Proceedings

Annual Research Review Workshop 2017

Date: 06-07 December 2017

Bangladesh Livestock Research Institute
Savar, Dhaka 1341, Bangladesh

Annual Research Review Workshop 2017

Date: 06-07 December 2017

BLRI Conference Hall

3rd floor, Building 3

PROGRAMME

Bangladesh Livestock Research Institute
Savar, Dhaka 1341, Bangladesh

TECHNICAL SESSIONS

Day 1: Wednesday, 06 December 2017

Technical Session I : **SOCIOECONOMICS AND FARMING SYSTEM RESEARCH**

Chairperson : **Dr. Md. Saidur Rahman**
Prof. Department of Agricultural Economics
Bangladesh Agricultural University
Mymensingh-2202

Co-Chairperson : **Dr. MA Monayem Miah**
Principal Scientific Officer
Planning Division
Bangladesh Agricultural Research Institute
Salna, Gazipur

Rapporteurs : **Md. Sirajul Islam**, SSO, BLRI
Md. Saiful Islam, SO, BLRI

09:30-09:40	Study on economic losses due to Foot and Mouth Disease outbreak in cattle and Buffalo in some affected areas of Bangladesh	E Islam
09:40-09:50	An economic study on Newcastle Disease in village chickens in some selected areas of Bangladesh	S Islam
09:50-10:00	Climate change, livestock production and income vulnerability: Bangladesh perspective	M Khatun
10:00-10:10	Processing plant for safe poultry meat production: A model	MSK Sarker
10:10-10:20	Development of milk products from buffalo milk and their evaluation	GK Deb
10:20-10:45	**Discussion**	
10:45-11.00	**Tea and Snacks**	
11.00-01:30	**Inaugural Session**	
01:30-02:00	**Lunch and Prayer**	
02:00-03:00	**Poster Presentation**	

Technical Session II : **FEEDS, FODDER AND NUTRITION**

Chairperson : **Dr. M Saadullah**
Professor (Rtd), Department of Animal Science
Bangladesh Agricultural University
Mymensingh 2202

Co-Chairperson : **Dr. Zahirul Haque Khandaker**
Professor, Department of Animal Nutrition
Bangladesh Agricultural University
Mymensingh 2202

Rapporteurs : **Dr. Sazedul Karim Sarker**, SSO, BLRI
Dr. Sadek Ahmed, SSO, BLRI

03:00-03:10	Study on growth performance, carcass characteristics and meat quality of native buffalo and cattle at different ages	BK Roy
03:10-03:20	Feeding effect of maize stover based densified Total Mixed Ration (TMR) on milk yield, milk composition and digestibility of RCC milking cows	D Yeasmin
03:20-03:30	Study of food-feed competitive efficiency of Moringa fodder in the Teesta-Meander Floodplain Agro-Ecological Zone of Bangladesh	MK Bashar
03:30-03:40	Biomass yield and nutritional quality of Moringa and its feeding effect on lactating cows	S Ahmed
03:40-03:50	Forage growth, yield and quality responses of Napier hybrid grass cultivars (Pakchong-1 and BLRI Napier hybrid-3) at similar cutting intervals	MRH Rakib
03:50-04:00	Adaptability of HYV fodder cultivars in drought prone Barind areas of Bangladesh	MT Hasan
04:00-04:15	**Tea and Snacks**	
04:15-04:25	Study of hydrophonic sprout of grain for feeding ruminant	MM Rahman
04:25-04:35	Effect of pre and post-natal nutrition on the performances of ewes and lambs under semi intensive management system	S Ahmed
04:35-04:45	Effects of different energy and protein levels on the performance and egg quality of hilly chicken during laying phase	H Khatun
04:45-04:55	Development of Natural Feed Additives (Probiotics & Mushroom) for Meat Type Chicken Production	MSK Sarker
04:55-05:15	**Discussion**	

Day 2: Thursday, 07 December, 2017

Technical Session III : **GENETICS AND BREEDING**

Chairperson : **Dr. Syed Shakhawat Hossain**
Professor, Depertment of Animal Breeding and Genetics
Bangladesh Agricultural University, Mymensingh 2202
and Ex VC, PSTU, Patuakhali

Co-Chairperson : **Dr. Md. Mizanoor Rahman**
Deputy Director (AI and Fodder Production)
Department of Livestock Services, Farmgate, Dhaka

Rapporteurs : **Mrs. Monira Khatun**, SSO, BLRI
Md. Yousuf Ali Khan, SO, BLRI

09:00-09:10	Comparative growth performance of F_1 progeny of different crossbred beef cattle	MP Mostari
09:10-09:20	Conservation and improvement of Munshiganj Cattle	MFH Miraz
09:20-09:30	Evaluation of performance of Murrah X Local (F1) crossbred and Niliravi X Local (F1) crossbred buffalo in Bangladesh	MF Afroz
09:30-09:40	Screening and development of different coat color variants of goat stock at BLRI	MF Afroz
09:40-09:50	Maintenance and conservation of pure lines and development of egg and meat type chicken	MR Hassan
09:50-10.00	Conservation and improvement of native chicken: Performance of sixth generation	S Faruque
10:00-10:10	Conservation and improvement of Quail: Performance of sixth generation	MOA Rahman
10.10-10.20	Conservation and improvement of native duck genotypes through on station and on farm trial	S Sultana
10.20-10.30	Evaluation of genetic potentials of BLRI improved indigenous chicken varieties under farmers condition	MA Rashid
10.30-10.50	**Discussion**	
10:50-11:10	**Tea and Snacks**	

Technical Session IV : **LIVESTOCK AND POULTRY DISEASES AND HEALTH**

Chairperson : **Dr. AS Mahfuzul Bari**
Professor, Department of Surgery and Obstetrics
Bangladesh Agricultural University, Mymensingh 2202
and Ex VC, CVASU, Chittagong

Co-Chairperson : **Dr. Md. Matiar Rahman Howlader**
Professor, Department of Physiology
Sylhet Agricultural University, Sylhet

Rapporteurs : **Dr. Md. Abdus Samad**, SSO, BLRI
Dr. Md. Rezaul Karim, SO, BLRI

11:10-11:20	Epidemiological studies towards formulating duck plague control strategy on piloting basis	MZ Ali
11:20-11:30	Tick borne blood protozoan diseases of farm based & slaughter house animal	MZ Hassan
11:30-11:40	Prevalence and antimicrobial resistance profile of foodborne pathogens in retail meats of super shop: a food safety risk	MA Samad
11:40-11:50	Prevalence of immune escape highly pathogenic avian influenza virus A/H_5N_1 in the vaccinated poultry in Bangladesh	MR Karim
11:50-12:00	Development of FMD free zone in Bangladesh as per OIE guidelines	MS Mahmud
12:00-12:10	Development of Peste des Petits Ruminants (PPR) free zone in selected areas of Bangladesh to meet global control strategy	M Giasuddin
12:10-12:20	Selection of potential probiotics for use as potent antibacterial agents against pathogenic bacteria	MR Karim
12:20-12:30	A comparative study on pregnancy diagnosis in goats (*Capra hircus*) using barium chloride and progesterone based- kit	S Akther
12:30-01:00	**Discussion**	
01:00-02:00	**Lunch and Prayer**	

Day 2: Thursday, 07 December, 2017

Technical Session V : **BIOTECHNOLOGY, ENVIRONMENT AND CLIMATE RESILIENCE**

Chairperson : **Dr. MAM Yahia Khandoker**
Prof. Dept. of Animal Breeding and Genetics
Bangladesh Agricultural University
Mymensingh-2202.

Co-Chairperson : **Dr. Md. Imtiaz Uddain**
Chief Scientific Officer and Head
Biotechnology Division,
Bangladesh Institute of Nuclear Agriculture
BAU Campus, Mymensingh 2202

Rapporteurs : **Dr. Parvin Mostari**, SSO, BLRI
Md. Faizul Hossain Miraz, SO, BLRI

02:00-02:10	Development of starter culture for yogurt: isolation and identification of potential lactic acid bacteria	MA KAbir
02:10-02:20	Development of suitable semen extender for cryo preservation of buffalo semen	MFH Miraz
02:20-02:30	Utilization of different livestock waste alone or in combination for improving biogas production	SM Amanullah
02:30-02:40	Study of vegetable waste based feed production system	NG Das
02:40-02:50	Development of new Napier cultivars through gamma-ray irradiation	MK Alam
02:50-03:20	**Discussion**	
03:20-04:00	**Tea and Snacks**	
04:00-05:30	**Closing session**	

POSTER SESSION

(Day 1: 02:00-03:00 pm)

SL No.	Title	Presenter
1.	A pilot project on anthrax control in selected areas of Sirajganj district in Bangladesh	MR Karim
2.	Sero-surveillance and clinical investigation of PPR Outbreak in Different areas of Bangladesh	MA Yousuf
3.	Study of livestock manure management and clean air production	JS Khanam
4.	Biomass yield, morphological characteristics, nutritional evaluation and production cost of different cultivars of Jumbo and Maize as fodder	BK Roy
5.	Evaluation of performances of Boer and Jamunapari goat at BLRI	MP Choudhury
6.	Improvement of Black Bengal Goat through community breeding	MP Choudhury
7.	Development of blended yarns and fabrics from Jute, Cotton and Native Sheep wool	MKH Majumder
8.	Validation of BLRI improved sheep at community level in selected areas of Bangladesh	MP Choudhury
9.	Identification of certain bioactive compounds with anthelmintic properties in *Azadirachta indica* and *Clerodendrum viscosum*	MZ Hassan
10.	Collection, conservation and improvement of guinea fowl at BLRI	S Sultana
11.	Pigeon production scenario in some selected areas of Bangladesh and conservation to improve some pigeon varieties at BLRI research farm	MRA Sumon
12.	A baseline study about farmers training on BLRI developed technologies	MZ Rahman
13.	Development of calcium salts of n-3 and n-6 fatty acid for dairy cattle	MM Rahman
14.	Adaptation and subsequent production of OPU derived embryos	GK Deb
15.	*In vitro* production of buffalo embryo	MFH Miraz
16.	Establishment of bovine fibroblast cell line for somatic cell nuclear transfer	MF Afroz
17.	Development of feeding systems and least cost ration formulation for buffalo	MA Kabir
18.	Effect of feed supplementation on age at puberty in growing buffalo heifers	MF Afroz
19.	Phenotypic and molecular characteristics of buffalo genetic resources in selected regions of Bangladesh	GK Deb
20.	Varietal demonstration of HYV fodder and development of existing feed resources based feeding system in Haor areas of Bangladesh	MA Habib
21.	Developing fodder production model in coastal and river basin regions of Bangladesh	MA Habib

INAUGURAL SESSION

(06 December, 2017)

Chief Guest : **Mr. Narayon Chandra Chanda, MP**
Hon'ble State Minister
Ministry of Fisheries and Livestock

Special Guest : **Mr. Mir Showkat Ali Badsha**, MP
Chairman, Standing Committee
Ministry of Fisheries & Livestock

Special Guest : **Mr. HM Ibrahim,** MP
Member, Standing Committee
Ministry of Fisheries & Livestock

Special Guest : **Dr. Bhagya Rani Banik**
Executive Chairman
Bangladesh Agricultural Research Council

Chairperson : **Dr. Talukder Nurun Nahar**
Director General
Bangladesh Livestock Research Institute

11:00 am	Guests take their seats
11:05 pm	Recitation from the Holy Qur'an & Holy Gita
11:15 pm	Welcome Address **Mr. Md. Azharul Amin**, Additional Director, BLRI
12:20 pm	Address by the Special Guest **Dr. Bhagya Rani Banik,** Executive Chairman, BARC
12:30 pm	Address by the Special Guest **Mr. HM Ibrahim,** MP and Member, Standing Committee Ministry of Fisheries & Livestock
12:40 pm	Address by the Special Guest **Mr. Mir Showkat Ali Badsha**, MP and Chairman, Standing Committee Ministry of Fisheries & Livestock
12:50 pm	Address by the Chief Guest **Mr. Narayon Chandra Chanda**, MP and Hon'ble State Minister Ministry of Fisheries & Livestock
01:10 pm	Vote of thanks **Dr. Nathu Ram Sarker** Principal Scientific Officer and Head Poultry Production Research Division, BLRI
01:15 pm	Address by the Chairperson **Dr. Talukder Nurun Nahar,** Director General Bangladesh Livestock Research Institute
01:30 pm	Refreshment

CLOSING SESSION

(07 December, 2017)

Chief Guest : **Mr. Kh. Azizul Huq Arzu,** MP
Member, Standing Committee
Ministry of Fisheries and Livestock

Special Guest : **Dr. Syed Shakhawat Hossain**
Professor, Department of Animal Breeding and Genetics
Bangladesh Agricultural University, Mymensingh 2202
and Ex VC, PSTU, Patuakhali

Special Guest : **Dr. AS Mahfuzul Bari**
Professor, Dept. of Surgery and Obstetrics
Bangladesh Agricultural University, Mymensingh 2202
and Ex VC, CVASU, Chittagong

Chairperson : **Dr. Talukder Nurun Nahar**
Director General
Bangladesh Livestock Research Institute

04:00 pm	Recitation from the Holy Qur'an & Holy Gita
04:05 pm	Presentation of Workshop Recommendation
04:15 pm	Open Discussion
04:45 pm	Address by the Special Guest **Professor Dr. Abu Saleh Mahfuzul Bari,** Bangladesh Agricultural University and Ex. Vice Chancellor, CVASU
04:55 pm	Address by the Special Guest **Professor Dr. Syed Sakhawat Husain,** Bangladesh Agricultural University and Ex. Vice Chancellor, PSTU
05:05 pm	Address by the Chief Guest **Mr. Kh. Azizul Huq Arzu**, MP and Member, Standing Committee on Ministry of Fisheries & Livestock
05: 20 pm	Vote of thanks by the Chairperson **Dr. Talukder Nurun Nahar** Director General, Bangladesh Livestock Research Institute
05:30 pm	Refreshment

CONTENTS

A study on economic losses due to Foot and Mouth Disease outbreak in cattle and buffalo in some affected areas of Bangladesh

M Giasuddin[1], E Islam[2], MS Mahmud[2], S Islam[3], MA Samad[1] and MR Karim[1]
[1]Animal Health Research Division, BLRI, Savar, Dhaka 1341; [2]Research on FMD and PPR in Bangladesh, BLRI, Savar, Dhaka 1341; [3]Socioeconomic Research Division
BLRI, Savar, Dhaka 1341

Executive summary

Foot and mouth disease (FMD) is a severe, highly contagious disease that causes immense economic loss due to mortality, reduced milk production, treatment cost for affected cattle and weight loss of fattening cattle, which occurs in Bangladesh almost every year. Outbreak of this disease causes huge losses to the farmer as well to the economy. The study was an attempt to analyze the morbidity, mortality and fatality of cattle affected by Foot and Mouth Disease (FMD) and financial loss incurred therein. Data were collected from some affected households of Savar Upazila of Dhaka, Kaligonj Upazila of Gazipur, Shazadpur and Tarash Upazilas of Sirajgonj, Paba Upazila of Rajshahi district and from Chittagong metropolitan area based on information of FMD outbreak. Data were collected from 277 affected households by a predesigned questionnaire in the study area during July 2016 to June 2017. The study found 2910 crossbred cattle and 448 native cattle out of 277 affected households. According to category the overall morbidity, mortality and fatality in crossbred cattle were 47.39%, 5.33% and 11.24%, respectively in crossbred cattle (Table 1). Morbidity in crossbred cattle was found the highest in bull (83.21%) followed by male calf (67.05%), female calf (61.08%), heifer (46.73%) and cow (38.46%). Mortality was the highest for female calf (13.12%), followed by male calf (11.88%), bull (6.87%), heifer (6.23%) and cow (2.11%). Fatality was the highest for female calf (21.48%), followed by male calf (17.71%), heifer (13.33%), bull (8.26%) and cow (5.48%).It was found that morbidity, mortality and fatality in crossbred cattle were differed significantly (χ^2=197.29, p<0.01; χ^2=112.66, p<0.01; χ^2=59.81, p<0.01). The overall morbidity, mortality and fatality were 66.96%, 2.23% and 3.33%, respectively in native cattle. Morbidity in native cattle was found the highest in bull (82.64%) followed by heifer (71.43%), male calf (60.24%), female calf (59.09%) and cow (57.64%) but mortality was highest for bull (4.96%), followed by female calf (4.55%), male calf (2.41%) and cow and heifer (0.00%). Fatality was the highest for female calf (7.69%), followed by bull (6.00%), male calf (4.00%) and cow & heifer (0.00%).

Table 1 Morbidity, mortality and case fatality rates in crossbred and native cattle by categories

Category	Crossbred cattle				Native cattle			
	Total cattle	Morbidity	Mortality	Fatality	Total cattle	Morbidity	Mortality	Fatality
Cow	1755 (60.31)	675 (38.46)	37 (2.11)	37 (5.48)	144 (32.14)	83 (57.64)	0 (0.00)	0 (0.00)
Bull	131 (4.50)	109 (83.21)	9 (6.87)	9 (8.26)	121 (27.01)	100 (82.64)	6 (4.96)	6 (6.00)
Heifer	321 (11.03)	150 (46.73)	20 (6.23)	20 (13.33)	56 (12.50)	40 (71.43)	0 (0.00)	0 (0.00)
Male calf	261 (8.97)	175 (67.05)	31 (11.88)	31 (17.71)	83 (18.53)	50 (60.24)	2 (2.41)	2 (4.00)
Female calf	442 (15.19)	270 (61.08)	58 (13.12)	58 (21.48)	44 (9.82)	26 (59.09)	2 (4.55)	2 (7.69)
All	2910 (100)	1379 (47.39)	155 (5.33)	155 (11.24)	448 (100)	300 (66.96)	10 (2.23)	10 (3.33)
χ^2 values* Significance		197.29 P<0.01	112.66 P<0.01	59.81 P<0.01		22.54 P<0.01	9.78 P>0.05	8.50 P>0.05

*Figures in parentheses are the percentages to the respective area total, *χ^2 was estimated from absolute numbers and not from percentages.*

Morbidity in native cattle was differed significantly (χ^2=22.54, P<0.01) but mortality and fatality did not (χ^2=9.78, P>0.05; χ^2=8.50, P<0.05) with categories. No affected buffalo was found at any farms in the study areas. Occurrence of FMD was found the highest in the months of January-February (52.71%), followed by March-April (20.22%), November-December (12.27%), September-October (11.91%), July-August (2.89%) (Figure 1).

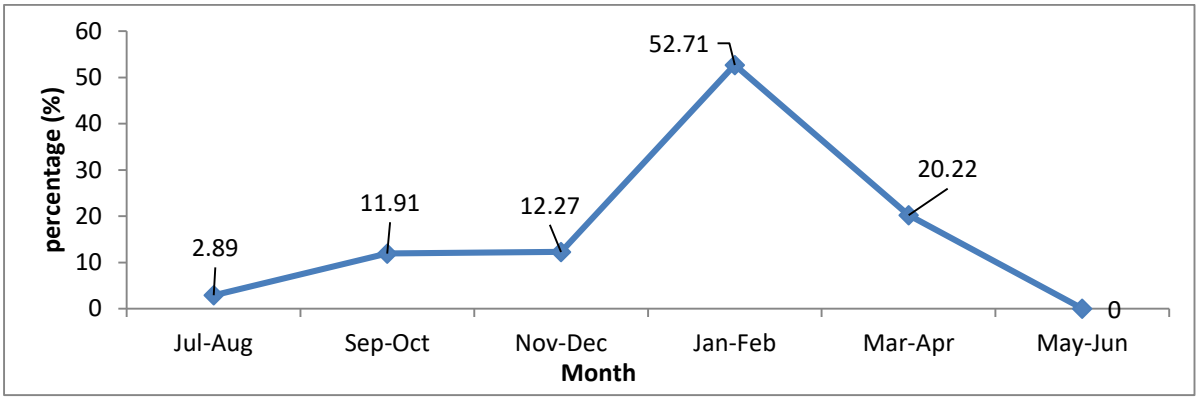

Figure 1 Prevalence of FMD by month (% of respondents)

It was reported that only 28.52% of the farmers vaccinated their cattle against FMD. More than 63% of the respondent farmers vaccinated their cattle through the vaccine produced by Department of Livestock Services (DLS) and only 15.71% from imported vaccines. A total of 1871 (64.29%) crossbred and 7 (1.56%) native cattle was reported to be vaccinated. Vaccination cost per crossbred cattle was Tk. 104.00 which was varied from Tk 46.00 to Tk. 180.00 and for native cattle this cost per cattle was Tk. 60.00 irrespective of vaccine used. For calculating financial loss due to FMD outbreak only direct losses such as milk production loss of affected in-milk cows, veterinary costs for treatment of affected cattle, death loss, weight loss of fattening animal, labor cost for taking care of affected cattle were considered. The total financial loss was summed up to Taka 1,04,82,842 (Table 2). Based on this calculation the estimated loss due to FMD outbreak would be Tk. 1,200 crores per year.

Table 2 Financial loss due to outbreak of FMD (Taka)

Description	Savar	Kaligonj	Shahzadpur	Tarash	Paba	Chittagong	All areas
Loss of milk	67388	33390	836954	26132	58174	856487	1878525
Death loss	465000	940000	2235000	190000	205000	1216000	5251000
Treatment cost	133990	84200	511800	44535	30480	1369000	2174005
Weight loss of fattening cattle	291000	122000	60000	297000	274000	0	1044000
Labour cost for taking care	21398	7278	67875	6268	5756	26737	135312
All area	978776	1186868	3711629	563935	573410	3468224	10482842

From the study it revealed that breed type, age categories, seasonal influence were the major risk factors for occurrence of foot and mouth disease in cattle. Both crossbred and native cattle are susceptible to this disease. Outbreak of Foot and mouth disease was found higher in January-February (53.71%) and this disease causes immense economic loss to the farmer as well to the economy. Therefore, findings of this study provide information on epidemiology of FMD and its potential impacts on household income, signifies the need of effective disease management and control strategies.

An economic study on Newcastle disease in village chickens in some selected areas of Bangladesh

S Islam[1], M Khatun[1], M Ershaduzzaman[2], HMS Islam[3], S Yasmin[1], A Hossen[4] and M Hasan[5]
[1]Socioeconomic Research Division, BLRI, Savar, Dhaka 1341; [2]Goat and Sheep Production Research Division BLRI, Savar, Dhaka 1341; [3]Bangladesh Agricultural University, Mymensingh; [4]Naikhongchori Regional Station, BLRI; [5]Research on FMD and PPR in Bangladesh, BLRI Savar, Dhaka 1341

Executive summary

Newcastle Disease (ND) is a highly contagious viral disease affecting domestic avian species. ND can cause upto 100 per cent mortality in susceptible populations during devastating outbreaks and the households face huge economic losses throughout the year. Still it is ranked 1st among other poultry diseases in village chickens. As it is one of the prime sources of safe animal protein supply and thought of prestigious consumption. However, the study was undertaken to determine the socioeconomic profile of the farm families and to estimate the direct and indirect economic losses of the farmer due to ND as well as to know the farmers' perception towards ND. The study was conducted jointly by Bangladesh Livestock Research Institute and Bangladesh Agricultural University. The study was encompassed four Upazilas from four Districts i.e. Gopalpur from Tangail, Nilphamary Sadar from Nilphamary, Gowainghat from Sylhet and Barishal Sadar from Barishal District. Both primary and secondary data were used in this study. From each Upazila 75 sample farmers were interviewed randomly who reared village chicken and the total sample size was 300. Primary data were collected through a structured questionnaire during the months of October 2016 to January 2017. Both tabular and statistical techniques were used.

It was evident that women were the sole reared of village chicken and were in age group 31 to 50 years and whose primary occupation was agriculture and they were housewife. Most of them were illiterate and family size was slightly higher than the national average 4.90 (HIES, 2015) and belonged to marginal farm category. The study also found that due to ND outbreak, average economic loss was calculate to BDT 2,561 per household per annum and average eight poultry birds were forgone per household per annum. On an average, the country incurred economic loss BDT 2.43802765 $*10^{10}$ per annum (Table 1).

Table 1 Household incurred economic loss due to ND outbreak

Items	Tangail	Nilphamari	Barishal	Sylhet	Average
Direct Loss	1998	1651	2344	1940	1983
Indirect Loss	674	525	770	341	578
Total Loss	2672	2176	3114	2282	2561
Death chicken (no.)	7.44	9.48	8.64	7	8

Source: Field survey, 2017

Only 26% household had access to Upazila Veterinary Hospital for the treatment of ND affected poultry bird to curb the fatal disease like ND. The study found an adverse impact on household dietary diversity showing score for affected 8.79 and non-affected 9.11. In case of animal source food consumption, affected household consumed 4.82 kg per week and on the other hand, non-affected household taken 5.76 kg per week. Swab sample result showed about 7% live village chicken carried ND and the tissue sample (sample taken from dead bird) result sowed 100% carried ND (Table 2).

Table 2 Swab sample and tissue sample result

Swab sample	Districts	Sample size	Positive	Percentage (%)
	Tangail	30	3	10
	Sylhet	42	0	0
	Barishal	36	6	16.67
	Nilphamary	33	0	0
	Grand total	141	9	6.38
Tissue sample	Districts	Sample size	Positive	Percentage (%)
	Tangail	0	0	0
	Sylhet	0	0	0
	Barishal	21	21	100
	Nilphamary	9	9	100
	Grand total	30	30	100

Source: Field survey, 2017

In conclusion, Native chicken might be an important source of safe animal protein supply cradle to human dietary menu. As it is one of the primary income sources of village housewives. So, government along with other organizations should come forward to protect this very cute enterprise of livestock and sustainable development of village chicken.In the light of research findings, the following steps should be considered:

- Flock size should not be higher than 20 birds
- Keep chicken and duck in separate shade
- Training for scientific rearing system and diseases control method
- Mass vaccination program is needed for sustainable growth and development of all livestock species

Climate change, livestock production and income vulnerability: Bangladesh perspective

S Islam[1], M Khatun[1], M Ershaduzzaman[2], A Khan[3] and S Yasmin[1]
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Executive summary

Climate change has a direct effect on overall livestock sector and as a result has an indirect effect on livestock rearing farmers. Ultimately climate change is affecting negatively on the livelihood of farmers who rear various kinds of livestock species. However, the study was conducted considering four specific objectives: i) to determine the socioeconomic profile of the respondent farmers; ii) to assess the factors affecting the livestock production; iii) to depict the present livestock scenario in the study areas; and iv) to delineate the effects of climate change on income vulnerability status of the respondents. Four districts namely Barguna, Bhola, Lalmanirhat and Kurigram of Bangladesh were selected on the basis of frequency of climate change events. From each district one Upazila such as Taltali under Barguna, Charfashion under Bhola, Patgram under Lalmanirhat and Bhurungamari under Kurigram district were selected. Of these, Taltoli and Charfashion Upazilas were more prone to natural catastrophic of cyclone and tidal surge; and Lalmanirhat and Bhurungamari Upazilas were severely vulnerable of flood and draught. Simple random sampling method was used to collect primary data with a structured questionnaire. Total sample size was 300 where 75 sample farmers were interviewed from each Upazila. Both tabular and statistical techniques were used to analyse the data. Descriptive statistics such as frequency, average, percentage, ratios were also estimated and STATA software was used to analyse the vulnerability status. The study found that 77% farmers were in age group 50 to 65 followed by 20%, 66 to 80 and 3% above 80 years old. 77% farmers had agriculture as their primary occupation followed by 15% business and 8% service. Average family size was found 5.56 which were higher than the national average 4.9 (HIES 2014) and farm size indicates small farm category which was 1.1 hectare. On an average, farmers had 41 years of farming experience. The study identified some factors which had devastating effects on livestock growth and development such as extreme temperature, high humidity, less average rainfall, prolonged drought length duration, flash flood, cyclone, tornado, tidal surge and salinity in the costal belt and very recent added thunder storm with heavy lightening. Among the sampled farmers, 81% of the respondents opined that major livestock species were reducing over the last three decades. Livestock population were reducing over the years and 56% respondents stated this scenario. On the other hand, livestock rearing cost was increasing alarmingly and it was found 4.45 times compared to three decades ago. The study found a scenario of major livestock population which indicated that livestock population per household was declining over the decades (Table 1).

Table 1 Major livestock population scenario at present and 30 years ago in the areas per HH

Areas	Time	Cattle	Buffalo	Goat	Sheep	Chicken	Duck	Pigeon
Lalmonirhut	Present	4	-	2.75	0.69	9.00	2.83	2.71
	30 yrs ago	9.25	0.28	5.87	1.63	16.58	5.87	4.97
Kurigram	Present	3	-	0.95	0.17	10.00	3.44	1.20
	30 yrs ago	8.37	0.21	3.96	1.11	14.68	7.28	4.28
Bhola	Present	4.44	0.75	1.49	0.60	14.00	7.25	3.92
	30 yrsago	9.65	10.56	3.4	0.07	23.00	18.48	3.77
Borghuna	Present	6	0.81	2.69	0.03	11.00	5.29	5.57
	30 yrs ago	15.93	4.72	6.63	1.16	26.00	17.00	14.00
Average	Present	4.45	0.39	1.97	0.37	11.00	4.70	3.35
	30 yrs ago	10.81	3.94	4.96	0.99	23.79	12.18	6.63

Source: Field survey, 2017

The study considered the household income flow of the respondents' farmer from agriculture (crop, livestock, and fisheries), business and service sectors. All agricultural components are strongly influenced by climatic factors for its production behaviour, therefore, income variability occurred. Among the studied farm household 93% and 84 % were found vulnerable at present and 30 years ago, respectively. At present and 30 years ago average vulnerability was estimated 0.93 and 0.85, respectively (Table 2).

Table 2 Estimation of income vulnerability status of the studied household farm

Areas	Score	Present	30 years ago
Lalmonirhut	1	70	67
	0	5	8
Kurigram	1	71	57
	0	4	18
Bhola	1	66	61
	0	9	14
Borghuna	1	72	68
	0	3	7
Average	1	279	253
	0	21	47
Average vulnerability		0.93	0.85

Source: Field survey, 2017

Frequent occurrence of viral and bacterial diseases caused huge economic losses to the HH. It was evident from the findings that farmers knowledge on disease is out broken now and then indicated that viral and bacterial diseases are fatal to livestock production (Table 3).

Table 3 Knowledge on disease prevalence at present and 30 years ago in large ruminant

Diseases	At present				30 years ago			
	Cattle							
	Acute	Moderate	Low	No idea	Acute	Moderate	Low	No idea
FMD	93 (31%)	104 (35%)	74 (25%)	29 (10%)	168 (56%)	56 (17%)	33 (11%)	43 (14%)
BQ	13 (4%)	119 (40%)	106 (35%)	62 (21%)	103 (34%)	67 (22%)	64 (21%)	66 (22%)
HS	17 (6%)	88 (29%)	139 (46%)	56 (19%)	76 (25%)	110 (37%)	55 (18%)	59 (20%)
Anthrax	69 (23%)	126 (42%)	56 (19%)	49 (16%)	139 (46%)	55 (18%)	50 (17%)	56 (18%)
Milk Fever	72 (24%)	21 (7%)	51 (17%)	156 (52%)	21 (7%)	42 (14%)	77 (26)	160 (53)
Parasitic & Vector	67 (22%)	57 (19%)	75 (25)	101 (34%)	54 (18%)	100 (33%)	48 (16%)	98 (33%)

Source: Field survey, 2017

Heat stroke, repeat breeding and less conception rate fall livestock production into jeopardized condition. It would be wise to adapt with predictable and unpredictable climate change for sustainable and profitable livestock enterprise in future.

Processing plant for safe poultry meat production: A model

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Executive summary

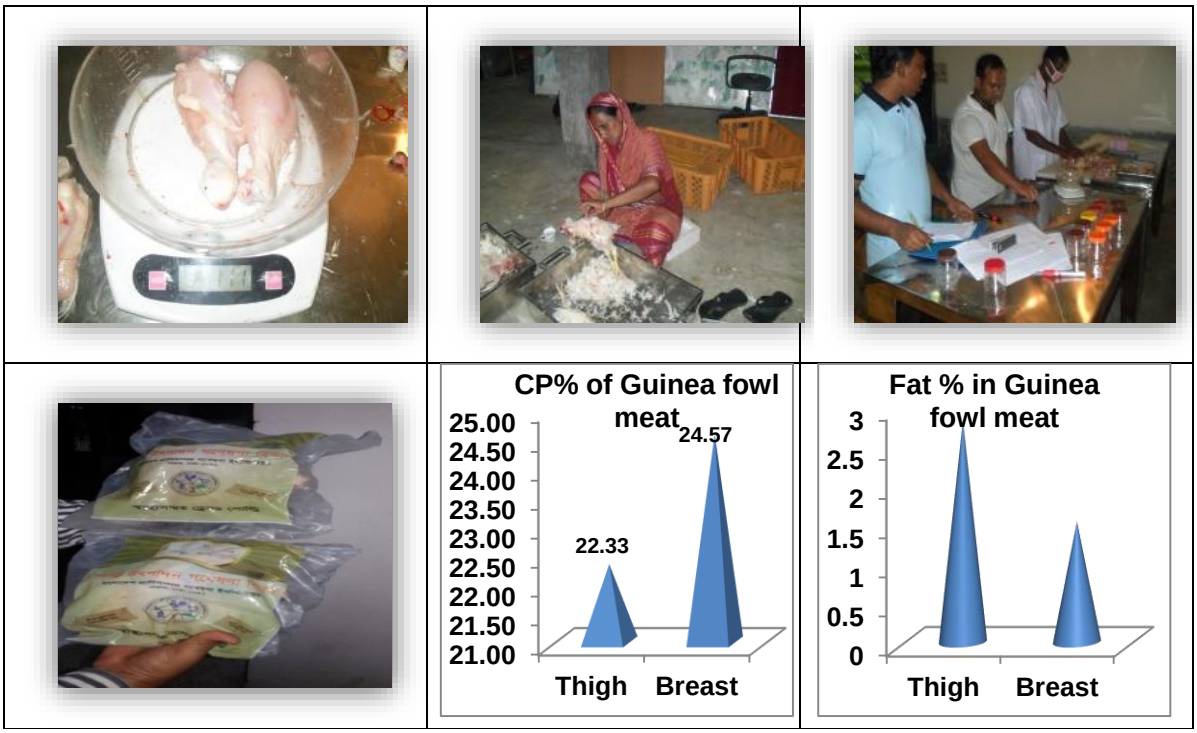
The livestock sub-sector offers important employment and livelihood opportunities particularly for the rural poor, including the functionally landless, many of whom regard livestock as a main livelihood option. About 75 percent people rely on livestock to some extent for their livelihood, which clearly indicates that the poverty reduction potential of the livestock sub-sector is high (Tareque et al., 2010). There is an estimated 150,000 poultry farms in Bangladesh (Wikipedia, 2017), The poultry sector will require up to Tk 30,000 crore in fresh investments to meet the increased demand for chicken meat and eggs by 2021 (The Daily Star, March 3). A growing number of small producers are raising poultry outdoors on pasture, processing the birds on-farm, and selling the meat directly to customers at the farm or at a farmers' market. Poultry and poultry products become as a cheap source of animal protein in terms of meat and eggs. Poultry meat alone contributes 37% of the total meat production in the country and 22 to 27% of total animal protein (Hamid et al, 2017). Khatun et al (2016) stated that the demand for food in Bangladesh and around the world is changing rapidly. This changing pattern is driven by economic growth, rising incomes, urbanization and demand is shifting away from traditional staples toward high-value food commodities.

Selling live poultry on the street

Selling live poultry on market place

In Bangladesh, needs economically-viable and safe processing plants for every small scale poultry farmers. Because live bird marketing or any open places bird dressing systems are now very much risky for poultry rearing system. It's a system or vehicle as a carrier of different contagious or non-contagious diseases. So creating public or poultry farmers awareness and encourage small scale poultry producers to establish suitable poultry processing plant in own farm area. One of many tools is now available in world moving toward a solution. Poultry farms in Bangladesh are producing approximately 7500 MT poultry waste per day (The Daily Star, 2013). If not properly manage, this huge amount of poultry waste are polluting our environment. The study has been carried out the objectives to identify the existing poultry processing problems and prospects and to analyze the nutrient content s and meat oxidation of fresh and preserved poultry meat for safe consumption. This work was done through an ongoing project of Bangladesh Livestock research Institute (BLRI). A total of 100 questionnaires were filled up through direct face to face interview with the mini poultry processors of Nabinagar and Savar area of Dhaka. The data were analyzed using computerized software program, MS Excel. The information was extracted and summarized considering their education level, types of poultry birds available for slaughtering and income of the poultry processors. All birds are slaughtered in Halal method by the locally made equipment. Processing wastes were used in the pond as fish feed (50% processors responded) taken by pond owners. The processors have no specialized training taken from any institute. About 57% processors managed their fund of their own and remaining had got loans. Their monthly income ranges from 20000 to 40000 taka from this mini poultry processing operation, their education level were mostly primary to SSC level. The types

of poultry are mainly commercial broiler followed by spent hen (culled laying hen after completion of laying cycle), cockerel and native chicken. They have also technical knowledge gap. It was pointed out that science based knowledge and technological support can enhance their business enterprises and also providing the safe poultry meat to the consumers. Experimentally about 8000 poultry birds (chicken, ducks and quail) were dressed, packaged, stored and supplied to the consumers which indirectly reduced the live marketing practice at our locality. This work should be continued to produce need based technology generation for the mini processors, improving of knowledge through establishing a model mini poultry processing plant for the community as well as training. Mini poultry processing items were accumulated as killing cone stand, evisceration table, working table, trey, digital weighing balance, SS trolley, aluminum saucepan, burner, plastic container, packing machine, dissecting box etc.



This research is a part of an ongoing work; it is required to consider healthy and hygienic meat production procedures, which we have a plan to conduct. For hygienic meat production proper processing procedure are following with the principles of HACCP. Hence, after completion of all the planned activities a model processing plant will be developed which finally distributed to different communities for safe poultry meat production to the consumers. This work should be continued to produce need based technology generation for the mini poultry processors, and to enhance their knowledge by training on the generated technologies.

Development of milk products from buffalo milk and their evaluation

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Executive summary

Buffalo contributed about 5% of the total national milk production. Buffalo milk and milk products are available and familiar in some buffalo concentrated areas of the country. For example, Dahi prepared from raw buffalo milk is popular in Bhola district of Bangladesh. Buffalo milk are known to more healthier than cow milk as it contain less cholesterol (total cholesterol 275 vs 330 mg and free cholesterol 212 vs 280 mg per 100 g of buffalo and cow milk fat), higher amount of calcium, better calcium to phosphorous ratio, less sodium and potassium and higher amount of omega 3 and 6 fatty acid than cow milk. Milk and different indigenous milk products prepared from cow milk are very popular throughout the country. In contrast, buffalo milk and milk products are restricted in few localities of the country. Buffalo milk is widely used in many western countries for the preparation of buffalo mozzarella cheese. Popularization of buffalo milk and milk products among the peoples will help buffalo development in Bangladesh. Therefore, it is essential to know the nutritional composition and health benefit and cost benefit ratio of preparation of milk products from buffalo milk and compared with cow milk products. Considering the stated facts, the present study designed to compare nutritional composition and health benefit and cost benefit ratio in preparation of Dahi, Ghee, Cheese and Butter from fresh buffalo and cow milk. Standard laboratory procedures were followed for preparation and nutritional evaluation of the studied dairy products. All dairy products were prepared in the Dairy Science Laboratory of Bangladesh Agricultural University, Mymensingh. Buffalo and cow milk were collected directly from famers and carried in to the laboratory for preparation of studied milk products. Milk collected from different farmers were pooled and mixed well. Then pooled milk sample were used for preparation of selected milk products. Similar procedures were used for preparation of dairy products from buffalo and cow milk. The fat (%) content was determined by Babcock fat test method. Dry matter (%) and ash (%) content were estimated by oven drying methods at Dairy Science Laboratory. Cholesterol and fatty acid profile were determined at the laboratory of Bangladesh Council of Science and Industrial Research (BCSIR), Dhaka by gas chromatography method. Data were analyzed following one way ANOVA using MINITAB. Results showed that fat (7.5 vs.4.3%), lactose (4.7 vs. 4.3%) and ash (0.70 vs. 0.69%) contents of buffalo milk were higher than cow milk used in the preparation of studied milk products. Preparation of 1 kg Dahi and Cheese will require 11.02, 28.60 and 22.37% less buffalo milk than cow milk (Table 1). The production cost of these products was shown in Table 1. The total solid content were higher in Dahi and Cheese prepared from buffalo milk than that of cow milk (Table 2). However, no differences were observed for moisture (99 vs 99 %), fatty acid (1.2 vs 1.7), saponification (227 vs 225), RM (26 vs 30), Polenskye (1.5 vs 1.2) and Kirschner (20 vs 25) values between Ghees made from buffalo and cow milk. The cholesterol contents were 32.16, 20.20, 34.73 and 28.90 % lower, in the Butter, Ghee, Dahi and Cheese respectively, of buffalo milk than cow milk (Table 3). Saturated fatty acid content was higher in cheese of buffalo milk ($p< 0.01$) than cow milk cheese. No significant differences were observed for mono unsaturated fatty acid (MUFA) and poly unsaturated fatty acid (PUFA) contents (%) between Butter, Ghee, Dahi and Cheese of Buffalo and cow milk, respectively (Table 3).

