish meal on growth and reproductive performance of crossbred heifers. *Journal of the Bangladesh Agricultural University* 10 : 261-266

1136. Khan MJ, Tareque AMM and Shahjalal M (1992). Effect of inoculation and nitrogen fertilization on yield, chemical composition, in vitro organic matter digestibility and energy content of cowpea (Vigna unguiculata) forage. *Indian Journal of Animal Nutrition* 9: 177-180

1137. Rahman MM, Islam MR and Islam M (1993). Effect of sowing methods and seed rates on production parameters and average chemical composition of fodder maize cv. Savar-1. *Asian Australasian Journal of Animal Science* 6: 123-126

1138. Rahman SMR, Sarker NR, Amin MR, Kamruzzaman M and Haque MR (2017). Identification of naturally available forage species and their feeding effect on dairy cows in different climatic vulnerable areas of Bangladesh. *Bangladesh Journal of Animal Science* 46 : 150-158

1139. Rahman MS (1971). Importance of vitamin A for dairy cattle. *Bangladesh Veterinary Journal* 4: 42-47

1140. Ali MH, Islam MN, Khan MAS and Islam MN (2006). Reproductive performance of different crossbred and indigenous dairy cows at Takerhat milk shed area under the Bangladesh milk producers' cooperative union limited (milk vita) of Bangladesh. *Journal of the Bangladesh Society of Agricultural Science and Technology* 3 : 91-94

1141. Das A, Ullah SN, Akter M and Knungo S (2009). Comparative study on productive and reproductive performance of three crossbred dairy genotypes in Chittagong metropolitan area. *Eco-friendly Agriculture Journal* 2 : 757-760

1142. Hussain SS and Mostofa KG (1985). Reproductive potentialities of local and crossbred animals under farm and village condition. *Livestock Adviser* 10: 15-19

1143. Islam N, Islam MN, Rahman MM and Faruque S (2002). Reproductive performance of different crossbred and indigenous dairy cattle under smallholder farming condition in Bangladesh. *Online Journal of Biological Science* 2 : 205-207

1144. Islam SS, Asraf A and Islam ABMM (2000). A study on the milking and reproductive performances of grazing indigenous cattle at semi-urban areas of Bangladesh. *Asian-Australasian Journal of Animal Sciences* 13 : 837-841

1145. Roy BK, Wadud A, Islam MN, Roy A, Bhuiyan MSA and Faruque S (2007). Quantitative analysis on productive and reproductive performances of different groups of dairy cows in two military dairy farms. *Bangladesh Journal of Livestock Research* 14 : 136-143

1146. Uddin MM, Islam MN, Ahmed S and Siddiki MSR (2005). Reproductive performances of different genetic groups of dairy cows under ideal management condition. *Journal of the Bangladesh society for Agricultural Science and Technology* 2 : 81-84

1147. Hossain SMJ, Miraz MFH, Deb GK, Afroz MF, Amanulla SM, Kabir MA and Rahman MM (2018). Ex situ productive and reproductive performances of Munshiganj cattle. *Global Advanced Research Journal of Agricultural Science* 7: 170-175

1148. Das A, Gupta MD, Khan MKI and Miah G (2011). Effect of non-genetic factors on the productive and reproductive traits of Friesian crossbred dairy cows. *Wayamba Journal of Animal Science*: 62-64 [1297506172.pdf]

1149. Rahman MS (1968). Reproductive efficiency of dairy cattle. *Pakistan Journal of Veterinary Science* 2: 78-83

1150. Habib MA, Bhuiyan AKFH and Amin MR (2012). Genetic and phenotypic parameter on fertility traits of Red Chittagong cattle in Bangladesh. *Bangladesh Veterinarian* 29 : 78-89

1151. Islam SS, Ahmed AR, Ashraf A and Khanam N (2004). Genetic and phenotypic parameters on reproductive traits of crossbred cattle in a selected farm of Bangladesh. *Pakistan Journal of Biological Sciences* 7 : 1269-1273

