Annual Research Review Workshop 2023

Date: 23-24 December, 2023

BLRI Conference Hall (3rd floor, Building 3)

PROGRAMME

Bangladesh Livestock Research Institute

Savar, Dhaka 1341, Bangladesh

BLRI ARRW-2023 Technical Committee

Sl No:	Name	Designation	Committee
1.	Dr. Nasrin Sultana	CSO & Director (Research)	**Convener**
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3.	Dr. Gautam Kumar Deb	PSO	Member
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10.	Dr. Md. Zulfekar Ali	SSO	Member
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INAUGURAL SESSION

09:00	Registration	
09:30	Guests take their seats	
09:40	Recitation from Holy Quran and Holy Gita	
10:00	Welcome Address	**Dr. Nasrin Sultana** Director (Research) and Convenor, Technical Committee APRW-2023 Bangladesh Livestock Research Institute
10:10	Unwrapping the "Livestock and Poultry Production Technology Manual (4th Edition)"	
10:20	Address by the Special Guest	**Dr. Md. Emdadul Haque Talukder** Director General, Department of Livestock Services
10:30	Address by the Chief Guest	**Dr. Nahid Rashid** Secretary, Ministry of Fisheries and Livestock
10:50	Address by the Chairperson	**Dr. SM Jahangir Hossain** Director General, Bangladesh Livestock Research Institute

PREFACE

Bangladesh Livestock Research Institute (BLRI) is a state-run research institute at national level for livestock and poultry sector under The Ministry of Fisheries and Livestock, Bangladesh. BLRI has developed 95 Packages and Technologies since its establishment for increasing livestock production. The mandate of the institute is to identify livestock and poultry production and their health constraints, develop solutions through a multi and interdisciplinary research approach and generate technologies compatible with other resources of the farmers to solve those constraints and problems. To address the mandates of the institute, BLRI has been conducting need based research activities in the five different disciplines namely, Animal and Poultry Breeding and Genetics; Feeds, Fodder and Nutrition; Animal and Poultry Diseases and Health; Animal Biotechnology, Environment and Climate Resilience and Waste management; Socio-Economics & Farming System Research. The research projects are implemented each year through a robust review process and finally approved by the Technical Committee to achieve the specific goals of the vision 2041 as well as SDG"s.

BLRI started formal ARRW in the financial year 1999-2000 and is still organizing 24th ARRW-2023. All the executive summaries of those research works are published in the proceedings of Annual Research Review Workshop after thorough reviewing and editing by agroup of panel reviewers. The Annual Research Review Workshop 2023 is presenting the researchactivities in the financial year 2022-23 that contained 83 research projects from revenue budget and developmental project budget. A total 83 executive summaries are presented where 49 for oral presentation and rest on 26 for poster presentation in the respectivedisciplines (remaining 8 projects are yet to be completed) that will help students, scientists, academicians and policy makers for developing future research programs and taking the decisions of development policy in livestock and poultry sector. However, I am very much happy to share you all that BLRI is unwrapping the "Livestock and Poultry Production Technology Manual (4th Edition)" in this ceremony. There are 95 technologies included in this directory that will helpful to entrepreneurs, researchers, academicians, farmers and policy makers who are directly or indirectly involved in livestock production and socio-economic empowerment.

The institute is acknowledging the strong support of Ministry of Fisheries and Livestock (MoFL) for the research endeavors and I am also very thankful for active participation of the all participates from the Department of Livestock Services, academia from different universities, scientists from different research institutes, representatives from NGO"s, experts from other Organizations who are sharing their expertise during this workshop. The institute highly appreciates all the scientists of technical committee for offering their utmost effort to publish the proceedings and other committee members for making this event successful. Finally, BLRI believes that technological innovation through livestock research and development is contributing at all levels of national development, poverty reduction, employment generation, woman empowerment and safe animal protein production.

Dr. S. M. Jahangir Hossain
Director General
BLRI, Savar, Dhaka-1341

FOREWARD

Bangladesh Livestock Research Institute is the only national research institute on livestock and poultry sector in Bangladesh under the Ministry of Fisheries and Livestock (MoFL). The Livestock and Poultry Sector has achieved increased heights and success over the last two and half decades where BLRI enormously provided technological support through developing 95 Technologies and Packages like beef fattening, high yielding fodder varieties, PPR vaccine etc. since its establishment. BLRI has been performing its activities through eight research divisions, three research centers and one support service division. The mandate of BLRI is to develop technology and knowledge through research for solving the existing problem of livestock and poultry production to ensure food and nutrition security of the country.

Through five research disciplines BLRI started a formal annual research review workshop in the fiscal year 1999-2000 and is still performing 24th ARRW-2023. The technical committee of ARRW is performing all technical activities related to the workshop. All the Executive Summary of those research works are published in the proceedings of Annual Research Review Workshop after thorough reviewing and editing by a group of subject matter expertise. The Annual Research Review Workshop 2023 delivers the research outcome in the financial year 2022-23, hence 83 research projects were from revenue budget and from developmental projects budget. A total of 83 executive summaries will be presented where 49 for oral presentation and 26 for poster presentation (remaining 8 projects are yet to be completed) in the respective disciplines that obviously generate knowledge for student, scientists, academician and policy makers for the development of policy in livestock and poultry sector. However, I am very much happy to share you all that BLRI is announced to unwrapping the "Livestock and Poultry Production Technology Manual (4th Edition)" in this ceremony. There are 95 technologies included in this directory that will helpful to entrepreneurs, researchers, academicians, farmers and policy makers who are directly or indirectly involved in livestock production and socio-economic progress.

The organizing committee of BLRI Annual Research Review Workshop 2023 grateful to BLRI administration, Ministry of Fisheries and Livestock (MoFL), active participation of the Department of Livestock Services, academia from different universities, scientists from different research institutes, representative from NGO"s, experts from other Organizations who are sharing their expertise during this workshop. I believe that most of the research results and messages documented in this report will be adopted by the farmers and livestock industry and this report will also be helpful to create employment opportunities, generate income & food security and safety in the country.

Dr. Nasrin Sultana
Director (Research)
BLRI, Savar, Dhaka-1341

TECHNICAL SESSIONS

Day 1: Saturday, 23 December, 2023
Venue: BLRI Conference Hall (3rd Floor)

Technical Session I : **ANIMAL AND POULTRY BREEDING AND GENETICS**

Chairperson : **Dr. A.K. Fazlul Haque Bhuiyan**
Professor, Dept. of Animal Breeding and Genetics
Bangladesh Agricultural University, Mymensingh

Co-Chairperson : **Dr. Md. Kabirul Islam Khan**
Professor, Dept. of Genetics and Animal Breeding
Chattogram Veterinary and Animal Sciences University, Chattogram

Rapporteurs : Dr. Mohammad Abdur Rashid, SSO, PPRD, BLRI
Nure Hasni Desha, SSO, BLRI-RS, Rajshahi

1.	11:10-11:20	Strategic development of beef breed(s) in Bangladesh	MP Mostari PSO
2.	11:20-11:30	Conservation and Improvement of Native Cattle	MF Afroz, SSO
3.	11:30-11:40	Productive and reproductive performance of BLRI developed dairy crossbred cattle	MS Islam, SSO
4.	11:40-11:50	Conservation and improvement of indigenous chickens as worthy genetic resources of Bangladesh and development of the heat tolerant high yielding breed/strain	S Faruque, PSO
5.	11:50-12:00	Improvement of egg and meat producing duck through selection and breeding: Production performance (G_8) and field trial of BLRI improved native duck	H Khatun, SSO
12:00-1:00		**Poster presentation (**Roof top, BLRI Conference Hall)	
1:00-2:00		**Lunch and Prayer**	
6.	2:00-2:10	Conservation and Improvement of Exotic germ plasms and validation the performance of BLRI layer chicken 1 (Shuvra) and BLRI layer chicken 2 (Shorna)	KN Monira, PSO
7.	2:10-2:20	Performance evaluation and crossbreeding effects of local, exotic duck and their hybrid (F1) under the semi-intensive system in Bangladesh	MA Hemayet, PhD Fellow
8.	2:20-2:30	Evaluation of exotic pure and their crossbreds sheep in Bangladesh	S Afrin, SO
9.	2:30-2:40	Conservation and Improvement of Black Bengal Goat and its color variants at Bangladesh Livestock Research Institute	NH Desha, SSO
10.	2:40-2:50	Performance evaluation of crossbred buffalo at on-station and on-farm	GK Deb, PSO
2:50-3:30		**Discussion**	
3:30-4:00		**Tae and Snacks**	

Day 1: Saturday, 23 December, 2023
Venue: Administration Building Conference Hall (1rd Floor)

Technical Session II : **ANIMAL AND POULRY DISEASES AND HEALTH**

Chairperson : **Prof. Dr. Nitish C. Debnath**
Former Vice Chancellor
Chattogram Veterinary and Animal Sciences University, Chattogram

Co-Chairperson : **Dr. Malay Kumar Sur**
Director (Planning)
Department of Livestock Services, Dhaka

Rapporteurs : Dr. Md. Amirul Hasan, SSO, AHRD, BLRI
Dr. Md. Zulfekar Ali, SSO, AHRD, BLRI

1.	11:10-11:20	Monitoring and evaluation of Peste des Petits Ruminants virus circulating in Bangladesh and development of vaccine seed	MM Hasan, SO
2.	11:20-11:30	Development of Lumpy Skin Disease Vaccine Seed from Circulating Strain in Bangladesh	D Roy, SO
3.	11:30-11:40	Genomic Mapping and Elucidating the Antimicrobial Resistant Pathogens Evolution in Companion and Farm Animals	MH Rahman, SSO
4.	11:40-11:50	Development of Avian Influenza H9N2 vaccine from circulating strain	MR Karim, SSO
5.	11:50-12:00	Development of Chitosan-Graphene-based Nanobiosensor for Curving Buffalo Mortality through Early-stage Detection of Haemorrhagic Septicaemia	MA Kafi, BAU
12:00-1:00		**Poster presentation (**Roof top, BLRI Conference Hall)	
1:00-2:00		**Lunch and Prayer**	
6.	2:00-2:10	Development of Goat pox vaccine seed from circulating local strain	A Hossen, SSO
7.	2:10-2:20	Identification of major goat health problems and their mitigation in different agro-ecological zones of Bangladesh	MH Rahman, SSO
8.	2:20-2:30	Investigation of Pneumonic Pasteurellosis in sheep and their mitigation to develop a model sheep health management package for ideal farming	MAH Zihadi, SO
9.	2:30-2:40	Surveillance and Molecular evolution of avian influenza virus in Bangladesh	MZ Ali, SSO
10.	2:40-2:50	Epidemiological investigation of major buffalo diseases and evaluation of effectiveness of deworming against buffalo diseases in Bangladesh	OB Paul, SO
2:50-3:30		**Discussion**	
3:30-4:00		**Tae and Snacks**	