Table 1 Amount of buffalo and cow milk required for production of per kg milk products

Milk products	Milk/Cream required (kg)		Production cost (Taka/kg)	
	Buffalo	Cow	Buffalo	Cow
Butter	2.20	2.11	758	790
Ghee	2.08	2.00	961	1001
Dahi	1.05	1.18	86	73
Cheese	2.22	2.86	243	240

Table 2 Chemical and physico-chemical analysis of milk products

Milk products	CHO (%)		Ash (%)		Total solid (%)		Moisture (%)		pH		Acidity (%)	
	Cow	Buffalo	Cow	Buffalo	Cow	Buffalo	Cow	Buffalo	Cow	Buffalo	Cow	Buffalo
Dahi	17.9	18.1	0.8	0.8	27.4	31.49	72.6	68.5	4.9	4.6	0.8	1.0
Cheese	2.2	2.6	4.2	4.5	43.6	52.35	56.4	47.7	5.8	5.9	0.2	0.2

Table 3 Total fat, cholesterol, saturated fatty acid, monounsaturated fatty acid and poly unsaturated fatty acid content of different milk products

Milk products	Total Fat (%)			Cholesterol (mg/100 g)				Saturated fatty acid (%) (SFA)			Mono unsaturated fatty acid (MUFA) (%)			Poly unsaturated fatty acid (PUFA) (%)		
	Cow	Buffalo	P value	Cow	Buffalo	P value	% less	Cow	Buffalo	P value	Cow	Buffalo	P value	Cow	Buffalo	P value
Butter	78.1	81.6±0.7	0.05	66.9	45.4±0.2	0.003	32.2	49.5	49.93±3.2	0.43	26.4	29.4±2.1	0.14	2.3	2.2±0.4	0.44
Ghee	96.4	95.9±0.2	0.08	56.2	44.8±9.7	0.17	20.2	63.8	65.2±3.5	0.34	30.0	28.8±2.7	0.32	2.6	1.8±0.8	0.18
Dahi	7.2	9.8±0.3	0.02	19.9	13.0±2.2	0.07	34.7	4.8	6.7±0.1	0.14	2.2	2.9±0.1	0.06	0.1	0.2±0.01	0.06
Cheese	18.7	27.4±2.1	0.05	7.4	5.2±0.3	0.03	28.9	11.9	19.9±5.4	0.01	6.0	6.7±1.7	0.33	6.0	0.4±0.5	0.22

Study on growth performance, carcass characteristics and meat quality of native buffalo and cattle at different ages

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Executive summary

The present study was undertaken with the objectives of determining the comparative performances of buffalo and cattle (two species) on meat production and productivity and quality at different ages (18 months, 24 months and 30 months) on a common plane of nutrition and management. A total of 36 bulls of BLRI Cattle Breed-1 (BCB-1) and local buffalo, each of three ages (18 Months, 24 Months and 30 Months) dividing into 6 equal groups reared on a common plane of nutrition for 105 days including a 8 days nutrient balance quantification period before the end of the feeding trial. Daily live weight gain (LWG), feed intake and digestibility (results on 60 days feeding trial was presented in Annual Review Research Workshop, 2016) were determined. Carcass characteristics according to FAO (1991) and beef quality according to standard methods were determined after slaughtering 5 bulls from each group while they were continued to raise on the same plane of nutrition till slaughtering of the animals. However, the ages of the both species during slaughtering were 28, 34, and 40 months, respectively. To determine treatment effects and their interactions on live weight gain (LWG), feed intake and digestibility, nutrient balances, carcass yield characteristics and meat quality were analyzed using a 2*3 factorial experiment in Completely Randomized Design (CRD) by a univariate GLM procedure of SPSS 17 computer software. Animal species and age had a significant effect on LWG of the animal. Irrespective of age, buffalo bulls had a significantly ($p<0.001$) higher daily LWG (1.11 kg) than BCB-1 cattle (0.88 kg). The LWG was also affected significantly ($p<0.01$) by the age of bulls. The bull of 24 months (1.041 kg) or 30 months (1.048 kg) ages showing almost similar growth performances ($p>0.05$) among the two age groups had significantly higher LWG than the bulls of 18 months (0.888 kg). Buffalo bulls (FCR, 6.72) were more efficient ($p>0.05$) in the conversion of feed into live weight than BCB-1 cattle (FCR, 6.86; Table 1). Irrespective of species, the bulls of 18 months (FCR, 6.24) or 24 months (FCR 6.81) age had a better ($p<0.05$) FCR than that of 30 months (FCR, 7.33) age. The FCR value of both the animal increased ($p<0.05$) linearly with the increase of age. Average slaughtering live weight was significantly ($p<0.001$) increased with the age of bull increased (Table 2). Irrespective of age, buffalo bulls (464 kg) had significantly ($p<0.001$) higher slaughtering live weight than that of BCB-1 cattle (389 kg). Similarly, a significantly ($p<0.01$) higher body condition score (BCS; 6-point scale) at slaughtering was observed in buffalo bulls (5.36) than BCB-1 cattle (5.13). The BCS value of both the animal increased ($p<0.01$) linearly with the increase of age. Carcass weights increased ($p<0.001$) with age but age had no influence ($p>0.05$) on dressing percent (warm & chilled), meat and bone ratio or bone percent. Species however, significantly influenced warm carcass weight ($p<0.01$), dressing percent ($p<0.001$) and meat and bone ratio or bone percent ($p<0.001$). Buffalo bulls had the highest ($p<0.01$) average carcass weight (242 kg) than BCB-1 cattle (215 kg). On the other hand, a significantly ($p<0.001$) higher dressing percent of both warm and chilled (55.3% and 54.7%) carcasses and meat to bone ratio (5.33: 1.0) was found in BCB-1 cattle than buffalo bulls (52.0% and 51.6%, respectively for warm and chilled dressing percent and meat to bone ratio 4.57:1.0). Species did not influenced ($p>0.05$) *longissimus* muscle (Eye muscle) area but age significantly ($p<0.05$) affected *longissimus* muscle area (cm^2). It was increased linearly ($p<0.05$) with the increase of age or live weight of the animals. The p^H values of meat (warm carcass) after 2 hrs postmortem and drip loss were not influenced ($p>0.05$) by the species or age. However, the age of animals significantly ($p<0.05$) influenced p^H of meat (chilled carcass) after 24 hrs postmortem. The higher p^H values were measured in meat from older animals than that of medium aged or younger animals. Species and age significantly ($p<0.05$) affected cooking loss of meat. BCB-1 cattle had significantly ($p<0.05$) higher (20.3%) cooking loss than that of buffalo bulls (18.2%), and with the advancement of age it increased significantly ($p<0.05$) resulting more cooking loss of aged animals. Species ($p<0.001$) and age ($p<0.05$) of animals significantly influenced marbling score of beef meat. As the age of animals increased marbling score of meat increased linearly ($p<0.05$). The

score was higher at 36 months indicating aged meat had more intra-muscular fat. Species ($p<0.01$), age ($p<0.001$) and species × age interaction ($p<0.01$) significantly influenced the color of meat. Buffalo meat appeared ($p<0.01$) darker (36.7) than the meat of BCB-1 cattle (40.1). As the age of animals increased the darkness of meat increased linearly ($p<0.001$). There were also significant ($p<0.05$) differences in meat redness between two species, the meat of buffalo (17.4) had deep red color than that of BCB-1 cattle (15.8). The proximate compositions except intramuscular fat contents in meat were not affected by species and age of the animals. Buffalo beef meat showed significantly ($p<0.001$) a lower IM fat (0.44%) than that of BCB-1 cattle (3.31%). The age of animals influenced ($p<0.001$) fat (intra-muscular fat), contents in meat. As the age of bulls in all two species increased the levels of intra muscular fat increased significantly ($p<0.001$). Older animals had significantly ($p<0.001$) higher intra-muscular fat (IM fat) than younger animals. Buffalo beef had significantly a higher tenderness ($p<0.01$) and acceptability ($p<0.001$) to consumers than BCB-1 meat. However, the overall acceptability score of meat of both the species decreased ($p<0.05$) as the age of the animals increased.

Table 1 Effect of species and age on LWG and FCR of bulls fed common plane of nutrition

Parameters	BCB-1			Buffalo			Species		Age			SED	Sig. level		
	18M	24M	30M	18M	24M	30M	BCB 1	Buffalo	18 M	24 M	30 M		S	A	S*A
LWG	0.77	1.00	0.86	1.00	1.08	1.24	0.88	1.11	0.89^{a}	1.04^{b}	1.05^{b}	0.03	***	**	*
FCR	6.32	6.58	7.69	6.14	7.05	6.97	6.86	6.72	6.24^{a}	6.81^{ac}	7.33^{bc}	0.23	NS	*	NS

Table 2 Effect of species and age on carcass yield characteristics of bulls fed common plane of nutrition

Parameters	Species		Age			SED	Sig. level		
	BCB-1	Buffalo	28 M	34 M	40 M		S	A	SxA
LW at slaughter (kg)	389	464	383^{c}	426^{b}	471^{a}	8.54	***	***	*
BCS (6-point scale)	5.13	5.36	5.08^{b}	5.25^{a}	5.41^{a}	0.05	**	**	NS
Warm carcass wt. (kg)	215	242	202^{c}	228^{b}	256^{a}	5.49	**	***	NS
Warm dressing %	55.3	52.1	53.1	53.5	54.4	0.42	***	NS	NS
Meat & bone ratio	5.33	4.57	4.77	5.07	5.02	0.12	***	NS	NS
Longs. muscle area, cm^2	82.6	81.5	77.7^{b}	79.6^{bc}	88.9^{ac}	2.84	NS	*	NS

Table 3 Meat physical, chemical and sensory qualities of BCB-1 and buffalo bulls of different ages

Parameters	Species		Age			SED	Sig. level		
	BCB-1	Buffalo	28 M	34 M	40 M		S	A	SxA
P^{H}, 2hrs of postmortem (W)	5.93	6.07	5.99	5.88	6.13	0.09	NS	NS	NS
P^{H}, 24hrs of postmortem (C)	5.64	5.84	5.63^{b}	5.63^{b}	5.96^{a}	0.08	NS	*	NS
Drip loss%	11.3	11.3	11.0	11.6	11.2	0.55	NS	NS	NS
Cook loss%	20.3	18.2	17.6^{b}	19.5^{bc}	20.7^{ac}	0.78	*	*	NS
Marbling Score	5.00	3.85	4.00^{b}	4.48^{bc}	4.80^{ac}	0.18	***	*	NS
*L** (lightness)	40.1	36.7	41.0^{a}	39.1^{a}	35.0^{b}	0.83	**	***	**
*a** (redness)	15.8	17.4	16.8	17.0	16.0	0.50	*	NS	NS
*b** (yellowness)	9.9	10.8	11.7^{a}	10.2^{ac}	9.4^{bc}	0.44	NS	*	*
Color Intensity (C)*	18.7	20.1	20.5	19.4	18.3	0.63	NS	NS	NS
DM	27.0	26.1	26.4	27.0	26.3	0.63	NS	NS	NS
Protein	20.8	20.2	20.6	20.7	20.2	0.24	NS	NS	NS
Fat (IM)	3.31	0.44	1.54^{c}	1.90^{b}	2.19^{a}	0.05	***	***	***
Ash	4.01	4.29	4.31	4.09	4.05	0.18	NS	NS	NS
Tenderness	6.66	7.42	7.27	6.97	6.88	0.14	**	NS	NS
Overall acceptability	7.43	8.00	7.89^{a}	7.78^{ac}	7.47^{bc}	0.11	***	*	NS

From the results, it may be concluded that the buffalo bulls, irrespective of their age, being high efficient in feed utilization and produced a higher average daily weight gain than BCB-1cattle. Higher carcass weight, more dark and red meat, higher tenderness & consumer acceptability, lower cooking loss and lower levels of intra muscular fat make meat of native buffalo more acceptable than that of BCB-1 cattle.

Feeding effect of maize stover based densified Total Mixed Ration (TMR) on milk yield, milk composition and digestibility of RCC milking cows

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Executive summary

Crop residues are the major roughage sources available for ruminant feeding in Bangladesh. The concept of "Total Mixed Ration (TMR) Block" is a novel approach, which provides a good opportunity to feed manufacturers and entrepreneurs to remove regional disparities in available feed and supplying balanced feed to the dairy and other ruminants on a large scale, especially in areas where of shortage of green fodder. Crop residues based densified TMR is a new concept in the feeding of dairy animals which delivering nutrients to bovines as a complete balanced forms. This study was conducted to formulate, process, and development of TMR for RCC milking animal by using locally available agro-industrial by-products. To determine the feeding effect of TMR, an experiment was conducted at Pachutia Research farm of Bangladesh Livestock Research Institute (BLRI), Savar Dhaka. A total of 18 milking cows were selected and equally divided into 3 treatment groups having 6 cows in each group considering their milk yield. One group was considered as control and fed regular feed supplied to the animal at the farm (T_0). In another two groups, animals fed TMR (50% roughages: 50% concentrate, contained 16% CP), where one fed as block (T_1) and another as mash form (T_2). For making TMR, maize stover was used as crop residue. Before preparation of TMR, maize stover was chopped through the chopper machine and then mixed with other concentrate ingredients.TMR blocks were prepared manually contained 5 kg materials with the dimension of 9cm×9cm×9cm. Animals of each group offered TMR twice daily as *adlibitum* at 8.00 am and at 4.00 pm. Data of Feed intake, milk yield, milk composition, body weight gain and nutrient utilization were recorded. The feeding trial was continued for a period of 45 days. In the middle of the feeding trial, a digestibility trial was conducted (Respective samples of feed, refusal and faeces samples were subjected to chemical analysis for determination of crude protein (CP), organic matter (OM),dry matter (DM), ash and Neutral detergent fibre (NDF), Acid detergent fibre (ADF) following the methods of AOAC (2005) and Van Soest *et al*., (1991), respectively. The data were analyzed using the "SPSS" statistical program with one way ANOVA in Completely Randomized Design (CRD) and Duncan's Multiple Range Test (DMRT) used to compare the significance of treatment means among the different parameter.

Table 1 Dietary Composition

Feed Ingredients	Amount in kg	
	T_0	T_1 & T_2
Maize stover	-	40.51
Napier 3	82	-
Wheat bran	5.85	0.65
Kheshari bran	1.8	0.65
Soybean meal	2.6	18.55
Molasses	-	5.25
Salt	0.09	0.35
DCP	2.7	1.75
DM (%Fresh basis)	21.01	35.01
CP (%)	16	16
ME req (MJ/D)	42.55	42.78
ME supply (MJ/D)	54.73	60.46

Table 2 Nutrient composition of different feed ingredients used in different treatment group

Ingredients	DM (%)	CP (%)
Wheat bran	87.43	15.06
Khesari bran	86.55	12.22
Soybean meal	85.78	44.13
Maize stover	88.96	5.72
Napier-3	20.39	9.40

The feed intake of animals supplied different form shown in Table: 3. Feed intakes were significantly higher in T_0 group than other treatment groups. DM intake, CP intake, DM intake % live weights were significantly higher in T_1 group and lowest observed in T_0 group. CP intakes differ due the variation of DM intake among different treatment groups. Milk production and composition of different treatment groups were shown in Table 4.There were significant difference observed in milk yield among different treatment group. Highest milk yield were observed in T_1 group and lowest milk yield were in T_0 group. There were significant difference observed in fat and SNF and no significant differences in protein, lactose content. Nutrient utilization of different treatment groups are shown in Table 6. Highest DM, CP, OM, digestibility were in T_1 group and lowest in T_0 group. Ash and NDF digestibility were higher in T_2 group and lowest in T_0 group. No significant differences observed in ADF digestibility.

Table 3 Feeding effect of TMR on intake

Parameter	Control(T_0)	TMR Block(T_1)	TMR mash(T_2)	Significance level
Fresh feed intake (kg/day)	24.93^{a}±0.008	14.40^{b} ± 0.02	14.01c ±0 .08	***
DM intake (kg/day)	4.49^{c}±0.001	5.07^{a}±.007	$^{4.91b}$±.0.02	***
CP req(kg/day)	0.362 ± .12	0.362 ± 0.09	0.362 ±0 .13	**NS**
CP intake (kg/day)	0.72^{c}±0.00	0.8^{a}±0.00	0.78^{b}±.004	***
DM intake% live wt	1.97±0.22	2.44±0.39	2.16±0.15	**NS**

***-p<0.001

Table 4 Milk production and composition of different treatment groups

Parameter	Control (T_0)	TMR block (T_1)	TMR mash (T_2)	Significance level
Initial milk yield (ltr)	2.98±0.31	2.98 ±0.21	2.98± 0.21	NS
Initial FCM (ltr)	3.20±0.14	3.20±0.14	3.20±0.14	NS
Current milk yield (ltr)	3.124^{b}±0.04	3.36^{a}±0.03	3.25^{ab}±0.07	**
Final FCM (ltr)	3.35±0.17	3.6±0.14	3.49±0.12	NS
Fat (%)	4.7^{b}±0.1	5.26^{a}± 0.14	5.28^{a} ± 0.08	***
Protein (%)	3.92±0.04	4.06±0.05	4.05±0.07	NS
Lactose (%)	5.65 ±0.05	5.77±0.06	5.72±0.07	NS
SNF (%)	10.27b±0.2	10.78a±0.07	10.74a±0.07	*

NS-non significant (p>0.05)

Table 5 Changes of live weight of different treatment groups

Parameter	Control (T_0)	TMR Block (T_2)	TMR mash(T_3)	Significance level
Weight gain(kg)	8.08±.712	7.83±.58	7.58±.41	NS
Live weight gain(kg/d)	0.16±.009	0.163±.012	0.161±0.006	NS

NS-non significant (p>0.05)

Table 6 Nutrient utilization of different treatment groups

Nutrients digestibility (%)	Control(T_0)	TMR Block(T_1)	TMR mash(T_2)	Significance level
DM	53.45^{b}±1.98	64.60^{a} ± 1.14	61.46^{a} ±2.11	**
CP	66.28^{b}±2.19	76.46a±.9867	72.83^{a}±1.96	**
OM	55.55^{b}±1.83	66.09^{a}±1.12	61.4^{a}±2.22	**
Ash	38.94^{b}±3.59	58.06^{a}±2.04	61.4^{a}±2.22	***
ADF	63.45±2.92	69.3±1.77	67.94±2.57	**NS**
NDF	52.38^{b}±1.58	56.77^{b}±1.29	64.98^{a}±1.99	***

***-p<0.001

Based on the results of the experiment, it can be concluded that maize stover based total mixed ration (50:50) can be substituted for conventional feeding as a diet for milking cow for higher milk yield, nutrient utilization and more profit.

Study of food-feed competitive efficiency of Moringa fodder in the Teesta-Meander Floodplain Agro-Ecological Zone of Bangladesh

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Executive summary

Moringafeed (M_f), a manufactured feed of Moringa (*Moringa oleifera)* plant twigs and branches, reported to replace conventional concentrates or their mixtures of ruminant diets (Sultana *et al.* 2012, Huque *et al.* 2015; Foidl *et al.* 1999; Sanchez *et al.* 2006) and produce safe food of animal origin smartly (Sultana *et al.* 2012). Backward integration of Moringa producers tackling food-feed competitions for land with its manufacturing process and creating farmers` awareness on its feeding benefits help livestock feed industry grow further. Keeping the above factors in view, the present research work was undertaken to (i) determine competitive land use efficiency of Morngafeed (M_f) production on farm compared to existing crops and (ii) demonstrate feeding impacts on farm of dairy cattle. For determining the Moringafeed feeding impact on milk production, twelve local cows of third or fourth parity after 1 to 2 weeks of calving of Gaibandha Sadar Upazila were selected and divided into three dietary groups having four animals in each considering their live weight and ante-diet daily milk yield. During 50 days feeding period all experimental cows were fed freshly threshed rice straw and keeping randomly a group under on farm practice that received supplementation of conventionally mixed concentrates (farm practice), the other two groups of cows were either received a commercial cattle feed available at the market (Market feed) or M_f replacing conventional concentrate supplements.

Table 1 Chemical composition of different feeds

Experimental diet	%, Chemical composition (DM basis)			
	DM	CP	ADF	NDF
Green R. Straw	87.07	4.20	60.12	73.26
Con. mixture	89.84	11.33	22.0	44.71
Commercial C. feed	88.98	16.72	37.94	57.24
Moringafeed(M_f)	88.5	17.02	38.97	53.8

The daily energy and CP requirement of the cows were calculated according to FAO ration tool (2016) and they were met through the diets. Feeding responses of different diets on different parameters was analyzed in an ANOVA of a Completely Randomized Design (CRD).

Table 2 Feeding effects on nutrient intake and production performance of local cows (means ± SE)

Parameters	Experimental rations			Significance	
	Farm Practice	Market feed	Moringa feed (M_f)	Overall SE	Level
Total DM intake(kg/day)	3.8^{b}±0.1	4.8^{a}±0.1	5.1^{a}±0.1	0.18	P<0.00
Total ME intake(MJ/day)	34.6^{b}±0.9	53.0^{a}±0.7	54.2^{a}±0.8	2.7	P<0.00
Total CP intake(g/day)	251.0^{c}±7.6	273.0^{b}±3.2	543.6^{a}±3.6	37.7	P<0.00
Ante-diet milk Prod.(kg/day)	0.83±0.1	0.81±0.2	0.96±0.3	0.1	P<0.832
On-diet 4% FCM yield (kg/day)	0.73^{b}±0.2	1.1^{ab}±0.2	1.64^{a}±0.2	0.14	P<0.022
Suckling of milk per day	0.71^{b}±0.1	0.65^{b}±0.06	1.04^{a}±0.05	0.06	P<0.01
Daily weight gain (g) of cows??	48.2^{b}±34.9	128.2^{b}±52.5	441.7^{a}±88.8	60.8	P<0.004

Here, Figures with different superscript in the same row differ Non significant

The replacement of concentrate mixture by M_f had a significant effect on daily DM, CP or ME intake. The Moringa group consumed the highest amount of DM, CP and ME (5.1 kg, 543.0 g and 54.2 MJ) compared to others. The on-diet (after feeding experimental diets) daily average 4.0% fat corrected milk production of M_f fed cows was the highest (1.64 kg/head) followed by 1.10 Kg/head of market feed and 0.73 Kg/head of cows fed conventionally (Table2). The response difference was significant ($p<0.022$). The calves of M_f suckled significantly ($p<0.01$) the highest amount of milk (1.04kg/day) than the calves of Market feed (0.65 Kg/head/day) or farm practice (0.71 Kg/head/day) group, and the M_f cows had significantly ($p<0.004$) highest daily gain(441.7 g/head) compared to the latter (128.2g/head and 48.2 g/head, respectively). Fig1 shows that the feeding of market feed or M_f increased daily milk yield by 53.09 % and 64.58 %, respectively and daily gain by 4.7% and 13.29 %, respectively compared to farm practice. The milk quality in terms of Fat, SnF, Lactose or CP did not vary significantly ($p>0.05$). It was also shown that Moringa feed (M_f) is better than the Market feed in the increase of milk yield and live weight gain of local cows. The on-farm M_f production was 26.67 ton/hectare and it was similar (25.34 ton/hectare) to that was reported by Huque *et al* (2015). Thus, feeding of M_f increased milk yield and live weight gain of cows compared to Market feed or conventional concentrate mixture.

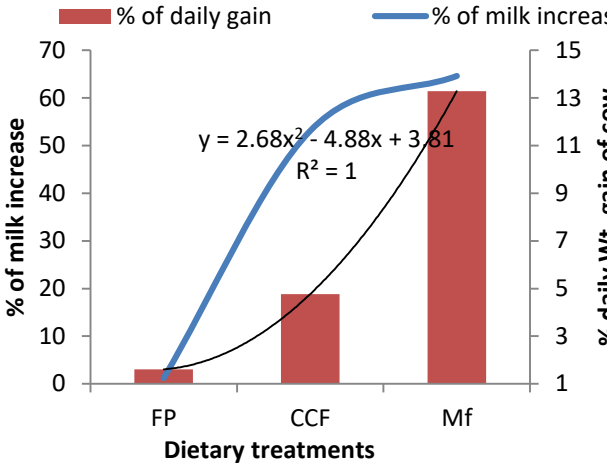

Figure 1 Feeding effects on % of milk yield & % weight gain

Biomass yield and nutritional quality of Moringa and its feeding effect on lactating cows

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Executive summary

Dietary imbalances in roughage and concentrate feeding in addition to the absence and/or inadequacy of quality protein feeds in the dairy cattle diets of Bangladesh hold down milk production performances of cows irrespective of their genetic potentiality. Feeding soybean meal, a major feed ingredient of commercial poultry that has been facing increased import competition in recent decades is very costly to dairy animals. Moringafeed (Mf) may be one of the best options, as it was found to be a high ranking cattle feed in terms of its efficiency of biomass production, animal production, reduction of enteric methane emission and benefit to cost of feed marketing. Taxonomical and molecular studies show that Black Seed Moringa (BSM) and White Seed Moringa (WSM), two different plant cultivars are locally available. Comparison of their biomass production efficiency and nutritional quality in terms of chemical composition, and rumen degradability *in sacco* of their dry matter (DM) and crude protein (CP) may help the selection of the best cultivar for feed production. After selection of the best cultivar the Mf was produced for determining its feeding impact on yield and quality of milk of lactating crossbred dairy cows.

Table 1 Biomass yield and quality of different cultivars

Parameter	Cultivars		SE	Significance
	BSM-L	WSM_L		
DM yield(ton/hac/yr)	24.70	7.43	2.35	p< 0.000
Stem: leaf	0.51	0.61	0.030	p< 0.030
Whole Plant %CP (DM basis)	22.28	22.13	0.10	p< 0.449
Effective degradability (%)	46.97	55.07	1.87	p< 0.001

Both BSM and WSM cultivars were cultivated following the agronomical practices during July 2015 to June 2017 in the animal research station Pachutia of (BLRI), Savar Dhaka for evaluating their biomass production efficiency and nutritional quality. Preparing a uniformly plain land of 64.8m^2, and dividing it into four blocks each of 16.2$m^2$and each block of four equal plots of each of 8.1m^2, saplings of the two cultivars were randomly planted at a space of 0.3 m x 0.3 m. The branch tops and twigs with leaves were harvested at an interval of 60 days keeping bottom stem height of 40 cm above the ground. Fresh or dry biomass, survival rate (%), the number of prunes per plant; stem: leaf ratio and chemical composition of biomass were determined at different harvesting times and differences in the cultivars were analyzed in an ANOVA of Completely Randomized Design (CRBD). The dry and milled biomass of the two cultivars were also evaluated in terms of their rate and extent of DM and CP degradability using five (5) rumen canulated native growing bulls following the method described by Ørskov and McDonald (1979), The chemical composition was done following the method described by AOAC (2005). The BSM was cultivated earlier and the biomass produced was used to support a feeding trial of twenty five (25) crossbred milking cows of 2^{rd}/3^{rd} parity and of 30/35 days lactation period conducted in the Central Cattle Breeding Station and Dairy Farm. Dividing the cows equally into five (5) different groups, a group was kept on farm feeding (Farm practice) and the rest four groups were randomly allocated to one of the four diets consisting the basal roughage of green grass and urea molasses mixed straw (UMS) used in farm practice and four different types of mixed concentrates. The concentrate mixture was prepared with Khesari bran, Rice bran, Soybean meal, crushed wheat, molasses and mineral. The first 3 mixture was replaced by Moringafeed at 0,40,60 and 100% keeping the rest constant for all mixtures were randomly fed to the rest 4(four) groups of cows designated as Mf at 0% (100C:M0), 40% (60C:M40), 60% (40C:M60), and 100% (0C:M100). The requirement of metabolizable energy (ME) and CP of each of the cows were calculated using FAO ration tool (2017) and the required ME and CP were available to cows through daily diets and

continuously adjusting an average of 60:40 ratio of roughage to concentrate. The feeding trial was conducted for 80 days. In the metabolism trial, of 10% samples of feed, feed refusals and feces were collected daily, combined, dried at 65°C for 72 h, and ground through a 1-mm sieve for each cow before analysis. Urine from each cow was also collected daily in a bucket containing 100 ml of 7.2 N H_2SO_4. The volume was measured and then diluted to 5 L with tap water, and a sample of 20 ml was collected, pooled for each animal, and stored at −20°C for analyzing total N and PD. Milk was routinely analyzed for determining qualitative test and blood samples were collected twice from all cow during the last month of experimental period for determining different blood metabolites. Fortnightly live weight changes of cows were recorded. During an initial ante diet (before starting feeding treatment diets) period of 10 days daily yield of milk and its fat% were also recorded for each cow. Dietary responses on different parameters were analyzed in an ANOVA of a Completely Randomized Design (CRD).

The average annual DM yield of BSM-L (24.70t/ha) was significantly ($p<0.000$) higher than that of WSM (7.43 t/ha), and a higher survivability of plants and prune number per plant supported a better biomass production of BSM. No significant ($p>0.05$) difference in chemical composition, especially of CP (22.28, & 22.13%) respectively. The DM of BSM was significantly ($p<0.002$) less rumen degradable (46.97%) than that of the WSM (55.07%, Table1). Considering production performances, chemical composition and rumen degradability *in sacco* BSM was considered to be a better feed for lactating cows.

Table 2 Nutrient intake and production performance of cows

Parameter	Experimental Diets				Farm Practice	SE	Sign. level
	100C:M0	60C:40M	40C:M60	0C:M100			
DM intake (kg/day)	9..21c	9.44^{b}	9.56^{b}	9.47^{b}	12.42^{a}	0.27	p< 0.000
CP intake (g/day)	1363.0^{b}	1356.9^{b}	1360.6^{b}	1365.1^{b}	1460.6^{a}	0.41	p< 0.002
Estimated ME intake (Mj/Day)	86.3^{bc}	87.9^{bc}	93.8^{ab}	81.9^{c}	100.8^{a}	0.22	p< 0.000
Fat (%)	4.48^{b}	4.53^{ab}	4.55^{ab}	4.76^{a}	3.76^{c}	0.10	p< 0.000
Ante diet Av. 4% FCM yield (kg/day)	6.00	6.14	6.09	6.34	6.10	0.14	--
On-diet Av. 4% FCM yield (kg/day)	7.60^{a}	7.36^{a}	7.80^{a}	7.98^{a}	5.91^{b}	0.24	p< 0.000

The cows fed treatment diets irrespective of Mf level had a significantly ($p<0.000$) lower daily per head DM intake of total diet (9.21 to 9.56 Kg), roughage (5.80 to 5.86 Kg) or concentrate DM (3.41 to 3.70 Kg) than that were continued on farm practice (12.42 Kg, 6.47 Kg and 5.95 Kg) respectively. Similarly, they had a significantly lower daily per head CP (1356 to 1365.1 g, $p<0.002$) or ME (81.9 to 93.8 MJ, $p<0.000$) intake compared to the latter (1460.6 g & 100.8 MJ) respectively. Treatment diets having any significant ($p>0.05$) response variation in milk yield among them increased per head average daily 4.0% fat corrected milk (FCM) yield vertically to 7.36 to 7.98 Kg from 6.0 to 6.34 Kg recorded during ante diet period of farm practice. During the trial period the 4%FCM of the cows under farm practice reduced from 6.10 Kg to an average of 5.91Kg making a significant ($p>0.00$) variation with that of treatment diets. Milk fat% was significantly increased in treatment diets indicating a significant linear relation with the dietary level of Mf. Mf linearly ($p<0.001$) increased milk yield resulting in a negative linear relations with the cholesterol content of blood or milk. Both biomass production efficiency and nutritional quality of BSM (Moringa *oleifera*) was better than its sibling variety and feeding BSM based manufactured feed (Mf) to crossbred lactating cows increased milk yield and its quality .Dietary nutritional balancing and feeding Mf may make dairy production cost effective and climate smart.

Forage growth, biomass yield and nutritional quality of BLRI Napier hybrid-3 and Pakchong-1 at different cutting intervals

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Executive summary

Livestock is one of the important components and fast growing sectors in integrated and subsistence farming system in Bangladesh. But, feeds and fodder scarcity is a major limiting factor of livestock production in Bangladesh in particular resulting in low productivity, poor growth and reproduction of animals. Access to a permanent forage base is a physiological priority for ruminants and an economic priority for farmers. Considering these aspects, the Napier hybrid cultivar Pakchong-1 (*Pennisetum purpureum x P. glaucum*) is recently introduced from Thailand, which is reported to grow over 3 m tall in less than 2 months, gives high yields and can be harvested after 45 days with a CP concentration of 16−18%. But, production performances of forage crops are highly correlated with area, location and seasons. Thus, there is a need to verify if Pakchong-1 can outcompete the existing cultivars in terms of forage yield, quality and growth characteristics, under Bangladesh conditions. Therefore, the present study was carried out to evaluate the effect of cutting interval on forage growth, yield and quality responses of Pakchong-1in native conditions compare to BLRI Napier hybrid-3. A 2 x 3 factorial experiment (2 cultivars -BLRI Napier hybrid-3 and Pakchong-1 grass x 3 cutting intervals; 40, 50 and 60 days) was conducted in 3 blocks (3 replications). Plot sizes for each cultivar was 25 m^2 (5 × 5) m and in every plot twenty-five stem cuttings per cultivar with 2 healthy nodes per cutting were planted with (1 x 1) m spacing. After each cut, chemical fertilizers i.e. urea was applied uniformly at the rate of 75 kg /hectare. Weeding were done regularly after each cutting. Both cultivars were harvested 05 cm above the ground by using hand sickles. At harvesting time, each plant constituted a bunch of tillers. Different parameters like, plant height, plant weight, basal circumference at 10 cm above ground level, number of tillers per plant, tiller diameter, leaves per tiller, leaves per plant, diameter of the lowest node were recorded.The GLM with a 2-factor ANOVA was used to compare the mean differences between cultivars subjected to the 3 cutting intervals with SPSS-20.0 statistical software program and Duncan's LSD test was used to test the differences between means. Differences between means were considered significant if P values were less than 0.05. Pearson's correlation was run to find relationships between different parameters.

Table 1 Effects of cultivar and cutting interval on growth parameters of BLRI Napier hybrid-3 and Pakchong-1 cultivars (mean±SE)

Treatment	Plant height (cm)	Basal circumference (cm)	No. of tillers (no.)	Tiller diameter (mm)	Leaves per tiller (no.)	Diameter of lowest node (mm)
Cultivar	**	NS	NS	**	*	**
BLRI Napier hybrid-3	237.6±3.98	76.6±3.29	19.07±1.6	13.01±0.34	12.89±0.27	17.34±0.42
Pakchong-1	211.67±3.98	76.13±3.29	21.6±1.6	16.18±0.34	11.96±0.27	20.43±0.42
Cutting interval	**	NS	NS	NS	**	NS
40 days	175.2^{a}±4.88	74.1±4.03	22.6±1.99	15.35±0.41	10.31^{a} ±0.34	19.37±0.52
50 days	213.0^{b}±4.88	77.7±4.03	20.0±1.99	14.05±0.41	11.69^{b} ±0.34	18.46±0.52
60 days	285.7^{c}±4.88	77.3±4.03	18.4±1.99	14.38±0.41	15.29^{c} ±0.34	18.83±0.52

**($p<0.01$); *($p<0.05$); NS= Non Significant

The effects of cultivar and cutting interval on plant height, basal circumference, tiller number and diameter, leaves per tiller and diameter of lowest node are presented in Table 1.For cultivars, plant height followed the order BLRI Napier hybrid-3>Pakchong-1, while basal circumference and number of tillers for both cultivars were similar and tiller diameter and diameter of the lowest node were significantly ($P<0.01$) higher inPakchong-1 than BLRI Napier hybrid-3. Cultivar had also a significant effect on number of leaves/tiller (BLRI Napier hybrid-3>Pakchong-1, $P<0.05$). Similarly, cutting interval had significant effects on plant height and leaves per tiller, with height increasing

progressively as cutting interval increased (P<0.01), while basal circumference at 50 and 60 day cutting exceeded that at 40 day cutting. Besides, the number of tillers declined significantly for all cultivars with increasing cutting intervals. There was also a significant cultivar x cutting interval effect on the number leaves per tiller (P<0.01) and tiller diameter (P<0.05).

Table 2 Effects of cultivar and cutting interval on leaf and stem DM and CP production and leaf: stem ratio (LSR) of BLRI Napier hybrid-3 and Pakchong-1 cultivars (Mean±SE)

Treatment	Leaf DM (kg/plant)	Stem DM (kg/plant)	Total DM (kg/plant)	Leaf CP (kg/plant)	Stem CP (kg/plant)	Total CP (kg/plant)	LSR
Cultivar	*	NS	NS	*	NS	*	*
BLRI Napier hybrid-3	0.17±0.02	0.22±0.02	0.39±0.03	0.11±0.01	0.10±0.01	0.21±0.01	0.54±0.02
Pakchong-1	0.23±0.02	0.19±0.02	0.42±0.03	0.14±0.01	0.13±0.01	0.27±0.01	0.61±0.02
Cutting interval	**	**	**	NS	NS	NS	**
40 days	0.15^{a}±0.02	0.10^{a}±0.02	0.25^{a}±0.04	0.13±0.01	0.10±0.01	0.22±0.02	0.69^{c}±0.02
50 days	0.18^{a}±0.02	0.19^{b}±0.02	0.37^{b}±0.04	0.12±0.01	0.11±0.01	0.23±0.02	0.55^{b}±0.02
60 days	0.27^{b}±0.02	0.33^{c}±0.02	0.60^{c}±0.04	0.14±0.01	0.12±0.01	0.26±0.02	0.49^{a}±0.02

**(p<0.01); *(p<0.05); NS= Non Significant

Cultivar had a significant effect on leaf DM production (Pakchong-1>BLRI Napier hybrid-3, P<0.05) whereas, cutting interval had a significant (P<0.05) effect on leaf and stem DM yield (Table 2).They had also a significant effect on leaf CP concentration with Pakchong-1 exceeding BLRI Napier hybrid-3(P<0.05). However, as the cutting intervals increased LSR decreased significantly (P<0.01).Correlations between growth parameters are presented in Table 3. While total production/ha was positively and strongly correlated (P<0.01) with plant height, leaf and stem DM and leaves per plant.Leaf and stem DM was strongly and positively correlated with plant height but negatively correlated with tiller number per plant. On the other hand, LSR was negatively and strongly correlated with plant height, leaves per plant, leaf and stem DM but had strong positive correlation (P<0.05) with no. of tiller and tiller diameter.

Table 3 Correlations between growth and production parameters

Parameters	Basal circumference	Plant height	No. of tillers	Tiller diameter	Leaves/ plant	Leaf DM	Stem DM	LSR
Plant height (cm)	0.11							
No. of tillers (no.)	-0.14	-0.25						
Tiller diameter (mm)	-0.04	-0.28	0.02					
Leaves/plant (no.)	-0.04	0.46**	0.50**	-0.26				
Leaf DM (kg/plant)	0.25	0.45**	0.38*	0.11	0.69			
Stem DM (kg/plant)	0.14	0.88**	0.03	-0.19	0.68**	0.72**		
LSR	-0.23	-0.78**	0.33*	0.34*	-0.36*	-0.36*	-0.75**	
Total Production/hector (kg)	0.20	0.53**	0.05	-0.13	0.46**	0.79**	0.62**	-0.51**

While both grass cultivars performed well in the experimental site, but they varied in terms of growth characteristics, forage yield and quality. BLRI Napier hybrid-3was superior to Pakchong-1 in terms of plant height and leafiness but Pakchong-1 had bigger tillers with numbers and higher overall CP production. From the forage standpoint, Pakchong-1 appears little advantages over BLRI Napier hybrid-3 as because of its fast re-growth and higher amount of CP production. However, further research with animal performance trials considering detail economic analysis are recommended for more concrete results.

Adaptability of HYV fodder cultivars in drought prone Barind areas of Bangladesh

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Executive summary

Drought is one of the main problems for many nations, and the severity of such issue goes big when it comes as obstacle to ensure an optimum agricultural production for a country like Bangladesh. Drought is being considered as the main cause which hampers the estimated agricultural production, here in Bangladesh over the last few decades. Every five years, Bangladesh is affected by the major country-wide droughts. However, local droughts occur regularly and affect crop production. The agricultural drought, linked to soil moisture scarcity, occurs at different stages of crop growth, development and reproduction. Northwestern regions of Bangladesh are particularly exposed to droughts. Apart from the agricultural losses, droughts have important effect on livestock population, land degradation, health and employment. In the drought prone areas, the scarcity of green fodder is one of the important problems in Bangladesh for rearing dairy cows. The Barind region is known as the major drought prone area, where the majority of households involved in rearing livestock. Lack of grazing facilities constrains mass rearing of cattle and goats. Therefore, the aim of this study was to increase the availability of green grasses in the Barind regions of Bangladesh. To achieve the goal, an adaptability trial with BLRI Napier cultivars (BN-1, BN-2, BN-3, BN-4, BN-5 and Pakchong) was conducted as pilot basis in three different locations (Chapainawabgonj sadar, Nachol and Gomostapur) of Chapainawabgonj district and BLRI regional station at Godagari, Rajshahi. Number of farmers in each location of Chapainawabganj was five as disperse replications. Thus, the design of the experiment was randomized completely block design (RCBD). In Godagari five blocks comprising 5 plots (for 5 cultivars) in each block measuring an area of (9.64×8) mper plot were prepared for the experiment. Stem cutting was planted in each plot. Before plantation, all plots were properly prepared by normal agronomical practice as farmers do conventionally (3-4 tillage, weeding and irrigation as per necessary), whereas in Godagari, standard agronomical practices as per BLRI was followed (3-4 tillage, fertilizing through cow dung@ 15-20MT/ha^{-1}, urea@50kg/ ha^{-1}, TSP@70kg/ ha^{-1} and MP@30kg/ha^{-1} at the time of land preparation and weeding and irrigation when required). Stem cuttings were planted in rows apart from 70cm and 35cm spacing between plants. Total biomass production and morphological parameters were studied in the experiment. Data were collected up to 8 cuts from Chapainawabganj and 5 cuts from Godagari and analyzed statistically by SPSS 22.0 program.

Table 1 Comparative performance of different Napier cultivars at Godagari, Rajshahi

Parameters	Mean(±SEM) of different type of Napier cultivars					P-value
	BN-1	BN-2	BN-3	BN-4	Pakchong	
Biomass yield (MT/ha^{-1}/annum)	96.63^{b}±3.64	104.11^{b}±3.04	96.06^{b}±6.93	108.17^{b}±2.30	121.35^{a}±2.80	0.002**
DM yield (MT/ha^{-1}/annum)	17.75^{b}±0.67	18.70^{b}±0.55	18.91^{b}±1.36	19.28^{b}±0.41	21.97^{a}±0.51	0.013*
No. of tiller/hill	22.59±1.12	22.60±1.11	20.48±1.07	19.28±1.26	20.64±1.07	0.161^{NS}
Plant height (inch)	49.21^{b}±1.16	46.20^{b}±1.10	46.23^{b}±0.96	55.73^{a}±0.87	54.83^{a}±1.22	0.00***
Leaf weight (g)	152.9^{d}±4.6	192.0^{ab}±12.2	209.4^{a}±11.8	180.8^{bc}±6.8	165.2^{cd}±4.2	0.00***
Stem weight (g)	232.7^{b}±11.0	156.1^{a}±9.1	165.3^{a}±8.1	184.0^{a}±11.9	235.5^{b}±10.2	0.00***
Sheath weight (g)	103.8^{a}±5.2	110.8^{a}±5.2	97.8^{a}±5.1	127.8^{b}±6.4	99.0^{a}±3.1	0.00***
Leaf:stem	0.69^{c}±0.04	1.30^{a}±0.11	1.33^{a}±0.09	1.07^{b}±0.07	0.74^{c}±0.04	0.00***

Means with uncommon superscript within the same row differed significantly ($p<0.05$); *-$p<0.05$; **-$p<0.01$; ***-$p<0.001$; NS- $p>0.05$

Table 1 illustrates the comparative performances of different Napier cultivars in Godagari, Rajshahi. The results show that significant differences were found for biomass yield, DM yield, plant height, leaf weight, stem weight, sheath weight and leaf to stem ratio among cultivars, while not for number of tiller per hill. In terms of biomass production, Pakchong yielded better than those of other cultivars.

But, BN-3 was better than other cultivars in terms of leaf to stem ratio. Plant height of BN-3 and Pakchong were significantly higher than other cultivars.

Fig. 1 shows the biomass production of different cuts which reveals that biomass production was increasing with progressing the frequency of cutting, obtained highest in 3rd cut (26.31 MT/ha^{-1}) and decreasing thereafter.

Table 2 Performance of different Napier cultivars at Chapainawabganj

Parameters	Mean(±SEM) of different type of Napier cultivars					P-value
	BN-1	BN-2	BN-3	BN-4	BN-5	
Biomass yield (MT/ha/cut)	21.57^{ab}±0.79	23.14^{ab}±0.90	23.71^{ab}±0.88	23.94^{a}±0.86	21.17^{b}±0.90	0.078^{NS}
DM yield	3.19^{ab}±0.11	3.27^{ab}±0.13	3.49^{a}±0.13	3.54^{a}±0.12	3.06^{b}±0.12	0.027*
No. of tiller/hill	18.05^{b}±0.72	22.06^{a}±1.16	17.18^{b}±0.81	18.48^{b}±0.72	16.48^{b}±0.73	0.000***
Plant height (inch)	43.24^{a}±1.39	39.26^{b}±1.23	43.29^{a}±1.33	40.16^{ab}±1.31	38.01^{b}±1.25	0.011*
Leaf: stem	0.84±0.04	0.89±0.05	0.80±0.03	0.91±0.04	0.89±0.05	0.428^{NS}

Means with uncommon superscript within the same row differed significantly ($p<0.05$); *-$p<0.05$; ***-$p<0.001$; NS- $p>0.05$

Table 2 shows the comparative performances of different Napier cultivars in Chapainawabganj. The results show that there were no significant differences of biomass yield and leaf to stem ratio among cultivars, but DM yield, number of tiller per hill and plant height differed significantly ($p<0.001$; $p<0.05$). Highest tiller number and plant height were obtained in BN-2 and BN-3, respectively.