1152. Siddiquee NU, Rahman SMA, Bhuiyan MSA, Rahman AKMA and Bhuiyan AKFH (2012). Genotype environment interaction in growth traits of dairy seed calves under semi-intensive production system. *Bangladesh Journal of Seed Science and Technology* 16 : 141-150

1153. Deb GK, Mufti MM, Mostari MP and Huque KS (2008). Genetic evaluation of Bangladesh Livestock Research Institute Cattle Breed-1: Heritability and genetic correlation. *Bangladesh Journal of Animal Science* 37 : 25-33

1154. Shaha SP, Alam MGS, Khatun M and Ahmed JU (2008). Breeding soundness of stud bulls. *Bangladesh Veterinarian* 25 : 51-61

1155. Islam MR, Husain SS, Talukder MKU and Rahman MS (2020). Evaluation of semen parameters of Brahman graded bull compared to Holstein graded and local bulls using computer assisted sperm analyzer. *Journal of the Bangladesh Agricultural University* 18 : 442-448 [doi: 10.5455/JBAU.81689]

1156. Saha NG, Hoque MA, Papri KN, Bhuiyan AKFH, Faruque MO, Bari J and Mahbubul M (2019). Status of farmers and cattle genotypes to introduce Brahman inheritance for increasing in production of beef at Sadar Upazila in Mymensingh district, Bangladesh. *Bangladesh Livestock Journal* 1: 1-6

1157. Hossain DMN, Talukder M, Begum MK and Paul AK (2016). Determination of factors that affect the pregnancy rate of cows after artificial insemination at Monirampur Upazila of Jessore district of Bangladesh. *Journal of Embryo Transfer* 31 : 349-353 [doi: 10.12750/JET.2016.31.4.349]

1158. Siddiquee NU, Wadud MA, Bhuiyan MSA, Rahman AKMA, Amin MR and Bhuiyan AKFH (2014). Suitability of temperature and tropical crossbred dairy cattle under peri-urban production system in Bangladesh. *Animals Review* 1 : 26-36

1159. Akhter S and Hossain MM (2000). Fresh or frozen cow faeces for in vitro digestibility assay of forages. *Bangladesh Journal of Animal Science* 29 : 97-103

1160. Akhter S and Hossain MM (1998). Cow faeces in in-vitro digestibility assays of forages. Asian *Australasian Journal of Animal Science* 11: 51-53

1161. Akhter S, Owen E and Hossain MM (1996). Effluent from RUSITEC inoculated with rumen liquor or cow faeces as a source of microorganisms for in vitro digestion of forages. *Asian Australasian Journal of Animal Science* 9: 375-379

1162. Akhter S and Hossain MM (1997). Effect of sources and concentrations of inoculum at different time on in vitro digestibility of hay. *Bangladesh Journal of Animal Science* 26: 31-37

1163. Chowdhury SA (1998). Effect of graded levels of wheat bran supplementation on intake, nutrient digestibility, microbial N yield and growth rate of native bulls fed rice straw alone. *Asian-Australasian Journal of Animal Sciences* 11 : 162-170

1164. Huque KS and Chowdhury SA (1997). Study on the supplementing effects or feeding systems of molasses and urea on methane and microbial nitrogen production in the rumen and growth performances of bulls fed a straw diet. *Asian-Australasian Journal of Animal Sciences* 10 : 35-46

1165. Alam SS, Khan MJ, Bhuiyan AKFH, Islam MN and Barua S (2010). The value of protein-rich supplements on the performance of Red Chittagong heifers (*Bos indicus*) fed urea molasses straw-based diet. *Tropical Animal Health and Production* 42: 1505-1511

1166. Huque KS and Talukder AI (1995). Effect of molasses supplementation of a roughage based diet on growth performance of cattle. *Asian-Australasian Journal of Animal Sciences* 8 : 337-342