Day 1: Saturday, 23 December, 2023
Venue: Goat Production Research Division Conference Room (3rd floor)

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

Chairperson : **Dr. Jahangir Alam Khan**
Former Director General
Bangladesh Livestock Research Institute (BLRI)

Co-Chairperson : **Dr. Mohammad Saidur Rahman**
Professor, Dept. of Agricultural Economics
Bangladesh Agricultural University, Mymensingh

Rapporteurs : Dr. Md. Saiful Islam, SSO, SERD, BLRI
DR. Md. Ashraful Islam, SO, FSRD, BLRI

1.	11:10-11:20	Establishment of "BLRI Technology village" at BLRI Regional station	MA Islam, So
2.	11:20-11:30	Reinforcement of Regional Livestock Research at Naikhongchari	S Sultana, SO
3.	11:30-11:40	Marketing of beef in different areas of Bangladesh	SB Sadrul, SO
4.	11:40-11:50	Assessing livestock rearing knowledge, attitude and practice in the coastal belt of Bangladesh	MP Mostari, PSO
5.	11:50-12:00	Analysis of Farmers" Willingness to Pay (WTP) and Perception for Improved Feeding Technologies in Buffalo Rearing: Evidence from Field Experiment	MR Amin, SO
12:00-1:00		**Poster presentation (**Roof top, BLRI Conference Hall)	
1:00-2:00		**Lunch and Prayer**	
6.	12:20-12:30	Identification of Research gap of Native chicken in some selected areas of Banglaesh	S Sultana, SO
7.	12:30-12:40	Assessing baseline status, and knowledge, service and technology need of livestock farmers in selected saline and drought affected areas	SM Amanullah, PSO
2:50-3:30		**Discussion**	
3:30-4:00		**Tae and Snacks**	

Day 1: Saturday, 23 December, 2023
Venue: Conference Room, Training Dormitory

Technical Session IV : **BIOTECHNOLOGY, ENVIROMENT, CLIMATE RESILIENCE AND WASTE MANAGEMENT**

Chairperson : **Dr. MAM Yahia Khandoker**
Professor, Dept. of Animal Breeding and Genetics
Bangladesh Agricultural University, Mymensingh

Co-Chairperson : **Dr. Md. Harun-ur-Rashid**
Professor, Department of Dairy Science
Bangladesh Agricultural University, Mymensingh

Rapporteurs : Jobaida Shovna Khanom, SSO, GPRD, BLRI
Anower Hosen, SO, DRTC, BLRI

1.	11:10-11:20	Analysis of Candidate Genes for Prolificacy Trait in Black Bengal Goat of Bangladesh	NH Desha, SSO
2.	11:20-11:30	Production and utilization of Gelatin from bovine hides	SA Tule, SO
3.	11:30-11:40	*De novo* whole genome sequence of indigenous chicken (Hilly chicken) of Bangladesh and genome annotation to unveil genetic variations to explore the evolution and adaptation at genome level	AMAMZ Siddiki, CVASU
4.	11:40-11:50	Determination of Oxalate content in Napier varieties and Identification of gene responsible for oxalate content in Napier	MT Islam, SO
5.	11:50-12:00	Establishment of milk processing facilities for the development of premium dairy products	AS Afsana, SO
12:00-1:00		**Poster presentation (**Roof top, BLRI Conference Hall**)**	
1:00-2:00		**Lunch and Prayer**	
6.	2:00-2:10	Assessment of environmental stresses on different genetic groups of dairy Cattle and development of their mitigation strategies	EA Pehan, SO
7.	2:10-2:20	Standardization of estrus synchronization techniques for improvement of reproductive efficiency of native buffaloes in Bangladesh	M Moniruzzaman, BAU
8.	2:20-2:30	Optimizing the process technology of manufacturing value added diversified buffalo milk cheese and rasomalai based on their nutritional and physicochemical profile	MA Islam, BAU
9.	2:30-2:40	Assessing the effect of postbiotics of lactic acid bacteria on improving the safety and quality of broiler meat	MM Rahman, PhD Fellow
10.	2:40-2:50	Production of beta-cyclodextrin for the development of low cholesterol milk and milk products	A Hosen, SO

11.	2:50-3:00	SNP Analysis and Gene Expression Profiling for Milk Fat and Protein Related Traits in River Buffalo Populations of Bangladesh	MSA Bhuiyan, BAU
12.	3:00-3:10	Unlocking the microbial diversity in artisanal „Buffalo Milk Curd" to formulate probiotic based bio-functional starter culture towards developing healthy Dahi	MM Rahman, BSMAU
3:10-3:40		**Discussion**	
3:40-4:00		**Tae and Snacks**	

Day 1: Saturday, 23 December, 2023

Venue: Poultry Production Research Division Conference Room (1st Floor)

Technical Session V : **NUTRITION, FEEDS AND FEEDING MANAGEMENT**

Chairperson : **Dr. Khan Md. Shaiful Islam**
Professor, Dept. of Animal Nutrition
Bangladesh Agricultural University, Mymensingh

Co-Chairperson : **Dr. A.B.M. Khaleduzzaman**
Director (Production),
Department of Livestock Services, Dhaka

Rapporteurs : Md Khairul Bashar, SSO, BLRI
Lipi Rani Sarker, SO, GPRD, BLRI

1.	11:10-11:20	Improvement of feeds and fodder for development roughage-based feeding strategy for Dairy and Beef Cattle production	MS Hasan, SO
2.	11:20-11:30	Development of TMR based Feeding Strategy for Dairy Cattle	MT Islam, SO
3.	11:30-11:40	Assessment of supplementing maize grain with best management practice (BMP) of Napier grass on intake, digestibility and growth performance of RCC bulls	BK Roy, PSO
4.	11:40-11:50	Field validation of stress tolerant mutant lines of fodder developed by BLRI	MM Billah, SO
5.	11:50-12:00	Effect of Complete Pellet feed on the Growth, Carcass and Meat Quality Characteristics of Different Age Group of Castrated Black Bengal Goat	S Ahmed, PSO
12:00-1:00		**Poster presentation (**Roof top, BLRI Conference Hall)	
1:00-2:00		**Lunch and Prayer**	
6.	2:00-2:10	Development of feeding and nutritional management practices for optimization of dairy performances in buffalo	M Miah, SO

7.	2:10-2:20	Fattening castrated male goat through cost effective grass based TMR under stall-fed condition	MF Afroz, SSO
8.	2:20-2:30	Nutritional Assessment of Some Selected Tree Fodder for Goat Feeding	JS Khanam, SSO
9.	2:30-2:40	Development of buffalo fattening model for quality meat production	MA Alam, SSO
10.	2:40-2:50	Production of value-added poultry meat and egg through dietary manipulation of selected herbal plants	MSK Sarker, PSO
2:50-3:30		**Discussion**	
3:30-4:00		**Tae and Snacks**	

Day 2: Sunday, 24 December, 2023
Venue: Roof top, BLRI Conference Hall (3rd Building)
Time: 9:30 am – 12:50 pm

POSTER SESSION

Evaluation Committee:

1. Dr. Mohammad Al-Mamun, Professor, Dept. Animal Nutrition, BAU, Mymensingh — Convener
2. Rajuana Afrin Khan, Dairy Officer, Central Cattle Breeding Station and Dairy Farm, DLS, Dhaka — Member
3. Dr. Mohammad Rafiqul Islam, CSO, BARC, Dhaka — Member Secretary

Sl. No.	Title	Presenter
1.	Evaluation of production performance and nutrient components of different fodder varieties and development of fodder germplasm bank at BLRI RS Rajshahi	AA Hossain, SO
2.	Development of meat type quail through appropriate breeding	MT Hossain, SO
3.	Development of meat type chicken utilizing native and exotic genetic resources suitable for climatic condition of Bangladesh	F Tabassum, PhD Fellow
4.	Collection, conservation and improvement of specialized fowl (Turkey, Guinea fowl and Pigeon) production at BLRI	MSK Sarker, PSO
5.	Conservation and performance evaluation of pure RCC cattle and their graded progeny at community level	D Das, SO
6.	Ex-situ conservation and improvement of native sheep at Bangladesh Livestock Research Institute	MMH Pasha, SO
7.	Conservation and Improvement of Black Bengal Goat at different community in Bangladesh	JS Khanam, SSO
8.	Molecular identification of the Black Bengal Goat in Bangladesh using DNA barcoding	S Ahmed, PSO

9.	Conservation and improvement of indigenous buffalo for milk production through open nucleus breeding program	KT Tahira, SO
10.	Development of animal recording and genetic evaluation system to foster indigenous buffalo selection program	AKFH Bhuiyan, BAU
11.	Development of cost-effective semen cryopreservation technique for indigenous Buffalo and Goat of Bangladesh	SF Shejuty, SO
12.	Quality and safety assessments of milk and the development of fortifying dairy products	S Sultana, SO
13.	Impact of waste management practices in buffalo farms	MIA Sarker, SO
14.	*In vitro* embryo production of buffalo	KT Tahira, SO
15.	Increasing efficiency of artificial insemination for improving conception rate in river buffalo	AK Paul, PSTU
16.	Recycling of poultry wastes for environment friendly low cost poultry production	MA Rashid, SSO
17.	Development of Feeds and Fodder Data Base for Efficient Feeding System for Livestock Production	MT Islam, SO
18.	On-farm measurement of noxious greenhouse gases from poultry litter and their possible utilization	S Sultana, SSO
19.	Conservation and development of native geese production package by determining feed requirement with supplemental forages	MUS Ety, SO
20.	Development of multivalent (*Eimeria tenella, E. necatrix, E. brunetti, E. maxima*) coccidial vaccine for poultry.	MZ Hassan, SSO
21.	Development of *Salmonella* vaccines from circulating strains of poultry in Bangladesh	ZB Bupasha, SO
22.	Classical, applied, and molecular epidemiological studies to develop disease risk management, treatment, and control model of FMD, Anthrax, and HS in Buffaloes	SSU Ahmed, SAU
23.	Exploring a model for the buffalo calf health management through improved therapeutics against pneumonia and diarrheal diseases in selected	MH Talukder, BAU
24.	Community involving economic diseases control model for chicken	MH Kabir, SSO
25.	Socioeconomic analysis of antibiotic use in poultry production in Bangladesh	MS Islam, SSO
26.	Impact of training given to farmers on BLRI technologies	MR Hasan, SO