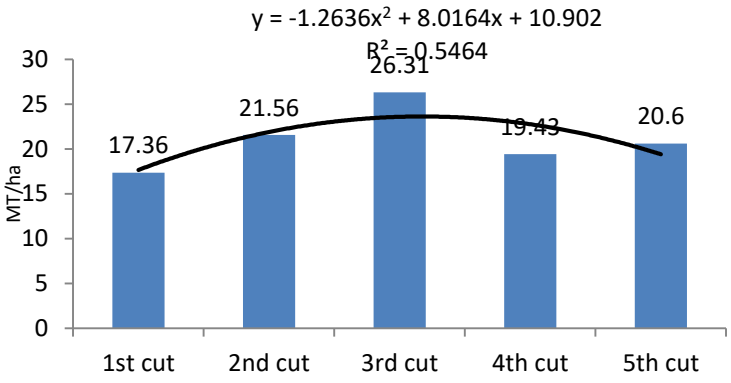

Fig. 1: Biomass yield (MT/ha^{-1}) for different cuts

Fig. 2presents the biomass production in different cuts which shows that there was an increasing trend of biomass production with increasing the frequency of cutting, obtained highest in 6th cut (35.07 MT/ha^{-1}) and decreasing thereafter.

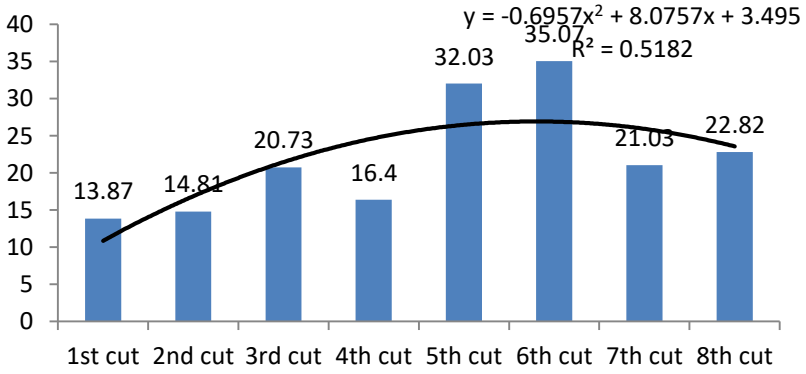

Fig. 2: Biomass yield (MT/ha) for different cuts

Considering the results so far obtained in this study, all cultivars are well adapted in drought prone barind areas in Bangladesh. However, in term of overall performance, Pakchong and BN-3 cultivars performed better in the studied areas.

Study on hydroponic sprout of grains for feeding ruminants

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Executive summery

Grains comprises about half of the concentrate diets of ruminants. A portion of this grain in animal diet if converted to sprout may incur some nutritional benefits and increase production. Studies suggest that sprouting converts complex nutrients into simpler form and thus increase availability. Sprout could be enriched with natural antioxidant (Vit. E), improved enzyme activity and reduced concentration of anti-nutritional factors e.g., tannin, gossypol etc. These nutritional modulations in sprout may have potential positive effects on animal production performances. Therefore, the present study was undertaken with the objective to know the yield and nutritional characteristics of maize, wheat and oat sprouts compared to their corresponding grains. Weighed amount of wheat (450g), maize (500g) and oats (210g) were soaked in water for 12, 24 and 2 hours, respectively. The variation in amount of seed and soaking time were due to differences in volume and water soaking capacity among the seeds. The seeds were then wrapped in cotton cloth and kept 48 hours for germination. The germinated seeds were dipped in 8 % H_2O_2 solution and then incubated in plastic trays for 7-8 days for producing sprouts. After harvesting, yield was recorded and samples were collected for various laboratory analysis. Twenty grams of sprout sample was homogenized with 180 ml of sterile de-ionized water in a laboratory blender and screened with three layers of cheese cloth for producing sprout extract, which was used for yeast and mold enumeration. Sprout was compared to their corresponding grain using paired sample t-test in SPSS 20.0 statistical package program.

Fresh yield (per kg seed) was found 2.74, 3.50, and 2.57 kg for maize, wheat and oat sprout, respectively (Table 1). The highest biomass yield was observed in wheat sprout (1.58kg) containing 0.450kg seed followed by maize (1.37kg from 0.500kg seed) and oat (0.54kg from 0.210kg seed). There were significant variations in yield of DM and OM for all three treatments. The dry matter (DM) content of grains was reduced in their corresponding sprouts, which might be derived from absorbing water by grains and utilization of some constituents for sprouting. In this experiment, DM loss in sprouted grains ranged from 11 to 50% by day 8. Significant variation was found in CP content of sprouts except oat sprout. The proportionate concentration of CP was found higher in sprout compared to their respective grains. The percent increase in EE content of the hydroponics fodder showed significant variation between grains and sprouts. The ADF and NDF content of hydroponically maize, wheat and oat were shown significant variation compared with their grains. The percentage increase in the NDF and ADF may be attributed to the increase in the number and size of cell walls for the synthesis of structural carbohydrates. During the sprouting process, the total ash was increased due to the decrease in the OM. Vitamin E was found higher in sprouts compared to grains (Maize: 3.51 *vs* 8.09, wheat: 1.07 *vs* 2.34 and Oat: 11.04 *vs* 13.42 mg/100g). Similarly, Soluble Sugar (SS) concentration was also found higher in sprouts compared to their grains except in the case of maize (Maize: 489.4 *vs* 462.8, wheat: 351.9 *vs* 356.3 and Oat: 443.8 *vs* 479.0 mg/100g).

In this experiment, wheat sprout counts for approx. $\log_{10}$ 7.16 CFU and $\log_{10}$ 7.00 CFU yeast and mold per g seed respectively. And oat sprout contains approx. $\log_{10}$ 5.74 CFU yeast per gm, whereas no mold growth occurs in both maize and oat sprout.

To evaluate the economics of sprouting is to start by costing the dry matter (DM) in and out of the system. A hydroponic production system predicted that, using 100 kg of wheat grain having 90% DM to turn off 350 kg of sprouts (3.5 folds) each day at 26.17% DM. Assumption is that, wheat sprouting needs 64.64Tk for 1 kg DM yield and is 1.66 times more expensive than the per kg DM yield from original grain.

Table 1 The biomass yield and nutrient content of hydroponic sprout

Grain	Prod.	Biomass yield and proximate composition									
		Yield (Kg/kg grain)	DM (g/kg)	Ash (g/kg)	OM (g/kg)	CP (g/kg)	EE (g/kg)	ADF (g/kg)	NDF(g/kg)	Vit-E*	SS*
Maize	Grain	1.00	857.4	9.7	847.7	62.0	42.8	70.57	159.3	3.51	489.4
	Sprout	2.7	764.7	13.2	751.4	81.0	49.4	196.8	333.5	8.09	462.5
	SEM	0.04	17.6	1.0	16.6	10.1	7.4	10.17	14.1	0.02	0.15
	Sig.	**	**	**	**	**	**	**	**	**	NS
Wheat	Grain	1.0	900.7	18.5	882.0	126.2	44.2	54.1	146.5	1.07	443.7
	Sprout	3.5	909.7	23.1	886.6	183.3	48.3	396.9	448.2	2.34	477.0
	SEM	0.05	23.2	2.7	20.8	11.3	5.43	43.6	19.8	0.02	1.10
	Sig.	**	**	**	**	**	**	**	**	**	**
Oat	Grain	1.0	911.5	9.6	895.3	139.4	15.5	150.9	242.2	11.04	351.5
	Sprout	2.6	453.0	19.0	434.3	89.7	21.5	109.3	270.8	13.4	356.2
	SEM	0.06	14.9	2.4	14.0	7.4	2.3	3.6	25.3		0.21
	Sig.	**	**	**	**	**	**	**	**	**	NS

*SS=soluble sugar (mg/100g), Vit-E= vitamin E (mg/100g)

Results indicated that, sprouting converted complex nutrients into simpler form, increased anti-oxidant contents and CP proportion in sprout. Extensive study is needed to know the impact of sprout on animal production performances.

Effect of pre and post-natal nutrition on the performances of ewes and lambs under semi intensive management system

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Executive summary

Twenty eight native Bengal ewes at 7 weeks gestation were randomly assigned to four dietary groups (T_0, T_1, T_2, T_3) and supplemented with a concentrate mixture at 0.0, 1.0, 1.5 and 2.0% of their body weight, respectively. All the ewes were allowed to grazed 8 hours in natural pasture. The group T_0 was considered as control group. The aim of the study was to know the effect of different level of pre and post-natal nutrition of dam on the performances of ewes and their lambs until 1 year of age. A creep mixture (20 g/lamb/day) was provided to lambs from 2 weeks age with an increment of 10 g/lamb/week. After weaning, twenty growing male lambs were selected and reared until 01 year of age with a concentrate mixture at 1.5% of their body weight and 8 hours grazing without having any treatment groups. The chemical compositions of the experimental diets are presented in the table 1. Parameters like, ewe's litter size, daily milk yield, post-partum heat and lamb's birth weight, weaning weight with live weight at 06 months, 09 months and 01 year of age were recorded. The data were statistically elaborated in an ANOVA of CRD using SPSS v. 20. The treatment responses were compared by DMRT at a probability level of $P<0.05$. After weaning the lambs, growth performances were analyse considering age (06, 09 and 12 months) as a fixed factor. The regression correlation among different parameters with different ages were also performed.

Table 1 Chemical composition of the natural grass in pasture and supplemented concentrate feed for ewe and lamb

Diets	DM (% fresh)	Chemical composition (% DM)				
		Ash	OM	CP	NDF	ADF
Natural Grass	17.41	11.46	88.54	13.80	75.55	49.635
Concentrate Mixture (ewe)	88.38	5.97	94.03	20.32	33.05	10.58
Concentrate Mixture (lamb)	88.15	5.41	94.60	21.16	32.76	10.76

The effect of maternal nutrition during pre and post-natal period on the performances of lambs under semi intensive management are presented in table 2. Although, birth weight not differ significantly among the treatment groups but daily milk yield ($P<0.01$) weaning weight ($P<0.05$) and weight gain of lamb until weaning differ significantly ($P<0.05$). Significantly higher daily milk yield, weaning weight and weight gain of lamb until weaning observed in T_2 treatment group. The result suggest that supplementation of concentrate enhances the performances of ewes and lambs.

Table 2 Effect of maternal nutrition during pre and post-natal period on the performances of ewes and lambs until weaning of lamb

Parameters	Ewe's diet				SEM	Level of Sig.
	T_0	T_1	T_2	T_3		
Litter Size (no.)	1.43	1.00	1.43	1.29	0.087	NS
Birth weight of lamb (kg)	1.66	2.15	2.01	2.19	0.089	NS
Milk yield of ewe (g/day)	253.60^{a}	318.76^{ab}	416.64^{b}	390.16^{b}	19.98	**
Post-partum heat of ewe (day)	61.14	56.29	45.86	41.43	3.964	NS
Weaning Weight of lamb (kg)	8.40^{a}	12.70^{b}	12.43^{b}	12.11^{b}	0.592	*
Weight gain of lamb until weaning (g/day)	74.00^{a}	116.00^{ab}	159.00^{b}	124.00^{ab}	0.011	*

The regression correlation among lambs weaning weight with different post weaning growth performances are presented in figure 1. The results showed a strong positive leaner relationship with lambs weaning weight and post weaning growth performances at different ages. Higher weaning weight of lamb depends on pre and post-natal nutrition of ewes. Thus, maternal nutrition strongly influenced the post weaning growth of lambs.

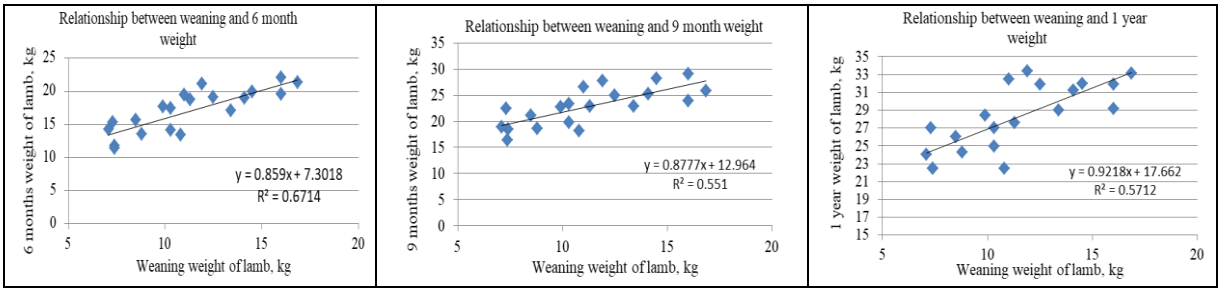

Figure 1 The relationship among lambs weaning weight (kg) with different post weaning growth performances

Figure 2 shows the lamb weight at different age and corresponding daily weight gain. Lambs weight at 06, 09, and 01 year of age differ significantly (P<0.01) along with corresponding daily weight gain (P<0.05). Although during 06 months and 09 months stages daily weight gain not differ significantly but from 09 months to 01 year stage it reduced significantly (P<0.05) that suggest that 09 months would be more profitable age for lamb marketing in semi intensive management system.

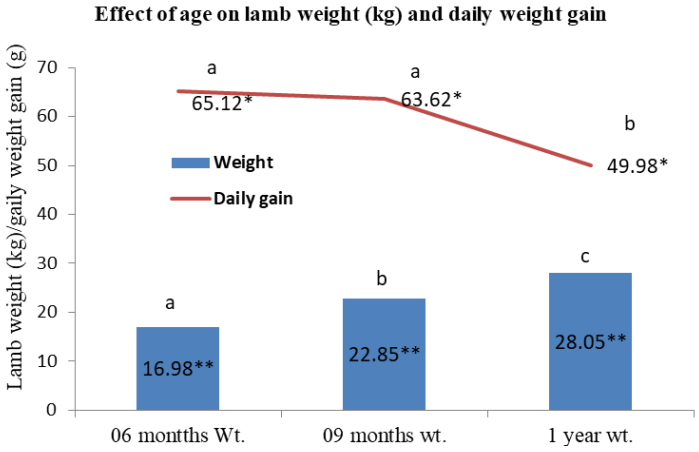

Fig. 2. Effect of age on lamb weight (kg) and daily weight gain (g).

In conclusion, it can be stated that lamb production in semi-intensive management, a concentrated supplementation at 1.5% body weight of ewe during late pregnancy to lactation is more efficient to get maximum performances form ewes and lambs. On the other hand, 09 months of age would be more profitable for marketing of lamb.

Effects of different energy and protein levels on the production performance and egg quality of hilly chicken during laying phase

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Executive summary

Hilly chickens are heavy variety among the indigenous chickens in Bangladesh. The effect of dietary energy and protein level on the performance of egg production and its quality of native chickens has been investigated extensively. However, investigation on the nutritional requirement of BLRI improved hilly laying chicken has been limited. The experiment was undertaken to determine the effects of varying energy and protein levels on egg production and its quality performance of BLRI improved hilly chicken. One hundred thirty five hens were collected from BLRI poultry farm. At 24 weeks of age, 135 pullets were weighed individually and randomly assigned to individual laying cages (16 × 9 × 15.5 inch) in a laying house. In a 2×3 factorial arrangement, the pullets were randomly assigned to experimental diets with 2600, 2700 and 2800 ME Kcal /Kg of diet each containing 16, 17 and 18% CP. Each dietary treatment was replicated three times in a completely randomized design. Each replication has 5 hens. All birds received 16 h constant lighting regimen and feed and water were supplied *ad libitum* throughout the experimental period. Feed consumption (FC), egg production, egg weight, egg mass, external and internal egg quality was measured during the experimental period. The mean feed consumption, egg production, egg weight, egg mass, body weight and mortality of hilly chicken fed diet containing varying ME and CP concentration from 24 to 72 weeks of age are presented in table 1. Egg production and body weight of the hilly chicken layers fed diets containing different ME and CP level were not significant (P>0.05). Egg weight was significant (P<0.05) at lower level of energy. Increasing dietary energy had a significant effect on feed intake (P<0.001). Dietary energy increased, feed intake increased from 89.5 to 92.4 g/hen/per day, which resulted in a 3g increased in feed intake. Feed intake was higher (P<0.05) in birds fed diets which contained 18% CP when compared with those fed 16 % CP diets. Egg mass was significantly higher (P<0.05) in hilly chicken that received diets containing 2700 ME kcal /Kg than those fed diets containing 2600 and 2800 ME kcal /Kg of diet. ME intake of the diets was increased (P<0.001) as the dietary energy increased reaching optimal ME values of 2800 kcal of ME/Kg DM. Protein intake of the hilly chicken was significantly increased as protein levels increased (P<0.001). Breaking strength, shell thickness and haugh unit at 40 and 60 weeks of age laying hilly chickens fed diets containing 2600 to 2800 kcal of ME Kcal/Kg of diet and 16 to 18 % CP of diet were not significant (P>0.05). Significantly (P<0.01) higher egg weight were found in diet containing 2700 kcal of ME/Kg of diet at 60 weeks of age. At 24-72 weeks of age the results suggested that 2700 kcal/kg ME and 17 % CP of the diet would enhance the egg production performance and egg quality of hilly chicken.

Table 1 Feed intake, Egg production, egg weight (g), egg mass of hilly chickens reared using different protein and energy combination

Parameter	Protein (%)	ME Kcal/kg			Average	SEM	Level of significance		
		2600	2700	2800			ME	CP	ME*CP
Egg production %	16	36.8	37.5	32.1	35.5		NS	NS	NS
	17	33.0	42.5	39.4	38.6	2.92	0.378	0.345	0.266
	18	37.9	38.2	40.2	38.8				
Average		36.34	39.6	34.7					
Egg weight g	16	44.6	47.7	44.2	45.5		*	NS	NS
	17	43.0	50.7	44.8	46.2	1.09	0.053	0.389	0.347
	18	42.8	44.1	45.2	44.0				
Average		43.5	47.5	44.7					
Feed intake g/h/d	16	90.2	91.3	91.0	90.8		***	*	NS
	17	88.6	90.7	92.6	90.7	.215	0.000	0.04	0.316
	18	89.9	92.0	94.0	92.0				
Average		89.6	91.3	92.6					
Egg mass	16	16.4	16	14.0	15.4	1.43	*	NS	NS

Parameter	Protein (%)	ME Kcal/kg			Average	SEM	Level of significance		
		2600	2700	2800			ME	CP	ME*CP
g/h/d	17	13.3	20.6	15.2	16.3		0.05	0.458	0.086
	18	17.5	17.2	16.1	16.9				
Average		15.7	17.9	15.0					
Body weight kg	16	1.53	1.57	1.59	1.59	36.83	NS	NS	NS
	17	1.55	1.53	1.57	1.55		0.908	0.341	0.120
	18	1.54	1.53	1.62	1.56				
Average		1.53	1.54	1.59					
Mortality %	16	0.16	0.09	0.17	.14	0.08	NS	NS	NS
	17	0.07	0.05	0.10	.07		0.314	0.285	0.429
	18	0.10	0.13	0.09	.10				
Average		0.11	.09	.12					
ME intake g/h/d	16	239.6	251.2	257.0	249.0	1.29	***	NS	NS
	17	237.5	253.4	261.5	250.5		0.000	0.649	0.066
	18	237.8	253.2	258.2	250.6				
Average		238	253.3	259.3					
CP intake g/h/d	16	14.5	14.6	14.5	14.5	0.078	***	***	NS
	17	15.2	15.6	15.6	15.5		0.000	0.000	0.067
	18	16.3	16.7	16.3	16.4				
Average		15.3	15.7	15.5					

Table 2 Effects of different dietary level of energy and protein on external and internal egg quality of hilly chicken at 40 weeks of age

Parameter	CP%	ME (Kcal/kg)			Average	SEM	Level of significance		
		2600	2700	2800			ME	CP	ME*CP
Egg weight g	16	44	47	46	45.6	0.79	NS	NS	NS
	17	45	47	44	45.3		0.20	0.10	0.15
	18	46	47	50	47.6				
Average		45.0	47.0	46.6					
Breaking strength kg/cm	16	0.37	0.36	0.40	0.38	0.01	NS	NS	NS
	17	0.38	0.34	0.37	0.36		0.09	0.16	0.48
	18	0.38	0.32	0.33	0.34				
Average		0.38	0.34	0.36					
Shell thickness mm	16	0.29	0.33	0.31	0.31	005	NS	NS	NS
	17	0.31	0.31	0.31	0.32		0.15	0.22	0.08
	18	0.32	0.32	0.33	0.32				
Average		0.31	0.32	0.32					
Haugh Unit	16	81.7	81.6	83.7	82.5	0.761	NS	NS	NS
	17	81.7	83.1	80.7	83.5		0.102	0.859	0.132
	18	85.0	86.0	77.6	82.8				
Average		82.8	83.6	80.7					

Table 3 Effects of different dietary level of energy and protein on external and internal egg quality of hilly chicken at 60 weeks of age

Parameter	CP%	ME (Kcal/kg)			Average	SEM	Level of significance		
		2600	2700	2800			ME	CP	ME*CP
Egg weight g	16	46	49	49	48.4	0.64	**	NS	NS
	17	46	49	49	48.7		0.006	0.813	0.507
	18	47	47	47	47.0				
Average		46.6	49.1	48.9					
Breaking strength kg/cm	16	0.31	0.36	0.32	0.33	0.01	NS	NS	NS
	17	0.29	0.33	0.35	0.33		0.196	0.704	0.121
	18	0.33	0.30	0.33	0.32				
Average		0.31	0.33	0.33					
Shell thickness mm	16	0.30	0.32	0.30	0.31	0.008	NS	NS	NS
	17	0.30	0.32	0.34	0.32		0.812	0.685	0.089
	18	0.33	0.29	0.31	0.31				
Average		0.31	0.31	0.31					
Haugh Unit	16	82.2	79.6	80.8	80.7	0.954	NS	NS	NS
	17	56.7	83.9	80.5	82.0		0.350	0.588	0.647
	18	84.8	85.6	78.68	83.1				
Average		84.6	83.0	80.0					

Development of Natural Feed Additives (Probiotics & Mushroom) for Meat Type Chicken Production

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Executive summary

Natural feed additives such as herbs, spices essential oils extracted from aromatic plants, enzymes, organic acids and probiotics are using as growth promoters in poultry diets in many countries for organic poultry production (Griggs and Jacob, 2005). Oxytetracycline (OTC) is a broad spectrum antibiotic known as tetracyclines which were developed to enhance the control of bacterial infections (Alam, 2000). Feeding of antibiotics is risky (Casewell, *et al*., 2003) not only due to cross resistance but also due to multiple resistances. This could pose a threat to public health if dangerous infections of drug-resistant bacteria were spread via the food chain (Smith *et al*., 2003). As a result, the use of antibiotics as growth promoters was banned from the EU on January 1, 2006 (Burch, 2006) and the potential for a ban in the United States and some other countries in Asia. In Bangladesh the use of most antibiotics growth promoter (AGP) also has been banned to preserve the effectiveness of important human drugs (Case well *et al*., 2003). So, there is increasing interest in finding alternatives to antibiotics for poultry production.Mushrooms have long been appreciated as an important source of bioactive compounds of medicinal value (Breene, 1990).Oyster mushrooms are popular in Bangladesh, and four different species of this mushroom like *Pleurotusostreatus, P. florida, P. sajor-caju*and *P. high king* are commercially cultivated all over the year by using sawdust and/or rice straw as main substrate.So**,** it is logical to assume that the inclusion of mushroom in poultry diet may have considerable health promotion benefits for poultry.Considering the above mentioned situation, the current study was designed to investigate the effect of feeding probiotic and mushroom on feed conversion efficiency and meat quality of broiler, replacing antibiotic in diet .

Trial 1. Effect of dietary probiotics as antibiotic alternative on growth performance, organ development and meat quality in broiler chicken

The aim of the study was to evaluate the effect of dietary probiotics on broiler growth performance, organ development and meat quality in replacing oxytetracycline. Dietary treatments were control (basal diet without additives), antibiotic (basal diet with0.05% oxytetracycline), basal diet with *Bacillus subtillis* and basal diet with *Lactobacillus* spp.A total of 192 birds were randomly allotted to four dietary treatments with four replicates having 12 birds each. Feed and water were supplied *ad libitum*. The results of the current study revealed that growth performances of broiler did not show significant difference ($P>0.05$) among the treatments (Table 1). Body weight and weight gain were numerically higher and FCR was lower in broilers, fed a diet contained2 different probiotic than control (Table 1). Though there were no treatment effects ($P>0.05$) on the weights of the liver, heart, kidney, spleen, gizzard, intestine and dressing percentage, but abdominal fat content was found significantly higher ($P<0.05$) in antibiotic group than that of probiotic (*Lactobacillus* spp.*)* fed group.

Trial 2. Dietary oyster mushroom on growth performance, meat yield traits and TBA value of broiler chicken

Two hundred forty (240) day old chicks of Cobb 500 broiler were studied to assess the nutritional value of oyster mushroom; *Pleurotusostreatus* feed additives in broiler diet. The treatments were control (basal diet), antibiotic (basal diet + 25ppm Oxytetracycline, OTC), 1.0%, 1.5%, and 2.0% *Pleurotusostreatus* powder with basal diet.

Table 1 Effects of antibiotic and probiotics in diets on the production performance of broiler

Tr.	BW (g)	WG (g)	FI (g)	FCR	EPEF
T_0	1819	1773.54	3259.27	1.84	276.50
T_1	1854	1808.81	3291.42	1.82	284.96
T_2	1836	1791.08	3267.81	1.83	280.70
T_3	1832	1786.75	3231.19	1.81	289.14
SEM	18.789	18.789	15.232	0.015	-
P-Value	0.944	0.944	0.618	0.945	-

T_0 =Control, T_1 = OTC, T_2 = Probiotic (*Bacillus*), T_3 = Probiotic (*Lactobacillus*); SEM, Standard Error of Mean; *EPEF = European Production Efficiency Factor (Average gram gained/day × % Survival rate /FCR × 10).

Table 2 Different meat quality characteristics of broiler fed different feed additives

Treatment	TBA	P^H	Cook loss	Color values		
				L*	a*	b*
T_0	8.81	6.30	18.25	53.33^{a}	4.44^{bc}	9.01
T_1	10.8	6.36	15.04	49.11^{b}	6.41^{a}	7.23
T_2	8.63	6.23	18.36	51.23^{ab}	3.48^{c}	8.21
T_3	11.19	6.42	17.76	51.99^{a}	5.31^{ab}	8.67
SEM	0.69	0.04	0.60	0.53	0.39	0.39
P value	0.47	0.49	0.17	0.016	0.04	0.42

SEM, Standard Error of Mean; * Meat color values of lightness (L*), redness (a*), and yellowness (b*); TBA,

The birds were randomly distributed in floor pens with 4 replications having 12 chicks in each following completely randomized design for 3 weeks and provided broiler starter diet. Then they were provided finisher diet, litter materials were used as rice husk for next 2 weeks. Oyster mushroom powder (1%) enhanced growth of broiler chicks compared to control and antibiotic diet but the differences were not significant (Table 3). Among the three levels of mushroom powder in the diet, it was found that addition gradually decreasing the weight gain (1824, 1749, 1665 g/b) followed by negative control (1823 g/b) and antibiotic (1878 g/b) (Table 3).

Table 3 Effects of different levels of mushroom on the production performance of broiler

Treatment	Body weight(g)	Weight gain(g)	Feed intake(g)	FCR
T_0	1822.92^{a}	1059.13^{a}	2097.90^{a}	1.97^{bc}
T_1	1877.81^{a}	1087.79^{a}	2101.96^{a}	1.93^{c}
T_2	1824.25^{a}	1072.01^{a}	2100.67^{a}	1.96^{bc}
T_3	1749.13^{b}	1009.75^{b}	2067.35^{a}	2.04^{b}
T_4	1665.25^{c}	934.88^{c}	1998.5^{b}	2.14^{a}
SEM	18.459	14.099	11.303	0.020
P-Value	0.0001	0.0001	0.0026	0.006

SEM, Standard Error of Mean; T_0=control, T_1=antibiotic, T_2=1% mushroom, T_3=1.5%mushroom, T_4=2%mushroom

Significantly reduced feed conversion ratio was observed in 1% dietary mushroom group (1.96) than other 2 levels (2.04, 2.14) and statistically similar with antibiotic (1.93) and control (1.97) (Table 3). Mushroom powder showed a potentiality up to 1% in contrast of antibiotic on weight gain, FCR and dressing yield (Table 3). Lightness of breast meat in all groups showed normal (L*=44-53) including light color (L*>50) observed except antibiotic ($p = 0.024$) where cooking loss followed similar trend ($p=0.030$).

We concluded that use of selected probiotics at 1% level resulted in improved performance parameters and reduced abdominal fat pad in broiler chickens (trial 1). Considering the findings of trial 2, it can be concluded that 1% oyster mushroom powder may be replaced in place of antibiotic in terms of growth performance, meat yield traits and TBA value. Therefore, addition of the probiotics and mushroom in broiler diet for replacing antibiotic could be utilized for safe poultry meat production.

Comparative growth performance of F_1 progeny of different crossbred beef cattle

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Executive summary

Bangladesh has a great demand of beef but it has been facing beef demand and supply mismatches due to insufficient production and supply of beef, low carcass yield of native cattle andno-cattle export policy of a long bordered neighboring country. Conventional beef production system coupled with intensive beef farming may help increasing beef production. Brahman crosses are being produced to support increased productivity of the cattle, but strategic approach for breed development that needs screening of multiple genotypes is ignored. Thus, the present work was undertaken to develop market beef cattle of average 150.0 kg carcass weight with an average FCR of ≈ 6.50 under on farm feeding and management conditions. Aiming at developing breeding bulls, the cows of BLRI Cattle Breed 1 (BCB-1) were inseminated with the imported frozen semen of Brahman, Simmental, Charolais or Limousine. The crossbred bulls of different assorted F_1 genotypes are being selected and their production and breeding performance are being evaluated and compared with BCB-1 (control).Artificial insemination (AI) was performed following standard procedure for the production of crossbred progeny. Not more than 2 AI services were allowed for single conception and subsequent calculation of service per conception. All pregnant (> 6 months of gestation period) cows were in pre-natal care, and all calves were raised in a single plane of nutrition and management. Total milk and feed intake, FCR, disease incidence and calf mortality of BCB-1 and its assorted genotypes were recorded. The effects of genotype on growth performance were determined. The economic traits (birth, weaning, 6th month, yearling weight, 18th month and average daily gain at different ages) were compared statistically in an ANOVA of a Completely Randomized Design (CRD) using General Linear Model Procedure of SPSS (17.0).
Table 1 showed that a total number of 49 progeny were produced up to June 2017 and out of that 10 were purebred BCB-1 and the 39 were F_1progenyofBCB-1.Table 2 and 3 revealed that all crossbred progeny performed better than BCB-1 in terms of live weight and ADG.

Table 1 Number of F_1 progeny of different beef genotypes

Genotype of calves	Sex		Total
	Male	Female	
Limousine×BCB-1	6	4	10
Simmental×BCB-1	2	7	9
Charolais×BCB-1	4	4	8
Brahman×BCB-1	7	5	12
BCB-1×BCB-1	5	5	10
Total	24	25	49

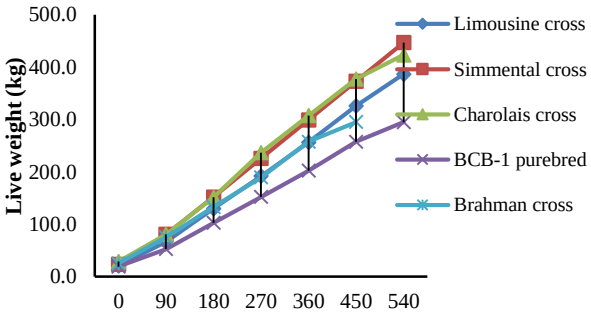

Figure 1 Growth curve of F_1 male progeny of different

The effect of genotype on live weight at different ages was highly significant ($p<0.001$). Among the crossbred progeny Charolais×BCB-1 had the highest birth weight (26.91±1.56 kg) followed by Brahman×BCB-1 (23.91±1.27 kg), Simmental×BCB-1 (22.13±1.47 kg) and Limousine×BCB-1 (21.74±1.39 kg) (Table 2). Charolais crossbreds also showed the highest live weight at weaning, 6 months, yearling and 18 months of age compared to other crosses (Table 2). In average daily weight gain, genotype also had highly significant effect ($p<0.001$) (Table 3).The Charolais cross gained the highest daily live weight up to 18th month of age except in 0 to 3 month. In 0 to 3 months of age, Simmental cross performed the best (0.58±0.04 kg/d) followed by Charolais (0.56±0.04kg/d), Limousine (0.51±0.03kg/d) and Brahman crosses (0.50±0.03kg/d). The purebred BCB-1 always showed the lowest daily weight gain (Table 3).

Table 2 Effects of genotypes on live weight (kg) at different ages

Live weight	Genotype(Mean±SE)					Significance
	Limousine× BCB-1	Simmental× BCB-1	Charolais× BCB-1	Brahman× BCB-1	BCB-1× BCB-1	
At birth	21.74±1.39 (10)	22.13±1.47 (9)	26.91±1.56 (8)	23.91±1.27 (12)	17.84±1.39 (10)	***
At weaning (3months)	66.84±3.47 (10)	75.82±3.66 (9)	77.01±3.88 (8)	68.66±3.16 (12)	49.08±3.47 (10)	***
At 6 months	129.15±5.12 (9)	141.66±5.12 (9)	145.00±5.43 (8)	127.25±4.43 (12)	94.01±4.85 (10)	***
At yearling (12 months)	255.571±9.45 (7)	279.42±9.45 (7)	281.00±10.20 (6)	240.71±9.45 (7)	187.90±7.90 (10)	***
At 18 months	380.57±15.55 (7)	396.00±15.55 (7)	417.50±20.57 (4)	312.66±23.75 (3)	267.10±13.01 (10)	***

Figures in the parentheses indicate number of observations

Table 3 Effects of genotypes on average daily body weight gains (kg/day) at different ages

ADG (kg/d)	Genotype(Mean±SE)					Significance
	Limousine× BCB-1	Simmental× BCB-1	Charolais× BCB-1	Brahman× BCB-1	BCB-1× BCB-1	
0-3 months	0.51±0.03(10)	0.58±0.04(9)	0.56±0.04(8)	0.50±0.03(12)	0.35±0.03(10)	***
3-6 months	0.67±0.03(9)	0.72±0.03(9)	0.73±0.03(8)	0.65±0.02(12)	0.50±0.03(10)	***
6-12 months	0.70±0.04(7)	0.74±0.04(7)	0.75±0.04(6)	0.64±0.04(7)	0.53±0.03(10)	***
12-18 months	0.69±0.04(7)	0.64±0.04(7)	0.71±0.06(4)	0.47±0.07(3)	0.43±0.04(10)	***

Figures in the parentheses indicate number of observations, ADG: average daily body weight gain

Calf scour and alopecia occurred in all genotypes. A total of 49 calves were born and out of that 2 calves were died due to coccidiosis and premature delivery. Under this breeding program, calf mortality was 4.08%.

In conclusion, Charolais×BCB-1 is performing as the best among five genotypes in terms of growth up to 18 months of age. More F_1 progeny is yet to be produced to evaluate their performance for the production of market beef cattle. Therefore, this breeding program should be continued for the coming years to achieve the target goal.

Conservation and improvement of Munshiganj Cattle

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Executive summary

Munshiganj cattle (MC) are one of promising varieties of indigenous cattle genetic resources in Bangladesh generally found in the Munshiganj district and its surrounding areas. It was popularly famous as milk producing variety before introduction of crossbreeding in the country. Farmers are replacing MC with high yielding crossbred cattle and population of MC is rapidly declining in their breeding tract. Considering the above facts, steps have been taken by BLRI for conservation, characterization and subsequent improvement of this valuable germplasms at their own habitat and BLRI. The present research project was designed 1) to know the potentiality of MC at their own habitat 2) to screen the promising cows and bulls from their habitat and3) to produce the superior progeny from the promising dams and sires. For in situ conservation, a Munsiganj cattle rearing community was established in two union of Munsiganj sadar upazilla consisting with 33 farmers having 42 Munsiganj cattle. A mini nucleus herd was established in BLRI and this herd has been enlarged with a total population of 28 animals including 10 cows, 4 breeding bulls, 7 heifer calves and 7 bull calves. The productive and reproductive performance was recorded and evaluated throughout the experimental period.Semen was collected form 3 sexually matured Munsiganj bulls with artificial vagina method twice in a week. The collected semen sample was transferred immediately in the laboratory for analysis with automatic semen analyzer (Hemelton Throne II). The analyzed semen was diluted with Tris- egg -yolk citrate diluter with proper ratio considering the concentration and motility of the fresh semen. After 4hr equilibration in a cold handling cabinet (Minitube, Germany) the semen was frozen with liquid nitrogen vapor with a programmable bio freezer (Minitube, Germany) at -140ºc and finally stored at -196ºc liquid nitrogen and were observed after 24 hr of storage for post thaw semen quality evaluation. The average birth weights of male calves (17.79±1.0kg) were higher than average of female calves (17.28±0.95 kg). The survivability of both sexes was 100% in the herd. Average gestation length (GL), postpartum heat period (PPH) and number of services for each conception (NSPC) were 279.17±3.76 days, 63.42±22.08 days and 1.58±0.79, respectively (Table 1).

Table 1 Reproductive performance of Munshiganj cows

Cows ID	Gestation period	Postpartum heat period	No of service per conception
001	276	75	2
002	287	53	3
003	278	120	1
004	279	66	1
005	284	73	1
006	282	40	3
007	278	57	2
008	281	45	1
0012	274	48	1
0015	278	52	1
M 26	275	82	1
M 27	278	50	2
Overall (Mean±SD)	279.17± 3.76	63.42± 22.08	1.58± 0.79

Munsiganj cattle are highly popular for its higher milk production potentiality rather than other indigenous variety. In BLRI nucleus herd, average lactation length, lactation yield and daily milk

yield per cow was found as 176.25±26.47days, 731.53±140.61 liters and 4.13±0.39liters/day, respectively (Table 3).

Table 2 Milk production potentials of Munsiganj cow

Cow ID	Lactation length (Days)	Lactation yield (Days)	Daily milk yield (L)
001	195	832.65	4.27
002	210	877.8	4.18
003	195	908.7	4.66
004	180	761.4	4.23
005	135	407.7	3.02
006	150	645	4.3
007	195	776.1	3.98
008	180	754.2	4.19
0012	135	567	4.2
0015	165	709.5	4.3
M26	210	833.7	3.97
M27	165	704.55	4.27
Overall (Mean±SD)	176.25±26.47	731.53±140.61	4.13±0.39

The fresh semen was thick creamy colour with an average volume and concentration of 4.273±0.54 ml and 1796±122.29 milion/ml, respectively. Total, progressive, static and slow motility of the fresh and post thawed semen samples were (84.69 ±4.28, 52.97±3.13), (72.53 ± 2.91, 43.71±1.57), (15.31±4.28, 47.03 ±3.13) and (1.23± 0.60, 0.58± 0.18), respectively (Table 3). Prepared frozen semen is now using in Munsiganj community herd for Artificial insemination (AI) and a total number of 22 AI has been performed.

Table 3 Motility parameters (Mean±SD) of fresh and frozen Munsiganj bull semen

Semen type	Volume (ml)	Concentration (million/ml)	Motility (%)			
			Total	Progressive	Static	Slow
Fresh semen	4.273±0.54	1796 ±122.29	84.69 ±4.28	72.53 ± 2.91	15.31± 4.28	1.23± 0.60
Frozen semen	--	--	52.97± 3.13	43.71±1.57	47.03 ±3.13	0.58± 0.18

In conclusion, Munsiganj cattle are highly potential valuable genotype needs to be conserved for complete *ex-situ* characterization, improvement and future multiplication.

Evaluation of performance Murrah x Local (F_1) crossbred and Nili-Ravi x Local (F_1) crossbred buffaloes in Bangladesh

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Executive Summary

Buffaloe of Bangladesh is recognized as indigenous type with very low milk production efficiency. The average lactation yield of indigenous buffalo is 500 to700 liters during a 270 days lactation period. However,the average yield of exotic high yielding buffalo breed in the world is 2000 to 2500 liters. Moreover, indigenous buffalo attainedpuberty at 30.30±1.43months age at on-station and 39.4 to 54.45 months at on-farm condition.Nili-Ravi and Murrah buffaloeswere widely used to increase dairy characteristics of indigenous buffalo population in Indo-Chinese Region and South America through crossbreeding. These crossbreeding programmes resulted increase in lactation milk yield from 700 to 2,000 kg per year in China. Considering above facts, this study aimed to improved lactation milk yield performance of indigenous buffalo through crossing with high yielding exotic Murrah and Nili-Ravi buffalo breed. The adaptability of crossbred buffaloes were evaluated during this study period. Phenotypic characteristics of crossbred buffalo including body weight at birth, 1, 3, 6, 12, 24, 30 month's age and reproduction traits includingage at puberty/age at first heat, services per conception, conception rate, gestation length, calving to conception length anddays open were evaluated. To increase reproductive efficiency, BLRI developed estrus synchronization (ES) protocol in buffalo last year. The BLRI developed ES protocol was validated at farmer's level. For validation of ES protocol, 15 buffalo cows at BLRI and 9 buffalo cows/heifers at GodagariUpazillaof Rajshahi were subjected to hormonal treatment as described in Figure 1.AI were performed twice in the morning and evening after detection of estrus at BLRI and once at Godagari. The average weight at birth,1, 3, 6 and 12 months of Murrah x Local (F_1) crossbred buffaloes were 27.23±1.20; 50.89±0.98; 84.5±1.70, 125.0±3.88 and 209.6±4.15 kg, respectively. On the other hand, weight at birth, 1, 6 and 12 months for on farm and on station were 30.0±2.08 and 25.83±1.19 kg; 52.33±2.60 and 50.17±0.79 kg; 86.0±2.31 and 83.6±2.44 kg; 120.0±9.45 and 128.0±2.97kg and 217.05±6.5 and 204.33±2.9 kg, respectively. All cows/heifers under estrus synchronization treatments showed estrus signs during this study.

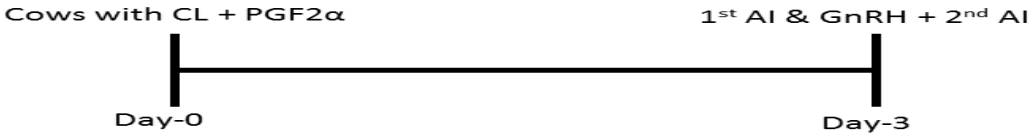

Figure 1 Estrus synchronization protocol in buffalo

Following AI, at BLRI Buffalo Research Herd 10 heifers/cows out of 15 were conceived (0.67%). On the other hand, at Godagari, Rajshahi 8heifers/cows out of 10 were conceived (0.80%) (Table 1). The overall conception rate was 72%.