1167. Akbar MA, Ahmed TU and Mondal MMH (2006). Improving animal productivity and reproductive efficiency: development and testing medicated urea-molasses multi-nutrient blocks in rural farms of Bangladesh. IAEA-TECDOC-1495. www-pub.iaea.org/MTCD/publications/PDF/te_1495_web.pdf

1168. Saadullah M, Haque M and Dolberg F (1981). Treatment of rice straw with lime. *Tropical Animal Health and Production* 6: 116-120

1169. Karim RA, Amin MR, Moniruzzaman M, Sarker MB and Kabir AKMA (2015). Effect of Moringa oleifera leaf on the efficiency to increase protein supply to ruminants. *Bangladesh Journal of Animal Science* 44 : 46-51

1170. Shahjalal M, Hashem MA and Khan MJ (1999). Frequency of feeding on growth and carcass characteristics of steers. *Bangladesh Journal of Animal Science* 28: 105-110

1171. Mannan AKMA (1968). The occurrence of psychrophilic bacteria on dairy barns' water. *Animal Science Journal of Pakistan* 1: 65-73

1172. Alam J, Rahman A, Sayeed MA and Hossain M (1993). A study on livestock credit in Bangladesh. *Bangladesh Journal of Livestock Research* 1: 63-75

1173. Alam J, Haque ABMM, Rahman MH and Sarker A (1999). Profitability of loanee dairy farms in selected areas of Bangladesh. *Bangladesh Journal of Animal Science* 28 : 37-45

1174. Ashrafuzzaman AKM and Rahman MH (1995). Profitability of dairy raising: Analysis of farm-level data from Bangladesh. *Progressive Agriculture* 6 : 21-26

1175. Barakatullah M, Islam MN, Rahman MM and Rashid MH (1997). Adoptation of livestock technologies and its relationship with selected characteristics of the farmers. *Bangladesh Journal of Animal Science* 26: 25-29

1176. Faruque MO, Bhuiyan AKFH and Ali A (1992). Utilization of biotechnology for efficient animal production in Bangladesh. *Bangladesh Journal of Training and Development* 5: 103-114

1177. Satter MA, Paul DC, Haque MF, Alam MS and Abedin MZ (1989). Matching technology generation with farmers need in a flood affected area: I. Studies on the farm level feeds and feeding under hazardous situation. *Bangladesh Journal of Animal Science* 18: 81-89

1178. Baset MA, Huque KS, Sarker NR, Amanullah SM, Hossain MM and Islam MN (2009). A simple urine collecting device for cows. *Journal of Science Foundation* 7 : 143-146

1179. Baset MA, Huque KS, Sarker NR, Hossain MM and Islam MN (2010). Evaluation of milk urea nitrogen of dairy cows reared under different feed bases in the different seasons. *Journal of Science Foundation* 8 : 111-124

1180. Chowdhury SA, Tareque AMM and Akbar MA (1987). Manure yield by cattle and buffalo of Bangladesh. *Bangladesh Journal of Agricultural Science* 14: 21-29

1181. Rashid MA and Abedin MZ (1997). Preparation of hygienic compost from agricultural wastes at farmers' level. *Bangladesh Journal of Animal Science* 20: 31-36

1182. Hossain ASS, Tarafder MMA, Hasan MN, Kabir AKMA and Azad MAK (2017). Garbage waste induced heavy metals on roaming cattle. *Bangladesh Journal of Animal Science* 46 : 24-28

1183. Zalil MA, Rahim QMF and Hoque M (1971). Statistical study on some economic traits of cattle in Bangladesh. *Bangladesh Veterinary Journal* 4: 52-57

1184. Rahman MM, Akhter S, Rabbani MS and Hossain MM (1999). Indigenous knowledge on livestock practiced by the farmers in Mymensingh district of Bangladesh. *Bangladesh Journal of Animal Science* 28: 97-103

1185. Majid MA (1995). A comparative study on the quality of chocolate milk made of different source of fat and solids-not fat. *Bangladesh Journal of Animal Science* 24: 195-290