RECOMMENDATION AND CLOSING SESSION

Day 2: Sunday, 24 December, 2023
Venue: BLRI Conference Hall (3rd Floor)

Time: 2:00-4:00 pm

Chief Guest	**Dr. Shaikh Mohammad Bokhtiar** Executive Chairman Bangladesh Agricultural Research Council, Dhaka
Special Guest	**A.T.M. Mostafa Kamal** Additional Secretary Ministry of Fisheries and Livestock
Chairperson	**Dr. SM Jahangir Hossain** Director General Bangladesh Livestock Research Institute Savar, Dhaka

CONTENTS

Research First

TECHNICAL SESSION: I

ANIMAL AND POULTRY BREEDING & GENETICS

ARRW-2023

Strategic development of beef breed (s) in Bangladesh

MP Mostari, KN Papry, MYA Khan, MF Afroz and BK Roy
Animal Production Research Division, Bangladesh Livestock Research Institute, Savar, Dhaka

Executive Summary

Beef is one of the greatest sources of animal protein and it has a great demand in Bangladesh. But the price of beef is increasing tremendously especially in the last 1.5 decades. The hike in beef prices that may be due to high feed costs and the lower carcass yield of native cattle. In addition, there is no specialized high yielding beef cattle breed in the country. Therefore, to meet the growing demand of this protein, uphold the nutritional status of the nation, beef production of the country must be increased many folds. Considering the above facts, the present research program was undertaken to select the suitable exotic beef sire (s) for crossing with native cattle. The goal of the experiment was to select suitable beef producer, which will be able to produce at least 200.0 kg carcass weight within 2 years of age under on farm feeding and management condition. For this, the cows of BLRI Cattle Breed 1 (BCB-1; dam line) were inseminated with frozen semen of Brahman, Simmental, Charolais and Limousine. A total of 101 F_1, F_2 and F_3 crossbred progeny of different beef genotypes were produced during the period of 2015 to 2023. Due to feeding trial, slaughtering for carcass yield & meat characteristics and routine culling at present a total number of 50 crossbred progeny of different genotypes are available at BLRI cattle research farm. Out of them, 26 (F_1=11, F_2=14, F_3=1) are Simmental cross, 19 (F_1=13, F_2=6) are Charolais cross, 2 (F_1) of Limousine cross and 3 (F_1) of Brahman cross. All beef progeny were raised under similar feeding and management condition and their feed intake, body weight at different physiological stages, average daily gains, disease incidence and mortality, meat yield & carcass characteristics, milk yield etc. were recorded and evaluated accordingly. All collected data were analyzed using "agricolae" package of R software (version 3.5.1). After performance evaluation of F_1 progeny and controlled purebred BCB-1, Simmental×BCB-1 and Charolais×BCB-1 crossbred were selected as future beef producer (s) and raised for production of F_2 progeny through *inter-se* mating.

Table 1. Comparative growth performance of F_1 progeny of different beef genotypes and BCB-1 up-to market age (2 yrs).

Live weight (kg)	Genotypes (Mean±SD)					Sig.
	Purebred BCB-1	Brahman cross	Charolais cross	Limousine cross	Simmental cross	
Male						
At birth	18.84^{b}±3.40(5)	24.90^{a}±2.48(7)	25.70^{a}±6.09(9)	22.43^{ab}±4.77(9)	23.08^{ab}±2.10(6)	*
At 1 yr	202.20±9.75(5)	250.14±19.75(7)	246.14±74.19(7)	231.62±41.41(8)	235.60±60.32(5)	NS
At 2 yrs	348.00^{d}±20.0(5)	407.14^{c}±15.23(7)	495.00^{ab}±40.92(4)	472.66^{b}±38.(6)	543.50^{a}±105.35(2)	***
ADG (0-24 M)	0.46^{d}±0.03 (5)	0.57^{c}±0.05 (7)	0.67^{ab}±0.03 (4)	0.65^{b}±0.04 (6)	0.74^{a}±0.16 (2)	***
Female						
At birth	16.84^{b}±4.13(5)	22.54^{a}±2.01(5)	25.55^{a}±4.16(6)	22.58^{a}±6.13(7)	22.79^{a}±2.87(13)	*
At 1 yr	173.6^{b}±9.31(5)	210.6^{ab}±26.43(5)	225.83^{a}±43.7(6)	205.57^{ab}±37.13(7)	229.72^{a}±45.49(11)	NS
At 2 yrs	290.8^{c}±11.79(5)	$323.6b^{c}$±14.32(5)	382.2^{ab}±47.83(5)	385.25^{ab}±69.73(4)	413.87^{ab}±75.88(8)	**
ADG (0-24 M)	0.38^{c}±0.01 (5)	0.42^{bc}±0.02 (5)	0.49^{ab}±0.07 (5)	0.50^{ab}±0.10 (4)	0.55^{a}±0.10 (5)	**

***Highly significant (p<0.001);**Significant (p<0.01); *Significant (p<0.05); SD= standard deviation; NS= not significant; value in the parenthesis indicate the number of observation; ADG; average daily gain

Table 1 showed the comparative live weights and average daily gain of F_1 progeny of different beef genotypes and BCB-1 up-to market age (2 yrs). Irrespective of sex, Simmental cross showed the highest live weight (p<0.01) and average daily gain (p<0.01) compared to other beef genotypes. Live

weight, carcass weight and meat to bone ratio showed significant differences among the studied genotypes (Table 2). Simmental crossbred showed the highest carcass weight and meat to bone ratio as compared to other genotypes (Table 2). In case of lipid profile, there was a significant difference ($p<0.05$) in HDL and LDL values (Table-2) among the different genotypes and the highest HDL was found in Simmental cross. Feeding trails with crossbred progeny of Simmental and Charolais crosses were conducted and found significant differences at market age between F_1 and F_2 progeny of Simmental and Charolais crosses (Table 3). Interestingly, in Simmental cross F_2 progeny showed better FCR than F_1 progeny that may be due to sample size and management practices. The daily milk yield of F_1 dams of Simmental cross varied from 5.75 to 20.40 liters/day with 4.97% fat. In the last year (2022-23), a total number of 5211 frozen semen straws of different F_1 crossbred bulls were produced and stored for further research purposes.

Table 2. Meat yield characteristics and quality of different F_1 crossbred beef genotypes and BCB-1 bulls

Parameter	Genotype (Mean±SD) at 2 years of age					Sig.
	Purebred BCB-1 (n=3)	Brahman cross 1(n=3)	Charolais cross (n=3)	Limousine cross (n=3)	Simmental cross (n=3)	
Live wt. (kg)	356.33^{c}±22.36	417.00^{bc}±13.52	487.00^{ab} ±46.13	488.67^{ab} ±21.38	542.33^{a} ±74.52	**
Warm carcass wt. (kg)	207.95^{c}±9.89	247.38^{bc}±10.97	288.89^{ab}±30.83	286.78^{ab}±15.21	314.13^{a}±45.42	**
Chilled carcass wt. (kg)	206.86^{c}±9.30	246.16^{bc}±11.11	287.70^{ab}±30.55	285.70^{ab}±14.85	313.06^{a}±45.40	**
Meat and bone ratio	4.98^{a}±0.10	3.97^{b}±0.08	4.95^{a}±0.06	4.89^{a}±0.26	4.98^{a}±0.18	***
Total fat %	2.44±0.50	3.30±0.29	2.85±0.55	3.95±0.74	2.40±0.74	NS
LDL (ug/g)	179.33±12.06	189.16±4.74	194.42±6.77	185.61±8.78	147.37±4.13	**
HDL (ug/g)	113.22±2.87	108.22±3.71	112.92±3.33	111.14±3.40	157.19±19.80	*

***Highly significant ($p<0.001$); ** Significant ($p<0.01$; *Significant ($p<0.05$); SD= standard deviation; NS= not significant; value in the parenthesis indicate the number of observation; HDL=High density lipoprotein; LDL= Low density lipoprotein

Table 3. Comparative live weight, growth and FCR of F_1 and F_2 of Simmental and Charolais crosses

LW (kg)	Mean±SD (n)					
	Simmental cross			Charolais cross		
	F_1	F_2	Sig.	F_1	F_2	Sig.
At birth	23.35±2.54(4)	23.48±2.77(5)	NS	27.30±7.01(6)	25.70±7.01(4)	NS
Weaning	63.25±21.04(4)	58.20±10.63(5)	NS	67.18±18.70(6)	56.29±9.94(4)	NS
1 year	244.25±65.98(4)	216.65±19.23(5)	NS	260.66±69.52(6)	187.00±40.20(4)	NS
2 years	499.66±123.92(3)	367.05±30(5)	*	456.33±66.67(6)	345.00±34.15(4)	*
FCR	11.22±0.20(6)	8.41±0.25(3)	***	11.33 ±0.71(5)	11.85±0.91(2)	NS

*Significant ($p<0.05$); SD= standard deviation; NS= not significant; value in the parenthesis indicate the number of observation

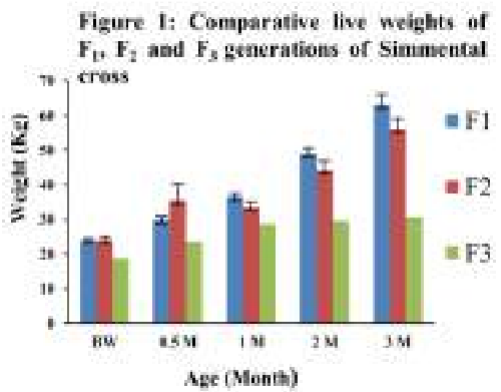

Figure 1 showed the highest body weight in F_1 progeny followed by two successive generations that may be due to high hybrid vigor. Based on the findings, it can be stated that Simmental crossbred showed the best performance among the studied genotypes. Production and evaluation of market beef cattle by using BLRI developed assorted beef bulls through field trial will be conducted. Thus, high yielding beef breeds of 75%, 50% and 25% genetic levels are yet to be produced to calculate their precise performance and achieve the goal.