Table 1 Validation of estrus synchronization protocol of buffaloes at on-farm and on-station

Farm type	Heifer/Cow numbers	Estrus observed (%)	Conception rate (%)
Godagari, Rajshahi at farmer's condition	10	100	80.00
BLRI Buffalo Research Herd	15	100	67.00
Overall	25	100	72.00

Figure 2 F1 crossbred buffalo born in BLRI Buffalo Research Herd. A: Nili-Ravi x Indigenous and Murrah x Indigenous calves and B: Murrah x Indigenous crossbred heifer at puberty age.

During this study period 8 Murrah x Local (F_1) crossbred buffalo (4 males and 4 females) calves and 12 Nili-Ravi x Local (F_1) crossbred buffaloes (4 males and 8 females) calves were born at BLRI (Figure 2). The average birth weight of Murrah x Local crossbred male and female calves were 34.50 kg and 31.75kg respectively at BLRI. The average birth weight of Nili-Ravi x Local crossbred male calf and female calves were 27.25 kg and 35.88kg respectively. One Murrah x Local crossbred buffalo heifer show first heat at 23.49 months of age. This is an ongoing study. This study will be continued until significant numbers of crossbred buffaloes are produced at BLRI for evaluation of their performances.

Screening and development of different coat color variants' goat stock at BLRI

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Executive summary

Plenty of works have so far been conducted on the morphological characteristics like body measurements and body weight, as well as distribution of coat color pattern of native goat in Bangladesh. But, inheritance of coat color in goat received less attention than that of quantitative economic important traits and lack of a similar importance for color in most goats. However, attempts to develop and conserve different color variety of goat have not yet been done for the satisfaction of consumer's preference. Coat color is also an identity of a specific breed's character. However, people have a fascination on color phenotype of animals. Goats have great variation in color and the genetic control can be tricky. Although, lots of solid and mixed colored goats are available in our country but the studies on coat color inheritance are very scanty in our country. Considering the point of view, the study has been taken to develop pure line native goat variety based on specific color available in our country as ultimate goal. Thus, the present study had been taken with the objectives to develop pure-line goat genotypes based on coat color variant and phenotypic characterization of different coat color goat genotype. The research conducted pachutia goat shed at BLRI. To develop different color variants' goat stock, primarily goats having three distinguished colors viz. solid white, Dutch belted and spotted (Toggenburg pattern) comprising flocks with 24; 29 and 20 had been established. Within color pure breeding are being followed for designing mating plan. Progenyare being screened based on their color inheritance. Admixtures of genes responsible for more than single color pattern are being discarded from the flock to maintain pure line generation. Semi-intensive management are being followed for animals of each flock. Genetic and phenotypic characterization of different coat color variants' goat is being recorded. The collected data had been analyzed statistically with SPSS 16.0. Table 1 shows the body weight and growth performances of kids at different ages.Irrespective of different genetic factors, the overall mean birth weight (BWT), three month body weight (3MWT), six month body weight (6MWT), growth rate at 0 to 3 month (GR_{0-3}) and growth rate at 3 to 6 month (GR_{3-6}) were 1.17±0.03kg, 8.90±0.44kg, 15.34±0.73kg, 85.79±4.87g/d and 66.49±5.28g/d, respectively. BWT of male kids were significantly ($p<0.001$) higher than those of female kids. However, sex, genotype, litter type and parity had no significant effect on 3MWT, 6MWT, $GR_{0-3}$and GR_{3-6}.

Table 1 Body weight of kid at different ages

Factor	Mean±SE				
	BWT (Kg)	3MWT (kg)	6MWT (kg)	GR_{0-3} (g/d)	GR_{3-6} (g/d)
Sex	***	NS	NS	NS	NS
Male	1.28±0.05(21)	9.71±0.81(10)	15.84±1.47(8)	93.33±9.09(10)	65.00±10.38(8)
Female	1.08±0.03(24)	8.33±0.46(14)	14.98±0.74(11)	80.39±5.09(14)	67.58±5.64(11)
Genotype	NS	NS	NS	NS	NS
Solid white	2.29±0.36(7)	8.28±1.32(5)	14.82±1.79(5)	78.44±14.37(5)	72.66±8.32(5)
Dutch belt	1.50±0.19(8)	9.56±0.48(15)	16.33±0.85(15)	92.88±5.30(15)	67.57±7.99(11)
Toggenburg	2.00±0.00(4)	7.23±0.73(4)	12.60±0.98(4)	68.33±8.43(4)	52.22±7.39(3)
Litter type	NS	NS	NS	NS	NS
Single	1.24±0.037(7)	9.65±1.06(7)	16.68±1.48(6)	93.49±11.56(7)	69.81±8.37(6)

Twin	1.14±0.048(22)	8.83±0.48(15)	14.72±0.81(13)	85.33±5.32(15)	64.96±6.87(13)
Triplet	1.17±0.068(12)	6.80±0.50(2)	-	62.22±4.44(2)	-
Quadruple	1.23±0.047(4)	-	-	-	-
Parity	NS	NS	NS	NS	NS
1st	1.14±0.04(23)	9.38±0.67(11)	16.00±0.97(10)	91.41±7.32(11)	68.89±5.53(10)
2nd	1.25±0.09(8)	8.06±0.73(7)	13.86±1.04(7)	75.87±7.74(7)	64.44±6.91(7)
3rd	1.23±0.05(4)	-	-	-	-
Min.	0.67	5.20	10.30	45.56	13.33
Max.	1.86	13.30	20.70	133.33	110.00
Overall	1.17±0.03	8.90±0.44	15.34±0.73	85.79±4.87	66.49±5.28

Figures in the parenthesis indicate number of observation; NS-Non-significant (p>0.05)

Table 2 shows the reproductive performances for different color genotypes of goat. The overall gestation length and litter size obtained in this study were 174.58±4.53 days and 1.89, respectively. However, color genotype, litter type and parity had no significant effect on gestation length. Similarly, litter size did not vary significantly for the effect of color genotype and parity.

Table 2 Reproductive performance for different genotype

Factor	Reproductive parameters (Mean±SE)	
	Gestation length	Litter size
Genotype	NS	NS
Solid white	177.57±7.32(7)	2.29±0.36(7)
Dutch belt	170.63±7.76(8)	1.50±0.19(8)
Toggenburg	177.25±9.89(4)	2.00±0.00(4)
Litter type	NS	-
Single	175.00±12.81(5)	-
Twin	177.00±4.24(12)	-
Triplet	159.00±20.00(2)	-
Parity	NS	NS
1st	175.50±6.06(14)	1.71±0.16(14)
2nd	166.33±2.60(3)	2.00±0.00(3)
Min.	128	1
Max.	194	4
Overall	174.58±4.53(19)	1.89±.17(19)

Figures in the parenthesis indicate number of observation; NS-Non-significant (p>0.05)

The results so far obtained in this study reveal that phenotypic performances among three coat color goat genotypes showed almost similar. However, the sample size estimated in this study is very scanty and more data need to be required to draw a concrete decision about their performance evaluation.

Maintenance and conservation of pure lines and development of egg and meat type chicken

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Executive summary

Bangladesh Livestock Research Institute (BLRI) has developed brown hybrid layer chicken (Shorna) through several years of experiment. Day old chicks of Shorna were sexed by feather color. Male chicks have whitish feather whereas, female have brown color. Therefore, to know the performance, adaptability, problems and prospects of Shorna, several experiments were undertaken from 2013-2016. In several on station trial results, 290-300 numbers of eggs were found annually from Shorna. In a comparison trial under the heat stress condition, egg production was dropped to 4% in commercial hen and 2 % in Shorna. Therefore, the present experiment was undertaken to validate the performance of Shorna under on-station and on-farm condition. A total of 5600 day old Shorna chicks were distributed at five different regions (Tangail, Khulna, Mymensingh, Barisal and Nilphamari district) of the country. Birds were reared under farmers existing condition. The ambient temperature, humidity and rainfall were recorded and used to determine the Temperature-Humidity index (THI) in accordance to Moraes*et al.*,(2008). Vaccination and other managements were practiced according to the farmer's facilities. Egg production (EP) and feed intake in each location were recorded daily and body weight (BW) and egg weight (EW) were weighed monthly. The feed conversion ratio (FCR) was determined as gram of feed consumed per gram of egg produced (g of feed/g of egg). Egg mass (EM) was calculated by multiplying egg weight with egg production rate. Hen mortality was recorded as it occurred and feed intake and egg production were adjusted. During this period, random samples of 30eggs/location were collected and qualities were analyzed. Egg shell breaking strength (ESBS) was measured by using an egg shell strength tester and egg qualities were measured by Egg Quality Measurement Stand (FHK Japan). Blood was collected and Hemagglutination Inhibition (HI) antibody titers of the sera samples were measured based on the Sabrin*et al.* (2012). To examine the economic viability of Shorna rearing cost and return was measured according to Singh and Saran, (2007). The Straight Line Method was used to compute the depreciation.All data were analyzed by one way ANOVA procedure of SAS and differences were determined by DMRT. Pearson's linear correlations and the above statistical analyses were performed using SAS softwear with $p<0.05$ considered statistically significant.

Table 1 Performance of Shorna under on station condition

Parameter	On station trial					SEM	P value
	Exp1	Exp2	Exp3	Exp4	Exp5		
Sexing accuracy (%)	95.50	97.00	96.33	94.75	95.02	5.42	0.343
Day old chicks weight (g)	37.42	36.84	37.19	38.02	37.36	0.625	0.516
Mature body weight (g)	1862.13	1896.64	1830.5	1857.0	1797.9	34.23	0.129
Age at first lay (d)	138.40	139.90	137.70	141.20	140.60	0.101	0.372
Egg production (%)	78.60^{b}	79.43^{b}	82.12^{a}	80.99^{ab}	80.10^{ab}	0.746	0.017
Egg weight (g)	65.44	65.30	63.64	64.49	65.06	0.262	0.231
Egg mass (g/d)	51.12	51.87	52.26	52.23	52.11	0.523	0.310
Feed intake (g)	119.81	113.23	114.27	118.78	117.25	2.471	0.324
FCR (g of feed/g of egg)	2.307	2.195	2.201	2.253	2.212	0.035	0.094
Annual egg production (no.)	286.89	289.91	299.73	295.61	292.03	13.96	0.341
Annual egg mass production (kg/b)	18.66	18.93	19.07	19.06	19.02	0.319	0.628
Convert to commercial layer egg (No.)	306-311	310-316	313-317	313-317	311-317	14.56	0.426

In on station trial results of Shorna, similar production performance was found among the experiments. During the last consecutive five experiments, sexing accuracy was found from 95-97 % and day old chick's weight was varied from 36 to 38 gram. Shorna was started their first egg at 137 to 141 days of age and mature body weight was found as1800-1900 g. From 20-72 weeks of age, average rate of egg production was 79-82 % and mean egg weight was recorded 64 to 66 g. In the present on farm trial, similar average THI was found among the location. In results, similar sexing accuracy (95-96 %) was found in five location of the country. At 8 weeks of age, average body weight

was higher in Barisal (809.12 g) and lower in Khulna (666.09 g) district. Age at sexual maturity was found higher in Tangail and lower in Mymensingh district. From 20-50 weeks result, rate of egg production was significantly higher in Mymensingh (85.65%) and Barisal (83.95 %) than that of Tangail region (80.60 %) due to the variation of management. But during the production period, data was missing in Khulna district due to natural disaster (flood). On the other hand, BW, EW and FI were not influenced among the location. Therefore, significantly higher egg mass production was found in Mymensingh than that of Tangail district. Though the FCR did not reached to the significant level, but better FCR was found in Mymensingh than that of other region. The production performance was not significantly influence between the on-station and on farm results of Shorna. At 40 weeks of age, though the serum HI antibody titre level of Mymensingh district was higher than the other region, but the effect did not reach to the significant level. On the other hand, both internal and external egg qualities were not influenced by the location.

Table 2 Performance of Shorna under on farm condition (20-50 weeks)

Parameter		On Farm trial			SEM	P value
	Tangail	Mymensingh	Niphamari	Barisal		
Sexing accuracy (%)	97.0	93.21	95.50	96.33	4.45	0.132
Day old chicks weight (g)	37.60	36.85	37.02	37.36	0.69	0.796
Mature body weight (g)	1857.23	1854.13	1813.01	1939.32	43.58	0.109
Age at first lay (d)	143.4	130.71	135.21	136.59	2.08	0.098
Egg production (%)	80.60^{b}	85.65^{a}	83.99^{a}	83.95^{a}	0.97	0.034
Egg weight (g)	62.51	62.39	62.87	63.15	0.52	0.241
Egg mass (g)	50.38^{b}	53.43^{a}	52.80^{a}	53.01^{a}	0.48	0.046
Feed intake (g)	112.68	115.16	114.58	116.30	1.04	0.427
FCR	2.236	2.157	2.176	2.194	0.032	0.289

Table 3 Pearson's correlation coefficients among variables in the data set with probabilities that the correlations are significantly different from zero

Parameter	THI	BW	EP	EW	EM	FI	FCR	HU	ESBS
THI	1	-0.735***	-0.455***	-0.239***	-0.667***	-0.363***	-0.051***	-0.225	-0.071**
BW		1	-0.604***	0.589***	0.743***	0.456	0.127***	-0.133	0.267
EP			1	-0.284***	0.662***	0.726*	-0.446***	0.521	-0.562
EW				1	0.332***	0.342**	0.273***	-0.094	-0.135**
EM					1	0.280***	-0.461***	-0.319	-0.329*
FI						1	0.711***	0.407	0.257
FCR							1	0.375	0.141
HU								1	0.862**
ESBS									1

Significant ($p<0.05$) negative linear correlations were found between THI and BW, EP, EW, EM, FI, FCR and ESBS but not with the HaughUnit (HU) of egg. Similarly, egg weight was negatively correlated with rate of egg production. Body weight also positive correlated with egg mass and feed intake and FCR. Egg weight was positively correlated with EM, FI and FCR. Though the egg mass production was correlated positively with feed intake but not with the FCR.Feed intake was positively correlated with FCR. Egg shell breaking strength was positively correlated with Haugh unit of egg. In economic evaluation, the total cost (fixed and variable cost) and gross return per year were found1389935.39and 1672817.75takarespectively. So, the net returns (gross return-total cost) per year were found 282882.75 taka for one unit of 1000 Shorna layer rearing under farmers condition. Therefore, the input output ratio was 1.203. Based on the on station and on farm trial, results indicated that production performance of Shorna is consistent, adaptable and profitable under farmer's condition of Bangladesh.

Conservation and improvement of native chicken: Performance of sixth generation

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Executive summary

The present study was conducted at Bangladesh Livestock Research Institute, Savar, Dhaka with the objectives (i) to assess the performances of three native chicken genotypes under intensive management, (ii) to select parental birds (males and females) and breed them in an assortative plan for the production of sixth generation birds. A total of 1488-day-old chicks comprising of 3 types of chicken namely Naked Neck (NN-316), Hilly (H-535) and Non-descript Deshi (ND-637) were hatched in one batch for this study. In sixth generation (G_6), selection was practiced at 8 week of age according to 8 week body weight. The data were analyzed by factorial arrangement in a CRD by General Linear Model (GLM) Univariate Procedure in SPSS Computer Program. Expected genetic progress due to selection in a generation for 8 week body weight was estimated for sixth generation (G_6) using the following equation (Falconer, 1981). $R = h^2 \times S$ where, R = Expected response, h^2 = heritability for 8 week body weight and S = Selection differential for the selected males and females.
Day old chick weight was significantly ($p<0.001$) highest in H (33.87±0.15 g). Significant ($p<0.001$) body weight differences among the genotypes were observed at 4^{th} , 8^{th} and 12^{th} weeks of age , with the highest body weight observed for H genotype (233.97±1.57, 705.76±5.12 and 1073.45±7.21g) than other two genotypes (Table 1) in all stages of age. NN genotype (3.79 %) had non-significantly ($\chi^2 = 0.64$; $p > 0.05$) higher chick mortality than ND (3.13 %) and H (2.80%) genotypes at 0-8 weeks of age which is shown in Table 2. The age at first egg laid was significantly ($p<0.001$) affected by genotype (Table 3). The estimated age at 1^{st} egg of Non-descript Deshi, Hilly and Naked Neck were 148.84, 152.39 and 153.24 days; respectively. NN genotype started laying of eggs at a higher age (153.24 days) compared to ND genotype (148.84 days) in G_6 generation. The average age at first egg of ND (148.84 days) was 4.40 days earlier than that of NN (153.24 days). Fertility was significantly affected ($p<0.05$) by genotype. The percentage of fertility ranges from 82.46 to 87.84 in different genotypes. The highest fertility was observed in ND (87.84%). Hatchability on fertile eggs differed significantly ($p<0.001$) among the genotypes. The NN had the lowest hatchability ($p<0.001$) on fertile eggs. Table 3 indicates that among the genotypes; hatchability tended to be highest in ND (88.98%), intermediate in H (83.72%) and lowest in NN (79.99%). Percentage of Dead in germ was affected ($p<0.001$) by genotype. Feed consumption from 9 to 16 weeks (Table 3) showed that there was significant ($p<0.001$) variation in feed intake among the native chicken genotypes. At the age of 16 weeks, the lowest (63.87g) and highest (84.42g) daily feed intake were recorded for NN and H genotypes, respectively. The effects of genotype on hen -day egg production (HDEP %) of native chicken is presented in Table 3. Hen-day egg production (HDEP %) observed in the present study were affected significantly ($p<0.001$) by genotype. In this study the average HDEP% of ND, H and NN were found to be 62.85±1.58, 51.92±1.59 and 57.79±1.57. As shown in Table 4 that 8^{th} week body weight of males ND, H and NN birds were expected to increase by 76.52, 67.81 and 45.33g, respectively. While in females ND, H and NN birds, the expected responses were 18.89, 17.66 and 16.76g, respectively. The response to selection for 8 weeks body weight in male and female for three genotypes (ND, H and NN) were expected to be positive (increase). It is concluded that Hilly genotype may be chosen for meat production and Non-descript Deshi genotype for egg production. For further improvement selection should be continued.

Table 1 Body weight of native chicken up to 12 weeks of age

Parameter	Genotype			Level of sig.
	ND (Mean±SE)	H (Mean±SE)	NN (Mean±SE)	
DOC weight (g)	33.28^{b}±0.13 (637)	33.87^{a}±0.15 (535)	32.05^{c}±0.19 (316)	p<0.001
4^{th} week weight (g)	188.44^{c}±1.42 (621)	233.97^{a}±1.57 (515)	199.32^{b}±2.05 (300)	p<0.001
8^{th} week weight (g)	564.33^{b}±4.75 (603)	705.76^{a}±5.12 (514)	560.94^{b}±6.75 (297)	p<0.001
12^{th} week weight (g)	864.98^{c}±6.65 (599)	1073.45^{a}±7.21(510)	891.87^{b}±9.53 (294)	p<0.001

DOC= Day Old Chick; ND=Non-descript Deshi; H=Hilly; NN=Naked Neck; figures in the parentheses indicate the number of observations; least squares means without a common superscript along the row within a factor differed significantly (p<0.001).

Table 2 Effect of genotype on chick mortality (%) of native chicken during 0-8 weeks of age

Genotype	ND	H	NN	χ^2 (df=2)	P-Value
Mortality (%)	3.13	2.80	3.79	0.64	p >0.05

Table 3 Productive and reproductive performance of native chicken genotypes

Parameter	Genotype (Mean ±SE)			Level of Significance
	ND (Mean±SE)	H (Mean±SE)	NN (Mean±SE)	
Age at first egg (d)	148.84^{b} ±0.65	152.39^{a}±0.67	153.24^{a}±0.79	p<0.001
Fertility (%)	87.84^{a}±2.13	82.85^{b}±1.95	82.46^{b}±2.47	p<0.05
Hatchability on fertile eggs (%)	88.98^{a}±3.16	83.72^{b}±3.05	79.99^{c}±2.21	p<0.001
Dead in germ (%)	3.22^{a}±0.52	2.52^{b}±0.41	3.01^{a}±0.70	p<0.001
Feed Intake(g/b/d) (9-16 weeks)	65.16^{b}±1.28	84.42^{a}±1.35	63.87^{b}±1.61	p<0.001
HDEP (%) (22-28 weeks)	62.85^{a}±1.58	51.92^{c}±1.59	57.79^{b}±2.11	p<0.001

Least squares means without a common superscript along the row differed significantly (p<0.05). HDEP=Hen day egg production

Table 4 Expected response to selection for 8 weeks body weight (g) in sixth generation (G_6) of native chicken

Genotype	Sex	Before selection		After selection		Selection Differential (S) (g)	Expected Response to Selection ®
		No.	Average	No.	Average		
ND	M	313	627.62	50	793.98	166.36	76.52
	F	286	495.05	200	536.12	41.07	18.89
H	M	246	765.01	509	912.44	147.43	67.81
	F	273	652.37	200	690.77	38.40	17.66
NN	M	150	616.45	50	715.00	98.55	45.33
	F	147	504.29	100	540.79	36.50	16.76

Conservation and improvement of Quail: Performance of sixth generation

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Executive summary

Individual selection is particularly essential in selection experiments for body weight in quail. Four genotypes of quail like Dhakai (D), White (W), Brown (Br) and Black (Bl) quail are being maintained at BLRI with the objective to develop a suitable meat type quail genotype for our existing farming. The parent males and females were being maintained in cages for single pair mating through selective breeding system for producing each generation. Pedigree records are being kept by using commercially available leg bands to identify quail of all ages. For producing sixth generation (G_6), parent quails of each genotype were selected from the fifth generation (G_5) on the basis of breeding value according to their 5th week body weight. Hatching eggs were collected from every single pen of the selected parent quails. A total of 994-day-old chicks comprising of 4 genotypes of quail namely D, W, Br, and Bl were hatched together. Diet containing 24% crude protein and 3000 kcal ME/kg were provided to the birds at laying period. Data on egg weight, hatchability, body weight of chick at day old, 2nd week, 4th week, 5th week and 6th week of age, feed intake, mortality, egg production were recorded to study their productive and reproductive performances. Collected data were analyzed in a CRD by General Linear Model (GLM) Univariate Procedure in SPSS Computer Program. Expected genetic progress due to selection in a generation for 5th week body weight was estimated for sixth generation (G_6) using the following equation (Falconer, 1981). $R = h^2 \times S$ where, R = Expected response, h^2 = heritability for 5th week body weight and S = Selection differential for the selected males and females.

Body weight of quails at 2nd, 4th and 6th week of age were significantly ($p<0.001$) influenced by genotype (Table 1). The 6th week body weight was 154.00± 0.72, 149.86 ± 0.96, 130.27 ±0.36 and 135.90± 0.85 g respectively for D, W, Br and Bl genotype. Significantly higher body weight was found in D followed by W, Br and Bl quail genotypes at different period of age. Dhakai genotype (2.65%) had non-significantly ($\chi^2 = 0.87$; $p>0.05$) higher chick mortality than other genotypes at 0-5 weeks (Table 2). The hatchability rate was significantly ($p<0.001$) higher in D (77.34%) compared to other three genotypes of quails, respectively (Table 3). The total number of eggs up to 24th weeks of age were 103.86 ± 1.17, 102.09± 1.62, 108.40± 1.42 and 114.04± 1.75 respectively, for D, W, Br and Bl genotypes of quail and significantly ($p<0.001$) differed among all genotypes. As shown in Table 4, 5th week body weight of males D, W, Br and Bl quails were expected to increase by 3.87, 2.29, 1.66 and 1.12g, respectively. While in females D, W, Br and Bl quails, the expected responses were 5.31, 3.55, 3.37 and 1.26g, respectively. Based on the performances, Dhakai quail was superior for body weight and Black quail for egg production. These findings suggested for continuing the quail breeding research for producing a suitable meat type quail genotype in our country.

Table 1 Least squares means (LSM) and standard error (SE) of different weight groups as affected by genotype

Genotype	2nd wk body wt (g)	4th wk body wt (g)	6th wk body wt (g)
Dhakai	45.34^{a}±0.51(149)	105.53^{a}±0.76(147)	154.00^{a}±0.72(146)
White	41.99^{b} ± 0.41 (400)	92.79^{b} ± 0.51 (398)	149.86^{b} ±0.96(396)
Brown	38.14^{c} ± 0.33 (304)	84.72^{d} ± 0.53 (301)	130.27^{d} ±0.36(299)
Black	41.32^{b} ± 0.55 (128)	86.97^{c} ± 0.86 (128)	135.90^{c} ± 0.85(127)
Level of significance	($p<0.001$)	($p<0.001$)	($p<0.001$)

Figure in the parenthesis indicate the number of observations. Least squares means without a common superscript along the column differed significantly (($p<0.05$).

Table 2 Effect of genotype on chick mortality (%) during 0-5 weeks of age

Parameter	Genotype				χ^2 (df=3)	P- value
	Dhakai	White	Brown	Black		
Mortality (%)	2.65	1.73	2.27	1.53	0.87	p>0.05

Table 3 Productive and reproductive performance of four quail genotypes

Parameter	Quail genotype (Mean ±SE)				Level of Significance
	Dhakai	White	Brown	Black	
Hatchability of setting eggs (%)	77.34^{a} ±1.67	75.43^{a}±2.53	65.21^{b}±3.64	72.60^{a}±2.24	p<0.001
Feed Intake(g/b/d)	19.16±1.37	18.32±1.19	17.69±1.23	18.26±1.25	NS
Egg production (No) (6-24 wks)	103.86^{c}±1.17	102.09^{c}±1.62	108.40^{b}±1.42	114.04^{a}±1.75	p<0.001

Table 4 Selection differential, selection intensity for 5 weeks body weight (g) in fifth generation

Genotype	Sex	Before selection		After selection		Selection Differential (S) (g)	Expected response to selection (R)
		No.	Aver.	No.	Aver.		
Dhakai	M	70	149.3	40	157.9	8.6	3.87
	F	76	158.7	40	170.5	11.8	5.31
White	M	185	135.4	120	140.5	5.1	2.29
	F	213	147.8	120	155.7	7.9	3.55
Brown	M	145	125.2	120	128.9	3.7	1.66
	F	156	133.0	120	140.5	7.5	3.37
Black	M	60	127.7	40	130.2	2.5	1.12
	F	68	134.9	40	137.7	2.8	1.26

Conservation and improvement of native duck genotypes through on station and on farm trial

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Executive summary

In Bangladesh, farmers prefer indigenous ducks due to their high adaptability to environment, unique foraging abilityand disease resistance capacity.Two indigenous egg type duck breeds called as white breasted black (Nageswari) and solid white (Rupali) are distributed throughout the country. Both duck breeds are resistant to common diseases and adapted to local environment. However, egg production performances of these breeds are low compared to improved egg producing duck duck breeds. Hence BLRI has taken research programme to improve performance of Rupali and Nageswari duck breeds through selective breeding approach. Productive and reproductive potentialities of native duck have alreadybeen evaluated from foundation to second generation (G_2) in previous years. During this study period,reproductive performances of third generation (G_3)and growth performances of fourth generation (G_4) werecarried out.In each generation selection were practiced on the basis of age at first lay, body weight at firstlay, egg production % (168-336 days) and egg weight.A total of 1050 hatching eggs comprising of 2 genotypes, namely Rupali and Nageswari were hatched to produce fourth generation (G_4). Ducklings were brooded on floor in duck brooding shed. Adult duck were housed in an open sided shed with concrete floor and maintained through family mating system.Diet contains 20 % Crude Protein & 3000 Kcal ME/kg DM; 16% Crude Protein & 2750 Kcal ME/kg DM and 17.5% Crude Protein & 2750 Kcal ME/kg DM wasprovided during starter, grower and finisher period respectively.Ducks were individually weighed weekly to determine the mean population weight.Body weight, feed consumption and feed conversion ratio (FCR) were measured weekly up to 12 wks of age.Egg production data of individual duck of 3rd generation were recorded. Selected male and female were mated at the maximum ratio of 1: 5 using natural mating.All recorded data were analyzed by SAS and differences were determined by DMRT.

Table 1 Growth performances of Rupali and Nageswari(G_4)

Parameters	Age (Wks)	Rupali	Nageswari	SEM	P-Value
Body weight(g)	DOC	39.00	37.47		
	4	421.16	397.53	3.710	0.452
	8	917	884.50	6.561	0.315
	12	1270	1200.50	9.360	0.147
Weight gain (g)	0-4	382.16	359.53	3.532	0.447
	5-8	495.85	486.97	4.317	0.306
	9-12	353.01	316.00	4.143	0.265
	0-12	1231.10	1162.0	10.671	0.139
Feed intake(g)	0-4	645.87	478.85	8.971	0.358
	5-8	1165.25	1131.97	9.184	0.863
	9-12	1291.19	1241.60	14.714	0.472
	0-12	3002.31	2852.42	21.542	0.097
Feed conversion ratio	0-4	1.69	1.331	0.943	0.109
	5-8	2.30	2.325	0.982	0.846
	9-12	3.657	3.929	1.182	0.768
	0-12	2.44	2.454	1.012	0.619

A typical pattern of growth performances of two native genotypes of Rupali and Nageswari were carried out from 0-day to 12thweek of age at 4 weeks interval. From 0-4, 5-8 and 9-12 wks of age, BW was higher in Rupali compared to Nageswari. After end of the12wks,BW of Rupali was numerically higher (1270) than BW (1201) of Nageswari ($p \leq 0.05$). Rupali duck was also consumed more feed and gained maximum weight than Nageswari duck at all ages of growing phase. FCR was observed 2.44 and 2.454from day old to 12th week of age in Rupaliand Nageswar, respectively.

Table 2 Selection differential, selection intensity and selection responses in third generation (G_3)

Genotype	Traits	Before selection	After selection	Selection differential	Selection intensity	Selection to response
Rupali	ASM (d)	157.21±9.5	154.81±9.13	-2.4	-0.25	-0.96
	BW (g)	1662.73±138.09	1664±57	1.27	0.01	0.635
	EW (g)	58.02±6.97	57.28±8.59	-0.74	-0.11	-0.37
	EP (%)	81.15±6.88	85.23±2.21	4.08	0.92	0.61
Nageswari	ASM (d)	152.63±12.94	151.66±11.58	-0.97	-0.07	-0.39
	BW (g)	1467.57±135.07	1472.53±155.36	4.96	0.034	2.48
	EW (g)	55.36±7.94	55.33±8.4	-0.03	-0.04	-0.01
	EP (%)	78.34±7.51	81.66±3.90	3.32	0.44	0.49

ASM-:Age at sexual maturity, BW:Body weight, EW:Egg weight, EP:Egg production, EM:Egg mass

Laying duck of third generation (G_3) were selected on the basis of selection criteria. After selection, age at sexual maturity was decreased in both Rupali and Nageswari. Body wt was increased 1-4 g in both genotypes. Egg weight was decreased but egg production was increased 3-4% in Nageswari and Rupali. Selection intensity on egg production was 0.92 and 0.44 in Rupali and Nageswari genotypes, respectively. Similarly, selection response on egg production was 0.612 in Rupali and 0.498 in Nageswari duck genotypes.

Table 3 Egg production performances ofRupali and Nageswari (24-76 wks)

Parameter	Rupali	Nageswari	SEM	P value
EP (%)	59.53[a]	53.15[b]	0.44	0.023
EW (g)	66.85[b]	64.52[a]	0.28	0.041
EM (g/d)	39.79	34.29	0.23	0.044
FI (g/d)	141.90	134.43	2.19	0.062
FCR	3.56	3.92	0.02	0.098
Annual egg no.	217.28 [a]	193.99 [b]	3.45	0.032

EP: Egg production, EW: Egg weight, EM: Egg mass, FI: Feed intake, FCR: Feed conversion ratio

The higher number of egg production, egg weight and egg mass were recorded by the Rupali compared to Nageswari ($p \leq 0.01$), which may be due to the inherent capability of egg production of genotype. Jalil*et al*,(1997) observed that the egg weight of Deshi duck was the highest followed by Khaki Campbell x Deshi (52.92 g) and Deshi (52.27 g).In Rupali, FCR was numerically lower (3.36) than FCR (3.92) of Nageswari. Das and Huque (2000), obtained 48% duck-day egg production in Jinding ducks which was lower than the egg production of present study may be due to selection and good intensive management system in BLRI developed native ducks.

Table 4 Comparative reproductive performances of Rupali and Nageswarifrom 1st to 3rd generations

Parameters	G1		G2		G3	
	Rupali	Nageswari	Rupali	Nageswari	Rupali	Nageswari
Age at first lay	159.37	153.58	157.23	152.63	155.37	151.43
Egg weight at first egg (g)	48.85	44.41	54.02	51.37	56.47	52.50
Body weightat first egg (g)	1560.96	1496.68	1662.73	1467.58	1657.89	1448.28
Egg production during 24 to 48 weeks(no)	97.35	98.11	146.43	137.01	148.02	138.13

Comparison among three generations, Table4, showed that in G_3 age at first lay had shorter than G_1&G_2. Egg weight was increased from G_1 to G_3. BW at first egg was higher in Rupalithan Nageswari from 1st to 3rd generations. Positive trend was observed in egg production. Egg numbers were increased in generation to next generation. Thus, it was observed a positive trend on egg production through selection of BLRI developed native duck genotypes (Rupali and Nageswari) generation after generation.

Evaluation of genetic potentials of BLRI improved indigenous chicken varieties under farmer's condition

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Executive summary

It may be changed by The productive performances of indigenous chicken varieties under intensive management system have been remarkably increased since its inception at Bangladesh Livestock Research Institute, Savar, Dhaka. That's why; more emphasis was given to explore the genetic potentialities of BLRI improved indigenous chicken varieties under farmer's condition. Considering the above points in mind, the present study was undertaken to evaluate the laying performances (18 weeks to 52 weeks of age) of BLRI improved indigenous chicken varieties {e.g. BLRI Non-descript Deshi (BND), BLRI Naked Neck (BNN) and BLRI Hily (BHI)} comparing with the existing/locally available Non-descript Deshi (LND) birds under farmers' condition. To conduct the study a total of 12 farmers were selected from each of the 3 project sites (Nakla, Sherpur; Dinajpur Sadar and Dumuria, Khulna) under Scavenging Poultry Conservation and Development Project (SPCDP). Among the 12 selected farmers, 2 males and 6 females' birds of BLRI improved varieties were provided to 9 farmers which replicated thrice for each of the variety in each location. The rest 3 farmers were provided existing/locally available Non-descript Deshi (LND) birds as control in each location. The housing, feeding and management were same for both the treatment and control groups. The locally available ready mash layer feed @ 60g per bird per day were supplied to the birds during laying periods as supplement. Clean and fresh water were supplied all the time. The birds were vaccinated against the common diseases found among the indigenous chicken in Bangladesh. The birds were reared on the similar management practices of BLRI developed native chicken rearing model. Data on daily feed intake (g/bird), weekly live weight (g), age (days) and weight (g) at sexual maturity, egg weight (g), egg production (no./day) and mortality were recorded for laying performances. The recorded data were arranged and analyzed using SPSS -11.1 computer programme.

Table 1 implies that irrespective to locations average age at sexual maturity was 155, 150, 150 and 148 days for LND, BND, BNN and BHI respectively. There was no significant variation among the varieties; while it was highly significant among the locations. The differences in sexual maturity among the locations might be of causes of variations in management and photoperiod. The lowest average live weight at sexual maturity was attained by the LND (1200g) followed by BNN (1345g), BND (1404g) and BHI (1615g) with highly significant differences among the varieties. Variations in live weight among the varieties are might be due to the genetic origin. However, there were no any significant variations observed among the locations for live weight at sexual maturity. The highest average first egg weight was found for BHI (32g) followed by BNN (31g), BND (30.7g) and LND (26g) ($p<0.001$). The percent of average hen day egg production (AHDEP) was obtained 41, 39, 37.7 and 28.5 for BNN, BHI, BND and LND ($p<0.01$) while the peak production was 87, 86, 83 and 77 percent for BND, BNN, BHI and LND. The highest average egg weight was recorded for BHI followed by BNN, BND and LND at 30, 40 and 50 weeks of age. The LND ranked the lowest regarding all the aforesaid laying parameters. On the other hand, among the BLRI improved varieties, BHI attained the highest live weight at sexual maturity ($p<0.001$) and also laid the largest egg ($p<0.01$), BNN laid the highest AHDEP ($p<0.01$) and BND showed the highest peak production ($p>0.05$).

Table 1 Performances of different varieties in different locations

Parameter		Location (L)	Varieties (V)				Level of significance		
			Local-ND (Mean ±SE)	BND (Mean ±SE)	BNN (Mean ±SE)	BHI (Mean ±SE)	V	L	VxL
Age at sexual maturity (days)		Sherpur	150.6±4.7	146.3±4.7	146.3±4.7	146.0±4.7	**NS**	***	**NS**
		Dinajpur	168.3±4.7	159.3±4.7	158.0±4.7	156.6±4.7			
		Khulna	146.0±4.7	144.6±4.7	144.3±4.7	142.0±4.7			
		(Mean±SE)	155.0±2.7	150.1±2.7	149.5±2.7	148.2±2.7			
Live weight at sexual maturity (g)		Sherpur	1134.6±52.7	1381.0±52.7	1318.6±52.7	1642.0±52.7	***	NS	NS
		Dinajpur	1229.6±52.7	1464.6±52.7	1322.0±52.7	1682.3±52.7			
		Khulna	1239±52.7	1367.3±52.7	1393.3±52.7	1521.6±52.7			
		(Mean±SE)	1201.1±30.4	1404.3±30.4	1344.6±30.4	1615.3±30.4			
First egg weight (g)		Sherpur	26.3±0.9	30.0±0.9	29.3±0.9	29.6±0.9	***	***	NS
		Dinajpur	28.0±0.9	33.6±0.9	33.3±0.9	35.0±0.9			
		Khulna	23.6±0.9	28.6±0.9	30.6±0.9	31.3±0.9			
		(Mean±SE)	26.0±0.5	30.7 ±0.5	31.1±0.5	32.0±0.5			
Average hen day egg production (%)		Sherpur	27.3±4.1	45.0±4.1	46.0±4.1	48.0±4.1	**	**	NS
		Dinajpur	24.6±4.1	31.6±4.1	39.0±4.1	28.6±4.1			
		Khulna	33.6±4.1	36.6±4.1	38.3±4.1	41.3±4.1			
		(Mean±SE)	28.5±2.4	37.7 ±0.5	41.1±2.4	39.3±2.4			
Peak production (%)		Sherpur	85.0±6.1	90.6±6.1	90.6±6.1	87.6±6.1	NS	*	NS
		Dinajpur	74.0±6.1	87.6±6.1	78.0±6.1	72.3±6.1			
		Khulna	72.3±6.1	83.0±6.1	88.6±6.1	88.6±6.1			
		(Mean±SE)	77.1±3.5	87.1±3.5	85.7±3.5	82.8±3.5			
Egg weight (g)	30 weeks	Sherpur	36.3±1.5	43.0±1.5	40.6±1.5	43.0±1.5	**	NS	NS
		Dinajpur	36.3±1.5	37.3±1.5	41.0±1.5	41.6±1.5			
		Khulna	38.0±1.5	38.0±1.5	41.0±1.5	41.3±1.5			
		(Mean±SE)	36.8±0.8	39.4±0.8	40.8±0.8	42.0±0.8			
	40 weeks	Sherpur	40.0±1.5	48.3±1.5	45.3±1.5	48.0±1.5	**	*	NS
		Dinajpur	39.6±1.5	45.0±1.5	44.0±1.5	45.6±1.5			
		Khulna	41.3±1.5	40.6±1.5	43.3±1.5	42.3±1.5			
		(Mean±SE)	40.3±0.8	44.6±0.8	44.2±0.8	45.3±0.8			
	50 weeks	Sherpur	47.0±1.4	52.6±1.4	52.6±1.4	53.6±1.4	***	***	NS
		Dinajpur	41.3±1.4	46.3±1.4	47.0±1.4	50.3±1.4			
		Khulna	42.3±1.4	43.0±1.4	45.0±1.4	45.3±1.4			
		(Mean±SE)	43.5±0.8	47.3±0.8	48.2±0.8	49.7±0.8			

*"***" means P<0.001; "**"means P<0.01; "*"means P<0.05; "NS" means P>0.05*

It should be changed by Results from the present study; it may be concluded that BLRI improved indigenous chicken varieties demonstrate better laying performances compare to locally available Non-descriptive Deshi (LND) chicken in three locations. It also clearly seen that BHI shows the better productive performance in terms of body weight at sexual maturity and egg weight at 30, 40 and 50 weeks of age.

Epidemiological studies towards formulating duck plague control strategy on piloting basis

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Executive summary

Duck plague (DP) is an acute, sometimes chronic, contagious virus infection that occurs naturally in ducks, geese and swans, under the family *Anatidae* of the order *Anseriformes* caused by duck herpesvirus 1 (anatid herpesvirus 1) is a member of the *Alphaherpesvirinae* subfamily of the family *Herpesviridae*. Most of the affected birds die without ample clinical manifestations and even sometimes the carcasses are found floating on the water surface. However, when clinical symptoms are evident, high mortalities especially in older ducks, vascular damage and subsequent internal hemorrhages, lesions in lymphoid organs, digestive mucosal eruptions, severe diarrhea and degenerative lesions in parenchymatous organs following fatal outcomes are noticed. Partially closed eyelids with photophobia, extreme thirst, loss of appetite, ataxia, nasal discharge, drooping plumage, watery diarrhea, soiled vents and tremors of head, neck and body are other clinical symptoms witnessed.This is an endemic disease in Bangladesh. Every year a large number of duck died due to this disease. The overall prevalence of duck plague in selected areas were reported as 26.45%.The objective of the study was sero-monitoring of ducks after vaccination with different types of DPV vaccine. Blood samples were collected from apparently healthy 200 ducks of different breeds randomly during 2016-2017 from Mohongonz, Mithapukur, Meherpur and BLRI duck farm. Two vaccines namely Vaccine-1 and Vaccine-2. Ducks were vaccinated at 28thdays of age and booster at 45thdays of age. Vaccine-2 was administered to Mohongonz and Vaccine-1 administered in rest three places. The blood was collected 3 times, before vaccination at 25th days of age and after first vaccination at 43th and 63th days of age. All serum samples were tested for specific anti-DPVantibody by commercially manufactured indirect Enzyme linked immune sorbent assay (iELISA) test kit. Antibody was absent in 100% (n=200) samples before vaccination. After 15 day of first vaccination (at 43th days of age) only 12.22% duck shown antibody. Subsequently after 15 days of booster (at 62th days of age) antibody was found in 17.78% duck. Vaccine-2 produce higher antibody that was 30.43% ducks shown anti-DPV antibody but on the other hand Vacciune-1 produces only 13.43% duck positive anti-DPV antibody. The serum antibody against DPV in 4 places was as 30.43% in Mohongonz, 21.05% in Mithapukur, 9.09% in Meherpur and 10.81% in BLRI duck farm (Figure 1). From above sero-monitoring after vaccination it is concluded that, the antibody production in duck from both sources of vaccine fail to produce protective level of antibody. To combat against DPV should produce effective vaccine seeds from local isolates and give training to farmer for proper vaccination.