Conservation and Improvement of Native Cattle

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Executive Summary

Munshiganj Cattle (MC), North Bengal Grey (NBG) and Netrokona Black cattle (NBC) are pure/improved varieties/types of cattle localized in some areas of the country, mainly found in Munshiganj & adjunct areas of the district, northern part and Netrokona & Haor areas, respectively in Bangladesh. However, the population of MC and NBG are declining gradually day by day in their breeding tract. Hence, conservation of MC and NBG, subsequent improvement and breeding with pure MC and NBG are necessary. Therefore, the present study was undertaken to consider the following objectives, i) to characterize MC and NBG cattle phenotypically and genetically under *ex-situ* condition ii) to study the distribution pattern, density, population size and phenotypic characteristics of NBG and NBC under surveyed area (in-situ). All kinds of productive and reproductive data were recorded in the nucleus herd. Data were analysed in an ANOVA of a Completely Randomized Design (CRD) using SPSS 25.0 version statistical package. The fixed factors considered parity, generation, season of birth for milk production and milk composition traits. The following parameters were estimated for milk production and milk quality assessment such as total locational length (TLL), daily milk yield (DMY), lactation yield (LY), fat, protein, SNF, lactose, conductivity, freezing point, temperature and ash content of MC milk. The morning and evening milk samples in every week were collected from MC considering with different lactation period. After milking of cows, the milk was stirred properly and 50ml milk sample was taken in test tube then Ultra-scan milk analyzer was used for testing the milk samples. A baseline survey was performed with a pre-tested questioner to determine the availability of NBG and NBC cattle in selected area of Rajshahi, Naogaon, Bogura, Joypurhat, Rangpur and Netrokona district to know the distribution, density, population dynamics and phenotypic characteristics with their farm categories and production systems. The morphometric body measurements of NBG were taken according to FAO guidelines (FAO, 2012). Morphometric encompassed body weight (BWT), body length (BL), heart girth (HG), wither height (WH), hip height (HH), neck length (NL), head length (HL), head width (HW), horn length (HL_1), horn distance (HD), ear length (EL), mouth circumference (MC) and tail length.

A total number of MC are 46 including 11 breeding bull, 22 adult females, 3 growing males, 7 heifer and 3 milking calves, respectively were conserved in BLRI nucleus herd.Generation of calving and calving parity did not affect ($p>0.05$) TLL, TMY, DMY and their respective average values were 184.16±10.36 days, 543.90±47.65 Kg and 2.89±0.16 Kg (Table 1). However, the composition of milk fat and density had significant ($p<0.001$) effect on parity and generation of MC. On the other hand, season of calving had no effect ($p>0.05$) on milk fat and density (Table 2). The average milk fat, protein, SNF, density, ash, conductivity, pH, temperature and lactose were 5.98, 3.26, 8.84, 28.51, 4.33, 0.73, 6.70, 34.89 and 4.86 % in MC cattle. The percent of milk fat increases with the advancement of the generation of calving and calving parity. In this year, two MC cows were procured from their habitat. For *in situ* conservation, a MC rearing community was established in Munshiganj district. Table 3 shows the NBG cattle distribution pattern whereas a total of 349 NBG found in four districts. Fig.1 shows NBG cattle distribution pattern by age in the surveyed areas. The morphometric traits of NBG were considered at adult age combined with sex. Most of the morphometric parameters were significantly affected by region of cattle at adult age. Effects of region were found to be significant on BL, HH, HL, ($p<0.05$), WH, HG, HL_1, HD ($p<0.001$) and BWT, EL ($p<0.01$), respectively. On the other hand, HW and MC were not significantly affected ($p>0.05$) by region of cattle at adult age. The average BWT, BL, HG, and WH of NBG were 177.30±3.98 kg, 41.48±0.66, 51.3±0.95 and 41.5±0.36 inch, respectively (Table 4). From the survey, it was revealed that NBC found 146 out of 431 in Netrokona (Table 5) to investigate the distribution of color pattern on coat, skin, muzzle, eye, eyelid, hoof and tail switch color in male and female were black in most of the cases. Fig. 2 represented the NBC cattle distribution pattern by age in the surveyed areas. It shows that animal population is constituted by 4 types of cattle such as 1) NBC, 2) Crossbred, 3) Deshi, and 4) RCC. Compositions of crossbreds are Holstein Friesian (HF) inheritance in Local or NBC. Proportion (%) of NBC, crossbred, Deshi and RCC were 33.95, 3.25, 61.16 and 1.63, respectively.

Table 1: Milk production Traits of MC as affected by generation of calving and calving parity

Factors	Milk production Traits (Mean± SE)		
	Total lactation length (d)	Lactation yield (Kg)	Av.Daily milk yield (Kg)
Generation (up to 3)	NS	NS	NS
Parity (up to 7)	NS	NS	NS
Overall mean	184.16±10.36 (51)	543.90±47.65 (51)	2.89±0.16 (51)

Table 2: Effect of season, parity and calving generation on milk properties of MC

Items		**Milk composition (mean±SEM) %**				
		Fat	**SNF**	**Density**	**Protein**	**Lactose**
Season of Calving	Winter	5.9±.0.17	8.93±.0.07	29.02±.36	3.30±0.033	4.91±0.03
	Rainy	6.06±.0.31	8.73±.0.06	27.91±.42	3.21±0.025	4.7±0.03
	Sig. lev.	NS	NS	NS	*	*
Calving Parity	1st	5.9±0.17	8.9±0.07	29. ±0.36	3.3±0.03	4.9±0.03
	2nd	4.2±0.21	8.8±0.09	29.7±0.51	3.2±0.05	4.8±0.04
	3rd	6.8±0.25	8.7±0.08	27.0±0.45	3.1±0.02	4.7±0.04
	Sig. lev.	***	NS	***	NS	*
Generation of Calving	1st	5.17±0.21	8.9±0.07	29.5±0.34	3.3±0.03	4.9±0.03
	2nd	6.6±0.18	8.7±0.06	27.5±0.37	3.2±0.02	4.7±0.03
	3rd	7.0±0.70	9.0±0.43	28.8±2.4	3.3±0.20	4.9±0.23
	Sig. lev.	***	NS	***	NS	*
Overall mean		5.9±0.16	8.8±0.05	28.51±0.28	3.2±0.02	4.8±0.02

Table 3: Number of cattle by breed/genotype in the surveyed areas

Districts	Upazila	N. of households	Total no. of cattle	Breed/Genotype					
				NBG	Deshi	RCC	Pabna	MC	CB
Rajshahi	Godagari	50	262	131	121	2	4	-	4
	Tanor	30	70	32	30	-	5	1	2
Bogura	Shibgonj	29	121	16	105	-	-	-	-
	Sadar	38	89	20	69	-	-	-	-
Naogaon	Sadar	60	173	90	73	1	6	1	2
Joypurhat	Sadar	47	20	3	-	3	-	-	14
	Kalai	106	334	57	115	-	-	-	162
Total		360	1069	349	513	6	15	2	184

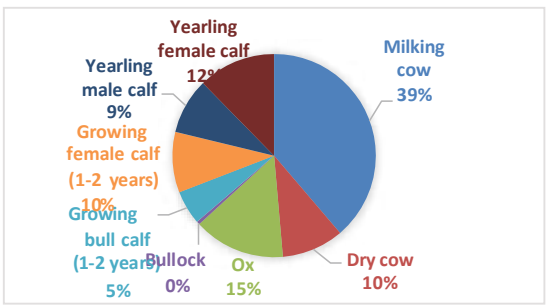

Fig. 1 NBG cattle distribution pattern by age in the surveyed areas

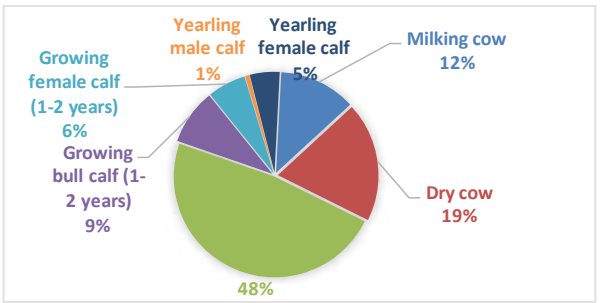

Fig. 2 NBC cattle distribution pattern by age

Table 4: Morphometric measurement of NBG (Mean±SEM) cattle

Parameters	Morphometric measurement (Mean±SEM)											
	BWT (kg)	BL (inch)	HG (inch)	WH (inch)	TL (inch)	HH (inch)	HL (inch)	HW (inch)	HL_1 (inch)	HD (inch)	EL (inch)	MC (inch)
Average value	177.30± 3.98 (135)	41.33± 0.30 (135)	52.70± 0.50 (135)	41.84± 0.25 (125)	29.48± 0.39 (133)	42.82± 0.21 (134)	15.92± 0.11 (134)	6.49± 0.30 (129)	15.92 ±0.11 (134)	4.84± 0.11 (129)	6.89± 0.08 (131)	14.36± 0.11 (131)

Table 5: Cattle population by breed/genotype in Netrokona district under four upazila

Type of cattle	Barhatta	Durgapur	Sadar	Modon	Total
NBC	8	2	126	10	146
Crossbred	6	3	3	3	15
Deshi	25	81	121	36	263
RCC	5	-	2	-	7
Total	44	86	252	49	431

Based on the above findings, it may be said that generation of calving and parity of cows had no effect on lactation length and total milk yield of MC. The predominant coat color in NBC in either sex is black. Whereas, the color pattern on the skin, muzzle, eye, hooves, horn, tail switch, and eyelids in both sexes was mostly black. The productivity of MC, NBG, and NBC can be increased by using a community-based breeding program that ensures farmers' participation and good management practices.