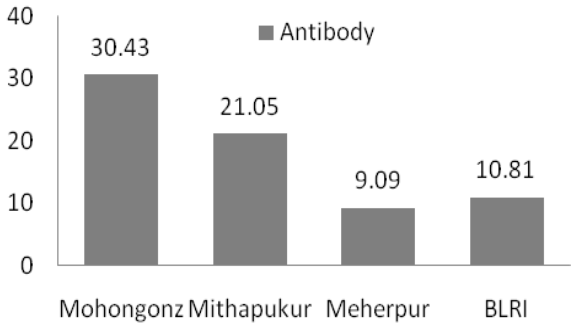

Figure 1 Sero-monitoring of DPV antibody according to location

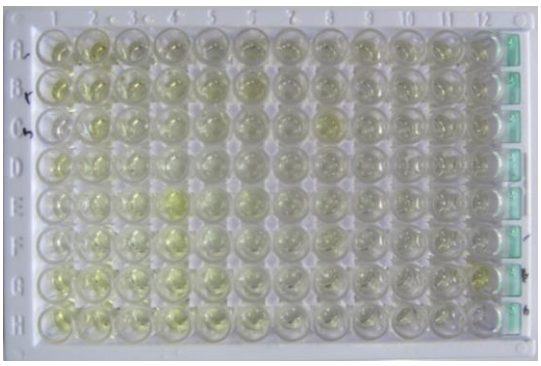

Figure 2 Yellow colored wells shown DPV antibody positive in ELISA plate

Tick Borne Blood Protozoan Diseases of Farm based & Slaughter House Animal

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Executive summary

Babesiosis, Anaplasmosis and Theileriasis are the most economically important tick borne blood protozoan diseases (TBDs) in tropical and subtropical countries including Bangladesh. Losses directly ascribed including morbidity, mortality, production losses together with the cost of veterinary diagnosis, treatment, tick control and annual gross losses between US$ 20 to 25 billion globally. A prevalence study on blood protozoan diseases was conducted in high yielding crossbred (50% to Above), indigenous cattle, local sheep and 100% pure exotic Sheep (Suffolk, Perendale, Dorper) particularly in selected areas of milk pocket areas of Sirajganj, hilly areas of Nikhongchori, organized cattle farm at Savar and Australian sheep farm at BLRI respectively. Blood samples (n=1150) were collected randomly on questionnaire basis in which 55 from Australian sheep 400 from dairy farm of high yielding milching cows and bulls, 400 from high yielding cattle from Milk Vita Bathan area (Baghabari), 200 from native cattle (Shirajgonj), 70 from native hilly cattle of Nikhongchori, 25 from native sheep and 50 spleen sample from slaughter house, clinically death animal from Savar and Shirajgonj. Blood samples were examined by Giemsa's stained blood smear (GMS) method (WHO, 2016) and confirmatory diagnosis through Polymerase Chain reaction (PCR). The effect of topography, season, age and sex were considered in this study. In GMS protocol blood samples were collected in EDTA tube from jugular and peripheral vein of animal, then thin and thick blood smear were prepared. After air dry blood smears were fixed in absolute methanol and stained with 10% Giemsa's stain. After washing, air dry and emulsification, Magnification under 10X and 100X objectives. In positive cases the blood protozoa shown slight purple color. In case of *Babesia* spp. short and long loop formation was found at the periphery of RBC (Piroplasmosis). In case of *Anaplasma marginale* rounded dot was observed at periphery of RBC and in *Anaplasma centrale* round dot was found inside of RBC as like as blooming flower in RBC. In case of *Theileria* spp RBC became slight triangle in shape and ring shaped (annular) as well as oval, round, dot, rod shaped *Theileria* spp were found.

Clinical sign included high fever (105-107^{0}F), complete off feeding, respiratory distress, continual panting, rapid breathing, sometimes bloody diarrhea, coffee colored urine at last stage of in Babesiosis were found. Post mortem lesion shown that epicardial and endocardial petechial haemorrhage, haemorrhage and spleenomegaly, highly congested and foamy lung, opaque and frazile liver, sometimes hepatomegaly and ruminal P^H>4. From the clinical investigation prevalence of TBDs was 100% (n=55) in Australian sheep, 80% (n=320) in dairy farm, 30% (n=120) in Bathan area, 22% (n=44) in native cattle, 31% (n=22) in hilly cattle, and 65% (=16) in native sheep. The overall prevalence of TBDs was 50.17% (n=577) in cattle and sheep in which *Anaplasma* spp was 43%, *Babesia* spp 19%, *Anaplasma* and *Babesia* spp 33%, *Theileria* spp 4% and mixed infection 1%. Tick, flie acted as vector of TBDs. On epidemiological study in Bangladesh it was observed that May to September environmental temperature is arise (above 30^{0}C, sometimes 40^0 C) and humidity is above 68% (sometimes above 90%) that triggers the multiplication of tick biologically and also multiplication (2^n, Budding and Binary) of TBDs protozoa both in tick and animal blood that progresses havoc of TBDs in high yielding animal and local animal act as carrier. But when environmental temperature is 30^{0}C or below and humidity is below 70% ie; October to March animal act as carrier (50.17%) but not showing clinical sign. High environmental temperature (above 30^0 C), high moisture (above 68 %), new introduction of animal, mixed with locally habituated animal, humid- semi humid tropical climatic zone, physical stress are main risk factors of TBDs. In case of high yielding animal and pure breed show high clinical sign and even death. In case of local and under 50% cross breed animal usually act as carrier and in some cases show clinical sign and also show positive response in treatment like diminazine aceturate, imidocarb,betamune buparvaquine, oxytetracycline, ceftiofur and also multivitamin, mineral premix,betamune (beta 1,3 d-glucan, propylene glycon,propiobacterium granulosum). Male and female

both are susceptible, lamb under 3 month of age, calf under 6 month of age show immunity due to maternal immunity of TBDs. From this positive sample (blood and spleen) Polymerase Chain Reaction (PCR) was done through commercial Genomic DNA Purification kit (Thermo Fisher Scientific Inc.).

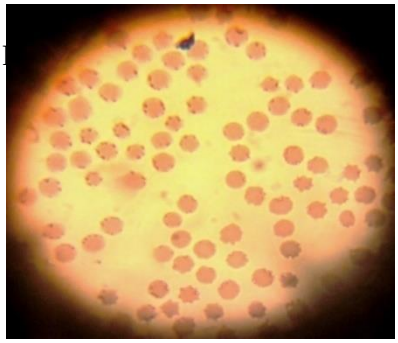

Figure *Anaplasma* spp.

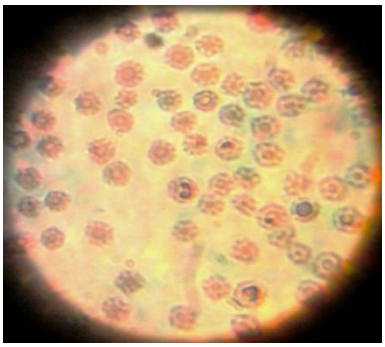

Figure *Babesia* spp**.**

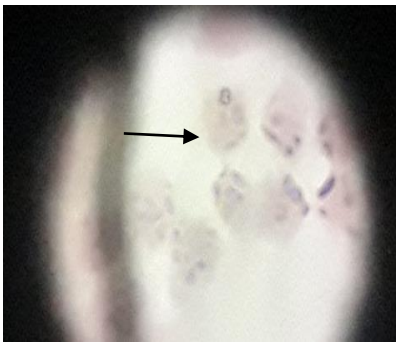

Figure *Theileria* spp.

Figure Spleen

Figure Heart

Figure Liver

Figure Lung

TBDs are vector borne diseases in livestock, so to introduce high yielding animal in a farm high Strict Biosecurity as well as sound animal health security is essential for adaptation of pure breed exotic animal in commercial or research farm. Now a day's livestock expert suggested that above 60% crossing in animal should be avoided.

Prevalence and antimicrobial resistance profile of foodborne pathogens in retail meats of Super shop: a food safety risk

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Executive summery

Food safety is a global health concern which describing hygienic handling, preparation, and storage of food in ways that prevent foodborne illness. Foodborne diseases are widespread and becoming a growing public health concern not only for the developing countries but also for the developed nations. Food can transmit disease from person to person as well as serve as a growth medium for bacteria that can cause food poisoning. Although the incidence of food borne diseases at global level is difficult to estimate but they pose a significant economic burden by straining health care systems and have immense impact on international food trade, tourism and development. Antibacterial-resistant strains and species of foodborne pathogens sometimes become as "superbugs", now contribute to the emergence of diseases that were for a while well-controlled. Considering these facts, the study was under taken to determine the prevalence of antimicrobial resistance profile of emerging and re-emerging foodborne pathogens in livestock and poultry value chain.

During July 2016 and June 2017, a total of 476 samples were collected from 10 super shop of Dhaka city; categorized in chicken meat (n=170), beef (n=68), mutton (n=34) and environmental samples(n=204). *Salmonella spp.* were isolated from the samples by using selective enriched media and confirmed by real-time PCR. Phenotypic resistance was determined by disk diffusion method. Extended-spectrum β-lactamases (ESBLs) and quinolone resistance genes were determined by PCR. The overall prevalence of *Salmonella spp.* was 18.5% (n=88; 95% C.I.15-22%) comprising in chicken meat 26% (n=44; 95% C.I.19.5-32.5%), beef 15% (n=10; 95% C.I.7-23%), mutton 18% (n=6; 95% C.I.6-30%) and environment 14% (n=28; 95% C.I.9.5-18.5%). In antimicrobial assay, 55% isolates were found multi-drug resistant (MDR). Among 22 tested antibiotics, extreme level of resistance was observed against Tetracycline and Erythromycin 99.1% (n=87, 95% CI: 94.5-99.9%), followed by Doxycycline 98%, Pefloxacin 93.9%, Azithromycin 92.2%, Enrofloxacin 91.2%, Moxifloxacin 89.7%, Nalidixic Acid 87.1%, Trimethoprim/Sulfamethoxazole 75%, Ciprofloxacin 53.4% and Streptomycin 49.6%. Nevertheless, only Ceftriaxone, Cefotaxime, Imipenem, Amoxicillin/Clavulanic acid showed good level of sensitivity as 82%, 73%, 73% and 68%, respectively. In minimum inhibitory concentration (MIC) assay, high level of MIC_{50}/MIC_{90} were observed against Amoxicillin (512/>1024), Flucloxacillin (512/1024), Cephradine (256/1024), Cefixime (2/512), Gentamycin (4/512), Chloramphenicol (32/512), Azithromycin (512/1024), Erythromycin (1024/>1024), and Sulfamethoxazole (512/>1024). Among the phenotypically resistant isolates, ESBL encoding genes were observed as bla (TEM) 80% (n=40/50), bla (shv) 10% (n=5/50), bla (ctx) 34% (17/50), bla (cmy) 8% (4/50); and Quinolone resistance genes qnrA 10.63% (5/47) gyrA 57.45 % (27/47) and gyrB 23.40% (11/47). High level prevalence of MDR *Salmonella* spp in retail meat which could cause foodborne illness is a great alarming issue for public health.

Prevalence of immune escape highly pathogenic avian influenza virus A/H5N1 in the vaccinated poultry in Bangladesh

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Executive summery

Highly pathogenic avian influenza virus (HPAIV) A/H5N1 subtype – is a major issue for the poultry industry in Bangladesh during first incursion of HPAIV in 2007. Bangladesh has one of the highest reported numbers of outbreaks of highly pathogenic avian influenza (HPAI) H5N1 in poultry. Furthermore, 7 cases of human infection with HPAI H5N1 were confirmed emphasizing the public health aspect of the on-going HPAIV H5N1 outbreaks. Following the initial spread of clade 2.2 H5N1 HPAI virus in Bangladesh in 2007, there have been new introductions of clade 2.3.2.1 and clade 2.3.4 virus in 2011. In addition to the HPAI H5N1 virus, the H9N2 subtype is widely circulating in poultry in Bangladesh, which raises concerns about the possible implications of the extensive co-circulation of these viruses. Their coexistence in the same susceptible population is likely to generate appropriate conditions for the emergence of novel reassortant virus variants, with unknown epizootic and zoonotic potential. Moreover, vaccination is one of the tools implementing in Bangladesh since 2013 including OIE classical methods to control HPAIV. Vaccination splits the scientific community, due to the risk of it being a potential driving force in HPAIV evolution through the selection of mutants able to escape vaccination-induced immunity. It is, therefore, essential to monitor the shading of HPAIV in vaccinated flock.

Considering the facts, we supervised commercial (n=60) and breeder (n=8) farms having different husbandry and receiving AIV (A/H5N1) vaccine, with filling a pretested questionnaire in a face-to-face interview of farm owner and/or designated workers to verify the hygienic practice and biosecurity. Cloacal and oropharyngeal swabs in case of live birds and morbid materials such as trachea have collected thrice yearly. Virus was isolated from the samples and performed rRT-PCR for influenza type A and subtype specific primers. Complete HA gene of selected isolates has been sequenced and analyzed. In biosecurity scoring test, most of the farms have poor biosecurity score of <17 followed by moderate and good biosecurity an average score of 27.40 and 35.97 respectively, from total score of 42. There were low ($<\log2^4$), moderately low ($\geq\log2^4$) and protective ($\geq\log2^6$) level of mean HI titer in 30% (n=18; 95% C.I. 19.25-40.8%), 23% (n=14; 95% C.I. 13.1-32.9%) and 47% (n=36; 95% C.I. 35.3-58.7%) farms respectively against HPAI vaccine. During active surveillance, 34% (n=23; 95% C.I. 22.9-44.1%) farms were shading AIV presumably allied with farm's bio-security and birds acquired immunity. Among vaccinated farms, 4.4% (n=3, 95% C.I. 0-9.2%) and 22% (n=15, 95% C.I.12.3-31.7) were shading H5N1 and H9N2 respectively. Coinfection of H5N1 and H9N2 were persist in 7.4% (n=5, 95% C.I. 1.2-13.5%) farms. Complete HA gene sequence data of H5N1 isolates revealed that shading virus strains were similar to 2.3.2.1a clade that circulated since 2015 in Bangladesh. Our findings suggest that LPAI and HPAI viruses are circulating in vaccinated flocks which might be due to vaccine strain variants, cutting vaccine dose or coverage that could result in enhanced antigenic drift.

Selection of potential probiotics for use as potent antibacterial agents against pathogenic bacteria

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Executive summary

Probiotics are live microorganisms which when administered in adequate numbers confer a health benefit on the host and control various infectious diseases particularly for the prevention of gastrointestinal infections. To date, probiotics have been mainly selected from the genera Lactobacillus and Bifidobacterium, because of their long history of safe use in dairy industry, and their natural presence in the human intestinal tract. Lactobacillus strains are among the lactic acid bacteria most commonly used as probiotics in animal feeds and human foods. The aims of this study were isolation and identification of probiotics and molecular characterization of isolated probiotics.

A total of 200 samples comprising 100 cloacal swabs and 100 intestinal contents were collected from healthy backyard poultry. Sterile cotton swab sticks was used for sample collection and collected samples were directly brought to the laboratory in an insulated ice box with minimum delay. Isolation and identification of probiotics were done according to the methods described in the Bacteriological Analytical Manual of the Food and Drug Administration (FDA). A total of 35 isolates were identified as *Lactobacillus* spp which produced round shape, creamy white colony in MRS agar. In microscopic examination, all the isolates were gram positive and rod shaped. In biochemical test, all the isolates were negative for the catalase test, MR-VP test and indole test. In carbohydrate fermentation test, all the isolates fermented lactose, sucrose, glucose, maltose, and mannitol. DNA was extracted from the isolated according to the manufacturer protocol (Qiagen Inc., CA, USA) and used as a template for the PCR. PCR was performed using the previously published protocol Timisjarvi and Alatossava (1997) for *Lactobacillus* spp, *Lactobacillus acidophilus, Lactobacillus ramnosus*. The PCR product was analysed on 2% (w/v) agarose gels stained in ethidium bromide and observed on a UV transilluminator and the PCR product was visualized at 247 bp, 606 bp, 448 bp respectively. In vitro assay for P^H, tolerance of Sodium Chloride was performed by the method of Aazami et al.,(2014). The isolates were able to grow at pH between 4.0 and 8.0, but the optimum growth was observed at pH between 5.5 and 6.5 when grown in MRS broth at 37°C. The isolated Lactobacillus spp were able to tolerate 1-9% w/v concentration of NaCl in the MRS broth. All the isolates maintained good growth up to 3% conc. of NaCl and growth declined sharply with the increase of salt concentration in the broth. Temperature tolerance of the isolates was determined by with overnight cultures, and incubated at 15, 37 and 45 ºC for 48–72 h. The isolated *lactobacillus* spp. fulfills the required criteria for a probiotic such as tolerance to harsh conditions such as high salt, low p^H. These isolates may be considered potential to be used as probiotic. The present study reveals that probiotics could be successfully used as modulation of intestinal microflora and pathogen inhibition, immunomodulation and promoting meat quality of poultry.

Development of FMD free zone in Bangladesh as per OIE guidelines

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Executive summary

FMD has been successfully controlled and eradicated in large parts of the world using conventional disease control measures including the vaccination of domestic animals. Nevertheless, several characteristics of FMD virus and factors inherent to the epidemiology of the disease complicate the idea of global eradication of FMD. In spite of intensive global, regional and national efforts to get ahead of the disease, more than one hundred developing and transitional countries of the world are still not free from FMD, thereby presenting a major challenge to move towards a global liberalised trade in animals and animal products, to ensure an ideal of global food security . Following the recommendations of the first international FMD conference held in Asuncion in 2009, a Global FMD Control Strategy has been prepared under the FAO/OIE Global Framework for the Progressive Control of Transboundary Animal Diseases (GF-TADs). The strategy was endorsed by participating members at the second international FMD conference held in Bangkok in June 2012.

The overall objective of a global FMD control strategy is to consolidate disease-free regions by a gradual reduction in the incidence of FMD in three distinct approaches: (i) to maintain the status in FMD-free countries and zones 'without vaccination'; (ii) to maintain the status in FMD-free countries and zones 'with vaccination' and where appropriate, progress to the status of FMD-free 'without vaccination'; and (iii) to gradually improve control in FMD-infected countries aiming at an OIE-recognized status. If the FMD free zone with vaccination is situated in an FMD infected country or borders of an infected country or zone, effective measures should be taken to prevent the introduction of the agent, physical and geographical barriers taking into consideration. The FAO has developed a stepwise pathway for countries or zones to move towards the ultimate ideal of obtaining official freedom from FMD: the so-called PCP (Progressive Control Pathway).

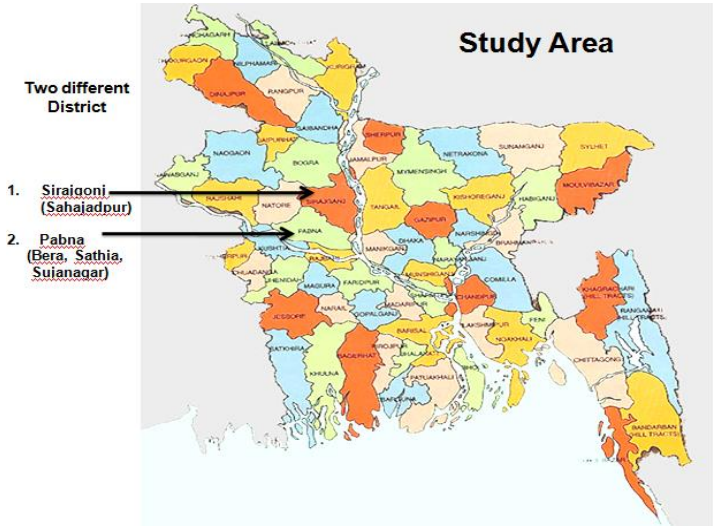

Figure 1 Two selected districts (Pabna and Sirajgonj) of Bangladesh for development of FMD free zone

Considering the food security and rural livelihoods of Bangladesh, and the OIE/FAO global control strategy for FMD, the study was undertaken with following objective -To establish a FMD free zone in a selected area of 'Pabna-Sirajgonj' of Bangladesh as per OIE guideline.

Simulation models (BLRI FMD control model) were developed to assess the impact of foot and mouth disease (FMD) outbreaks on cattle herd. FMD control methods of BLRI model included regular deworming, mass vaccination, farmer's training, vaccination of new introducing cattle after quarantine and regular immunity checking. Bangladesh Livestock Research Institute started this FMD control model research at selected areas of Bangladesh. This study was conducted in two different districts such as Pabna and Sirajgonj, among them three upazila (Bera, Sathia, Sujanagar) from Pabna district and Sahajadpur upazila from Sirajgonj of Bangladesh selected (Figure 1). Two villages has also been taken in same area as control. Questionnaire based data on age, sex, health status, deworming, vaccination and knowledge of farmers were collected from crossbred and native cattle of selected areas. A total of 785 cattle were from 137 farms at Alokdiar village of Bagabari area, Shahajadpur during the period from November-2012 to October-2016. Before starting of BLRI FMD control program at Alokdiar, 10% cattles were observed to infect with FMD during February 2013. After application of control model, FMD infection rate was decreased (less than 2%) in this area during March 2013 to December 2014. Finally Alokdiar village of Sirajgonj district was FMD free from April 2014 to November 2017 by following BLRI FMD control program. In cattle farms of Pabna and Sahajadpur area, trivalent FMD vaccine were used to protect the animals from FMD infection. High protective level of colostrum antibody was found in serum of cattle up to 5 month of age. It can be concluded that BLRI FMD control model can be used to develop effective and efficient policies to control FMD outbreak in Bangladesh.

Development of Peste des Petits Ruminants (PPR) free zone in selected areas of Bangladesh to meet global control strategy

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Executive summary

Peste des Petits Ruminants (PPR) is a highly fatal viral disease of goat and sheep which is characterized by high fever, depression, oro-nasal secretion, respiratory distress, diarrhea, high morbidity and mortality in small ruminants. The objectives of the project involve determination of goat and sheep population in the selected areas, conduct sero-surveillance and epidemiological studies of PPR, awareness campaigns on PPR recognition, prevention and control, development of PPR control strategy, assessment of conferred immunity and vaccine efficacy.

Goat population was determined in 19 selected villages under Jicorgacha upazilza of Jessore district by door to door baseline survey with pre-tested questionnaire. Sixteen villages of Magura union and one village of Simulia union under Jicorgacha upazila of Jessore district were treated as treatment villages. On the other hand, Hariadira of Jicorgacha union and Sreerampur of Simulia union were treated as control villages. A mass vaccination program was carried in all goats (3+ months of age) of 17 treatment villages (where around 11293 goats were vaccinated) after initial sero-surveillance; subsequently regular vaccination was carried out for kids and newly purchased goats of the treatment villages. Three hundred and seventy-one sera samples were collected (according OIE guidelines, based on the study population and considering age groups) for conducting sero-surveillance from the control and treatment villages and 827 sera samples were collected from vaccinated goats for post-vaccination (after 60 days) sero monitoring. All sera samples were tested by cELISA following the instruction of the manufacturer of the kit (BDSL and the Pirbright Institute World Reference Laboratory for PPR, United Kingdom).

Pre-vaccination sera analysis showed that in eight treatment villages, seropositive goats were 86.49%, 82.13%, 64.44%, 76.92%, 61.22%, 25.80%, 61.90%, and 40% in Rugonathnagar, Ghoradah, Nayemgali, Dohormagura, Borokhuli, Monohorpur, Amitobazar and kayemkhola, respectively, whereas in the control villages seropositive goats were 29.41% and 23.81% in Sreerampur and Hariadiara, respectively. Overall 60.89% goats were seropositive in treated villages before vaccination. Sera analysis from 60 days post-vaccinated goats from the 17 treatment villages showed post-vaccination herd immunity rose to 87.85% whereas in the control villages seropositive goats that 31.58% and 37.93% were positive in Hariadiara and Sreerampur, respectively. After 45 months of post vaccination, the long life immunity level was found 86% and 94.11% in Modhukali and Misridiara village.

Epidemiologically, PPR, FMD and some other non-specific diseases were also recorded in the study areas. New entry of goats in the household or village was one of the most important risk factors for PPR virus circulation and found several outbreaks surrounding the treatment villages. Morbidity and case fatality rate recorded were 14.00% and 70.55%, respectively during outbreaks. There was no outbreak of PPR in the treatment villages. Sero-positive goats were also higher in number in the treatment villages compare to the control villages, reflected that locally produced PPR vaccine confers sufficient herd immunity that could protect PPR disease in goat and eventually helps to meet global PPR control strategy.

A comparative study on pregnancy diagnosis in goats (*Capra hircus*) using barium chloride and progesterone based- kit

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Executive summary

To fulfill the growing demand of animal protein, sheep and goats are considered important and promising animal resources in Bangladesh. Profitable goat and sheep farm requires a planned reproductive management. But due to lack of proper diagnosis of pregnancy in early stage of gestation serious economic losses are faced by the farmers. Considering these issues, the present study was undertaken to develop a low cost technique for early diagnosis of pregnancy in goats to minimize the losses. This study was conducted in Goat and Sheep Research Farm and Small Ruminants Health Laboratory under Goat and Sheep Production Research Division of Bangladesh Livestock Research Institute (BLRI), Savar, Dhaka from July 2016 to June 2017. About 100 goats of different age groups were randomly selected for the trial and goats were categorized under four groups according to their gestation length such as group-1 included 0.5 to 1 months of gestation, group- 2 included >1 to 1.5 month of gestation, group -3 included >1.5 to 2 months of gestation and group- 4 included >2 to 2.5 months of gestation. Blood from vein and morning urine sample were collected from four groups and brought to the laboratory and serum was separated from the blood under sterile condition. Then 1%, 1.5% and 2% barium chloride solution were prepared by adding 1gm, 1.5gm and 2gm barium chloride with 100 ml, 150ml and 200ml of distilled water. For each concentration of barium chloride solution 1 ml was mixed with 1 ml of urine sample and allowed for 5 and 10 minutes for interpretation. Presence of precipitation interpreted as negative pregnancy and absence of precipitation interpreted as positive pregnancy. For each blood sample 3 to 5 drops of serum were added in each Bovipreg kit and wait for 5 minutes to observe the presence of one or two red line in the kit. One red line interpreted as negative pregnancy and two red lines interpreted as positive pregnancy. In case of 1% barium chloride, the highest average positivity was 93.5% for the goats having 0.5 to 1 month of gestation (Table 1). In case of 1.5% barium chloride, the highest average positivity was 92% for the goats having 0.5 to 1 month of gestation (Table 1). In case of 2% barium chloride, on the other hand, the highest average positivity was 91.5% for the goats having >1 to 1.5 month of gestation (Table 2). Conversely, the average positivity for progesterone-based early pregnancy diagnostic kit was 96.5% (Table 1).

Table 1 Results of pregnancy diagnosis in goats at different lengths of gestation

Gestation Length	Barium Chloride									Progesterone-Based Kit (Average +ve) (5 min.)
	1% (Average +ve)			1.5% (Average +ve)			2% (Average +ve)			
	5 min.	10 min.	Mean	5 min.	10 min.	Mean	5 min.	10 min.	Mean	
0.5 to 1 month (n=25)	93%	94%	93.5%	91.5%	92.5%	92%	90%	91%	90.5%	97%
>1 to 1.5 month (n=25)	92%	93%	92.5%	93%	92.5%	92%	91%	92%	91.5%	97%
>1.5 to 2 months (n=25)	91%	93%	92%	90.5%	92.5%	91.5%	90%	92%	91%	96%
>2 to 2.5 months (n=25)	90%	92%	91%	90%	91%	90.5%	90%	90%	90%	96%

Development of starter culture for Yogurt: isolation and identification of potential lactic acid bacteria

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Executive summary

Yoghurt is a fermented dairy product obtain from control fermentation of milk by a selective culture of lactic acid bacteria produced a flavor and typical aroma. Starter cultures are those food graded microorganisms that are used in the production of cultured dairy products such as yogurt. These lactic acid bacteria in yogurt work as probiotic and bring lots of health benefits upon ingestion. However, unlike developed countries, dried starter culturein small packet for preparing yogurt by consumers is not available in Bangladesh. Consumers are dependent mostly on marketed yogurt, bacterial contents of which are non-descriptive and often not live or viable for further use as starter culture. Therefore, the present study was undertaken to develop a suitable starter culture for yogurt preparation at consumer's home followed by processing, packaging and marketing technique development.
For this purpose Nine yogurt Samples (Milk vita, Mew, Pran Sweet, Pran Sower, Well food, Quality, Bikrampur, Nabingar, Bogra) from local market of different areas were collected and cultured in a selective culture media (MRS). Catalase negative, Grams stain positive colonies were initially isolated as LAB. Then the isolates were purified by sequential culturing in MRS broth and MRS agar media. Biochemical properties of selected colonies were evaluated by performing gas production from glucose, growth at different temperature (10ºC,15ºC and 45ºC), growth at different NaCl Concentrations (2, 4 and 6.5% NaCl) and carbohydrate fermentation profile (lactose, sorbitol, salicin, trehalose, mellibiose, sucrose, manitol, melezitose, maltose, galactose, glucose, arabinose, raffinose andribose).

Table 1 Biochemical properties of selected isolates

Yogurt name	Milk vita			Mew	Pran Sweet			Pran Sower				Bikra-mpur		Bogra	
Isolates	1	2	3	1	1	2	3	1	2	3	4	1	2	1	2
Cell shape	Rod	Rod	Cocci	Cocci	Rod	Cocci	Cocci	Rod	Rod	Cocci	Cocci	Rod	Cocci	Rod	Cocci
Gas from Glucose	-	-	+	+	-	+	+	-	-	+	+	-	+	-	+
Growth in different NaCl solution															
2%	+	+	-	-	+	-	-	+	+	-	-	+	-	+	-
4%	+	-	-	-	-	-	-	+	+	-	-	-	-	+	-
6.5%	+	-	-	-	-	-	-	+	+	-	-	-	-	+	-
Growth at different temperature															
10˚ C	-	-	+	+	-	+	+	-	-	+	+	-	+	-	+
15˚ C	-	-	+	+	-	+	+	-	-	+	+	-	+	-	+
45˚ C	+	+	-	-	+	-	-	+	+	-	-	+	-	+	-
Sugar fermentation test															
Lactose	+	+	-	-	+	-	-	+	+	-	-	-	-	+	-
Sorbitol	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-
Salicin	+	-	-	-	+	-	-	+	+	-	-	-	-	+	-
Trehalose	+	-	-	-	+	-	-	+	+	-	-	-	-	+	-
Mellibiose	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Yogurt name	Milk vita			Mew	Pran Sweet			Pran Sower				Bikra-mpur		Bogra	
Isolates	1	2	3	1	1	2	3	1	2	3	4	1	2	1	2
Sucrose	-	-	-	-	+	-	-	-	+	-	-	-	-	-	-
Manitol	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-
Melezitose	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-
Maltose	+	-	-	-	+	-	-	+	+	-	-	-	-	+	-
Galactose	-	-	+	+	-	+	+	-	+	+	+	-	+	-	+
Glucose	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Arabinose	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Raffinose	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ribose	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Identified Species	*LL*	*LB*	*LC*	*LC*	*LA*	*LC*	*LC*	*LL*	*LH*	*LC*	*LC*	*LB*	*LC*	*LA*	*LC*

** LL= Lactobacillus lactis , LB= Lactobacillus bulgaricus, LC=Leuconostoccremoris,*
L A= Lactobacillus acidophilus, LH= Lactobacillus helveticus

Out of 9 samples, live viable bacteria were found in 6 samples and the concentrations ranged from 9.5×10^5 to 1.0×10^4cfu/ml. The Nabinagar, Quality and Well food yogurt sample did not showed any bacterial growth on selective culture media. Among 6 yogurt sample based on catalase negative and Garm's stain positive a total 15 colonies were selected for farther biochemical identification. According to biochemical activities (Table 1) Lactobacillus lactis was identified in Milk vita, Pran sour and Bogra yogurt, while Lactobacillus bulgaricus was found in Milk vita and Bikrampur yogurt. The species Leuconostoccremoris was found in all 6 yogurts containing live viable bacteria. On the other hand Lactobacillus acidophilus and Lactobacillus helveticus was found only in Pran sweet and Pran sour sample, respectively. Isolation and identification process is going on for other bacteria suitable for starter culture.

Development of suitable semen extender for cryopreservation of buffalo semen

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Executive summary

Artificial insemination (AI) is the most efficient assisted reproductive technology ever devised for the propagation of farm animal with desired genetic traits. In Bangladesh, different Government and Non-Government Organization (Central Cattle Breeding and Dairy Farm, BRAC, LAL TEER, AMERICAN DAIRY LIMITED) has developed semen cryopreservation technique for production of frozen semen and artificial insemination in cattle as a major assisted reproductive tool. But in case of buffalo, semen collection, processing, cryopreservation and artificial insemination are not standardized so far. Therefore this study was designed to investigate the effect of different extenders to screen a suitable extender for cryopreservation of buffalo semen.Semen was collected from 3 sexually mature (2.5-3 yearsold) and healthy indigenous breeding buffalo bulls through artificial vagina method twice in a week. After initial evaluation (motility >70%), each semen sample was divided into three aliquots and diluted with three different extenders viz. Andromed,Tris-egg-yolk extender and soya-milk based extender. The 0.50 mL French mini straws filled from each aliquot were gradually cooled to 4-5°C, equilibrated at 4°C for 4 h and frozen in liquid nitrogen vapor using programmable biofreezer. Just before freezing (post-equilibration) and 24 h after frozen storage, the samples were evaluated for various sperm quality parameters using standard protocols. The plasma membrane integrity of spermatozoa was assessed using a HOS test employing 150 mOs/L solutions of sodium citrate and fructose with 30 min of incubation at 37°C. AI was performed in 9 buffalo cows using frozen semen straws preparedby Andromed,Tris-egg-yolk extender and soya-milk based extenders.

The mean percentage of total, progressive, static and slow motility of freshly collected semen was 92.86±0.30,74.64±2.76,7.14±0.30 and 11.86±0.37,respectively (Table 1).The mean percentages of pre-freeze sperms in Andromed, Tris-egg-yolk extender and soya-milk based extender in terms of total motility (77.06±0.98vs72.28±0.58vs 65.32±1.29) progressive motility (59.82±1.02vs 53.66±1.26vs 48.70±1.17),static motility (22.94±0.96vs 27.72±0.58vs 34.68±1.29), slow motility (2.10±0.36vs 2.32±0.38vs 3.18±0.49), and hypo-osmotic swelling (HOS) reactivity (63.23±0.32vs 60.42±0.42vs 58.65±0.37) varied significantly ($p<0.01$) among extenders (Table 1). Similar level of significant ($p<0.01$) variations among these extenders for post-thaw sperm total motility (52.28±1.13vs 46.02±1.49vs 33.52±0.67), progressive motility (47.42±1.29vs39.82±0.45vs 27.12±0.46), static motility (47.72±1.13vs 53.14±0.74vs 66.48±0.67), slow motility (2.18±1.12vs 2.70±0.18vs 4.36±0.66), and hypo-osmotic swelling (HOS) reactivity (46.81±0.76vs 43.32±0.82vs 39. 05±0.84) was also observed for Andromed, Tris-egg-yolk extender and soya-milk based extenders (Table 1).

The mean values of post thaw sperms shows significant differences ($p<0.01$) in different sperm kinematics among Andromed, Tris-egg-yolk extender and soya-milk based extenders in terms of VAP (84.66±0.51vs 82.02±0.48vs 63.15±0.71), VSL (68.73±0.71, 66.45±0.47, 58.03±0.88), STR (85.29±0.73 vs 82.38±0.60vs67.93±0.89), and BCF (26.20±0.47vs 26.06±0.38vs 19.38±0.50), respectively (Table 2). Following artificial insemination with prepared frozen semen, Andromed and Tris- egg- yolk extender group showed higher (100%) conception rate rather than soymilk extender group (33.33%) (Table 3). Pregnancy was confirmed by rectal palpation after three months of insemination by rectal palpation.Out of the pregnant animals 3 calves (2 female and 1 male calves) were born and rest of the animals will give birth soon.

Table1 Effect of different extenders on motility parameters (Mean±SE) of buffalo semen at different stages of cryopreservation

Freezing stage	Extender	Total motility %	Progressive motility %	Static%	Slow%	HOS reactive sperm (%)
Fresh semen	-	92.9±0.3	74.6±2.8	7.1±0.3	1.9±0.4	72.3±0.2
Pre-freeeze	Andromed	77.1^{a}±1.0	59.8^{a}±1.0	22.9^{a}±1.0	2.1±0.4	63.2^{a}±0.3
	Tris –egg- yolk	72.3^{b}±0.6	53.7^{b}±1.3	27.7^{b}±0.6	2.3±0.4	60.4^{b}±0.4
	Soya milk	65.3^{c}±1.3	48.7^{c}±1.2	34.7^{c}±1.3	3.2±0.5	58.7^{c}±0.4
Post Thaw	Andromed	52.3^{p}±1.13	47.4^{p}±1.29	47.7^{p}±1.1	2.2^{b}±1.1	46.8^{a}±0.8
	Tris –egg- yolk	46.0^{q}±1.5	39.8^{q}±0.5	53.1^{q}±0.7	2.7^{b}±0.2	43.3^{b}±0.8
	Soya milk	33.5^{r}±0.7	27.1^{r}±0.5	66.5^{r}±0.7	4.4^{a}±0.7	$39.\ 1^{c}$±0.8

Means bearing different superscripts among extenders at pre-freeze (a,b,c) and post-thaw (p, q, r) stage differ significantly ($p<0.01$)

Table 2 Effect of different extenders on kinematic parameters (Mean±SE) of fresh and post thawed buffalo semen

Freezing stage	Extender	VAP (μm/s)	VSL (μm/s)	VCL (μm/s)	STR (%)	LIN (%)	ALH Mm	BCF Hz
Fresh		98.7±0.7	79.7±0.7	140.8±0.7	88.9±0.8	57.9±0.4	7.4±0.6	27.9±0.6
Post thaw	Andromed	84.7^{a}±0.5	68.7^{a}±0.7	139.8±0.69	85.3^{a}±0.7	54.2^{a}±0.5	7.0±0.5	26.2^{a}±0.5
	Egg yolk	82.0^{b}±0.5	66.5^{b}±0.5	138.6±1.0	82.4^{b}±0.6	53.0^{a}±0.6	7.0±0.3	26.1^{a}±0.4
	Soya milk	63.2^{c}±0.7	58.0^{c}±1.0	139.3±1.0	67.9^{c}±0.9	46.9^{b}±0.6	6.6±0.4	19.4^{b}±0.5

Means bearing different superscripts among extenders at post-thaw (a,b,c) stage differ significantly ($p<0.01$)
VAP: average path velocity; VSL: straight line velocity; VCL: curvilinear velocity; STR: straightness; LIN: linearity; ALH: amplitude of lateral head displacement; BCF: beat cross frequency; WOB: wobble.

Table 3 Effect of different extender on conception rate after AI of cryopreserved buffalo semen

Extender type	No. of animal inseminated	No. animal conceived	Conception rate (%)	No. of calf born
Andromed	3	3	100	Pregnant
Tris egg yolk extender	3	3	100	3
Soy milk based extender	3	1	33.33	Pregnant

In conclusion, the present experiment demonstrated the semen characteristics of indigenous buffaloes and established the semen cryopreservation system. Considering pre-freeze and post thaw sperms characteristics it may be concluded that, Tris-Egg-Yolk semen extender may be used for cryopreservation of buffalo semen at efficiency similar to commercially available semen extender like Andromed.

Utilization of different livestock wastealone or in combination for improvingbiogas production

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Executive summary

Livestock manure could be a valuable resource, which if used appropriately, can replace significant amount of chemical fertilizers, be used as biomass for renewable energy source, and thereby, make livestock farming more profitable and sustainable. However, all wastes produced from livestock farming enterprizes are not using or being used in limited scale for biogas production. There are many scopes for utilizing efficiently all those wastes for biogas production and other value added product development. The objective of present research is to find out some efficient ways for bringing all those wastes in utilization and increase biogas production rate and methane concentration in biogas digester fed with different feedstock biomass originated from livestock farm waste. For this purpose, two separate experiemnts were conducted to know the effects of mixing cowdung (CD)with slaughter house rumen digesta (SHRD) and cowdung withlayer droppings (LD) on biogas production, composition and bioslurry characteristics. In the first experiment, CD and SHRD were mixed in ratios of 100:0 (T_1), 25:75 (T_2), 50:50 (T_3),75:25 (T_4) and 0:100 (T_5) and incubatedin triplicates in 3.5 litter laboratory simulated biogas digester.The digeter was connected to a 60 ml disposable syringe through collection tube by which gas production was measured three times a day. Biomass and water ratio was maintained roughly 1:2. to faciliate hydrolysis. In the second experiment, CD and LD were mixed in ratios of 100:0 (T_1), 25:75 (T_2) and 50:50 (T_3) and incubated in triplicates similarly as in experiment 1. The digesters were then sealed to provide anaerobic condition and kept in mesophilic temperature (at about 35^0C) for about 8 weeks. Gas production was measured from syringe and pressure was released periodically. Gas sample was analysed weekly with the help of sensor based digital biogas analyser (Biogas5000, Geotech, UK). The incubation was stopped when gas production was in declining trend. At openning of digester, pH of biosulrry was recorded and samples were collected for microbial enumeration (E. coli and Salmonella) and mineral analysis. Gas composition data were analysed using Repeated Measures in General Linear Model (GLM), while all other data were subjected for Analysis of Variance (ANOVA) in complete randomized design (CRD) in SPSS 20.0. In Experiment 1, gas production was observed highest ($P<0.05$) in T_2 (CD:SHRD=75:25), while methane concentration was highest in T_2 (CD:SHRD=75:25), T_3 (CD:SHRD=50:50) and T_4 (CD:SHRD=25:75). Organic C concentration in slurry was higher ($P<0.01$) in T_2, T_4 and T_5, while highest ($P<0.01$) N concentration was found in T_3. The P concentration was not varied ($P>0.05$) among the treatments and ranged from 2.1 to 2.4%. Potassium (K) concentration was found highest ($P<0.01$) in T_2 (2.6%) and T_4 (2.6%), while lowest in T_5 (1.8%). Though the fresh CD and SHRD contained 7.42 and 5.82 $\log_{10}$CFU/g of *E. coli,* but none of the slurries contained any *E. coli.* There was no *Salmonella* observed in both fresh substrates as well as resulted bio-slurry in any treatments. In experiment 2, neither gas production nor methane concentration varied significantly among the treatments. However, about 25% higher (numerically; $P>0.05$) gas production was observed in T_2 (CD:LD=75:25) compared to others. Organic C concentration of slurry was found highest ($P<0.01$) in T_1 (15.22%) followed by T_3 (11.35%) and T_2 (10.44%), while N concentration was found highest ($P<0.01$) in T_2 (1.67%). The P and K concentrations of bio-slurry were increased ($P<0.01$) with the increase of LD in the substrate. In this experiment, fresh CD contained 5.82 $\log_{10}$ CFU/g of *E. coli,* but not any *Salmonella.* On the other hand, LD contained 6.93 and 7.10 $\log_{10}$ CFU/g of *E. coli* and*Salmonella,* respectively, while none of the slurry samples contained any of those microbes.

Table 1 Effect of mixing cow dung (CD) with slaughter house rumen digesta (SHRD) in different ratios on biogas production, composition and slurry characteristics.

	Control (T_1) (100:0)*	T_2 (75:25)	T_3 (50:50)	T_4 (25:75)	T_5 (0:100)	SEM	p-value
Biogas production and composition							
Total Gas, l	16.0^{ab}	19.6^{a}	17.1^{ab}	14.9^{b}	14.6^{b}	1.483	0.02
Daily gas, ml/d	258.6^{ab}	315.9^{a}	276.2^{ab}	240.9^{b}	235.4^{b}	24.091	0.021
CH_4, %	35.3^{b}	40.7^{a}	40.2^{a}	40.3^{a}	37.1^{ab}	4.71	0.009
CO_2, %	34^{a}	37.3^{a}	35.7^{a}	34.5^{a}	29.2^{b}	4.75	0.002
NH_3, ppm	242.7^{b}	298.4^{a}	287.9^{a}	185.7^{c}	108.9^{d}	46.39	<0.001
H_2S, ppm	790.9^{b}	1114.4^{a}	1027.5^{a}	661.5^{b}	282.2^{c}	247.68	<0.001
Bioslurry characteristics							
Slurry pH	6.9	7	7.1	7.1	7.1	0.054	0.052
Organic C, %	12.6^{b}	13.5^{a}	12.7^{b}	13.7^{a}	13.4^{a}	0.23	0.001
N, %	1.3b^{c}	1.4^{ab}	1.5^{a}	1.3^{bc}	1.2^{b}	0.054	0.001
C/N	9.5b^{c}	9.9^{b}	8.6^{c}	10.3^{ab}	11.1^{a}	0.43	<0.001
P, %	2.4	2.3	2.2	2.3	2.1	0.141	0.155
K, %	2.2^{b}	2.6^{a}	2.3^{b}	2.6^{a}	1.8^{c}	0.109	<0.001
*Cow dung (CD): Slaughter house rumen digesta (SHRD)							

Table 2 Effect of mixing cow dung (CD) with layer droppings (LD) in different ratios on biogas production, composition and slurry characteristics.

	Control (T_1) (100:0)*	T_2 (75:25)	T_3 (50:50)	SEM	p-value
Biogas production and composition					
Total Gas, l	16.0^{ab}	19.6^{a}	17.1^{ab}	1.483	0.02
Daily gas, ml/d	258.6^{ab}	315.9^{a}	276.2^{ab}	24.09	0.021
CH_4, %	35.3^{b}	40.7^{a}	40.2^{a}	4.71	0.009
CO_2, %	34^{a}	37.3^{a}	35.7^{a}	4.75	0.002
NH_3, ppm	242.7^{b}	298.4^{a}	287.9^{a}	46.39	<0.001
H_2S, ppm	790.9^{b}	1114.4^{a}	1027.5^{a}	247.68	<0.001
Bioslurry characteristics					
Slurry pH	6.9	7	7.1	0.054	0.052
Organic C, %	12.6^{b}	13.5^{a}	12.7^{b}	0.23	0.001
N, %	1.3b^{c}	1.4^{ab}	1.5^{a}	0.054	0.001
C/N	9.5b^{c}	9.9^{b}	8.6^{c}	0.43	<0.001
P, %	2.4	2.3	2.2	0.141	0.155
K, %	2.2^{b}	2.6^{a}	2.3^{b}	0.109	<0.001

*Cow dung (CD): Layer droppings (LD)

From results of the present study, it could be said that slaughter house rumen digesta is a potential feedstock biomass for biogas digester, however, the gas and methane production efficiency was higher when it was mixed with cowdung at ratio of 25 to 50%. Similarly, layer droppings also were increased gas production and proportionate methane production when mixed with cowdung at 25%. Mixing feedstock biomass is also a good strategy for producing slurry of improved fertilizer characteristics.

Study of vegetable waste based feed production system

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Executive summary

Vegetable wastes (VW) from marketplace, which was reported to be safe as animal feed, was fed to growing bulls at the rate of 9.68 % of diet or 0.30 % of live weight without affecting the production and health. It may also have the potentiality to convert into other cost effective value added products, such as, silage or blocks. However, development of an enterprise based on VW based feed manufacturing may requires their year round constant availability. Therefore, the study was conducted with the objectives to quantify year round VW biomass in vegetable market, their physical and chemical composition, and potentiality to reduce methane emission from landfills by recycling them into feed. In order to achieve this objective, the work was conducted at Karwan Bazar vegetable market, Farmgate, Dhaka and the data on waste produced in the transport, wholesaler storage and the retailer shops were collected by measuring individually, and interviewing of transporters, wholesalers, retailers and market cleaners and filling up a pre-set questionnaires in every 2 days interval during the whole year. For convenience, the whole year was divided into three vegetable production seasons, such as summer (March to June), rainy (July to October) and winter (November to February). The chemical composition of some major VW was done according to AOAC (2004).The neutral detergent fiber (NDF) and acid detergent fiber (ADF) contents were determined according to van Soest et al. (1991). Total digestible nutrients (TDN) were calculated according to Ball et al. (2001). The data on the estimation of methane emission for the disposal of total wastes to landfills is calculated according to IPCC (1996), considering 100% disposal of them. Enteric methane emission of cattle, when vegetable waste portion of total waste is used as feed, was estimated by calculating gross energy (GE) content of vegetable wastes according to Ball, et al. (2002) and Moran (2005). Then, enteric methane was calculated according to IPCC (2006). The data on the composition of market wastes and their biomass supply in different seasons, and the proportional waste of some vegetables in marketing chains were analyzed by one way ANOVA using SPSS (SPSS 11.5) computer program.The daily amount of vegetable waste biomass produced in different seasons of a year is presented in Table 1. It was found that the daily vegetable supply, waste produced and its proportion in relation to market supply differed significantly ($P<0.01$). The daily average market supply of vegetable was 4547.38 ton/d, and in summer, rainy and winter the amount was 4894.05, 4094.10 and 4654.00 ton/d, respectively. The average amount of vegetable waste during these seasons was 52.05, 36.96 and 38.53 ton/d, respectively with an average of 42.51 ton/d. The calculated vegetable waste represented 1.01, 0.87 and 0.82 % of market vegetable supply, respectively in different seasons.

Table 1 The amount of vegetable supply and waste produced

Parameters	Amount			Average	SEM	P values
	Summer	Rainy	Winter			
Total vegetable supply, ton/d	4894.05[a]	4094.10[b]	4654.00[a]	4547.38	536.53	< 0.01
Total vegetable waste, ton/d	52.05[a]	36.95[b]	38.53[b]	42.51	11.53	< 0.01
Proportion of vegetable waste, %	1.01[a]	0.87[b]	0.82[b]	0.91	0.17	< 0.01

SEM, Standard Error of Mean; [ab,] Means with different superscripts in the same raw differ significantly; P > 0.05, Not Significant.

The proportion of waste of different vegetables in their marketing chain is presented in Table 2. A highly significant ($P<0.01$) proportion of waste was found to produce during the wholesale storage of some vegetables, such as brinjal, bitter gourd, cabbage, tomato and radish, which was followed by retaining and transport wastes. The range of wholesale waste of them was 7 to 14%, and it was 5.91and 3.14% for retailer storage and transport, respectively on average. Moreover, the proportion of wastes during wholesale storage and retailing was similar, but differed significantly with transport waste ($P<0.05$) for some vegetables, such as sweet gourd, cauliflower, cucumber, carrot and spotted gourd. In this case, the range of wholesale storage or retail waste may range from 5.84 to 9.39%, with

the transport waste of 3.01% on average. Among the vegetables, the highest proportion of total waste was found in case of radish (23.21%) which was followed by cauliflower (20.80%), tomato (19.83%), cabbage (19.27%), spotted gourd (17.37%), brinjal (16.89%), bitter gourd (16.56%), carrot (16.15%), sweet gourd (15.25%) and cucumber (14.52%), respectively.

Table 2 Wastes of some vegetables (% fresh marketed) in different market chains

Name of vegetables	Vegetable wastes in marketing chains (%)			SEM	P values	Total (± SD)
	Transport	Wholesaler	Retailer			
Brinjal	3.10^{c}	7.85^{a}	5.94^{b}	2.51	0.000	16.89±4.67
Bitter gourd	3.04^{b}	7.01^{a}	6.51^{a}	1.81	0.000	16.56±4.00
Cabbage	2.99^{c}	10.89^{a}	5.39^{b}	3.88	0.004	19.27±7.22
Tomato	2.80^{c}	10.69^{a}	6.34^{b}	5.57	0.006	19.83±12.02
Radish	3.77^{c}	14.06^{a}	5.38^{b}	3.58	0.000	23.21±6.29
Sweet gourd	2.45^{b}	6.89^{a}	5.91^{a}	3.43	0.029	15.25±7.01
Cauliflower	3.65^{b}	9.39^{a}	7.76^{ab}	3.62	0.040	20.80±9.65
Cucumber	2.78^{b}	5.87^{a}	5.87^{a}	2.95	0.020	14.52±6.40
Carrot	2.53^{b}	7.78^{a}	5.84^{ab}	2.87	0.040	16.15±6.63
Spotted gourd	3.65^{b}	6.52^{a}	7.22^{a}	2.59	0.011	17.37±6.71

SEM, Standard Error of Mean;^{abc,} Means with different superscripts in the same raw differ significantly (P>0.05 or 0.01); SD, standard Deviation.

The chemical composition of some vegetable wastes is presented in Table 3. The DM content was found to range from 3.97 to 10.39% of fresh weight. Among the vegetables, cauliflower had the highest CP content (26.9%), and the lowest was found in brinjal (17.15%). The levels of NDF and ADF of the samples ranged from 33.74% to 61.26%, and 20.90 to 42.06%, respectively. The TDN content of the VW ranged from 58.44% to73.16%.

Table 3 Chemical composition of some vegetable wastes

Name of wastes	Chemical composition (%DM ± Standard Deviation)					
	DM (% fresh)	OM	CP	NDF	ADF	TDN
Cucumber	3.97±0.82	90.1±2.47	20.06±1.29	42.72±3.72	37.51±3.76	61.59±2.63
Bitter gourd	6.00±1.39	87.6±5.29	18.77±1.72	54.10±5.50	41.10±6.53	58.86±4.24
Spotted gourd	7.74±1.99	94.7±1.56	19.42±1.17	61.26±1.76	35.93±9.74	62.64±6.30
Cabbage	9.87±2.77	86.4±2.16	17.25±0.73	33.74±15.54	20.90±1.64	73.16±1.09
Cauliflower	10.39±3.61	84.6±3.90	26.9±1.03	58.41±0.41	30.35±6.28	66.61±4.42
Brinjal	7.75±1.41	90.6±3.36	17.15±0.88	47.16±8.02	42.06±4.82	58.44±3.37
Snake gourd	4.25±1.02	95.1±1.10	18.35±0.91	47.96±6.82	37.73±4.62	61.42±3.22

The annual methane emission for the disposal of that market VW, enteric methane emission for their utilization as cattle feed, and the benefit of recycling them as cattle feed in terms of methane emission reduction are presented in Table 4. It was found that the VW of that market, when disposed into landfills, may emit 0.49 giga-gram (Gg = 1000 tonnes) methane. Contrary to disposal to landfills, when the vegetable waste was feed to cattle, it produces only 0.05 Gg methane. Therefore, recycling of available vegetable waste at Karwan bazaar into feed may contribute to the reduction of methane emission by 90% (0.44 Gg/year).

Table 4 Reduction of methane emission by recycling market vegetable waste into feed

Parameters	Amount (±SD)
Methane emission from landfill sites of market waste, Gg year^{-1} (Gg = 1000 tonnes)	0.49±0.15
Rumen enteric methane emission for feeding processed vegetable waste, Gg	0.05±0.02
Reduction of methane emission, Gg year^{-1}	0.44 ±0.13
Methane emission reduction efficiency, %	90.11±0.11

It may be concluded that the daily available VW biomass at Karwan Bazar is 42.5 t/d and the value addition of this biomass into feed, instead of land-filling, may reduce anthropogenic methane emission by 0.44 Gg/year.

Development of new Napier cultivars through gamma-ray irradiation

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Executive summary

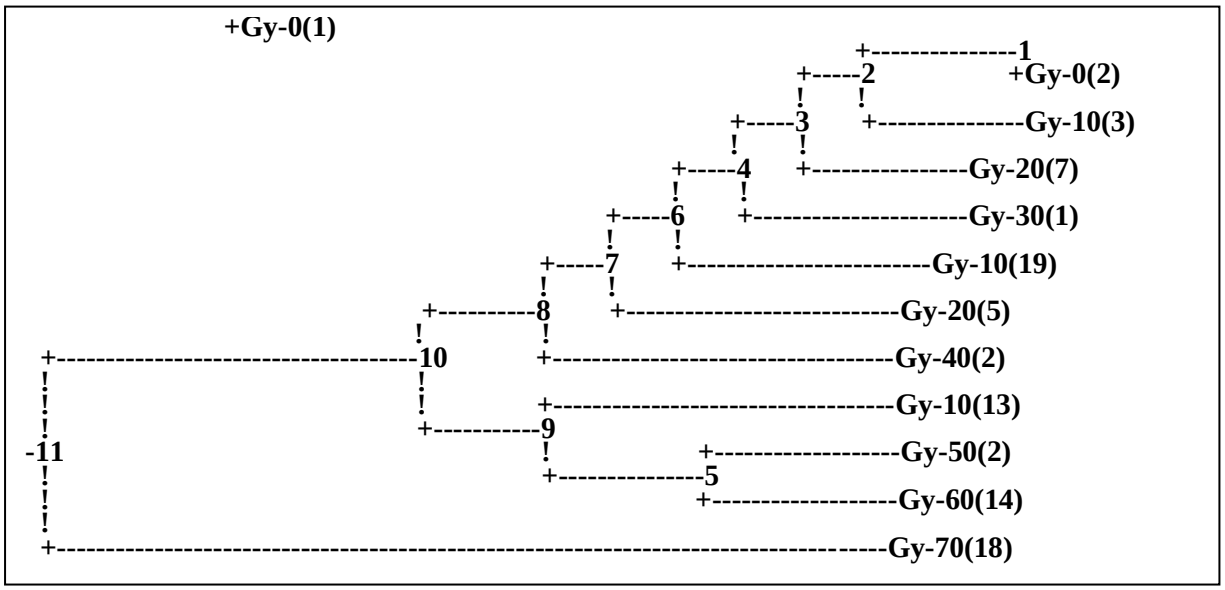
Napier cultivars are potential fodder germplasms have been widely accepted among the cattle farmers in all over the country except few areas of coastal and saline zones. Therefore, an experiment was conducted to develop new Napier cultivars through use of Gamma irradiation. Hence, two Napier cultivars (BN-3 and BN-4) were selected to assess the effectiveness of different dosages Gamma rays on survivability, growth behavior, yield traits, and nutritional value. For this purpose, 20 (Twenty) double node cuttings were treated for 10, 20, 30, 40, 50, 60, 70, 80, 90 and 100 Gy doses, respectively in the department of Electronics, Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh. All the material was planted in Complete Randomized Design. Survival rate was calculated as a percentage of cuttings with re-growth divided by the total number. The data-points obtained in this way were fitted to the probit function. $Probit\ (p) = a+b\sqrt{2}erf^{-1}(2p-1)$; where *a* is the y-intercept, *b* is slope and *p* is the normalized survival probability. The fit was performed by using the Excel and SPSS packages. The probit function was used to determine lethality dose (LD). An analysis of variance was done to determine the varietals differences. Collected data were analyzed statistically by using Compare Means (CM) procedure of One-Way Analysis of variance (ANOVA). In order to estimate genetic variation in mutants, randomly amplified polymorphic DNA (RAPD) analysis was performed. The RAPD analysis was performed using ten random primers from Operon Technologies: OPA-01, OPA-09, OPA-13, OPA-16, OPC-02, OPC-06, OPAK-04, OPS-12, OPAW-09 and OPAW-19. Amplification reactions were conducted with a total volume of 25 µL, containing Master Mix 12.5 µL, primer (10 pmol) 2 µl, Template DNA 1µl (50 ng), and water 9.5 µl. The polymerase chain reactions (PCR) were conducted as follows: 2 min at 95°C, continuing for 42 cycles (95°C for 30 sec, 30-40°C for 30 sec and 72°C for 1 min), and a final extension at 72°C for 5 min. RAPD bands were scored visually on the basis of 'presence (1)' or 'absence (0)' of bands of same molecular weight, respectively. Scores in respect of all primers were pooled for constructing a single data matrix. This data matrix was used to estimate polymorphic loci, overall gene frequencies, gene diversity (NEI 1973), genetic distance (NEI 1972) and constructing an Unweighted Pair GroupMethod with Arithmetic Mean (UPGMA)dendrogram using POPGENE.

Days to initiation of shooting and days to completion of shooting (average shooting time) were delayed by higher doses of gamma-ray irradiation. Delay in germination may be due to be inhibitory effects of gamma rays on cutting dormancy. The result shows that linear increasing of average days need for shoot initiation with increasing gamma-rays doses. Averages days need to shoot initiation of BN-3 and BN-4 cuttings irradiated at 0, 10, 20, 30, 40, 50, 60, 70, 80, 90 and 100 G*y* were 10, 13, 14, 14, 15, 15, 16, 16, 17, 18 and 18 days respectively. The linear decreasing number of the shoot initiation with increasing gamma-rays doses. Number of shoot initiation of BN-3 and BN-4 cuttings irradiated at 0,10, 20, 30, 40, 50, 60, 70, 80, 90 and 100 G*y* were 20, 20, 18, 15, 12, 10, 9, 10, 7, 5, 3 and 20, 20, 18, 16, 14, 11, 8, 8, 5, 3, 2, respectively.Survival rates of BN-3 and BN-4 cuttings irradiated at 10, 20, 30, 40, 50, 60 and 70 G*y* were 95%, 80%, 60%, 45%, 30%, 25%; 15%; 95%, 75%, 60%, 50%, 40%, 20% and 15%, respectively. BN-3 and BN-4 cuttings irradiated at 80 and above G*y* were not survived. Probit analysis indicated that LD_{50} dosages for BN-3 and BN-4 were 28.18 and 27.54 G*y*, respectively. The results however, reveal that BN-3 and BN-4 have a same tolerance to gamma irradiation.

Some mutants from BN-3 were selected on the basis of eye observation within treatment group and compared to the control. Mutants identified from the different treatment groups of 10 to 70 Gy showed significant difference in tiller height where highest tiller height were obtained from 70, 10, 50 Gy and lowest tiller height were observed in 20 and 40 Gy. Mutants of BN-3 from 20, 10, 30 and 40 Gy contained the highest proportion of leaf. The DM content was significantly higher ($p<0.01$) in 70,

20(5), 50 and 60 Gy group (13 & 91). Crude protein contents were significantly higher in 60, 30(1), 10(3) Gy. BN-4 mutants identified from the different treatment groups of 20-70 Gy showed significant differences in tiller height where highest tiller height were obtained from 10(10), 20(11). Mutants from 60(5), 50(2) and 40(17) Gy contained the highest proportion of leaf. The DM content was significantly higher ($p<0.01$) in 70, 50(2), 40, 30(10) & 10(17) Gy lines. Crude protein contents were significantly higher in 60, 30(1), & 10(3) Gy and lowest in 20(5), 20(7) & 40(2) Gy treatment lines.

The average GC content of ten primers was 60-70% and the band was obtained between 280bp-3000bp. All primers showed the private loci (PL) and produced total 18 PL. These primers detected 97 amplified loci of which, 74 were polymorphic and accounting 76.29% of the total loci. Average loci per locus were 7.4 per primer. Among the ten primers and twelve mutant's line of BN-3, the average observed number of alleles was 1.76±0.43 and effective number of alleles was 1.33±0.32. The overall average gene diversity and information index were 0.21±0.17 and 0.33±0.23, respectively. The primer OPA-09 and OPC-06 disclosed higher level of gene diversity (average 0.33 and 0.30) whereas gene diversity value determined by the primer OPA-01 was found to be lowers (average 0.12). The highest gene diversity was found between 70 Gy line rests of other treated lines including control whereas the lowest gene diversity value was found between control 1, 2, 10(3), 10(19), 20(5) and 20(7) Gy mutants line.



The dendrogram showed two main clusters (a and b); the first (a) include 70 Gy line and the second cluster (b) includes others eleven mutants line including control. The second cluster is divided in two sub clusters (b1 and b2). In one of them (b2) are grouped the three mutants line viz., 10(13), 50(2) and 60(14) Gy. The other sub-cluster (b2) contains other eight mutant's line. The 70(18), 60(14), 50(2), 10(13) and 40(2) were highly distant from the other mutants line and control. This study confirmed that there were some degree of morphological, nutritional and genetic variation in mutant's line of BN-3 and BN-4. Supporting RAPDs a marker used in BN-3 mutant lines from different gamma-ray irradiation, dendrogram showed distinct difference of mutant line of Gy-70(18), Gy-60(14), Gy-50(2), Gy-10(13) from other mutant lines. Based on single hill performance, plants which record significant difference with different variables will be studied in further generations to develop new Napier cultivars adaptable under climatic stress conditions.

A pilot project on anthrax control in selected areas of Sirajganj district in Bangladesh

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Executive summery

Anthrax is a zoonotic disease caused by spore forming *Bacillus anthracis*. Throughout the world, it causes illness in livestock, wildlife, and sometimes secondarily infects humans and causes a major public health threat. *B. anthracis* is a Gram-positive, capsulated, and spore forming bacterium. The spores are very robust and can survive in suitable soil for several decades. In the Kruger National Park (Africa) B. *anthracis* spores have been isolated from animal bones estimated to be about 200 years old. The ability of *B. anthracis* spores to survive outside the body is key for the ecology and evolution of this pathogen. The spores survive in soils rich in organic material and calcium and much better in alkaline soil with pH above 6.0 and a temperature of about 15°C. In humans, *B. anthracis* can penetrate into the organism through micro-abrasions or cuts (developing a coetaneous form), via inhalation of the spores (pulmonary form), and through the consumption of infected meat (intestinal form). Anthrax was reported in Bangladesh from 1980 to 1984 affecting both cattle and man, but it reemerged in 2009-2010 with wider involvement. The animal anthrax, locally known as 'Torka', is believed to have been enzootic in Bangladesh for a long time, and historically human outbreaks were always preceded by animal outbreaks. The Government of Bangladesh declared alert due to a sudden explosive outbreak of anthrax in 2010 that hit 12 districts and affected 607 people. The outbreak was investigated and thought to have been caused by the slaughter of infected cattle and selling or eating contaminated meat. The outbreak was most prevalent in the districts of Pabna, Sirajganj, Rajshahi, Kushtia and Tangail, which have greater cattle populations. Health and livestock officials in Bangladesh have expressed great concern over a fresh outbreak of human anthrax prevailed in up to June 2016, mostly affecting Ullapara, Shahzadpur and Kamarkhand upazilas of Sirajganj (125 cases) and Pabna (32 cases). Additionally, districts of Bogra, Meherpur and Tangail had cases of anthrax.
The objective of this study was conduct surveillance and epidemiological studies to determine present status of anthrax, risk factors for the spread and the disease persistence. The study was conducted in two villages (Alokdiar and Potajia) of Shahjadpur upazilla under Sirajgonj district. Baseline survey was performed with pre-tested questionnaire. Awareness on anthrax recognition, prevention and control among the farmers was done during vaccination. Required anthrax spore vaccine was collected directly from vaccine production center, LRI, Mohakhali. The vaccination campaign and awareness development activities were done by the local vaccinators and scientists of BLRI. This study was run to achieve immunity in the available flock through phased vaccination of cattle population against anthrax in the selected areas of the country. Two villages from Shahjadpur upazilla were selected; one village (Alokdia) was treated as treatment village and other village (Potajia) was treated as control village. The strategy involved using a phased vaccination strategy and sero-surveillance which was applied for intensive vaccination of whole flock of the treatment village. The cattle of control village were not getting any vaccine or intervention except epidemiological observation. About 80% anthrax outbreak in animal was found in low land area. Anthrax outbreak was not observed in the treatment village (Alokdiar) in which the animals were vaccinated. 70% farmers were not aware on anthrax that's why they slaughtered diseased animal. Dead animals were not disposed properly. Meat samples of cattle were collected from Anthrax outbreak areas. Molecular detection of Anthrax was done by conventional PCR system.

Sero-surveillance and Clinical Investigation of PPR Outbreak in Different areas of Bangladesh

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Executive summary

Small ruminant (sheep and goat) production can be a very important source of quality protein supplied through meat and milk. In 2010, Bangladesh produced 214,000 tons of sheep and goat meat and is among the top ten[1] goat producing countries of the world (Ranked 8th). Majority of the small ruminants in the country belongs to landless, marginalized peasant farmers. Therefore, improvement in the productivity of small ruminants will directly benefit the poorest part of the society, through poverty alleviation, employment generation and improvement in nutrition. Peste des Petits Ruminants (PPR) is an important OIE listed transboundary animal disease (TAD) of small ruminants with devastating socio-economic impacts due to heavy production losses resulting from very high mortality (up to 100%) and high morbidity (10-100%). PPR is frequently confused with other diseases that present fever and grossly similar clinical signs, especially pneumonic pasteurellosis or contagious caprine pleuropneumonia (CCPP), Diarrhoea, coccidiosis or gastro-intestinal helminth infestations and Pneumonia pasteurellosis. PPR is a disease that can be eradicated, because vaccinated animals usually acquire lifelong immunity post vaccination. Immunity is also acquired when infected animals recover from challenge by natural infection. With the following aim to convey the objectives are to conduct sero-surveillance and outbreak investigation to determine present status of PPR in different 6 (six) areas of Bangladesh. To undertake clinical outbreak-monitoring activities to determine the level of morbidity and mortality rate. To enhance the knowledge of small ruminant farmers, public and private technical personnel on PPR recognition, prevention and control through awareness campaigns. Serum samples were conducted by cELISA for immunological response and clinical investigation of PPR virus detected by RT-PCR technique. For sero-positive of PPR antibodies of 573 serum samples were collected at different 6 areas of Bangladesh such as CDIL 66.67% (4 out of 6), Bogra 85% (17 out of 20), Sirajganj 87.04% (47out of 54), Mymensingh 55.32% (52 out of 94), Meherpur 70.77% (46 out of 65), Chuadanga 64.70% (22 out of 34), Potuakhali 22.83% (42 out of 184) and Dhaka 29.31% (34 out of 116). The clinical outbreak of PPR, the total 124 samples was collected as above locations of the country and highest case fatality (morbidity) was recorded at Meherpur district (69.23%) in the Table 1. The average morbidity rate and mortality rate was 74% and 24%, respectively in the Figure 1.

Table 1 Outbreak investigation of PPR Virus using RT-PCR tools

Location	No. of Sample	Type of Sample	Rate of		Result of RT-PCR	
			Morbidity%	Mortality%	% of Positive	% of Negative
CDIL	5	Nasal Swab	50	6.67	20% (1)	80% (4)
Bogra	6	Nasal Swab	40	12	50% (3)	50% (30)
Sirajganj	8	Nasal Swab	35.18	3.70	25% (2)	75% (6)
Mymensingh	6	Nasal swab & Faecal sample	15.96	1.06	66.67% 4)	33.34% (2)
Meherpur	80	Nasal swab	69.23	13.07	93.75% (75)	6.25% (5)
Chuadanga	19	Nasal swab	47.05	7.65	78.95% (15)	21.05% (4)

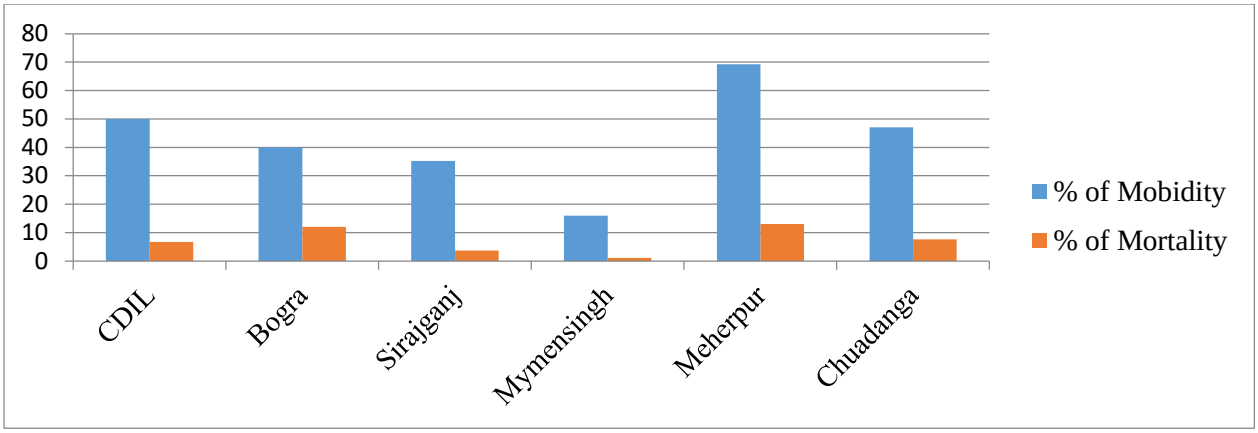

Figure 1 The percentage of morbidity and mortality rate of PPR Outbreak.

New entry of goats in the household or village is most important risk factor for PPR virus circulation which was found in several outbreaks in the non-vaccinated and surrounding villages. Also Purchase of new goats, vaccination during outbreak of PPR Distribution of goats by NGO was one of the risk factor for PPR circulation. Finally it may be concluded that this study showed varying antibody levels in the affected areas reflecting the infection and vaccination profiles of herds. There was serological evidence of sero conversion to the vaccine and sero prevalence to the circulating PPR Virus suggesting the level of vaccine coverage which is enough to achieve herd immunity and to develop effective control strategies for PPR in large area of the country.

Study of livestock manure management and clean air production

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Executive summary

Bangladesh is a country of 374.99 million livestock producing 155.8 million ton manure every year could be a great resource for national economy through it's scientific management. At present, through the conventional management of farmers, this valuable wealth is not utilizing by its full potential and pollutes environment by emitting greenhouse gases like methane, nitrous oxide and carbon-di-oxide. Anaerobic digestion of livestock manure is getting popular day by day as a promising source of renewable energy and substitution of burning fossil fuel. The final product of anaerobic digestion is biogas and digestate of which biogas can be utilized for cooking, electrifying and vehicle fuel, where as digestate could be returned in agricultural field as recycled nutrient or organic fertilizer. This digestate is a high moisture containing (≥ 90%) semisolid biomass named as bio-slurry. The amount of annual produced manure of Bangladesh is capable of establishing minimum 3 million domestic biogas plant from where every year 18 million tons of dry bio-slurry could be produced which is equivalent to 0.57 M tons of urea, 0.61 M tons of TSP, 0.12M tons of MOP and 0.33 M tons of gypsum and can save 643 million ($) annual fertilizer cost. But currently due to the lack of appropriate slurry handling technology every year about 51% of total produced bio-slurry of Bangladesh becomes completely wasted, polluting environment and creates social hazards. Development of a cost effective and safe value addition technique of bio-slurry may harvest a most profit earning value added product of livestock manure. This technique may essentially contribute to crop production as our soil quality is getting deteriorated due to the gradual declining of it's organic components. In the context of this situation a research was conducted to developa safe, cost-effective and environment friendly bio-slurry based organic fertilizer production technique in the previous financial year. Considering the nutritional value and heavy metal content of bio-slurry based organic fertilizer a further research was conducted in the current financial year to determine it's impact on crop production at both on-station and on-farm condition. This work was jointly done with Soil Science Division of Bangladesh Rice Research Institute (BRRI), Joydebpur, Gazipur. Total 15 plots of (4m*5m) of BRRI research field was taken to accomplish the on-station trial. Total 5 treatments (T_1=NPKSZn, T_2=0.5 ton org. fer.+NPKSZn, T_3=1.0 ton org. fer.+NPKSZn, T_4=2 ton org. fer. with Integrated Plant Nutrient System(IPNS) chemical fertilizer and T_5= Control) were applied with three replications of each. In case of on-farm trial total 1 acre land of 3 different farmers of Pakundia, Kishorgonj district were cultivated separately and total 3 treatments (T1=0.5 t/ha org.fert.+NPKSZn, T2=2 t/ha org.fert.+IPNS and T3= Farmers practice) were applied there. The selected crop for cultivation was rice in case of both on-station and on-farm condition. Yield of grain and straw, physical characteristics of rice plant at harvesting stage (Tiller no., panicle no., panicle height and 1000 grain weight) was considered parameter for recording. Total nutrient uptaken by plant was also calculated by total yield with the nutrient content of straw and grain. Cost-benefit was calculated

Table 1 Effect of yield productivity and nutrient uptake under organic and inorganic fertilization

Treatments	Grain yield (t/ha)	Straw yield (t/ha)	Nutrient uptake (kg /ha)			Tiller no.	Panicle no.	Panicle height (cm)	1000 Grain Weight (gm)
			N	P	K				
Control	2.9^{c}	3.7^{b}	65^{b}	20^{b}	32^{b}	208	178	22.1	17.98
NPKSZn	3.9^{b}	4.9^{ab}	112^{a}	29^{a}	60^{ab}	251	234	23.1	18.66
0.5 ton org. fer.+NPKSZn	4.4^{a}	5.4^{a}	116^{a}	30^{a}	62^{ab}	341	328	25.4	18.89
1.0 ton org. fer.+NPKSZn	4.2^{ab}	5.7^{a}	121^{a}	32^{a}	76^{a}	297	276	26.0	18.08
2 ton org. fer. with IPNS	4.6^{a}	6.2^{a}	124^{a}	34^{a}	81^{a}	396	378	28.0	18.93
$LSD_{0.05}$	0.14	0.40	4.5	2.78	9.26	-	-	-	-
CV (%)	4.53	9.58	5.13	11.28	18.25	-	-	-	-

comparing the treated group and farmers' common practice for cultivating rice. Cost of labour, fertilizer, seedlings and total yield gained was considered to calculate the cost and benefit.Table1 shows on-station trail findings and data reveals that 2 ton organic fertilizer with IPNS basis chemical fertilizer (T_4) yielded highest (p-value) grain (4.62 ton/ha), straw (6.20 ton/ha), tiller no (396), panicleno (378), panicle height (28cm),and 1000 grain weight(18.93 gm) than 100% chemical fertilizer (3.38 ton/ha grain, 4.94 ton/ha straw, 251 tiller, 234 panicle, 23 cm panicle height and 18 gm 1000 grainweight).The rate of nutrient (N, P and K) uptake was also higher in the same application and the respective value was 124 kg N, 34kg P and 81 kg K per hectare of land. No significant difference ($P>0.05$) was observed in grain (4.4 and 4.2 t/ha) and straw (5.4 and 5.7 t/ha) yield and nutrient uptake rate (116 and 121 kg, 30 and 32 kg and 62 and 76 kg/ha N, P, K respectively) in application of 100% chemical fertilizer with 0.5ton and 1 ton organic fertilizer. The application of 2 ton bio-slurry based organic fertilizer with chemical fertilizer on IPNS basis increased($P<0.05$) grain and straw yield 15.2 and 21% respectively than 100% chemical fertilizer yield and reduced 30% chemical fertilizer utilization cost of total required fertilizer for rice cultivation. Similar trend of yield was found in farmer's field trial and results on yield, nutrient uptake and harvesting characteristics are shown in table-2.Data shows that maximum grain and straw yield was obtained from application of 2 ton bio-slurry based organic fertilizer with chemical fertilizer on IPNS system and it was significantly higher ($P<0.05$) than traditional farmer's rice cultivation practice. The value of grain and straw yield, tiller no, panicle no, panicle height and 1000 grain weight was 4.8 ton/ha, 5.8 ton/ha, 417, 396, 28cm and 19 gm respectively. The rate of nutrient uptake by plant was also highest ($P<0.05$) in the applied treatment (T_2) than the usual fertilizer application pattern followed by farmers (T_3). Highest ($P<0.05$) amount of nutrient was up taken(126kg N, 35 kg P and 76 kg K/ha) byplants from the field treated with 2 ton organic fertilizer and IPNS basis chemical fertilizer. The respective value of the same parameter of field treated with farmer's common fertilizer application dose was significantly ($P<0.05$) lowered (104 kg N, 27 kg P and 45 kg K/ha) than other two treatments. No significant difference ($P>0.05$) was observed in T_1 and T_2 in terms of yield, harvesting criteria and nutrient uptake rate.Application of 2 ton organic fertilizer combined with chemical fertilizer at farmer's field increased grain and straw yield 15 and 17% respectively and reduced 27% chemical fertilizer cost of total required fertilizer.

Table 2 Effect of yield productivity and nutrient uptake under organic and inorganic fertilization at Pakundia, Kishorgonj

Treatments	Grain yield (t/ha)	Straw yield (t/ha)	Nutrient uptake (kg /ha)			Tiller no.	Panicle no.	Panicle height (cm)	1000 Grain Weight (gm)
			N	P	K				
Farmers' Practise	4.06^{b}	4.73^{b}	104^{b}	27^{b}	45^{b}	381	360	26	18
0.5 ton org.fer.+NPKSZn	4.61^{a}	5.34^{a}	116^{ab}	31^{ab}	64^{a}	398	378	27	19
2 ton org. fer. with IPNS	4.8 ^{a}	5.8^{a}	126^{a}	35^{a}	76^{a}	417	396	28	19
$LSD_{0.05}$	0.05	0.11	3.57	1.40	3.34	-	-	-	-
CV (%)	1.37	2.64	3.80	5.50	6.65	-	-	-	-

It may be concluded that bio-slurry is a potential resource for producing a high quality organic fertilizer through which farmer can harness the compensation of feed cost and earn more money. This management system may conserve our natural resource (soil) healthy, make livestock farming much more sustainable and keep climate clean. Development of packaging and marketing system of this valuable organic fertilizer is of utmost importance now to ensure the improved livestock manure management system and give them provision to contribute national economy strongly.

Biomass yield, morphological characteristics, nutritional evaluation and production cost of different cultivars of Jumbo and Maize as fodder

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Executive summary

Ranking of fodder crops based on their production efficiency of fodder biomass and animals, the reduction efficiency of enteric CH_4 emission in the rumen and benefit to cost efficiency are important to select a fodder crop for on farm cultivation. Recently in Bangladesh, different seed marketing agencies have been importing different fodder seeds particularly of Shorghum (Jumbo) or Maize of exotic origins and marketing them locally taking the certification of the Seed Certification Agency (SCA) of the country. The absence of validation test of production and productivity of fodder crops and its responses to animal or benefit and cost ratio, or even the efficiency of enteric methane emission in the rumen has been creating problems for farmers and extension workers to select suitable fodder and subsequently farmers are economically exploited. In this connection, the production potential, feeding impact and biometrical ranking of various fodder crop/roughage such as Maize, varieties of Napier, Jumbo cultivars such as Sugar graze Jumbo, Australian sweet Jumbo, Jumbo green, UMS of Rice straw (Boro and Aman), Plicatulum, Andropogan, Para, German and Moringa plant fodder has been done and a Maize index (M_i) has been developed through a series of feeding trial during 2014-2016. In continuation of research works, Jumbo-Gold, Jumbo-Plus and Jumbo-Super, three new fodder crops certified by the Seed Certification Agency (SCA) are introduced newly by different marketing agencies. They are required to be ranked accordingly. Thus, the present research work was undertaken with the objectives to investigate and compare the biomass yield efficiency, morphological characteristics, nutritional quality and production cost of different Jumbo cultivars where maize fodder was considered as control. An agronomic trial was conducted with three Jumbo cultivars (*Sorghum bicolor*) keeping Maize (*Zea* mays) as control at the red soil Madhupur tract of Savar. The seeds of Maize (Hybrid, BARI), Jumbo-Gold, Jumbo-Super and Jumbo-Plus were procured from the authorized dealer in local market and they were cultivated in the fodder field of the BLRI under identical condition. The biomass produced was harvested at recommended maturity and ensiled for feeding to animals. Maize was harvested with cobs at their dough stage and ensiled. Data on agronomical practices, biomass production, botanical fractions, production cost, harvest losses etc. were recorded for determining the harvest index and Maize index (M_i) of different fodders. The chemical composition of different fodder biomass was determined according to AOAC (2004) and NDF & ADF was determined according to Georing and Van Soest (1970). Data were compared statistically in an ANOVA of a Completely Randomized Design (CRD) using SPSS, 17 computer software packages.

Table 1 Biomass yield, harvest loss and production cost of different fodders

Parameters	Fodder				SED	Sig.
	Maize	Jumbo-Gold	Jumbo-Super	Jumbo-Plus		
Biomass yield (t/h/cut)	46.9^{a}	30.3^{bc}	34.1^{ac}	25.3^{bc}	3.02	*
DM yield (t/h/cut)	9.82^{a}	5.76^{bc}	7.21^{ac}	5.75^{bc}	0.63	*
CP yield (t/h/cut)	0.89^{a}	0.51^{bc}	0.68^{ac}	0.49^{bc}	0.06	*
Harvest loss (t/h/cut)	0.72	1.08	1.11	1.03	-	-
Prod. cost (Tk./kg fresh)	1.23	1.60	1.48	1.91	-	-
Prod. cost (Tk./kg silage)	1.29	1.68	1.55	2.00	-	-
Prod. cost (Tk./kg DM silage)	6.14	8.84	7.31	8.83	-	-

The biomass yield, harvest loss and production cost per hectare land/cutting of different fodder crops are presented in Table 1. It shows that, Maize had a significantly ($p<0.05$) higher biomass yield compared to that of Jumbo cultivars. However, a single cultivation of different cultivars of Jumbo was harvested 3 times in a year. On the other hand, maize was cultivated separately 3 times in a year. The differences of biomass yields however, did not vary significantly ($p>0.05$) among the different

cultivars of Jumbo. Table 1 also shows that, Maize had significantly ($p<0.05$) higher DM yield and CP yield followed by the DM and CP yield of Jumbo-Super, Jumbo-Gold and Jumbo-Plus. The biomass yield, DM yield and CP yield per cutting of Maize, Jumbo-Gold, Jumbo- Super and Jumbo-Plus were 46.9,9.82, 0.89; 30.3, 5.76, 0.51; 34.1, 7.21, 0.68 and 25.3,5.75, 0.49 metric tons/ha, respectively. The harvest lost (HL) of the respective fodders (fresh basis) per hectare land during mowing, transportation and ensiling process were 0.72, 1.08, 1.11 and 1.03 metric tons/cutting. The cost included both variable and fixed for Kg fresh biomass of Maize, Jumbo-Gold, Jumbo-Super and Jumbo-Plus were Tk, 1.23, 1.60, 1.48 and 1.91, respectively and the cost for Kg silages of the respective fodder crops were Tk. 1.29, 1.68, 1.55 and Tk. 2.00, respectively. Similarly, the cost involvements for kg DM yield of Maize, Jumbo-Gold, Jumbo-Super and Jumbo-Plus were Tk. 6.14, 8.84, 7.31 and Tk. 8.83, respectively (Table 1).

Table 2 Chemical composition of different fodders

Fodder	DM, % of fresh biomass	Chemical composition (%DM)				
		OM	CP	ADF	NDF	Ash
Maize	20.88^{b}	93.21^{a}	9.12^{b}	56.54^{c}	70.33^{d}	6.79^{c}
Jumbo Gold	19.13^{c}	89.65^{b}	8.83^{b}	67.18^{a}	77.44^{b}	10.35^{b}
Jumbo Super	21.20^{b}	87.39^{c}	9.49^{a}	60.43^{b}	74.07^{c}	12.61^{a}
Jumbo Plus	22.75^{a}	94.33^{a}	8.47^{c}	62.14^{b}	80.67^{a}	5.67^{c}
SED	0.23	0.40	0.06	0.50	0.61	0.40
Sig. level	***	***	***	***	***	***

Table 2 shows that, the DM and OM content was significantly ($p<0.001$) higher in Jumbo-Plus (22.75% & 94.33%, respectively) than that of other fodder crops. The CP content was significantly ($p<0.01$) higher in Jumbo-Super fodder (9.49%) than other three (Maize, Jumbo-Gold & Jumbo-Plus: 9.12%, 8.83% & 8.47%, respectively). Similarly, the highest ($p<0.001$) ADF and NDF content were found in Jumbo-Gold (67.18%) and Jumbo-Plus (80.67%), respectively and the lowest was in Maize (56.54% and 70.33%, respectively). The Maize contained significantly ($p<0.05$) higher proportion of leaf (33.62%) and flower (13.67%) but lowest ($p<0.05$) proportion of stem (52.71) than the three other cultivars of Jumbo. However, the leaf and stem ratios did not vary significantly ($p>0.05$) among the Jumbo cultivars (Table 3). The biometrical ranking of the new fodder crops requires data of animal production and enteric rumen methane emission reduction efficiency, which are yet to be completed.