Productive and reproductive performance of BLRI developed dairy crossbred cattle

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Executive Summary

Crossbred cows are popular to farmers because they produce more milk than indigenous cows. Crossbreeding of indigenous cattle with exotic breeds of high genetic potential could be considered a rapid and effective method for the genetic improvement of dairy animals. Appropriate data recording of productive and reproductive performance with pedigree information is a prerequisite for an efficient crossbreeding program. In Bangladesh, crossbreeding in cattle started through Artificial Insemination (AI) to increase milk production. Crossbreeding without proper records leads to genetic dilution of the promising indigenous cattle. Moreover, most of the crossbred genotypes are genetically admixed with several breeds, which are not justified for a breed development program. In consequence, limited systematic information on the crossbred cattle population is available in the country. Thus, it is necessary to establish crossbred dairy cattle by crossing a known purebred native cows with exotic bulls to determine the actual productive and reproductive performance of the crossbred. In this perspective, Bangladesh Livestock Research Institute (BLRI) has taken the initiative to establish a crossbred dairy cattle herd of 50% Holstein Friesian (HF) × 50% Pabna cattle at Regional station, BLRI, Baghabari. A nucleus herd of indigenous Pabna cattle was established at the regional station (RS), BLRI, Baghabari in 2017 before conducting crossbreeding program. Productive and reproductive data were recorded throughout the year in both hard and soft forms. The independent sample *t-test* was performed to compare the mean value using the SPSS 22.0 statistical program. Table 1 showed the present population of dairy crossbred cattle (49) consisting of 21 males and 28 females and purebred Pabna cattle (62) involving 40 females, and 22 males. Highly significant ($p<0.001$) differences were found in body weights at birth, 6-month, 12-month, 18-month, and 24-month of ages between dairy crossbred and purebred Pabna cattle (Table 2). Average daily gain (ADG) was found significant difference between dairy crossbred and purebred Pabna cattle at birth to 6 months, 6-12 months, 18-24 months, birth- 24 months except 12-18 months of age (Table 3). Weight at puberty (kg), age at first conception (days), and age at first calving (days) were found significant difference between two groups except age of puberty (days) (Table 4). Total milk yield (l), average milk yield (l/d) at 105 days were found 651.62±114.58, 6.21±1.09 and 290.84±28.51, 2.77±0.27 for dairy crossbred and purebred Pabna cattle, respectively. In conclusion, newly developed dairy crossbred cattle by crossing 100% HF with pure indigenous Pabna cows would be a suitable for sustainable and profitable dairy farming in the changing climatic condition of Bangladesh.

Table 1: Present population of dairy crossbred and purebred Pabna cattle at Baghabari

	Male	Female	Total
HF× Pabna	21	28	49
Purebred Pabna	22	40	62
	Grand Total		111

Table 2. Productive performance of BLRI developed dairy crossbred cattle compared to purebred Pabna

Parameters	Crossbred	Purebred Pabna	Level of significance
	Mean ±SE (n)	Mean ±SE (n)	
Birth weight (kg)	22.14±0.33 (57)	18.86±0.23 (101)	***
6-month (kg)	96.21±3.75 (36)	80.92±1.77 (55)	***
12-month(kg)	189.48±4.82(23)	117.91±2.61(43)	***
18-month(kg)	232.31±5.53 (16)	171.32±7.04 (24)	***
24-month(kg)	276.93±5.64 (11)	245.47±9.97 (19)	**
Total milk yield at 105 days (L)	651.62±114.58	290.84±28.51	***
Average milk yield at 105 days (L/D)	6.21±1.09	2.77±0.27	***

***Highly significant at 1% level; **Significant at 1% level

Table 3. Average daily gain (ADG) of BLRI developed dairy crossbred cattle compared to purebred Pabna

Age	Crossbred	Purebred Pabna	Level of significance
	Mean ±SE	Mean ±SE	
Birth to 6-month	0.45±0.31	0.35±0.19	*
6 to 12-month	0.46±0.48	0.21±0.24	***
12-18-month	0.28±0.03	0.26±0.04	NS
18-24-month	0.27±0.02	0.41±0.04	*
Birth -24-month	0.71±0.02	0.63±0.03	**

***Highly significant at 1% level; **Significant at 1% level; *Significant at 5% level, and NS=non-significant difference at 95% confidence interval ($p>0.05$)

Table 4. Reproductive performance of BLRI developed dairy crossbred cattle compared to purebred Pabna

Parameters	Crossbred	Purebred Pabna	Level of significance
	Mean ±SE	Mean ±SE	
Age at puberty (days)	692.36±37.14	760.14±55.14	NS
Weight at puberty (kg)	256.97±7.23	179.57±7.47	***
Age at first conception (days)	709.57±41.73	855.57±30.38	*
Age at first calving (days)	1003.38±45.24	1130.57±31.04	*

***Highly significant at 1% level; *Significant at 5% level, and NS=non-significant difference at 95% confidence interval ($p>0.05$)

Development of climate resilient egg and meat type breed/strain using native germplasm

Component A: Conservation and improvement of indigenous chickens as worthy genetic resources of Bangladesh and development of the heat tolerant high yielding breed/strain

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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 indigenous chicken genotypes under intensive management, (ii) to select parental birds (males and females) and breed them in an assortative plan for the production of eleventh generation, (iii) to estimate variance, covariance components and genetic parameters of economic traits of Indigenous Chicken genotypes and (iv) to develop heat tolerant high yielding dual purpose variety suited for the extreme hot-humid climatic condition of Bangladesh. A total of 4118-day-old chicks comprising of 3 types of chicken namely Naked Neck (NN-1318), Hilly (HI-1240) and Non-descript Deshi (ND-1560) were hatched in two batches to produce eleventh generation (G_{11}). Improvement target of egg production (EP) rate is to increase by 2% per generation, improvement target of egg weight (EW) is to increase by 1 g, and improvement target of growth rate is to increase by 20 g per generation. In the eleventh generation (G_{11}), selection was practiced at 40 week of age on the basis of selection index to produce next generation. Selected males and females were mated assortatively with a maximum male to female ratio of 1: 5. The artificial insemination protocol was used to avoid mating among close relatives. Semen was collected manually from male by abdominal massage technique at 28, 32 and 36 week of age. Recorded data were analyzed in a CRD by Generalized Linear Model (GLM) procedure using SPSS 20.0 for Windows

Body weight at day old chicks and at 8th week was significantly ($p<0.001$) higher in ND (30.6 g) and HI (717.5 g) respectively compared to other genotypes (Table 1). Feed conversion ratio (FCR) was significantly ($p<0.001$) better in HI (2.91) than ND (3.26) and NN (3.34) up to 8 weeks of age. Annual egg production (no) was significantly ($p<0.001$) higher in NN (193.5), intermediate in ND (187.4) and lowest in HI (165.5). The fertility rate was higher ($p<0.001$) in NN (84.80%) whereas the hatchability (83.19%) on fertile eggs obtained from HI was higher ($p<0.001$). Age at sexual maturity (ASM) varied among three genotypes of indigenous chickens ($p<0.001$). The NN (155.8 days) reach in sexual maturity ($p<0.001$) 10.8 days earlier than HI (166.6 days).Table 2 showed that EP of ND, HI and NN birds was expected to increase by 0.83, 2.24 and 1.41%, respectively. The EW of ND, HI and NN birds was expected to increase by 0.09, 0.28 and 0.19g, respectively. Higher semen volume was observed in NN at all stages of age compared to other genotypes (Figure 1). In all genotype semen volume was increased with the increased of body weight group (Figure 2). Number of effective population size (Ne) was 100 (Table 3). The rate of inbreeding (ΔF) calculated for the native chicken considering the existing flock size and management practice was 0.005 (0.5%). The rate of inbreeding in *ex-situ* conservation system is found very negligible. It is concluded that different genotypes have significant effect on chick weight, 8th week body weight, FCR, egg production, fertility, hatchability and age at sexual maturity. On the other hand body weight group and genotype had significant effect on semen volume.

Table 1: Performances of native chicken genotypes at 11th generation (G_{11})

Parameter	Genotype (Mean±SE)			Sig. level
	ND	HI	NN	
Day-old chick weight(g)	30.6^{a}±0.16	29.8^{b}±0.17	30.4^{a}±0.15	p<0.001
Body weight at 8th week (g)	640.2^{b}±4.93	717.5^{a}±5.90	631.6^{b}±5.39	p<0.001
FCR (0-8 week)	3.26^{a}±0.3	2.91^{b}±0.04	3.34^{a}±0.04	p<0.001
Annual egg production (no.)	187.4^{b}±1.2	165.5^{c}±1.2	193.5^{a}±1.2	p<0.001
Fertility%	80.5^{b}±1.7	81.6^{b}±1.71	84.8^{a}±1.6	p<0.001
Hatchability (on fertile egg)%	78.8^{ab}±1.9	83.19^{a}±2.04	75.39^{c}±2.0	p<0.001
Age at Sexual maturity (d)	157.9^{b}±1.1	166.6^{a}±0.9	155.8^{b}±0.9	p<0.001

BW=Body weight; ND=Non-descript Deshi, HI=Hilly, NN=Naked Neck, FCR= Feed Conversion Ratio; least squares mean without a common superscript along the row within a factor differed significantly (p<0.001), NS=Non-significance; Values are (mean ± SE).

Table 2: Estimation of genetic parameters of indigenous chickens in eleventh generation (G_{11})

Genotype	Trait	Before selection	After selection	Selection differential (SD)	Selection intensity (i)	Heritability (h^2)	Expected response (R)
ND	EW(g)	45.2	45.38	0.18	0.307539	0.49	0.09
	EP (%)	61.2	62.86	1.66	0.184274	0.50	0.83
HI	EW(g)	43.72	44.33	0.61	0.373657	0.46	0.28
	EP (%)	45.5	50.08	4.58	0.216581	0.49	2.24
NN	EW(g)	44.94	45.33	0.39	0.272785	0.49	0.19
	EP (%)	57.51	61.54	4.03	0.279889	0.35	1.41

ND=Non-descript Deshi, HI=Hilly, NN=Naked Neck, EW=Egg weight, EP=Egg Production

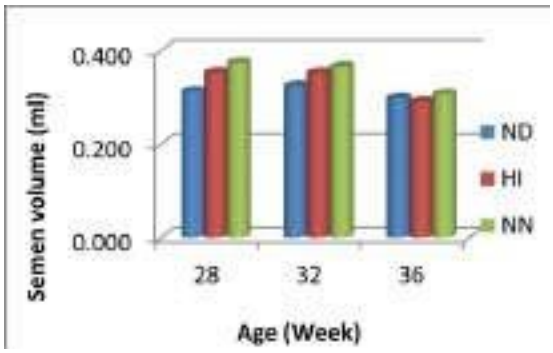

Fig 1: Effect of age on semen volume (ml)

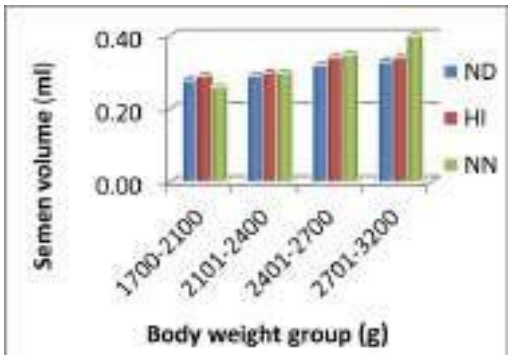

Fig 2: Effect of body weight on semen volume (ml)

Table 3: Estimation of effective population size and rate of inbreeding of three indigenous chickens

Generation	Sires	Dams	Effective population size (N_e)	*Selection intensity (i)	Rate of inbreeding (ΔF)
ND- S_{11}	30	150	100.00	0.558	0.005
HI-S_{11}	30	150	100.00	0.596	0.005
NN- S_{11}	30	150	100.00	0.567	0.005

S_{11} indicates the generation of selection; *Selection intensity only for egg production (%)

Development of climate resilient egg and meat type breed/strain using native germplasm

Component B: Improvement of egg and meat producing duck through selection and breeding: Production performance (G_8) and field trial of BLRI improved native duck

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Executive Summary

A duck breeding program is essential for the conservation of pure lines and to improve the genetic potential of existing local duck populations. So far, guided breeding and scientific management practices have not been followed in the country, which will result in the loss of rich native duck germplasm. Bangladesh Livestock Research Institute (BLRI) has conserved two native duck genotypes since 2012. The purpose of this study was to investigate the performance of the 8th generation of BLRI 1 (Rupali) and BLRI 2 (Nageswari) ducks. Selections were made based on age at lay (day), body weight at lay (g), egg production (168-280 days), and egg weight (g). A maximum ratio of 1:5 was used to mate the males and females. The egg production data of 8th generation ducks were recorded. At the age of 40 weeks, 20 eggs from each duck genotype were randomly collected and evaluated using different formulae. Additionally, Rupali and Nageswari ducks are being validated at field level. 10 farmers from Sathkhira areas were selected and received Rupali, Nageswari, local and Jending ducks. A total of 60 g of supplementary feed was provided in the morning and evening. They were also scavenged at other times. Other husbandry practices, including vaccination and medication, were followed. Data were data collected on body weight (g), egg production (no.), and age at sexual maturity (days). To minimize production costs, duck rations could be supplemented with azolla. Azolla pinnata contains 6.6% DM, 24.53% CP, 4.40% EE, 14.6% CF, and 14.45% TA. Pekin ducks were fed fresh azolla pinnata in their diet to determine its effects on performance. Sixty native laying ducks (1-10 weeks) were divided into four groups (each group had three replications with five ducks per replication) and were randomly fed four experimental diets: T_0 as a control diet (duck layer diet (DLD), no azolla), T_1 (DLD decreased by 10% + fresh azolla @ 100g/duck/day, T_2 (DLD reduced by 15% + fresh azolla @ 150g/duck/day) and T3 (DLD reduced by 20% + fresh azolla @ 200g/duck/day) for a period of 70 days. Data were analyzed by SPSS version 20 and differences were determined using DMRT.

The egg production performance of Rupali and Nageswari ducks are presented in Table 1. Egg mass (EM) was significantly higher in Rupali duck (41.42g) than Nageswari duck (39.43g) per day, while EP% did not differ significantly between two genotypes at 24 to 48 weeks. The EP% of Rupali and Nageswari ducks, were 53.45% and 53.85%, respectively. The Nageswari ducks consumed 137.60 g/d significantly ($P<0.05$) less feed than the Rupali ducks (140.34 g/d). Rupali (3.45) ducks had significantly ($P<0.05$) better FCR than Nageswari (3.82). Table 1 also showed the mean values for external and internal egg quality traits for two genotypes. Rupali duck eggs had an optimum weight. In contrast, other egg quality parameters did not show a significant difference between two genotypes. Table 2 showed the performance of BLRI improved native ducks on farmer's fields. Among the genotypes, there was a substantial ($P<0.05$) difference in age at sexual maturity (d) in Jending ducks. The Rupali duck had a higher body weight and there was a significant difference ($P<0.05$). In 161 days of egg production, Jending ducks produced more eggs than other genotypes ($P<0.05$). Compared with control groups, Pekin ducks fed fresh azolla @200g/duck/day significantly ($P<0.001$) decreased feed consumption, but FCR was significantly (2.59) better in T_2 (Table 3). There were also significant ($P<0.05$) improvements in final body weight and daily weight gain in the T_2 group ($P< 0.05$). Table 4 showed the effect of fresh azolla on the carcass characteristics of Pekin ducks. There was a significant amount of breast meat found in T_2 ($P<0.05$) group, while wing meat was better in T_3 ($P<0.05$). There were no significant differences among the T_2, T_3, and T_4 in terms of final body weight, thigh meat, and liver. However, lower fat was observed in the T_2 ($P<0.05$) and T_3 ($P<0.05$) groups.

Table1: Production performance and egg quality of BLRI 1 (Rupali) and BLRI 2 (Nageswari) ducks in eighth generation (G_8) (Mean ± SE)

Production Parameters	Rupali	Nageswari	p value
Body weight at first laying, g	1601.60±71.25	1568.57±59.30	0.001
Age at sexual maturity, day	158.34±5.67	156.33±4.68	0.078
EP %	53.45±3.74	53.84±3.78	0.988
Egg weight, g	64.63±4.46	62.60±2.55	0.001
Feed intake, g	140.34±3.67	137.60±4.0	0.05
EM (g/d)	41. 42±0.72	39.43±0.75	0.044
FCR	3.45±0.09	3.82±0.08	0.057
Egg quality parameters			
Egg weight (g)	68.58±5.67	65.03±4.04	0.003
Egg length (mm)	59.42±2.76	58.82±2.42	0.433
Egg width (mm)	47.37±1.06	46.94±0.59	0.089
Albumen hight (mm)	9.08±1.41	8.99±1.55	0.342
Albumen length (mm)	81.21±3.69	81.87±2.18	0.455
Yolk weight (g)	21.83±2.15	21.04±1.50	0.147
Shell weight (g)	10.78±0.39	7.22±0.64	0.263

Table 2: Performance of BLRI improved native duck at farmer's field (Shatkhira)

Parameters	Rupali	Nageswari	Local duck	Jending	P-value
		Mean ± SE			
Age at sextual maturity (day)	210^{ab}±10.15	224^{b}±10.75	256^{b}±10.75	189^{a}±10.75	0.013
First egg weight, g	53.66±1.14	53.0±1.14	54.0±1.14	54.33±1.14	0.860
Body weight, kg	1.70^{a}±0.04	1.62^{a}±0.04	1.46^{b}±0.04	1.56^{ab}±0.04	0.02
Egg production, no. (161 days)	68.06^{a}±5.1	63.11^{b}±5.14	55.03^{b}±5.14	78.23^{a}±5.14	0.057

Table 3: Effect of feeding fresh azolla on the performance of Pekin duck (Mean ± SEM) up to 10 weeks of age

Treatment	Initial body weight (g)	Final body weight (g)	Body weight gain (g)	Cumulative feed intake (g)	FCR (Feed: gain)
T_1	38.93±1.17	1975.41±68.90	1885.58^{b}±68.84	5463.83^{a}±1.66	2.90^{a}
T_2	40.66±1.17	2152.47±68.90	2113.75^{a}±68.84	5401.70^{b}±1.66	2.59^{b}
T_3	40.85±1.21	2054.27±71.97	2012.90^{a}±71.90	5284.10^{c}±1.66	2.64^{b}
T_0	40.26±1.17	1904.30±75.48	1860.40^{b}±75.48	5284.10^{c}±1.66	2.82^{ab}
P- value	0.659	0.058	0.051	0.000	0.053

Table 4: Effect of fresh azolla on carcass characteristics of Pekin duck (Mean ±SE), gm

Treat.	Final body weight	Thigh meat	Breast meat	wing	Liver	Fat
T_1	1990±77.91	103.33±6.8	207.33^{a}±12.47	174.00^{a}±11.94	41.66±3.10	11.66^{b}±3.1
T_2	2067.33±77.9	112.66±6.8	236.00^{a}±12.47	168.00^{ab}±11.94	42.66±3.10	8.65^{abc}±3.1
T_3	1970.00±77.9	89.33±6.8	190.66^{b}±12.47	189.33^{a}±11.94	44.00±3.10	7.33^{c}±3.1
T_0	1921±77.91	92.66±6.8	194.33^{b}±12.47	160.23^{b}±11.94	38.00±3.10	21.33^{a}±3.1
P-value	0.589	0.142	0.049	0.050	0.585	0.055

The egg production rates of Rupali and Nageswari ducks were almost similar. Thus, both ducks have been conserved for improvement. Side-by-side validation program of BLRI improved ducks conducted. Azolla is the best alternative feed for ducks since they consumed more feed. By consuming 150 grams azolla/duck/day, better performance was achieved.

Conservation and Improvement of Exotic germ plasms and validation the performance of BLRI layer chicken 1 (Shuvra) and BLRI layer chicken 2 (Shorna)

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Executive Summary

Four pure chicken breeds are maintaining at BLRI Poultry Research Farm for their conservation and genetic improvement of egg production. Current study aimed to estimate genetic gain in 4 pure chicken breeds under intensive management condition and to evaluate the cross-breed, of locally adopted exotic germplasms. A total of 8000 pedigree hatched day old chicks (2000 for each breed) were hatched as 20th generation and they were identified individually by wing band. Males and females were selected at the age of 8 and 16 weeks on the basis of pedigree records and phenotypic characteristics. Finally, 50 males and 200 females were selected at 40 weeks of age on the basis of selection index to produce next generation. The parent males and females were maintained in single cage open housed system. through selective breeding produce successive generation. The experimental chickens were reared under standard management practices throughout the experimental period. Egg production (EP) and feed intake were recorded daily and body weight (BW) and egg weight (EW) were weighed monthly. Selection was done for 20th generation at 40 weeks of age by determining the selection index in each egg production record while males were selected based on family average. The age at first egg (days), body weight (g) at 38 weeks of age, egg production (%) (168-280 days), egg weight (g) at 38 weeks of age traits were considered during calculation of selection index. The selection Index was computed by the equation; Selection Index (I) = $b_1x_1 + b_2x_2 + \ldots\ldots\ldots\ldots + b_nx_n$,, where, x_1, x_2,…….x_n represent the phenotypic value for the trait and b_1, b_2,…….b_n denote the relative weight given to each of the trait.