Table 3 Proportion of botanical fractions (% fresh BM) of different fodders

Fodder	Botanical fractions (%)				
	Leaf	Stem	Flower	L:S:F	Plant height (cm)
Maize	33.62^{a}	52.71^{b}	13.67^{a}	33:53:14	149.7^{c}
Jumbo-Gold	26.97^{b}	70.51^{a}	2.53^{c}	27:70:3	182.1^{bd}
Jumbo-Super	27.62^{b}	69.11^{a}	3.27^{cb}	28:69:3	239.7^{a}
Jumbo-Plus	26.08^{b}	69.48^{a}	4.44^{b}	26:70:4	167.4^{cd}
SED	1.06	0.73	0.41	-	4.71
Sig. level	*	***	***	-	***

Based on the biomass production, DM, CP yield and cost of production, it may be concluded that Maize is better than other three cultivars of Jumbo. Among the Jumbo cultivars, Jumbo-Super is better than Jumbo-Gold and Jumbo-Plus.

Evaluation of performances of Boer and Jamunapari goat at BLRI

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Executive summary

The indigenous goats available in Bangladesh are not able to meet up our huge demand of meat due to their smaller body size and lower growth. Boer Goat (*Capra hircus*) is considered to be one of the most desirable goat breed for meat production. They are higher growth rate, drought resistance, tolerance to tannins, can digest fiber efficiently and adaptation to various ambient temperatures. Another type goat in our country named Jamunapari or Jamnapari goat and called Indian crossbred and their crosses are available throughout the country. Small ruminants in our country exhibit variable performances. Considering the increased demand of meat, milk and skin, goat development program in the country, Bangladesh Livestock Research Institute has under taken this project with the objectives of evaluation of the productive and reproductive performances of Boer and Jamunapari goat and to evaluate the adaptability of Boer goat at hot and humid climatic conditions. Initially, ten (10) does and two (2) buck of Boer goats were collected from Bengal Livestock and Fodder, a sister concern of Bengal Meat. Similar number of Jamunapari cross bred 'does' and bucks were also reared at Goat Research Farm, BLRI. Within breed pure breeding program was followed at Goat Research Station of Bangladesh Livestock Research Institute, Savar, Dhaka, in such a way, which maintained as minimum inbreeding level as possible. Green grass was supplied *adlib* basis and concentrate (17% CP, 11MJ ME/kg DM) was offered twice daily (morning and evening) at the rate of 300g per head per day. Subsequently, data on phenotypic measurement, productive and reproductive performances was recorded and analyzed by SPSS 17.0 Statistical computer programme.

Table 1 Productive and reproductive performances of Boer and Jamunapari goat

Parameter	Boer Goat (Mean±SE)	Jamunapari Goat (Mean±SE)	Level of Significance
Birth weight (kg)	3.36^{a} ±0.07 (105)	1.73^{b}±0.08 (35)	***
Growth rate (kg/d) (up to 120 days)	0.156^{a}±0.02 (10)	0.064^{b}±0.01 (9)	***
Weaning weight (kg)	13.78^{a}±1.31 (13)	9.59^{b}±0.49 (33)	***
Weaning age (days)	95.00^{a}±2.09 (13)	124.33^{b}±2.31 (33)	***
Age at sexual maturity (days)	285.00^{a}±20.05 (5)	396.43^{b}±35.08 (7)	*
Weight at sexual maturity (kg)	24.42^{a}±1.22 (5)	18.52^{b}±0.99 (7)	**
Litter size (no)	1.55^{b}±0.07 (65)	1.93^{a}±0.12 (30)	**
Post kidding body wt. (kg)	46.02^{a}±1.97 (10)	31.61^{b}±1.08 (28)	***
Placenta wt.(kg)	0.61^{b}±0.09 (7)	0.36^{a}±0.02 (29)	***
Post Partum Heat Period (days)	145.33^{b}±43.88 (3)	72.06^{a}±5.94 (15)	**
Kidding interval (days)	278.13±12.77 (16)	251.73±14.32 (11)	NS
Gestation length (days)	149.00±1.90 (6)	147.29±1.05 (27)	NS

Means with uncommon superscripts differ within the same rows significantly. Figures in the parenthesis indicate the number of observation.= Significant at 5% level of probability (p<0.05), **= Significant at 1% level of probability (p<0.01),**= Significant at 0.1% level of probability (p<0.001), NS= Not significant (p>0.05).*

Table1 shows the productive and reproductive performances of Boer and Jamunapari goat. The birth weight, growth rate, weaning weight and post kidding weight of does in Boer goat were significantly (p<0.001) higher while weaning age (p<0.001) and age at sexual maturity (p<0.05) were significantly lower than Jamunapari goat. Weight at sexual maturity of Boer goat (24.42±1.22) were significantly (p<0.01) higher than Jamunapari goat (18.52±0.99). The litter size of Jamunapari goat (1.93±0.12) was significantly (p<0.01) higher than Boer goat (1.55±0.07). The Post Partum Heat Period of Jamunapari goat (72.06±5.94 days) was significantly (p<0.01) lower than Boer goat (145.33±43.88 days). The kidding interval of Boer goat (278.13±12.77 days) and Jamunapari goat (226.50±13.24 days) Gestation length of Boer goat and Jamunapari goat were 147.33±3.84 days and 145.33±1.58

days, respectively. Phenotype wise Boer goats have distinct meat characteristics and have higher birth weight, growth rate, weaning weight. However, litter size and kidding interval were significantly lower in Boer goat than the Jamunapari goat. The present study suggested that this goat breed will be promising breed for Bangladesh but more data with longer period of research will need for significant results. Benefit Cost ratio (BCR) will be needed to study by comparing with native breeds before suggesting the suitable breed for goat farming in Bangladesh.

Improvement of Black Bengal Goat through community breeding

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Executive summary

Bangladesh has only one goat breed of its own, popularly known as the Black Bengal (BB) goat. There are wide variations in coat color, body size and weight of BB goats (Husain, 1993). The BB is a dwarf breed and is famous for its high adaptability, fertility, prolificacy, delicious meat and superior skin (Devendra *et al.,* 1983, Devendra, 1985, Saadullah, 1991 and Husain *et al,* 1996). Selection is one of the vital tools for improving the native genetic resources. Since 1988, the Bangladesh Livestock Research Institute has been attempted to improve Black Bengal goat through selective breeding. In this situation, "Co-operative Village Breeding Program" may play a vital role in the improvement of indigenous goat. Such type of breeding program was tested in Africa as "Community Breeding Program" and found to be very successful (Husain, 2004).The primary objectives of community breeding program is to improve indigenous goat and provide smallholder goat farmers with improved breeding animals particularly males. The objectives of this study were to evaluate the productive and reproductive performances of BB goat at farmer level, to improve the BB goat at farmer level and to improve livelihood of community farmer through rearing BB goat. The research was conducted at three villages namely Pachpai, Borochala and Gangatia under Bhaluka Upazilla of Mymensingh district. A well organized questionnaire was developed for baseline survey through Participatory Rural Appraisal (PRA) which was helped to know population number of BB goat, local management, feeding and breeding system of BB goat, available local breed of goat and social status of farmers among others. Fifty (50) farmers were selected randomly in the project area to conduct baseline survey. Fourteen (14) farmers were selected randomly on the basis of elaborate questionnaire who had at least 4-5 years Black Bengal goats rearing experiences to form goat rearing community in the project area. Twenty (20) maiden BB does from BLRI Goat Research farm were given to 10 selected farmers and 6 superior bucks were also given to the 4 buck rearing farmers. Goats of each farmer in the community were identified through the giving identification number. A well-organized recording card was used for recording different traits at farmer's house in the goat rearing community. Routine vaccination and de-worming were practiced. Obtained information was putted and stored on to the Excel spread sheet. Then data were analyzed using Statistical Package for the Social Sciences (SPSS) version 17.0.

Table1 1 Performances of BLRI improved Black Bengal goat at farmer's level

Parameters	Progeny of BLRI doe	Progeny of BLRI buck	Sig
	Mean±SE	Mean±SE	
Birth weight (kg)	1.10 ± 0.04^{b} (23)	1.27 ± 0.04^{a} (27)	*
Weaning weight (kg)	6.10 ± 0.40^{b} (13)	7.59 ± 0.28^{a} (23)	*
Weaning Age (days)	97.45 ± 1.17^{a} (13)	101.36 ± 2.05^{b} (11)	*
Six month weight (kg)	9.31 ± 0.51^{b} (8)	10.97 ± 0.43^{a}(7)	*
Litter size (no)	1.53 ± 0.12^{b} (17)	2.33 ± 0.14^{a} (12)	***
Gestation length (days)	145.82 ± 0.77^{a}(11)	146.36 ± 1.14^{b}(11)	NS
Kidding interval (days)	257.25±37.32 (4)	-	-

Means with uncommon superscripts differ significantly. Figures in the parenthesis indicate the number of observation.=Significant at 5% level of probability (p<0.05). ***= Significant at 0.1% level of probability (p<0.001). NS= Not significant (p>0.05).*

Table 1 shows the progeny performances of BLRI improved BB goat at farmer's level. Birth weight, weaning weight and six month weight were significantly ($p<0.05$) higher in progeny of BLRI buck than progeny of BLRI doe. Weaning age and gestation length were significantly ($p<0.05$) higher in progeny of BLRI doe than progeny of BLRI buck. Litter size progeny of BLRI buck (2.33±0.14) was highly significant ($p<0.001$) than progeny of BLRI doe (1.53±0.12).

Table 2 Effect of sex, parity and litter size on performances of BLRI improved BB goat at farmer's level

Factors	Traits (Mean±SE; kg)			
	BW	WW	6M	GL
Sex				
Male	1.14±0.07 (12)	6.69±0.90 (7)	9.78±0.34 (5)	147.00±1.02 (8)
Female	1.01±0.11(4)	5.99±1.40 (3)	9.58±0.45 (2)	145.13±1.72 (3)
LS (F- value)	NS	NS	NS	NS
Parity				
First	1.15±0.07 (6)	6.43±1.01 (5)	9.65±0.31 (5)	145.94±1.25 (5)
Second	1.31±0.08 (9)	6.13±0.85 (4)	9.65±0.59 (2)	144.73±1.25 (5)
Third	0.94±0.18 (2)	6.48±1.83 (2)	9.75±0.59 (2)	147.53±2.58 (2)
LS (F- value)	NS (	NS	* (25.0)	NS
Litter size				
Single	1.18±0.09 (8)	6.62±1.2 (5)	10.93±0.39 (3)	146.59±1.52 (4)
Twin	0.99±0.08 (8)	6.07±1.03 (5)	8.43±0.33 (4)	145.54±1.31 (7)
LS (F- value)	NS	NS	NS	NS

BW= Birth weight, WW= Weaning weight, 6M=6 month weight, GL= Gestation length, LS= Level significant. Figures in the parenthesis indicate the number of observation.*= Significant at 5% level of probability ($p<0.05$). NS= Not significant ($p>0.05$).

Tablet 2 shows effect of sex, parity and litter size on performances of BLRI improved BB goat at farmer's level. There was no significant effect of sex, parity and litter size on birth weight, weaning weight, 6 month weight and gestation length expect parity on 6 month weight. The 6 month body weights of Black Bengal goat differed with parity ($p<0.05$) at farmer's level. This study need to be continued for developing a model community based goat production system.

Development of blended yarns and fabrics from Jute, Cotton and Native Sheep wool

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Executive summary

Native sheep are considered as an important and promising genetic resource in Bangladesh. It is important for socio-economic development in Bangladesh, especially for poverty alleviation, employment generation, improving nutrition. A large number of farmers are rearing sheep all over the country. Enormous quantity of local sheep wool is wasted due to lack of processing. Currently, the contribution of sheep in Bangladesh can be summarized as a source of meat and wool. Bangladesh possesses about 3.40 million sheep. Average 800 to 900gms of wool is collected from each sheep per year. About 3.06 thousand metric tons of raw wool can be collected from local sheep. Wool is a potential by product of sheep which is being used throughout the world for producing yarn and fabrics. It has huge potentiality for ending fibers of textile use. With the conciseness is growing for the use of natural fiber products. This fiber can play a significant role if proper processing technology and products of today's necessity can be developed out of this fiber. A research has been taken for commercial use of wool in Bangladesh through yarn and fabrics production with the joint collaboration of Bangladesh Livestock Research Institute and Bangladesh Jute Research Institute. The aims of the research work are to produce blended yarn and fabrics; to determine the physical properties of blended yarns and fabrics; to compare the blended properties with respective 100% cotton, jute and woolen properties and to increase the diversified use of wool and cotton blended products with small entrepreneur**.** This experiment was conducted during 2016-17 at BLRI and BJRI. Sheep wool was collected from sheep research farm of BLRI and also from different sub-station of sheep project and sent to BJRI. Jute was collected from local market. Cotton was collected from cotton board. Fresh wool was obtained by chemically washed and carbonized of collected wool. Finally it was blended with jute and cotton in cotton spinning system with some adjustment.

Table 1 Physical properties of sheep wool, jute and cotton fiber

Property	Jute fiber	Cotton fiber	Sheep wool
Fiber fineness	5.05µg /inch	3.35µg /inch	8.03µg /inch
Moisture	13-14%	7-8%	9-10%
Tenacity g/tex	35	25	32

In the present study, it was observed that 30% wool, 30% jute and 40% cotton fiber blended 12s count yarn has been successfully developed. After operating, there were observed some limitation in spinning section. Wool dropping was more than jute and cotton fiber. But count strength product (CSP) was nearer to wool blended yarn with jute cotton blended yarn. Yarns were produced at different proportion. Jute and wool was available in the locality. Cotton fiber was costly. For these reason the cost of blended yarn was less than 100% cotton yarn. Shawl was produced with the production cost of Tk. 244 (7ft×3ft) and suiting fabrics (pant piece, blazer piece etc.) with the production cost of Tk. 588 (per 1 meter). Comfortable blanket was produced from 50:50 ratio of wool-jute yarn with the production cost of Tk. 495 (6ft×8ft). Dining mate and floor mate were produced with the combination of wool and jute in the ratio of 40:60 and the production cost of Tk. 280 and Tk. 140.

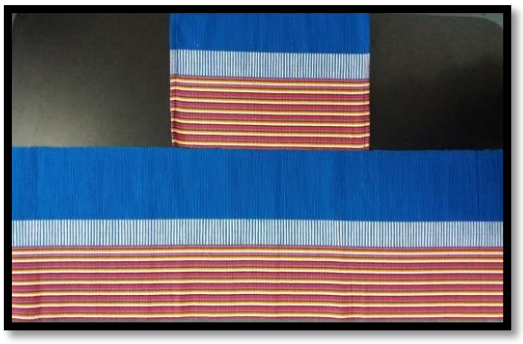
Wool made products can play an important role for the dissemination of native products in Bangladesh. For the development of blended yarns and fabrics from jute, cotton and native sheep wool research will be continued for the production of various essentials native products at cheap cost. These findings are useful for all stakeholder and policy maker for the development of wool based industry in Bangladesh.


Blended yarns

Shawls

Suiting fabrics

Blanket



Dining mate

Floor mate

Validation of BLRI improved sheep at community level in selected areas of Bangladesh

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Executive summary

Among livestock species, sheep is an important and promising animal genetic resource contributing national meat production in Bangladesh. Sheep are extremely resistant to various infectious diseases. Sheep possesses important economic characteristics, which are also reflected in socio-economic aspects relating to asset reserves, provision of cash for unanticipated occasions. Bangladesh possesses 3.34 million sheep (Bangladesh Economic Review 2016) which secured its 3rd position in number among the ruminant species of Bangladesh. Nojoro (2001) reported that the farmers are not quite focused on what end product they require. Technical guidance could be a clear breeding policy to guide them on the way forward in their breeding program. In this situation, "Co-operative Village Breeding Program" may play a vital role in the improvement of indigenous sheep. The primary objectives of community breeding program is to improve indigenous sheep and provide smallholder sheep farmers with improved breeding animals particularly males. Although, the primary goal would be the improvement of performance, the focus of all activities could be directed at utilization and conservation concomitant improvement of the indigenous sheep. Considering the above facts and circumstances, the study was undertaken to evaluate the productive and reproductive performances of native sheep at farm and farmers' level, as to improve their genetic potentiality by maintaining a sheep flock at BLRI and to improve livelihood of community farmer through rearing sheep. The study was conducted at Bhuapur upazila in Tangail district. Six unions namely; Gabsara, Aloa, Gobindeshi, Arjuna, Falda, Nikrail and one pourasova in Bhuapur were randomly selected as the locale of the study area. A number of **1**00 sheep farmers from the selected areas were chosen randomly for taking interview with the help of Livestock Service (DLS). Twenty (20%) percent of the population were randomly selected as the sample of the study. A well structured interview schedule was developed based on objectives of the study for collecting information. The interview schedule was constructed containing direct and sample questions both in open form and close form keeping view the dependent and independent variables. Appropriate scales were developed to measure both independent and dependent variables. The questionnaire was pre-tested with ten sheep farmers prior to going for final data collectionconducted from March, 2017 to April, 2017. The independent variables were: age, education, family size, duration of involvement in sheep rearing, farm size, annual income, training experience, credit availabity, attitude towards sheep rearing, problems faced by the farmers. The dependent variable of the study was knowledge about sheep rearing.
Table 1 indicates that the middle aged farmers constitute the highest proportion (49%) followed by young aged category (37%) and the lowest proportion were made by the old aged category (14%) .
Table 1 Distribution of the farmers according to their age

Categories of respondent farmers	Number of respondents	Percent	Mean	Standard Deviation
Young aged (below 35 years)	37	37	38.02	12.33
Middle aged (35-50 years)	49	49		
Old aged (above 50 years)	14	14		
Total	100	100		

Illiterate farmers category constitute the highest proportion (37%) and the lowest proportion (6%) were above secondary education level (Table 2).

Table 2 Distribution of the farmers according to their education level

Categories of respondent farmers	Number of respondents	Percent	Mean	Standard deviation
Illiterate (0)	37	37	4.58	3.90
Primary education (1-5 class)	24	24		
Secondary education (6-10 class)	33	33		
Above secondary (above 10 class)	6	6		
Total	100	100		

Table 3 Distribution of the farmers according to their experiences on sheep rearing, family size, income, duration of training on sheep rearing and farm size

Categories	No. of respondents	Percent	Mean	Standard deviation
Low experience on sheep rearing (below 10 years)	51	51	11.99	9.70
Medium experience on sheep rearing (11-20 years)	27	27		
High experience on sheep rearing (above 21 years)	22	22		
Small size family (below 4)	35	35	5.47	1.81
Medium size family (5-8)	56	56		
Large size family (above 8)	9	9		
Low income (below 80000)	56	56	94555	47787.56
Medium income (80000-160000)	30	30		
High income (above 160000)	14	14		
Low duration training on sheep rearing (below 4 days)	46	46	3.57	2.51
Medium Duration on sheep rearing (4-8 days)	49	49		
High duration on sheep rearing (above 8 Days)	5	5		
Marginal (0.02-0.2 ha)	41	41	0.46	0.51
Small (0.21-1.0 ha)	44	44		
Medium (1.1-2 ha)	11	11		
Large (above 2.0 ha)	4	4		

About (51 percent) respondents were engaged with sheep rearing below 10 years and (27 percent) respondents were involved in 11-20 years and (22 percent) above 21 years. The medium family category constitute the highest proportion (56%) followed by small size category (35 percent) and large family size category (9 percent). The farmers family having low income constitutes the highest proportion (56 percent) followed by the farmers family having medium annual income (30 percent) and high family income (14 percent) (Table 3). Among all respondents about 46% of the farmers received low duration training, 49% received medium duration training and 5% received high duration training. Small farm holder constitutes highest of 44% and lowest of 4% for large farm holder. The study is on-going and need to be continued until a significant improvement of native sheep stock at farm and farmers' level is achieved.

Identification of certain bioactive compounds with anthelmintic properties in *Azadirachta indica* and *Clerodendrum viscosum*

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Executive summary

This study was carried out to confirm the presence of certain bioactive compounds with anthelmintic properties such as tannic acid, quercetin, etc in two well-known medicinal plants *Azadirachta indica* and *Clerodendrum viscosum*. The experiment was done in the laboratory under Pharmacy Department of Janhangirnagar University, Savar, Dhaka from July/16 to June/17. Solid-phase extraction (SPE) was used to extract phenolics and flavonoids based on the method published by Afroz *et al.,* 2016. Briefly, plants powder (5 g) was dissolved in 50 mL acidified deionized water (pH 2, achieved by the addition of 0.2 M HCl). The solution was passed through preconditioned C18 cartridges (3 mL 3 500 mg) purchased from Agilent Technologies (Santa Clara, California). The cartridges were preconditioned by sequentially passing through 3 mL each of methanol and acidified water (pH 2) at a drop-wise flow rate. The aqueous extract solution (10 mL) was then applied to the preconditioned cartridges at a drop-wise flow rate to ensure the efficient adsorption of phenolic compounds. The adsorbed phenolics were then eluted from the cartridges with 1.5 mL of 90% v/v methanol/ water solution at a drop-wise flow rate. The entire extraction procedure was repeated three times. The eluent was collected and stored at 22^0C before HPLC (High Performance Liquid Chromatography) analysis.

Phenolic compounds were identified by HPLC because this method is the most commonly used technique to analyze the chemical components of natural products (Yaoa et al. 2005). HPLC was performed based on the method published by Kaškonienė *et al*., 2009 using an HPLC system (SPD-20AV, Serial no.: L20144701414AE, Shimadzu Corporation, Kyoto, Japan) equipped with a UV detector (SPD-20AV, Serial no.: L20144701414AE, Shimadzu Corporation, Kyoto, Japan). A Luna phenomenex, C18 100A (150 3 4.60 mm, 5 µm), HPLC column was used. A linear gradient at a flow rate of 0.5 mL/min was used, with total analytical time of approximately 35 min. The binary mobile phase consisted of solvent A (ultrapure water with 0.1% phosphoric acid) and solvent B (pure methanol with 0.1% phosphoric acid). Elution from the column was achieved with the following gradient: 0–10 min of solvent B, increased from 35 to 55%; 10–25 min of solvent B, increased to 62%; 25–30 min of solvent B increased to 85%; the final composition was kept constant up to 35 min. All solvents were of HPLC grade. The detection wave length was set between 200 and 450 nm, with specific monitoring at 265 nm.

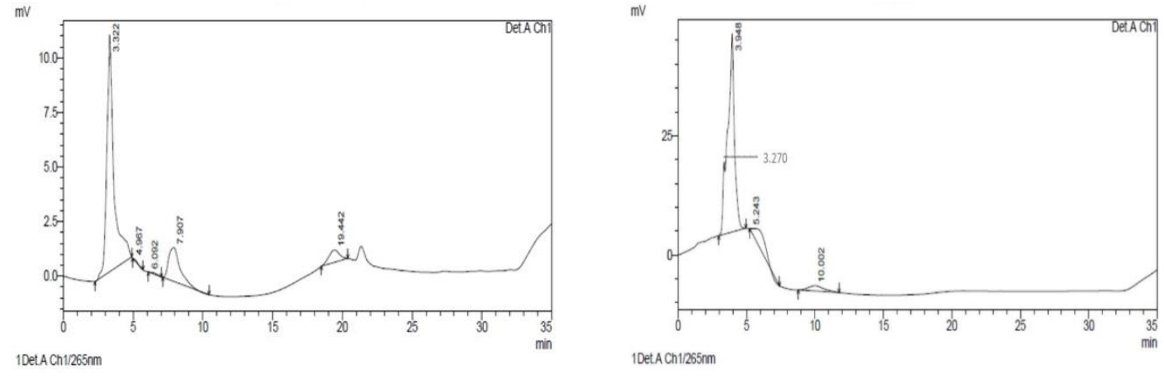

Figure 1 HPLC chromatograph of methanolic leaf extract of *Azadirachta indica* and *Clerodendrum viscosum*

The identification of phenolic and flavonoid compounds was performed by comparing the retention times of the analytes with reference standards. Gallic acid, tannic acid, vanillic acid, benzoic acid, salicylic acid, pyrogallol, catechin, naringin, rutin and quercetin were purchased from Sigma-Aldrich (St. Louis, Missouri) to be used as reference standards.

From the HPLC analysis *A. indica* showed peak retention time which was similar to standard phenolic compounds including tannic acid (*A. indica* ret. Time 3.270 min, STD ret. time 3.271 min) and pyrogallol (*A. indica* ret. Time 3.948 min, STD ret. time 3.795 min). Benzoic acid (*C. Viscosum* ret. Time 6.092 min, STD ret. time 6.067 min), tannic acid (*C. Viscosum* ret. Time 3.322 min, STD ret. time 3.271 min) and quercetin (*C. Viscosum* ret. Time 4.967 min, STD ret. time 4.222 min) was detected in leaf part of *C. Viscosum.* So it can be concluded that HPLC can detect the bioactive compounds of herbal product more accurately.

Collection, conservation and improvement of guinea fowl at BLRI

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Executive summary

The guinea fowl (*Numida meleagris*) is a promising genetic resource for evolving a low-input poultry enterprise mostly in developing countries (Teye and Gyawu, 2002). In Bangladesh, 90% of the total poultry population, chicken is dominant over others, followed by 8% of domestic duck and remaining 2% may include specialized fowl in Bangladesh such as quails, geese, pigeons, guinea fowls etc. (Das *et al.,* 2008). Guinea fowl's population was declined dramatically during last decades may be due to price, unavailability, lack of interest and knowledge about guinea fowl. Thus, guinea fowl has a lot of opportunity in our country to reduce poverty, fulfill nutrient requirement and to maintain biodiversity. It can be kept both for meat and egg production for the village farmers of Bangladesh. Egg production ranges from 60 to 90 eggs per bird per year under extensive conditions (Ayorinde, 1991), and usually from 130 to 145 eggs under intensive conditions (Royter, 1991). The eggs keep longer than domestic fowl because of their thick shell (Ayorinde, 2004). Guinea fowl meat contents higher protein, more essential amino acids, higher mineral content, lower fat and cholesterol contents than chicken or turkey (Singhand Raheja, 1990). There are no cultural barriers against consumption of meats (Saina *et al.,* 2005). These birds are more tolerant to harsh environment than the chicken and resistant to common diseases like bronchitis, marek's disease, lymphoid leucosis and Ranikhet disease and having great tolerance of aflatoxin. But little is known about their performance and survivability in Bangladesh condition. Thus the present research was undertaken to collect, multiplication, improvement of guinea fowl germplasm at BLRI. Therefore, a total of 150 of 1month old of pearl variety guinea fowl keets (chicks of Guinea fowl) were collected and raised in floor rearing system. The feed with required nutrient (ME-2950 kcal/kg & CP-23%) was supplied to the birds. Clean water was also supplied *ad libitum*. The temperature, ventilation and humidity were maintained as per the requirement of the birds. Data were recorded on weekly body weight (g/bird), average daily feed intake (g/bird/day), and mortality (%). Live weight, feed consumption, and feed conversion ratio (FCR) were measured weekly throughout the period. Birds were individually weighed weekly to determine the mean population weight.

Table 1 Growth performances of guinea fowl from 5 to 16wks of age

Age (wks)	Live weight (g)	Weight gain (g/wk)	Feed intake (g/wk)	FCR	Mortality %
5	163.09	133.09	283	2.126	0.00
6	290.62	127.53	315	2.471	0.00
7	400.38	109.76	315	2.869	0.66
8	508.32	107.94	346.5	3.210	0.67
9	608.24	99.92	371.7	3.719	0.00
10	700.36	92.12	390.6	4.24	0.00
11	783.93	83.7	409.5	4.90	0.00
12	869.95	86.02	428.4	4.98	0.00
13	956.68	86.73	453.6	5.23	0.67
14	1043.86	87.18	472.5	5.42	0.00
15	1128.8	84.94	491.4	5.78	0.00
16	1214.22	85.42	504	5.90	0.00

In present study, average live weight, weight gain, feed intake and FCR of guinea fowl were recorded from 5 to 16th weeks of age and summarized in Table 1. Live weight of guinea fowl were 100g, 508.32g, 869.95g and 1214.22 g at the age of 4, 8, 12 and 16 wks respectively. Saina (2005) reported that guinea fowl reared under intensive systems had lower live weight (LW) of 807±17.24 g at 12 weeks of age. Our results are consistent with Saina (2005) but lower than the findings of Tjetjoo *et al.,*

(2013) who found the mean body weight around 1400 g at 9 weeks of age. The parent stock of guinea fowl of this current study was not selected for meat production, may be this could be the reason of body weight variation and genotype is also an important factor on body weight gain. According to Knox (2000), the optimum age of slaughtering the guinea fowls is the 16th week of age on account of the subsequent decline in feed conversion efficiency. Mundra *et al*.,(1993) stated that at this age live weight of unimproved indigenous guinea fowl reach approximately 1 kg while improved strains reach approximately 2 kg (Embury, 2001). However, compared to that our study reported higher body weight (1214.22 g) during the same period of indigenous guinea fowl. Feed intake and FCR were increased with the increased of age.

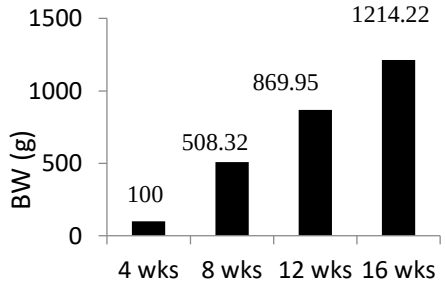

Figure 1 Live weight (LW) at different ages

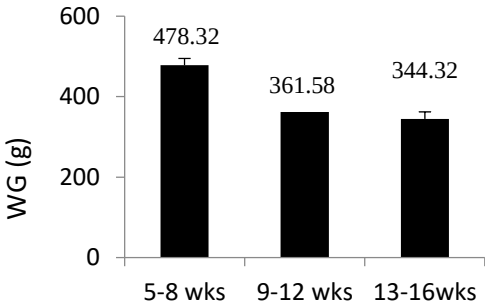

Figure 2 Weight gain (WG) at different interval of ages

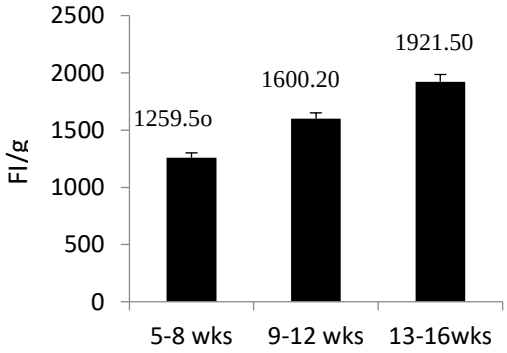

Figure 3 Feed intake (FI) at different ages

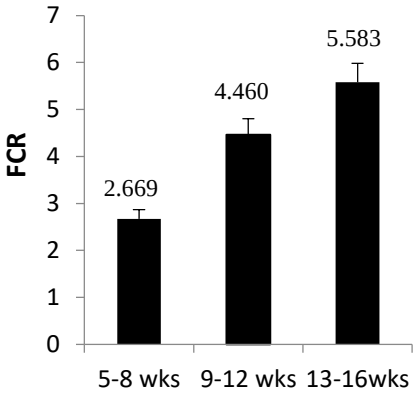

Figure 4 FCR at different interval of ages

At the different interval of age, the maximum cumulative weight gain and feed intake were found at 5-8 wks and 9-12 wks of age respectively and the average FCR was 2.669, 4.96 and 7.085 at 5-8, 8-12 and 13-16 weeks of age (Fig. 4). Seabo *et al*. (2011) reported higher FCR of 6.37 to 6.71 when feeding commercial a grower diet from 6 to 12 weeks of age under intensive system which is higher than our results may be due to different diets fed, management regime and also environmental factors. According to Ikani and Dafwang (2005), guinea fowl have high FCR because of their tendency to waste feed by scooping and picking of the feed which was also observed in this study. Based on the results of present study it can be concluded that the growth performances at the rearing period was satisfactory under intensive rearing system. Mortality was noticed very negligible. The study is going on and further study should be conducted to investigate the production performance of eggs, measurement of egg quality characteristics under intensive rearing system and improvement of BLRI selected guinea fowl in Bangladesh.

Pigeon production scenario in some selected areas of Bangladesh and conservation to improve some pigeon varieties at BLRI research farm

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Executive summary

Pigeon production in Bangladesh are popular both in rural and urban areas which has economic importance as supply of meat production and income generation especially to young people and woman. Pigeon farming has many advantages than other poultry species. Some of these are comparatively lowest keeping cost, short generation cycle, rapid growth, early sexual maturity i.e. 5-6 months of age, less feed and housing cost required; create employment opportunities, supplies delicious animal protein, environment friendly, associated with ecological balance, natural beautification and ornamental keeping as a good source of recreation. In spite of these, people of all religions like squab meat. Squab meat is very lean, easily digestible and rich in proteins, minerals and vitamins. It is also used as tasty, delicate and fancy meat. Pigeons are used for meat production, ornamentals, sports and experimental animals. Chinese people consider the meat of pigeons as having medicinal value and squab is a part of celebratory banquets for holiday such as Chinese New Year. Egyptians raised pigeon for food. Pigeons were popular in Romans, France and England as a means of livelihood to produce squab. Generally pigeons are reared under semi scavenging system mainly for squab production in rural areas and in urban areas for fancy birds. This piece of research was conducted through an ongoing research project entitled "Collection, conservation and improvement of Pigeon at BLRI research farm" with the objectives to develop a database on pigeon production system in some areas of Bangladesh and to collect and conservation of some varieties of pigeons.

A total of 90 questionnaires were filled up through face to face interview method taking 15 pigeon raisers from each of 6 sites viz. Dumuria of Khulna, Kotalipara of Gopalgonj, Nokla of Sherpur, Dinajpur sadar, Jaypurhat sadar and Sonagaji of Feni. The collected data were inserted and analyzed for making summary table to get the basic information of the pigeon farmers. It was noted that in villages, farmer supply supplementary feed in the morning, then allow the pigeon to collect scavenging feeds like fallen grain at farm field, railway yards, grain elevators, fruits, leaves, insects and weed seeds and come back home at evening and given some supplementary feed. Farmer supply mixed feed such as paddy, rice and mustard seed grain to their pigeon for better reproductive performance. The quantity of feed supplied to semi scavenging pigeon on an average 40.00 g/b/d which was about to similar with findings of Islam (2010), they reported a range 32.5 - 42.50g/day, with an average of 38.1g/day. Balanced ration is one of the fundamental requirements to successful pigeon farming. Optimum nutrition promotes proper growth, production and disease resistance (Levi, 1977).

Table 1 shows that family members of the pigeon raisers are 4 to 5 persons in each family. The land area showed a wide variation from 41.07 decimal in Feni sadar to 162.27 decimal in Dinajpur areas. Farmers of Dumuria showed higher education among other 5 regions. HSC educated farmers concentration was found highest in Nokla areas than other regions followed by Dinajpur and others. No farmers were found illiterate in the study area. Among the 6 sites, pigeon farmers of Feni sadar were 100% in SSC or below followed by 93% Gopalgonj and 73% in Joypurhat.

Table 1 Family members, land and education of the pigeon raisers in different regions of Bangladesh

Regions	Family members	Land (decim)	Education		
			Degree	HSC	≤ SSC
Dumuria, Khulna	4	126.73	20%	20%	60%
Kotalipara, Gopalgonj	5	43.53	6.67%	-	93.33%
Feni sadar	4	81.67	-	-	100%
Joypurhat sadar	5	41.07	6.67%	20%	73.33%
Dinajpur sadar	5	162.27	13.33%	46.67%	40%
Nokla, Sherpur	4	83.60	6.67%	73.33%	20%

Table 2. shows that highest number of pigeon as well as poultry was found in Dinajpur areas per farm followed by Joypurhat, Feni, Khulna, Gopalgonj and Nokla. The supplementary income is also followed the same trend, meaning highest income per pigeon farm was recorded 14571 taka / farm in Dinajpur that other regions. Their experience on pigeon rearing is also more (5.77 yrs) than others. New castle, fowl pox, cholera are common diseases found in the study areas with diarrhea sometimes. As a remedy most of the farmers provide ND vaccine with few Fowl pox vaccines. Some problems in predator was also found in different areas of the study.

Table 2 Flock size and economic return of the pigeon raisers in different regions of Bangladesh

Regions	Number of Poultry	Number of Pigeon	Squab/Year/Pair	Income (Tk/year)	Experience (Years)
Dumuria, Khulna	32	12	21	4913	4.87
Kotalipara, Gopalgonj	21	10	15	6125	1.84
Feni sadar	26	13	14	7367	4.27
Joypurhat sadar	26	18	9	4917	3.87
Dinajpur sadar	67	44	8	14571	5.77
Nokla, Sherpur	13	8	9	6593	2.90

There are four different local pigeon germplasms (Golla 3 varieties, Giribaz) with King variety have been conserving at our BLRI research shed. We are going to include 2 more varieties of pigeon with for studying with a total of 7 genotypes aiming the economic squab production efficiency of the local varieties and the exotic ones. The technology will be generated for both the raisers for supplementary income generation and as fancy birds for commercial pigeon keepers as well.

At this stage it seems to us pigeon raising may be a viable and economical supporting tools for the village farmers within their agro ecological scope. Besides this the fancy commercial raisers can also get a couple of benefits for social beautification and income generation as well. The study is ongoing and in future we are planning to produce squab as broiler pigeon for supplying pigeon meat to the consumers.

A baseline study about farmers training on BLRI developed technologies

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Executive Summary

Bangladesh is basically an agricultural country and nearly three-fourth population depends on agriculture, livestock and allied sectors for livelihood. The share of agriculture sector in national GDP is 18.70 and the share of livestock sub-sector is 2.45 (BER, 2013). As a national research intitute for livestock development BLRI is commited to develop native breeds of cattle, chicken and duck, techniques for their feeding and nutrition, disease prevention and health management and models for milk, meat and egg production system through strategic research. Since inception BLRI has developed 77 packages/technologies on livestock and poultry production. These technologies have presumably made a significant response to increase milk, meat and egg production and generation of income and creation of employment at farm level. BLRI technologies are important for livestock rearing in our country. During the last 3 years BLRI has conducted training on cattle, goat and poultry rearing and management. But after training we have no information about how good or useful it is in the field condition. Considering the situation a study was under taken to know the socio-economic status of trainee on adoption of technologies in the field. A total of 300 farmers who took part in training on livestock rearing & management from 2015-16 to 2016-17 were selected for this study. Survey method was followed to collect data. Mostly descriptive analysis was used to achieve the objectives.

The education level of the farmers were 40% primary level, 30% SSC, 20% HSC and 10% graduates/masters level. The family members of male were below 18 years 2.00 and over 18 years 2.8 number per family. The females below 18 years accounted for 1.94 and over 18 years 2.00 number per family. The land availability such as housing area were 0.90 acre, cultivated area 2.90 acre, uncultivated area 0.50 acre and fodder land area 0.25acre per family.The Agriculture was the highest (60%) occupation followed by business (30%), services (2%) and others (8%).The possessions of cattle was 4.62 no./family. In case of small ruminants, average no. of goat and sheep were 6.66 and 1.81 no./family, respectivly. Most of dairy cows were indigenous/ local. Some farmers reared crossbred cattle. The average milk production (l/d), birth wt. (kg), calf mortality (%) and lactation period (d) of cattle were, 3.86, 20, 17.80 and 180, respectively. The average litter size (no. per year), kid birth wt (kg) and kid mortality (%) were 1.53, 0.76 and 30%, respectively. Fodder land (acre) use and fodder production (ton/year) were 0.04 and 2.31, respectively.

T**able 1** Information on livestock productivity, mortality and fodder production

Parameters	Mean±SE
No. of dairy cows	3.00±0.37
No. of bulls	1.62±0.29
Milk production (l/d) (Dairy cow)	3.86±0.43
Birth wt.(Kg) (cattle)	20.00±1.37
Calf mortality (%)	17.80±0.89
Lactation period (d) (Dairy)	180±10.37
Litter size (no/year) (Goat)	1.53±0.45
Kid birth wt. (kg)	0.76±0.07
Kid mortality (%)	30%±4.87
Fodder land (acre)	0.04(40) ±0.27
Fodder prodn(ton/year)	2.31±0.19

Incomes (Tk per year) from milk, cattle sale, cowdung, compost and goat sale (live) were 69853.60, 87919.10, 9152.60, 17100.00, 63000.00 and 247025.30, respectively. The total annual income was Tk. 247025.303.

Table 2 Annual income from livestock products or by-products of farm families (Tk./year)

Source of income	Mean±SE
Milk	69853.60±32.32
Cattle sale	87919.10±18.33
Cowdung	9152.60±19.62
Compost	17100.00 (3) ±12.89
Goat sale (live)	63000.00±37.67
Total	247025.30±38.76

Table 3 Total livestock rearing (cattle & goat) rearing cost (Tk./year)

Source of income	Mean±SE
Rearing cost (Feed, medicine, labor)	190500.00±41.23

On average, the total annual household expenditure was Tk. 217567.6

Table 4 Annual household expenditure (Tk./year)

Particulars	Mean±SE
Food	90335.60±16.56
Clothing	7010.60±19.67
Health care	5621.3±11.33
Education	13000.00±12.98
Cosmatics	4071.9±8.36
Total	217567.6±19.45

Farmers overall consumption of all food items was 1035.50 g per day per capita).

Table 5 Consumption of different food items (g/d/capita)

Food item	Mean±SE
Rice	373.30±9.21
Ata	87.90±6.33
Pulse	34.5±3.26
Fish	40.20±4.73
Meat	38.9±3.47
Milk	235.7±11.35
Egg	4.6±0.42
Vegetables	220.4±12.21
Total	1035.50±18.59

The finding of the study represents small scale livestock production. Calf mortality rate was higher and less fodder production than needed. On the other hand marginal profit was observed from livestock rearing in the surved areas. Besides, socioeconomic condition of livestock farmers had shown no significant difference.