Table 1. Selection parameters of four pure line chicken genotypes in 20th generation (G_{20}).

Pure lines	Selection criteria	(SD)	(S)	(R)	(i)	(h^2)	Culling level
White Leghorn (186)	ASM (d)	6.33	1.68	0.67	0.27	0.40	$121 \leq x \leq 176$
	EW (g)	8.61	3.92	0.96	0.46	0.50	$56.5 \leq x \leq 65.6$
	BW (g)	139.83	-6.55	-3.27	-0.05	0.50	$1640 \leq x \leq 2300$
	EP%	5.99	12.53	1.88	2.09	0.15	$84.9 \leq x$
Rhode Island Red (186)	ASM (d)	10.33	2.50	1.00	0.24	0.40	$124 \leq x \leq 180$
	EW (g)	4.67	1.08	0.54	0.23	0.50	$46.5 \leq x \leq 71.0$
	BW (g)	197.85	-15.55	-7.77	-0.08	0.50	$1237 \leq x \leq 2588$
	EP%	12.53	7.60	1.14	0.61	0.15	$91.0 \leq x$
White Rock (134)	ASM (d)	5.92	3.11	1.24	0.53	0.40	$128 \leq x \leq 168$
	EW (g)	4.03	1.73	0.86	0.43	0.50	$47.0 \leq x \leq 70.3$
	BW (g)	147.15	-15.08	-7.54	-0.10	0.50	$1202 \leq x \leq 2059$
	EP%	18.08	18.76	2.81	1.04	0.15	$95.5 \leq x$
Barred Plymouth Rock (164)	ASM (d)	6.19	-2.13	-0.85	-0.34	0.40	$131 \leq x \leq 177$
	EW (g)	4.20	1.51	0.75	0.36	0.50	$36.6 \leq x \leq 71.6$
	BW (g)	168.20	-34.98	-17.49	-0.21	0.50	$1114 \leq x \leq 2198$
	EP%	19.59	15.92	2.39	0.81	0.15	$88.3 \leq x$

SD=Standard deviation, S=Selection Differential, R= Selection response, i= Selection Intensity, h^2= Heritability, ASM=Age of sexual maturity, BW=Body weight, E= Egg production, EW=Egg weight

Table 1 showed that Four selection criteria were observed in 4 different pure line chickens where after selection, selection differential (s) was expected to increase 3.9,1.08,1.73 and 1.51 in egg weight (g) and 12.53,7.60,18.76 and 15.92 in egg production (%) in WHL, RIR, WR and BPR genotypes respectively.

After selection in WHL, RIR, WR and BPR chicken genotypes, selection intensity(i) was 2.09,0,61,1.04 ,0.81 and selection response was 1.88, 1.14, 2.81 and 2.39 respectively.

Table 2. Rate of Inbreeding of four genotypes in 20th generation (G_{20}).

Generation	Sire	Dam	Effective population size (Ne)	Rate of inbreeding (ΔF)
S20(WLH)	25	125	83.33	0.006
S20(WR)	25	125	83.33	0.006
S20(RIR)	25	125	83.33	0.006
S20(BPR)	24	120	80.00	0.063

Table 2 showed that the rate of inbreeding (ΔF) was 0.006, 0.006, 0.006 and 0.063 in WLH, WR, RIR and BPR respectively which was negligible

Table 3**.** Performance of different cross bred chickens (0-12 wks. of age).

Parameters	Cross bred chicken			
	Cross 1	Cross 2	Cross 3	P value
Body weight (g) 12wks	1302.5^{ab}±73.51	1215.1^{b}±94.57	1352.8^{a}±66.57	0.0328
Weight gain (g)	1265.19^{ab}±71.51	1179.23^{b}±67.36	1314.74^{a}±63.58	0.0315
Feed intake (g)	3431.21^{a}±94.63	3115.65^{b}±89.12	3447.25^{a}±102.23	0.0247
FCR (Feed conversion ratio0	2.712±0.453	2.642±0.562	2.622±0.641	0.1496

^{a,b,c}Mean values within a column followed by the same letter are not significantly different (p>0.05)

The average body weight at 12 weeks of age, weight gain, feed intake and FCR were found 1302.5, 1215.1, 1352.8g; 1265.19, 1179.23, 1314.74g; 3431.21, 3115.65, 3447.25g and 2.712, 2.642 & 2.622 in cross1, cross2 and cross 3 respectively. Therefore, body weight and weight gain were significantly (P<0.05) higher in cross 3 chicken than others.

Table 4**.** Carcass characteristics weight of three different cross chickens.

Parameters	Cross bred chicken			
	Cross 1	Cross 2	Cross 3	P value
Live bird weight (g)	1302.5^{ab}±73.51	1215.1^{b}±94.57	1352.8^{a}±66.57	0.032
After slaughter wt.(g)	1253.5^{ab}±67.21	1171.7^{b}±87.17	1293.9^{a}±67.58	0.031
Carcass weight (g)	687.6^{a}±56.33	644^{b}±52.67	709.1^{a}±41.01	0.043
Edible carcass wt.(g)	970.59^{a}±65.47	854.7^{b}±66.09	949.29^{a}±52.35	0.029
Breast weight (g)	93.1±7.33	91.8±9.74	99.5±5.24	0.513
Thigh weight (g)	131.8±10.10	124.4±13.17	136.5±5.72	0.571
Wing weight (g)	76.5±7.31	71.6±6.46	80±5.60	0.469
Drum weight (g)	124.4±7.92	119±12.14	133±10.09	0.623
Abdominal fat wt.(g)	5.1±2.66	7.7±2.33	4.2±1.30	0.238
Dressing %	52.59±1.52	53.04±0.60	52.36±0.68	0.892
Edible dressing (%)	74.31±1.19	70.36±0.49	70.08±0.80	0.348

^{a,b,c}Mean values within a column followed by the same letter are not significantly different (p>0.05)

The carcass weight, dressing percentage and abdominal fat weight were found 687.6, 644, 709.1; 52.59, 53.04, 52.36 and 5.1, 7.7 and 4.2 in cross 1, 2 & 3 respectively. In conclusion, based on above result, pure lines are conserve avoiding inbreeding and cross 3 performance is better than others. Further follow up experiment is needed to know the performance under different farming condition.

Phenotypic and genotypic characterization with meat quality assessment of hybrid duck produced through three-way crossing in Bangladesh

Sub-title: Performance evaluation and crossbreeding effects of local, exotic duck and their hybrid (F1) under the semi-intensive system in Bangladesh

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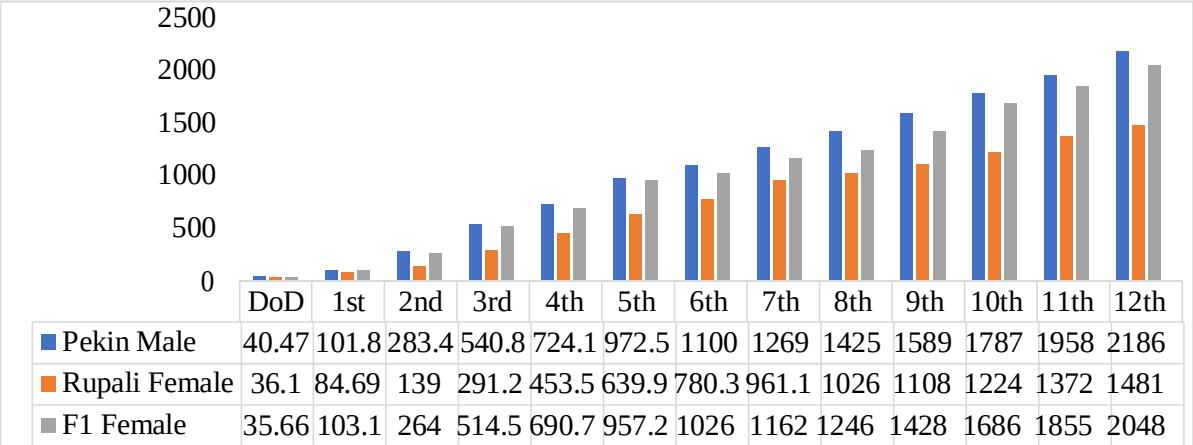
Executive Summary

Previous research has demonstrated that intra and intergeneric crossbreeding improves productivity, meat quality and reproductive traits. Crossbreeding could increase growth and output by taking advantage of heterosis. This study was, therefore, designed to compare meat production potential of different duck genotypes (Pekin♀ and Desi common white♀) under local conditions and to compare the performance of those different genotypes in terms of growth, feed consumption, feed conversion and meat yield. The flocks were kept at the BLRI Duck Research farm up to 12th week of age. For the duration of the trial, strict biosecurity protocols and hygiene controls were maintained to secure a healthy environment for the ducks. The feed and water were supplied *ad libtium*. They were fed broiler starter diet containing 21 % CP and 2950 Kcal (0-4 wk) and broiler layer containing 19 % CP and 3050 Kcal (4 wks–marketing age). This study examined six distinct morphometric features, including shank length, neck length, body length, wing length, bill length, and shank circumference. From day old to the 12th week of age, live weight was recorded weekly. At the end of all three treatment age (8th, 10th, 12th week), 04 no. of ducks from each replicate was selected, slaughtered and dissected. Dressed carcass weight, blood weight, featherweight, head weight, heart weight, liver weight, gizzard weight, breast meat weight, thigh meat weight, drumstick meat weight, wing meat weight and abdominal fat weight were recorded. Before statistical analysis, data on all meat yield parameters were converted into percentages of respective live weight. Data were analyzed using SPSS software for Windows (SPSS ver.22), all descriptive statistics and ANOVA, were carried out.