Development of calcium salts of n-3 and n-6 fatty acid for dairy cattle

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Executive Summery

The strategy of fatty acid (FA) supplementation is being used in ruminant nutrition with the aim to modify rumen fermentation, reducing enteric methane emission, boosting growth or milk production, and improving reproduction. The recent trends of feeding oil sources of n-3 and n-6 FA is due to their enormous health benefits. The conjugated linoleic acid (CLA), an anti-carcinogenic agent only found in milk is produced from n-6 FA. These two FA groups can influence the reproductive status of cows by increasing the number and size of follicles, plasma concentration of progesterone, controlling the secretion of prostaglandin and thereby regulating the lifespan of corpus luteum. However, these FAs usually degraded in the rumen through biohydrogenation. Producing calcium salt of these FA protect them from ruminal biohydrogenation and also added calcium increase supply of the most essential mineral for milk production and growth. Therefore, this study was undertaken with the objective to develop calcium salt of n-3 and n-6 FA for ruminants and their nutritional evaluation in terms of fatty acid profile and mineral contents. Sunflower oil (SFO) and linseed oil (LSO) was collected as the source of n-6 and n-3 FA, respectively. The procedure practiced by N.R. Sarker earlier in BLRI was followed to prepare the protected fatty acids. According to their protocol, aqueous solutions of NaOH (6M) were added to oil, and saponification was performed at 100^0C. Prepared Na-soaps were then mixed in water and dissolved it keeping at 100^oC using 1:5 ratio of soap to water. Then saturated solution of CaCl2 at 1:3.5 ratio of soap to water was added for salting out. The Ca-salts were finally sundried. The resulted salt was than analyzed for fatty acid profile and mineral concentration in FAO Public Health laboratory. Table 1 showed, about 95.88% recovery of n-6 fatty acid were achieved in calcium salt of sunflower oil (Ca-Salt of n-6 FA) by following this protocol, but n-3 fatty acid were not recovered in calcium salt of linseed oil (Ca-Salt of n-3 FA). Studies suggested that the n-3 fatty acids of Ca-Salt from LSO might be leached out when heated above 65 -70^0C temperature. So, the method of preparing Ca-Salt from LSO has been standardized by changing hydrolyzing and saponification temperature. The modified methods were A) saponification at 100^0C on Hot plate, B) saponification at 60^0C using water bath and C) mixing of LSO and Mustard oil (MO) at 1:1 ratio followed by saponification at 60^0C using water bath. The resulted salts were then sun dried and kept for analysis.

Table 1 Fatty acid & mineral composition of oils (SFO & LSO) and Ca-salts (of SFO & LSO)

Fatty Acid, %	SFO (n-6)		LSO (n-3)	
	Oil	Ca-salt	Oil	Ca-salt
Myristic acid (C14:0)	0.03	0.04	0.36	0.08
Palmitic acid (C16:0)	4.58	4.73	6.89	14.07
Stearic acid (C18:0	1.90	1.09	2.90	9.66
Oleic acid (C18:1)	63.61	65.13	28.06	57.45
Linoleic acid (C18:2n-6), n-6	27.60	26.41	10.92	6.52
Linolenic acid (C18:3n-3), n-3	0.23	nd	50.73	nd
Arachidic acid (C20:0)	0.13	nd	-	9.45
Behenic acid (C22:0)	1.55	0.49	0.11	0.27
Minerals				
Ca, %		3.73		3.89
Na, mg/100g		65.21		51.88

Table 2 showed, about 5.93% (Oil vs. Ca-Salt of n-3 FA = 50.73 vs. 3.01), 78.36% (Oil vs. Ca-Salt of n-3 FA = 50.73 vs. 39.75) and 71.23% (Oil vs. Ca-Salt of n-3 FA = 41.12 vs. 29.29) recovery of n-3 fatty acid were obtained in Ca-Salt of n-3 FA by following this modified protocol A, B and C respectively. In suggested protocol approx. 3.73% Ca & 65.21 mg/100g Na and 3.89% Ca & 51.88 mg/100g Na were detected in Ca-Salt of n-6 FA and Ca-Salt of n-3 FA respectively. After

standardizing the protocol, similar results were found in calcium content (A, B and C) but in case of sodium content it was found higher content than suggested protocol (A, 18.92g/kg, B, 21.39 g/kg and C, 11.28g/kg). The variation found on calcium and sodium content could be due to the variation of solution used, keeping time of dissolved Na-soap and washing methods.

Table 2 Fatty acid and mineral composition of Ca-salts of LSO after modification (A, B and C)

Fatty Acid, %	Modified methods (Ca-salt of LSO preparation)*			
	A	B	Mixed oil (LSO+MO)	C
Myristic acid (C14:0)	0.16	0.05	0.006	0.05
Palmitic acid (C16:0)	21.79	7.29	5.35	4.15
Stearic acid (C18:0	15.99	3.83	3.24	3.14
Oleic acid (C18:1)	55.22	40.07	25.94	24.28
Linoleic acid (C18:2n-6), n-6	0.66	6.17	11.65	11.80
Linolenic acid (C18:3n-3), n-3	3.01	39.75	41.12	29.29
Arachidic acid (C20:0)	-	0.15	0.09	0.17
Behenic acid (C22:0)	0.54	1.97	8.92	26.23
Mineral				
Na (g/Kg)	18.92	21.39		11.28
Ca (%)	4.28	4.75		4.52

*A = saponification at 100^0C on Hot plate, B = saponification at 60^0C using water bath, C = Using LSO & Mustard oil (MO) at 1:1 ratio, saponification at 60^0C using water bath

The standardized methodology developed in the laboratory by using saponification temperature at 60^0C in water bath the recovery rate of of n-3 fatty acid in calcium salts of linseed oil was satisfactory. Considering the highest recovery rate of n-3 FA in calcium salt of LSO, the mass preparation of protected n-3 might be executed.

Production of calves through transfer of IVP embryo

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Executive summary

In vitro embryo production (IVEP) technology is one of the modern reproductive biotechnology approaches that are used with traditional cattle breeding programme for increasing the rate of genetic progress. This technology is used to increase reproductive efficiency and to reduce generation interval. *In vitro* embryo can be produced from two different sources of oocytes, i.e. slaughterhouse ovary and oocyte from live elite donor cows. Ultrasound-guided transvaginal ovum pick-up (OPU) technique is routinely used for collection of oocytes from live elite cows for their multiplication. The OPU in combination with conventional IVEP has enabled repeated production of large number of embryos from donors of high genetic merits. Considering these facts, the present research programme was designed to adopt OPU technology for collection and production of OPU derived embryos from live animals.

Oocytes were collected throughout the experimental period from six regular breeder Red Chittagong cows, without subjecting the cows to hormonal stimulation. Follicles were visualized using an ultrasound scanner equipped with a sectorial probe fitted in a custom made intra-vaginal OPU probe-holder. Follicle numbers were recorded according to their diameter using ultrasonography. An 18 gauge disposable hypodermic needle connected to a 50 mL conical tube by Teflon tubing was used for follicular puncture. Negative pressure was applied using a vacuum aspiration pump and the aspiration vacuum was adjusted to a flow rate of 15 mL of water per minute. The cumulus oocyte complexes (COC) collection tube and aspiration medium was kept at 38°C in a water bath. Oocytes were collected in Tyrodes lactate -HEPES medium enriched with 2% (v/v) fetal calf serum, 100 iu/mL penicillin, 0.1 mg/mL streptomycin and 5 iu/mL heparin. To minimize abdominal straining during OPU, epidural anesthesia was performed with 5 mL of lidocaine. A twice/week OPU schedule was used for collection of oocytes from elite donor cows. The collected oocytes were searched under a stereomicroscope to calculate the oocyte recovery rate and further processing.

Table1: Follicular statistics and oocyte recovery during OPU from Red Chittagong Cows

OPU session	No. of follicles observed	No. of follicles punctured	% of oocytes recovery
1	6	0	0
2	7	4	57.14
3	5	0	0
4	5	0	0
5	7	2	28.57
6	5	0	0
7	4	0	0
8	8	3	37.5
9	6	0	0
Total	53	9	16.98

During the experimental period nine attempts were taken to collect oocytes from live animals in which 3 attempts were success and the oocyte recovery rate was 57.14%, 28.57% and 37.5% respectively. In total, 53 follicles were observed throughout the OPU session in which 9 oocytes were recovered and overall oocyte recovery rate was 16.98% (Table 1). Due to poor oocyte recovery in vitro embryo production and embryo transfer activities were not performed. This experiment is continuing for increasing oocyte recovery efficiency.

***In vitro* production of buffalo embryo**

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Executive summary

Buffalo is a highly potential animal species in terms of milk and meat production but traditionally they are regarded as a poor breeder. This is manifested mainly as late maturity, long postpartum anestrous intervals, poor expression of estrus, poor conception rates (CR) and long calving intervals. In order to improve reproductive efficiency of buffalo, assisted reproductive technologies such as artificial insemination (AI), multiple ovulation and embryo transfer (MOET) and *in vitro* production of embryos have been introduced (Nandi *et al.* 2002). Application of these technologies in assisted reproduction of buffalo is necessary to rescue the precious germplasm. In addition, female buffaloes have few primordial follicles and a high rate of follicular atresia. These limiting factors also limit the embryo transfer technology in buffalo. Therefore, the emphasis has now shifted to *in vitro* embryo production (IVEP). Considering the above fact, Bangladesh Livestock Research Institute (BLRI) has been conducting research on in vitro buffalo embryo production since 2016. This study aimed to customize buffalo in vitro embryo production protocol at BLRI. A total of 72 ovaries of slaughtered buffaloes were collected from abattoir located at Kaptan Bazar, City Corporation Slaughterhouse, Gulistan, Dhaka in physiological saline at ambient temperature and transported to the laboratory within 4 to 5 hr of slaughter. Cumulus-oocyte-complexes (COCs) were aspirated using a 10-mL disposable syringe attached with a 21G needle. Cumulus-oocyte-complexes (COCs) possessing an even cytoplasm and covered with minimum 3 layers of compact cumulus cells was selected for *in vitro* maturation (IVM) and placed into a 4-well culture dish containing IVM media for 24 hr (5% CO_2 in air at 38.5°C with maximum humidity). About 120 COCs were placed in to IVM medium. After IVM, all presumptive matured COCs were co-cultured with capacitated fresh spermatozoa for 18 to 20 hr through placing them in to a well of 4-well dish (700 µL). Sperm were capacitated through incubation with IVF media containing heparin sodium salt for 15 min. After IVF, the presumptive zygote were denuded, washed and110 presumptive zygotes were transferred in to in vitro culture medium (IVC-I) for 3 days. After three days cleavage were recorded and 4 cell embryos were transferred in to in vitro culture media (IVC-II) for next 3 days. The development of embryos was evaluated on day 3 after IVF.

About 96 out of 120 COCs showed cumulus cell expansion following 24 hr IVM. Cumulus cell expansion indicates maturation of oocytes. Hence in vitro maturation rate of buffalo oocytes was 80% (Table 1). During IVC-I, 68 out of 120 COCS were underwent at cleavage stage. Among the cleaved embryos, 46 were at 2-cell stage and 22 were at 4-cell stage. Therefore, the development rates to 2-cell and 4-cell stage were 38.33% and 18.33% respectively (Table 1). No embryo developed beyond 4-cell stage during this study period. This might be associated with poor culture condition.

Table 1 Status of in vitro embryo production of buffalo ovary collected from slaughterhouse

Total COCs for IVM	COCs with cumulus expansion (%)	Cleavage (%)	Embryo development efficiency		
			Two cell (%)	Four cell (%)	Blastocyst (%)
120	96 (80%)	68 (56.67%)	46 (38.33%)	22 (18.33%)	0

N.B. Maturation, cleavage and embryo development efficiency rates were calculated on total COC set for IVM

This can be concluded that current culture system support in vitro embryo production up to 4-cell stage. This study need to be continued for improving culture system to develop blastocyst stage embryos.

Establishment of bovine fibroblast cell line for somatic cell nuclear transfer

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Executive Summary

Somatic cell nuclear transfer (SCNT) is the procedure by which a nucleus from a fully differentiated cell (e.g., fibroblast) undergoes complete genetic reprogramming when it is introduced into an enucleated oocyte. The prime advantage of SCNT is the possibility of creating multiple genetically identical animals. Nuclear transfer is a powerful tool for studying genomic imprinting, nuclear-cytoplasmic interaction, totipotency, and the contribution of paternal and maternal genomes to developing embryos. Parameters affecting the success rate include the age of donor cells, cell cycle stage, ploidy and developmental stage of recipient cells, and activation schedule following fusion. In breeding programs, cloning can be used to increase the accuracy of selection and the rate of genetic progress in order to speed up the dissemination of genes from animals of exceptionally high genetic merit to the commercial population and to reproduce transgenic animals. However, the main limitation of cloning is the low success rate and, consequently, the high cost of producing an animal ready for reproduction. SCNT require combination of a number of technologies including oocyte aspiration, *in vitro* maturation, *in vitro* embryo culture and embryo transfer and nuclear transfer among others. BLRI has adopted oocyte aspiration, somatic cell culture protocol, *in vitro* maturation, *in vitro* embryo culture and embryo transfer protocols. Considering above facts, the proposed research project aimed to customize SCNT technology at BLRI. Considering these facts, the present research programme was designed to development of fibroblast cell line for somatic cell nuclear transfer technology in Bangladesh. The research conducted by cell culture lab in biotechnology division at BLRI. A cell culture protocol was developed for culturing of cell, a piece of buffalo's skin or ear tissue and navel cord from new born buffalo calves were taken in the cultured medium to develop primary fibroblast cell line. The skin or ear tissues were washed in PBS in a petri dish, cut into small fragments and transfer these to a flask. The small tissue fragments had distributed over the bottom surface of the flask by using a sterile pasture pipette. Then the culture flask was passed rapidly and carefully through the Bunsen flame in order to evaporate the medium so that the tissue pieces adhere to the plastic surface. BME medium were added carefully for fibroblast growth, firmly close the lid of the flask and place in CO_2 incubator. Culture medium was replaced after two days and then to be replaced three times a week. The fibroblast were started to grow from 2 to 3 days after incubation. In culture, cell grows either as a single cell layer attached to specially treat plastic surface or in suspension. In order to kept adherent cells healthy and actively growing it is usually necessary to subculture them at regular intervals. To maintain a cell line part of cultured primary cell had cryopreserved and the rest were sub-cultured continuously. The general morphology and growth of cell population and presence of any microbial contaminants checking regularly under an inverted microscope in phase contrast. Flasks with cells at about 70% confluences had treated with trypsin, the cells harvesting was frozen and divided for further proliferation. Medium from the dishes with non-confluent cells were is discarded and replaced with fresh medium to used different size of flask. The medium was changed 3 times in a week to maintaining proper proliferation and growth of cells to avoid contamination. The quality of cell lines had evaluated for confirmation of fibroblast cell line, cell morphology and apoptotic status. To estimate cell number and determine cell viability were used Hemocytometers with the aid of an exclusion dye such as Trypan Blue.

Figure 1: Different steps of cell culture: A: Preparation of skin tisse for cell culture, B: Adhering of tissue on the culture flask and C) Visualization of cultured fibroblast cell.

Cryopreservation of cultured fibroblast cell lines had developed. Viable cells were detected by Trypan Blue. Confluence of cells ranged from 75 to 90%. Subcultures were performed. Confluence of cells in passaged 10 ranged from 73 to 91%. Concentration of cells in passaged 10 were $2.65x10^5$ per ml. Out of the total cells, 93% were found viable. Further researches may be conducted to characterize cells produced through established SCNT protocols.

Development of feeding systems and least cost ration formulation for buffalo

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Executive summary

Buffaloes are called black diamond but most of buffaloes are indigenous type reared in extensive system in Bangladesh. Therefore the present study was undertaken to develop a practical feeding system and least cost ration using the locally available feed ingredients in Sirajgonj district. For this purpose three feeding systems and least cost rations were formulated for native buffalo and tested their effects on milk production, milk composition and benefit-cost ratio. One feeding system was representing the existing practice that considered as the control, and the remaining two were improved with incorporating urea-molasses straw (UMS) and/or qualitative and quantitative modification of concentrate mixture. Before commencing the study, a field survey was conducted to know the existing practice of feeding system and production efficiency of buffaloes in Sirajgonj District. Based on survey result, a total of 21 milking buffaloes from fourteen farmers were selected in such a way so that each group has similar number of animals of same parity and lactation stage. The average body weight, milk production and fat % of milk of the milking animal were around 450 kg, 2.5 kg per day, and 6% respectively. All the animals were ear tagged and dewormed before starting the experiment. There were seven day's adaptation periods before starting the experiment. The existing system (T1) comprises of feeding straw (10 kg), wheat bran (1kg), broken rice (0.5 kg), mustard oil cake (100 g) and grazing for 4 hours a day. The T2 consisted of same ingredients but in different proportion, e.g., 6 kg straw, 2 kg wheat bran, 0.7 kg broken rice, 350 g mustard oil cake and 50 g di-calcium phosphate (DCP). While, T3 consisted of 12 kg UMS, 1.5 kg wheat bran, 0.5 kg broken rice, 200 g mustard oil cake and 50 g DCP. The experiment was continued for 100 days and nutrient requirement was calculated according to Paul and Lal. Data and samples were collected 15 days interval.

Table 1 Nutrient intake of different treatment group

Parameter	Treatment group			SEM	P-Value
	T_1	T_2	T_3		
DMI (Kg)	7.75	7.82	7.65	0.14	NS
OMI (Kg)	6.78^{b}	6.94^{a}	6.83^{ab}	0.11	<0.001
CPI (Kg)	0.54^{c}	0.61^{b}	0.75^{a}	0.0089	<0.001
ADFI (Kg)	2.88^{a}	2.49^{b}	2.93^{a}	0.06	<0.001
NDFI(Kg)	5.09^{a}	4.75^{b}	5.08^{a}	0.1	<0.001
EEI(Kg)	0.10^{c}	0.18^{a}	0.12^{b}	0.00	<0.001
ASHI (Kg)	0.96^{a}	0.88^{b}	0.82^{c}	0.03	<0.001

Table 2 Daily and Total milk yield and milk composition of the buffalo cow

	Treatment group				
Parameter	T_1	T_2	T_3	SEM	Significance
Total milk yield (kg)	233.8^{a}	285.7^{a}	376.5^{b}	40.93	P<0.05
Daily milk yield (Kg/d)	2.4^{a}	2.9^{b}	3.8^{c}	0.2	P<0.01
SNF (%)	10.22	10.26	10.56	0.29	NS
Fat (%)	7.07	7.65	7.25	0.63	NS
Protein (%)	3.72	3.73	3.84	0.11	NS
Lactose (%)	5.58	5.58	5.76	0.17	NS

a–b Within a row, means without common superscripts differ (P<0.05).

After completion the experiment, there were significant variations of nutrient intake among treatment groups except DM intake (Table 1). At the same time significant variations were also observed at total milk yield ($P<0.05$) and daily milk production ($P<0.01$). But there were no significant difference on milk composition (SNF, Fat, Protein and lactose) but was a small increase in fat in T2 group compared to T1 and T2 group (Table 2).

To evaluate the economics among these three production system it was found that total cost per animal per day in existing production system, improved existing feeding system and UMS based improved existing were 98, 105 and 201 Tk respectively and profit from milk marketing per animal per day ware 161, 196 and 266 Tk respectively. SO, net profit in existing system was 63 Tk/ animal/day, whereas improved existing feeding system profit was 43% but on the other hand UMS based improved existing feeding system was 3% profitable.So improved existing feeding system can be practice in sirajgonj district for buffalo production.

Effect of feed supplementation on age at puberty in growing buffalo heifers

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Executive Summary

The Buffalo is the potential animal genetic resource. Reproduction efficiency of buffalo is generally poor compared to cattle. However, higher plain of nutrition can improve fertility of buffaloes. Age at first calving is a very important trait which may be reduced through providing balanced feeding, improved management and minimize disease prevalence .To get faster growth rate for early puberty on cost effective basis recommended that forge should be the main feed and concentrate feeds may be supplemented. Buffaloes are suitable for breeding at about 24 months of age. But in the majority of dairy buffaloes calving occurs at 4-6 years of age. This is due to an inadequate supply of feed and nutrients during the growing phase. Most buffalo cease ovarian cyclicity during hot summers probably due to the combined effects of nutrition, environment and management. Nutritional manipulations may influence the period of sexual maturation. In Bangladesh, buffalo is an important animal; estimated buffalo population in Bangladesh is about 1.47 million (BER, 2016) and they are mostly local type. Buffalo shares about 2.0% (FAnGR, 2005) and 0.94% (BBS, 2012) of total domestic milk and meat, respectively. Contribution of buffalo on national red meat production is also very low (2.06%). This negligible share of buffalo to domestic milk and meat production is associated with their low production potential. Indigenous buffalo attained puberty at 30.30±1.43 months age at on-station and 39.4 to 54.45 months at on-farm condition. The optimal puberty age of river buffalo is 15 to 18 months and swamp buffalo is 21 to 24 months at on-station. These values deteriorate up to a significant extant under field condition. Low reproductive efficiency (late maturity, long calving interval and silent heat etc.) is a serious constraint to buffalo production. Considering above facts, this study aimed to investigate the effect of dietary feed supplementation on age at sexual maturity of buffalo. Sixteen buffalo heifers aged from 6 months to 12 months were selected and divided into four treatment groups (Group A, B, C and D). Buffaloes of all groups have been feeding urea molasses straws and water adlibitum. The experimental buffaloes have been receiving concentrate at the rate of 0.5% (group A), 0.75% (group B), 1.00% (group C) and 1.25% (group D) of body weight. Required amount of concentrates were provided twice a day (50% in the morning and 50% in the evening). Buffalo heifers were allowed to move freely within their barn. *Ad-libitum* fresh water was supplied to separate manger for each buffalo. The age of sexual maturity were recorded when the animals had showed the first sign of heat or responded to teaser bull. The susceptibility of buffalo with common diseases was evaluated. Any reproductive diseases were monitored. Daily feed intake; body weight; feed evaluation; nutrient requirement calculation, date of birth; feed conversion ratios were recorded. Regular de-worming and vaccination against common diseases were ensured during experimental periods for all four groups. Table 1 shows the feed intake of buffalo heifer for different treatment groups. Intake of UMS and total feed and FCR did not differ among treatment groups. Intake of concentrate differed among treatment groups due to restricted supply as per experimental design.

Table 1 Feed intake of buffalo heifer for different treatment groups

Intake	Treatment group (Mean±SE)				Level of significance
	A	B	C	D	
UMS intake (Kg/d)	7.63±0.35	7.73±0.38	7.47±0.27	7.50±0.40	NS
Concentrate intake (Kg/d)	1.05^{a}±0.09	1.78^{b}±0.33	2.15^{b}±0.32	2.85^{b}±0.51	*
Total feed intake (Kg/d)	8.67±0.44	9.50±0.71	9.62±0.57	10.36±0.90	NS
FCR	16.67±1.06	20.27±2.73	19.85±2.79	24.98±4.10	NS

*A=UMS (adlib)+0.5% concentrate; B=UMS (adlib)+0.75% concentrate; C=UMS (adlib)+1.0% concentrate; D= UMS (adlib)+1.25% concentrate; NS-not significant (p>0.05); *-significant at 5% level (p<0.05); mean with uncommon superscript within the same row differed significantly (p<0.05).*

Table 2 Body weight and sexual maturity of buffalo heifer for different treatment groups

Body weight & growth	Treatment group (Mean±SE)				Level of significance
	A	B	C	D	
Initial body weight (Kg)	195.5±19.62	220.38±41.23	194.75±28.51	203.5±37.19	NS
Final body weight at 205days (Kg)	302.5±19.50	319.25±40.77	297.25±22.46	292.25±31.69	NS
Total body weight gain (Kg)	107.0±2.42	98.88±8.81	102.5±7.58	88.75±8.05	NS
Daily body weight gain (g/d)	521.9±11.78	482.3±42.99	500.0±36.96	432.9±39.25	NS
Age at sexual maturity (m)	23.49±0.09 (02)	23.39±0.82 (02)	23.49±0.02 (02)	24.59±0.29 (02)	NS

A=UMS (adlib)+0.5% concentrate; B=UMS (adlib)+0.75% concentrate; C=UMS (adlib)+1.0% concentrate; D= UMS (adlib)+1.25% concentrate; NS-not significant (p>0.05); NS-significant at 5% level (p<0.05); Figures in the parenthesis indicate number of observations.

Table 2 shows the body weight and sexual maturity of buffalo heifer for different groups where initial body weight, final body weight, total body weight , daily body weight gain and age at sexual maturity had no significant (p>0.05) variation among experimental groups. Figure 1 show that the growth curve for 4 treatment groups for a period of 205 days. The growth was steadily upward but stage 3 to 4 downward due to unavoidable situation (adverse climatic condition).

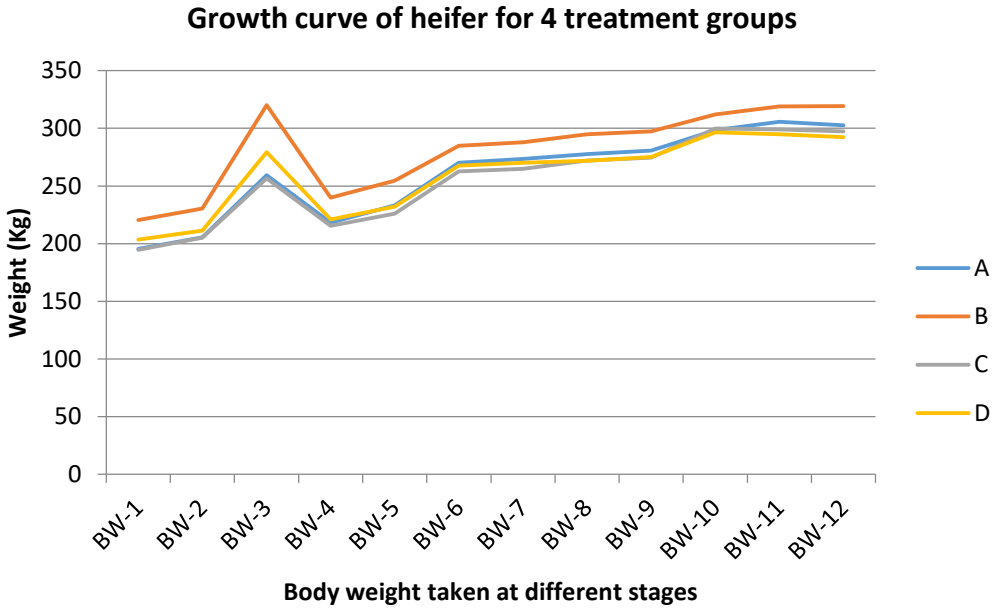

Fig.1. Growth curve of heifers for 4 treatment group at the period of 205 days

This is an ongoing experiment. To evaluate the effect of different levels of concentrate supplementation on age at sexual maturity, this experiment will be continued until all heifers showed their first heat.

Phenotypic and molecular characteristics of buffalo genetic resources in selected regions of Bangladesh

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Executive Summary

Commercial utilization of buffalo is limited due to their poor production and reproduction efficiency in Bangladesh. Limited research work has been done on characterization of buffalo and there is no clear indication about buffalo breed available in Bangladesh. For improvement of any species, characterization is the first and foremost priority. Therefore, performance of undocumented indigenous buffalo of Bangladesh needs to be evaluated and focused globally. Considering the above facts, the present investigation was designed to categorize buffalo population into different breeds considering their phenotypic characteristics. A questionnaire has been developed and pre-tested before final survey for this study. Buffalo were categorized into different breeds considering their phenotypic characteristics (coat color, horn pattern, white marking, head shape, and body size). Phenotypic data were collected on 2554 buffaloes from different char, plain and coastal areas. For molecular characterization, 20 microsatellite markers were selected. About 20 blood samples were collected from each group of buffalo population. DNA samples were extracted and PCR protocols were standardized. Fragment length analysis is going on at BLRI Biotechnology Laboratory.

Percentages of buffalo belonged to different coat color, horn pattern, white marking, head shape, and body sizes were presented in Table 1. Results showed that buffaloes are varying for their coat color (10.42% Jet black, 56.90%, black in grey black in 20.56%, 11.55% light grey and 0.56% whitish), horn pattern (2.69% crescent, 3.29% sickle, 54.19% C-shape 14.98% back upward front and 23.95% short spiral), white marking (7.65% in head, 60.80% in tail, 22.05% in hock area and 9.50% in dewlap), head shape (33.42% thin long, 40.32% big and 6.35% short) and body sizes (13.96% large, 66.38% medium and 19.66% small). Four distinct categories of buffaloes were found namely indigenous type (87%), Murrah cross (7%), Nili Ravi cross within river type buffalo (4%) and swamp type (2%) according to their distinct body feature (Figure 1). About 80% of the buffaloes contain distinct 'back up ward front' shaped horn pattern. Therefore, it is indicated that these buffalo population may be the indigenous breed of Bangladesh. Molecular characterization using microsattelite markers is going on.

Table 1 Phenotypes of buffalo population in different zones of Bangladesh

Zone	Coat color (N=2554)					Horn pattern (N= 2532)					
	Jet black	Blakish	Black grey	Light grey	Whitish	Crecent shape	Sickle	C shape	Back up front	Short spiral	Front down ward
Char area	54.8 %	59.1%	81.9 %	86.7 %	85.7%	63.5%	76.9 %	80.4 %	78.3 %	11.7 %	77.8 %
Plain area	13.2 %	28.6%	14.0 %	11.9 %	14.3%	19.3%	12.8 %	19.3 %	21.7 %	60.6 %	22.2 %
Coastal area	32.0 %	12.3%	4.1%	1.5%	.0%	17.2%	10.3 %	.3%	.0%	27.7 %	.0%
Significant	**	**	**	**	**	**	**	**	**	**	**

*** Significant at 1% level; N: number of observations*

Table 1 Phenotypes of buffalo population in different zones of Bangladesh (cont.)

Zone	White marking (N=434)				Head shape (N=1942)			Body size (N=1994)			Tail type (N=1805)	
	Head	tail	Hock area	Dewlap	Thin long	big	short	Large	Medium	small	Long	short
Char area	84.4 %	87.6 %	54.7 %	3.1%	67.0 %	59.7 %	63.2 %	70.8 %	54.0%	74.4 %	64.6 %	64.0 %
Plain area	15.6 %	12.4 %	45.3 %	96.9%	31.6 %	24.9 %	17.4 %	28.2 %	21.3%	24.6 %	25.0 %	26.6 %
Coastal area	o	o	0	0	1.4%	15.5 %	19.5 %	1.0%	24.8%	1.0%	10.4 %	9.5%
Significant	**	**	**	**	**	**	**	**	**	**	NS	NS

*** Significant at 1% level; N: number of observations*

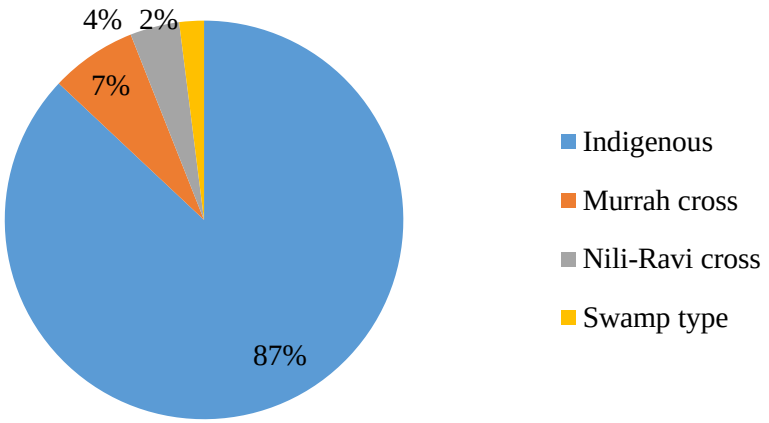

Figure 1: Available buffalo breed/types in study areas of Bangladesh

Varietal demonstration of HYV fodder and development of existing feed resources based feeding system in Haor areas of Bangladesh

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Executive Summary

Bangladesh is a low-lying riverine country located in the southern Asia, covering areas of 147570km^2. The north eastern part of Bangladesh is a low lying bowl-shaped basin covering about 6,000 sq. km in Sylhet division**,** mostly in Sunamganj district of Bangladesh called as haor. Haor is water-logging wetlands in where cattle are an inseparable and integrated part of small holder subsistence farmers in Bangladesh. But, the areas are covered with water for most of the periods in the year. So, no doubt that there are acute shortages of feeds and fodders for ruminants throughout the years as a result of water logging for a prolonged period in every year. Due to severe scarcity of green grasses round the year, fodder production model with high yielding variety along with locally available feed resources is very much essential for the survivality of the cattle in haor areas. Recently, fodder production and preservation gets momentum as an income generation and employment opportunity in certain areas of Bangladesh, especially where small scale dairying, fattening and milk marketing facilities are prevails. Nevertheless, water tolerant fodder or forges or those grown in water needs to be adopted as an alternative approach. In view of this situation, research was directed towards the development of alternate fodder production model which makes better uses of local resources that are available throughout the year. Thus, this study was carried out to select the suitable cultivar through varietal demonstration of HYV fodder germplasms and development of existing feed resources based feeding system in haor areas.

For demonstration of HYV fodders, 5 small-scale dairy farmers having sufficient land for fodder cultivation were selected in Sunamganj sadar upazila. Two varieties of Napier cultivars (BN-3 and Pakchong) were distributed among the selected five farmers as disperse replications. Before planting, all the experimental plots were properly prepared with normal agronomical practices farmers do traditionally (ploughing, leveling, fertilizing, weeding, irrigation etc.). Stem cuttings were planted in rows apart from 70cm and spacing between plants were 35cm. First harvest was done 80 days after planting, thereby biomass yields were estimated from 1m^2 yields in five random locations from each of the plots and converted yields into hectare^{-1}. Based on chemical analysis, total dry matter (DM) yields/ha^{-1} and total crude protein (CP) yields/ha^{-1} were also estimated with mathematical calculations. In the same way, morphological data like number of tillers per hill and plant heights were estimated from five plants taken 5 random locations of each of the experimental plots. There were two varieties (as treatment) and for each variety there were 5 plots (as replication). Thus the design of experiment was CRD. All the data were recorded and analyzed statistically with SPSS.

The biomass production and morphology of both fodders are presented in Table 1 which shows that fresh biomass yield of Pakchong was significantly ($p<0.01$) higher than that of BN-3. Dry matter and crude protein yields of Pakchong were also significantly ($p<0.01$; $p<0.05$) higher than that of BN-3. Numbers of tiller per hill and plant height for Pakchong and BN-3 did not differ significantly ($p>0.05$).

Table 1 Comparative performance of Pakchong and BN-3 in haor

Parameter	Pakchong	BN-3	P-value	Sig. level
Biomass Yield (MT/ha^{-1})	49.33±0.67	35.00±2.89	0.008	**
DM yield (MT/ha^{-1})	5.35±0.07	3.55±0.29	0.004	**
CP Yield (MT/ha^{-1})	0.46±0.01	0.37±0.03	0.037	*
Tiller/hill (no.)	9.60±0.76	9.33±0.73	0.801	NS
Plant height (inch)	48.00±1.52	48.93±1.69	0.685	NS

***Significant at 1% (p<0.01; NS-not significant (p>0.05)*

Nutrients compositions of both Napier cultivars according to botanical fraction are presented in Table 2 and Table 3. DM, ash and CP contents in different botanical portion of the plant differed significantly ($p<0.05$-$p<0.001$) for both cultivars. Highest DM and CP contents were found in leaf and

lowest in sheath (Table 2 and 3). Table 2 and Table 3 further show that highest ash content was found in sheath and lowest in stem.

Table 2 Nutrient composition of Pakchong fodder from first harvest

Nutrient composition	Botanical fraction (mean±SE)				P-value with Sig.
	Stem	Leaf	Sheath	Whole	
DM (%)	08.55^{c}±0.21	20.84^{a}±0.26	12.24^{b}±0.92	10.85^{b}±0.45	0.000^{***}
Ash (%)	06.59^{c}±1.19	10.38^{b}±0.43	14.45^{a}±0.56	11.73^{ab}±1.37	0.003^{**}
CP (%)	05.28^{c}±0.23	11.48^{a}±0.15	04.92^{c}±0.36	08.68^{b}±0.25	0.000^{***}

*#Means with uncommon superscript within the same rows differed significantly (p<0.05); **Significant at 1% level (p<0.01; ***-Significant at 0.1% level (p<0.001)*

Table 2 Nutrient composition of Napier hybrid (BN-3) fodder from first harvest

Nutrient composition	Botanical fraction (mean±SE)				P-value with Sig.
	Stem	Leaf	Sheath	Whole	
DM (%)	8.90^{d}±0.08	25.83^{a}±0.31	12.58^{b}±0.54	10.13^{c}±0.09	0.000^{***}
Ash (%)	04.14^{b}±2.20	09.11^{a}±0.23	10.42^{a}±0.04	09.47^{a}±0.13	0.026^{*}
CP (%)	05.76^{c}±0.48	14.08^{a}±1.29	05.39^{c}±0.54	10.41^{b}±0.30	0.001^{***}

*#Means with uncommon superscript within the same rows differed significantly (p<0.05); *Significant at 5% level (p<0.05); ***-Significant at 0.1% level (p<0.001)*

The results exposed that both cultivars are best suited and produced potentially in the haor areas, but Pakchong comparatively performed better in term of biomass production. Farmers in haor areas can easily adopt these cultivars to compensate their green grass scarcity for cattle.

Developing fodder production model in coastal and river basin regions of Bangladesh

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Executive Summary

Green fodder production for feeding livestock has not yet been popularized among the rural farmers of Bangladesh, but this is an immense need for improvement of ruminant production. An appropriate fodder production system round the year for different regions of Bangladesh is a crying need of time for sustainable ruminant production. Based on a retrospective baseline survey results on fodder production, demand, livestock rearing, problems and so on, two districts from river basin (Jamalpur and Kurigram) and one from coastal regions (Noakhali) were selected to conduct on-farm study to develop a sustainable fodder production system for improving productivity. For this purpose, two upazilas from each district were selected. A total of thirty farmers having minimum two dairy cows (5 from each upazila) were selected according to farmer's interest on fodder production. Selected farmers were motivated and trained up on high yielding fodder production, preservation as silage and hay making and feeding system. BLRI developed high yielding Napier-3 fodder cuttings were supplied to all farmers for cultivation in their own land. Leguminous fodder (M*atikalai*) as intercrop was produced in those lands at the time of inter cutting period and were preserved as hay for monsoon and winter seasons. The data on biomass yield and nutrient composition of cultivated fodders (Napier-3 and *Matikalai*) were recorded for one year. Daily milk yield of cows in two groups (traditional and interventional feeding) for a period of two months were also recorded. Interventional feeding was provided based on cows' requirement by traditional plus supplemented fodders. Feed and nutrient intake and digestibility were also estimated. Design of experiment was completely randomized and all the data collected from the experiment were analyzed statistically by SPSS 16.0.
Biomass production, DM and CP contents of Napier-3 and *matikalai* produced from different areas are given in Table 1 which shows that biomass yields of both fodders differed significantly among areas, but DM and CP contents did not differ significantly.

Table 1 Biomass yield and nutrient composition of cultivated fodders

Upazilas	Parameters (mean±SE)					
	Biomass yield (MT/ha)		DM (%)		CP (%)	
	Napier-3	Matikalai	Napier-3	Matikalai	Napier-3	Matikalai
Jamalpur Sadar	13.7±0.68	7.3±0.51	18.58±0.04	21.78±0.05	11.34±0.03	24.74±0.06
Melandah	13.9±0.76	6.9±0.35	18.55±0.08	21.15±0.08	18.55±0.08	24.54±0.28
KurigramSadar	11.3±0.34	7.0±0.54	11.00±0.42	22.00±0.02	11.32±0.18	24.75±0.12
Rajarhat	09.6±0.78	7.2±0.12	10.00±0.12	21.92±0.14	11.00±0.06	25.00±0.06
NoakhaliSadar	12.2±0.48	6.5±0.40	14.12±0.46	21.54±0.36	11.62±0.02	24.65±0.32
Subornochar	11.9±0.52	6.4±0.62	15.00±0.54	22.00±0.13	11.10±0.12	25.10±0.12
Overall mean	12.1±0.51	6.9±0.42	14.56±0.4	21.73±0.13	11.36±0.02	24.80±0.16
Significant level	**	**	NS	NS	NS	NS

***-P<0.01; NS-not significant (P>0.05; MT-metric tons; ha-hectare; DM-dry matter; CP-crude protein*

Milk production of cows of two treatment groups in two different seasons are given in Table 2 which shows that milk yield of cows fed interventional feeding (T_1) was significantly (P<0.001) higher than those of cows fed traditional feeding (T_0) for both seasons. However, Table 3 shows the fat corrected milk yield (FCM) and milk composition of cows in two treatment groups. FCM yield and milk protein content in cows of interventional feeding i.e. T_1 (traditional with *matikalai* hay) were significantly (P<0.001; P<0.05) higher than those of cows fed traditional feeding (T_0). Feed and nutrient intakes and digestibility for two different groups are illustrated in Table 4. Rice straw and concentrate feed as provided to the cows of interventional feeding group (T_1) were significantly (P<0.001) lower than those amounts provided to the cows of traditional feeding group (T_0). Although, total dry matter (DM)

intake of cows of two treatment groups were not varied significantly (P>0.05), but total nutrient intake and their digestibility of cows in T_1group were significantly higher (P<0.05-P<0.001) than those of cows in T_0 group.

Table 2 Effect of interventional feeding (traditional with Napier-3) on milk production in two different seasons

Month of milk yield	Summer Season			Winter Season		
	Daily milk yield (kg) (mean±SE)		Significant level	Daily milk yield (kg) (mean±SE)		Significant level
	T_0	T_1		T_0	T_1	
1	9.50±0.15 (n=30)	10.32±0.09 (n=30)	***	4.00±0.18 (n=30)	5.07±0.05 (n=30)	***
2	8.75±0.13 (n=30)	11.00±0.16 (n=30)	***	4.13±0.20 (n=30)	5.41±0.10 (n=30)	***
Total	9.10±0.14 (n=30)	10.68±0.13 (n=30)	***	4.07±0.13 (n=30)	5.25±0.07 (n=30)	***

*T_0-traditional feeding; T_1-interventional feeding (traditional plus Napier-3); *Figures in the parenthesis indicate sample size, ***-P<0.001; n= number of milch cow*

Table 3 Effect of interventional feeding (traditional with *Matikalai* hay) on milk yield and composition

Parameters	Mean±SE of two groups		Level of significance
	T_0 (n=30)	T_1(n=30)	
Milk yield(4% FCM) kg/d	4.14±0.14	6.31±0.45	***
Milk fat (%)	4.12±0.02	4.19±0.03	NS
Milk protein (%)	3.43±0.03	3.52±0.03	*
SNF (%)	8.59±0.06	8.65±0.05	NS

*T_0-traditional feeding (straw based diet); T_1-interventional feeding (traditional with matikalai hay); *-P<0.05; ***-P<0.001; FCM-fat corrected milk yield; SNF-solids not fat; n= number of milch cow*

Table 4 Feed intake and nutrient digestibility of cows in two treatment groups

Parameter	T_0	T_1	Level of significance
Rice straw intake (kgDM/d)	5.98±0.06	4.58±0.01	***
Matikalai hay intake (kgDM/d)	Not provided	1.55±0.003	-
Concentrate intake (kgDM/d)	5.03±0.004	4.14±0.002	***
Total DM intake (kg/d)	10.49±0.05	10.40±0.02	NS
Total CP intake (kg/d)	1.00±0.002	1.12±0.001	***
DCP (kg/d)	0.59±0.005	0.74±0.007	***
Total ME intake (MJ/d)	75.68±0.019	77.38±0.05	**
DM digestibility (g/100g)	66.51±0.40	68.55±0.26	**
CP digestibility (g/100g)	58.59±0.65	66.23±0.67	***
TDN (%)	72.54±0.43	73.86±0.33	*

*T_0-traditional feeding (straw based diet); T_1-interventional feeding (traditional with matikalai hay); *-P<0.05; **-P<0.01; ***-P<0.001); DM-dry matter; CP-crude protein; DCP-digestible crude protein; ME-metabolizable energy; TDN-total digestible nutrient*

The results clearly indicate that interventional feeding performed better in terms of milk yield, milk composition and nutrient digestibility in compare to traditional feeding in the study areas. However, farmers in the coastal and river areas can adopt this fodder cultivation and feeding system for better production.

Annual Research Review Workshop 2017

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