The presence of the dominant extended white gene resulted in F1 crossbred ducks exhibiting phenotypic characteristics resembling both indigenous ducks (Rupali,R) and exotic ducks (Pekin,P). The P♂ × R♀ genotype had a uniform white coloration in the head, wing, and breast regions, which extended consistently to the belly area. The observed phenotype of the P♂ × R♀ genotype had a strong yellowish tint, resembling that of the Pekin breed. There were substantial variations observed in the morphometric characteristics, such as neck length, bill length, shank circumference, wing length, and body length, across the three genotypes. However, no significant changes were detected for body width, wing length, shank length, shank circumference, and shank. The growth performances of Rupali, Pekin, and their crossbreds were evaluated under intense care until the 12th week of age. During the marketing stage, at the 12th week, it was observed that Pekin ducks and the F1 crossbred resulting from the mating of Pekin (♂) and R (♀) exhibited a significant increase in live weight. Compared to pure indigenous Rupali ducks, the Pekin ducks acquired around 705 g more, while the F1 crossbred gained approximately 567 g more. Significant variations ($p<0.05$) in meat yield characteristics were identified between the Pekin and F1 crossbred groups for key meat yield parts, including carcass weight, dressing %, breast meat and drumstick with thigh weight. The hybrid resulting from the cross between P♂ and R♀ has a notable 50% inheritance from its native genetic background, hence enhancing its ability to adapt more effectively in a hot and humid ecological setting. Breast meat yield and dressing % was found higher ($P<0.05$) in P X R than that of parent line (Table 1). The live weight, thigh meat, wing meat, dressing was found significant differences among the genotypes, whereas no difference was observed on liver, carcass and drumstick weight, gizzard, feather, blood and abdominal fat among the genotypes.

Figure 1. Body weight (g) of different genotypes in different week of age



	DoD	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th
Pekin Male	40.47	101.8	283.4	540.8	724.1	972.5	1100	1269	1425	1589	1787	1958	2186
Rupali Female	36.1	84.69	139	291.2	453.5	639.9	780.3	961.1	1026	1108	1224	1372	1481
F1 Female	35.66	103.1	264	514.5	690.7	957.2	1026	1162	1246	1428	1686	1855	2048

Effect of heterosis on carcass parameters of PR cross showed negative heterosis for body weight, neck, drumstick, abdominal fat, wings, total fat, thigh and the edible meat parts (-7.54, -14.72, -14.43, -32.55, -0.6, -6.28 and -4.8% respectively), however, there was positive heterosis for dressing, liver, breast meat, skin fat and giblets (3.32, 9.01, 6.75, 2.17 and 12.62% respectively). Concerning breast muscle, the PR cross recorded positive heterosis for major and minor muscles. Makram et al. (2016) found negative heterosis for liver and gizzard for the developed hybrids from Sudani duck strain.

Table 1. Different carcass % of all breeds of duck

Parameters	Pekin ♂	Rupali ♀	P ♂ * R♀	LS
Live weight (g)	2274.50^{a}±61.32	1480.09^{b}±59.27	1735.50^{a}±103.15	***
Carcass weight with giblet (g)	1,584.75^{a}±43.20	999.90^{b}±35.98	1260.85^{a}±60.68	NS
Carcass weight without giblet (g)	1368.05^{a}±6.97	854.55^{b}±5.51	1057.45^{ab}±9.17	*
Dressing (%)	60.16^{ab}±0.60	57.75^{b}±1.14	60.92^{a}±0.68	***
Liver weight (g)	59.00^{a}±2.48	46.75^{b}±1.93	57.05^{c}±2.27	NS
Drumstick weight	110.75^{a}±8.68	75.85^{b}±9.18	80.75^{a}±4.55	NS
Thigh weight (g)	121.25^{a}±5.07	91.00^{b}±4.49	95.00^{ab}±17.14	***
Wing weight (g)	208.53^{a}±8.19	141.75^{b}±6.24	164.75^{b}±7.36	***
Breast meat weight (g)	224.55^{a}±24.19	173.50^{b}±7.19	238.75^{a}±19.06	***
Total fat (g)	339.87^{a}±8.68	194.45^{b}±9.18	266.75^{a}±4.55	***

Table 2. Effect of heterosis on the carcass of F1

Parameters	Heterosis (%)
Live weight (g)	-7.54
Dressing (without giblet)	3.32
Dressing (with giblet)	5.58
Liver	9.01
Giblets	12.62
Edible meat parts (with giblet)	-4.8
Neck	-14.72
Breast Meat	6.75
Thigh	-10.58
Drumstick	-14.43
Abdominal fat	-32.55
Skin fat	2.17
Total fat	-0.6
Wings	-6.28

In conclusion, considering growth, morphology and meat yield characteristics, our results suggested the F1 (P♂×R♀) crossbreds might produce a suitable genotype to improve the meat production potential of duck reared under Bangladesh weather. This crossbred genotype possesses 50% native inheritance and therefore, adaptability would be expected higher under hot and humid conditions of Bangladesh compared to exotic Pekin duck.

Evaluation of exotic pure and their crossbreds sheep in Bangladesh

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Executive Summary

Most of the sheep in Bangladesh are native non-descript types but no established sheep breed in the country. Moreover, the growth rate of native sheep is low, so crossbreeding could be an effective tool to increase their growth rate and productivity. However, very limited research work has done on crossbred sheep development in Bangladesh. Thus, the present study was undertaken to evaluate the productive and reproductive performance of different crossbreds and to evaluate the adaptability of different crossbreds in hot and humid climatic conditions. The breeding program was conducted at Sheep Research farm, BLRI, Savar, Dhaka. The crossbreeding program was conducted with native sheep (Coastal and Jamuna River Basin) as dam and Dorper, Perendale, Suffolk and Damara sheep as sire. The breeding program was designed in such a way that resists inbreeding and maintain 50% foreign blood. Then, *inter-se* mating within all the crossbreds was practiced. The selection targets for crossbreds were minimum birth weight 3 kg, 6 months body weight 20 kg and 12 months body weight 30 kg. Subsequent data on productive and reproductive performance were recorded regularly. The recorded data were analyzed by General Linear Model (GLM) procedure of Statistical Package for the Social Sciences (SPSS) version 20.0. To see the significant differences among the mean values, Duncan's multiple range test (DMRT) was performed.

The performance of exotic sheep according to generation is presented in Table 1. The highest litter size was found in Suffolk followed by Perendale and Dorper, respectively. In case of growth performance highest values were found in Dorper followed by Suffolk and Perendale, respectively. Table 2 shows the performance of crossbreds sheep. Generation wise performance of different crossbreds are presented in fig. 1-4. In case of average litter size, Damara and Dorper crossbred performed significantly better (p=0-0.001) followed by Perendale and Suffolk, respectively. Among the crossbreds, growth performance was found non-significant (p>0.05).

Table 1: Least-square means (LMS) with standard errors (SE) of performance of exotic sheep at BLRI according to generation

No.	Genotype	Generation	Litter size	Birth weight (kg)	6-month body weight (kg)	12-month body weight (kg)
1	Dorper	1	1.0±0.32 (02)	3.10±0.64 (02)	39.25±5.51 (02)	52.35±7.24 (02)
		2	1.17±0.19 (06)	3.90±0.37 (06)	38.14±3.49 (05)	50.26±4.58 (05)
		3	2.0±0.23 (04)	3.43±0.46 (04)	23.75±5.52 (02)	37.25±7.24 (02)
2	Perendale	1	1.50±0.11 (16)	4.11±0.24 (15)	37.32±2.60 (09)	49.54±3.41 (09)
		2	1.46±0.10 (22)	3.90±0.20 (21)	28.79±2.09 (14)	38.69±2.73 (14)
		3	1.0±0.20 (05)	3.30±0.46 (04)	25.13±4.50 (03)	37.57±5.91 (03)
3	Suffolk	1	1.0±0.45 (01)	2.10±0.90 (01)	38.70±7.80 (01)	49.0±10.23 (01)
		2	2.0±0.23 (04)	3.88±0.46 (04)	35.98±3.90 (04)	48.63±5.12 (04)
		3	1.5±0.17 (07)	2.84±0.41 (05)	18.23±3.90 (04)	27.43±5.12 (04)

Figure in the parenthesis indicate the number of observations

Table 2: Least-square means (LMS) with standard errors (SE) of performance of crossbreds sheep at BLRI

Parameters (Mean ± SE)	Crossbreds sheep				
	Dorper Crossbred	Perendale Crossbred	Suffolk Crossbred	Damara Crossbred	Level of sig.
Litter size	1.44[a]±0.07 (62)	1.14[b]±0.10 (28)	1.12[b]±0.13 (17)	1.67[a]±0.09 (33)	***
Birth weight (kg)	2.04±0.05 (62)	2.09±0.07 (28)	2.06±0.09 (17)	2.02±0.06 (33)	NS
Weaning weight (kg)	11.53±0.47 (37)	11.65±0.57 (18)	11.90±0.70 (12)	11.41±0.63 (15)	NS
6 months body weight (kg)	15.67±0.69 (20)	14.68±0.71 (18)	15.04±0.89 (12)	14.74±0.85 (13)	NS
12 months body weight (kg)	21.58±0.95 (13)	20.35±1.03 (11)	21.80±0.99 (12)	20.11±1.22 (09)	NS

Figure in the parenthesis indicate the number of observations. ***= significant (p=0-0.001). NS= non significant (p>0.05)

Fig1. Dorper crossbred sheep performance

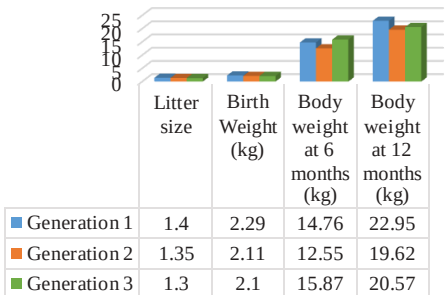


Fig2. Perendale crossbred sheep performance

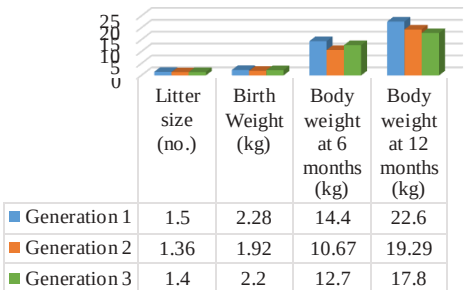


Fig3. Suffolk crossbred sheep performance

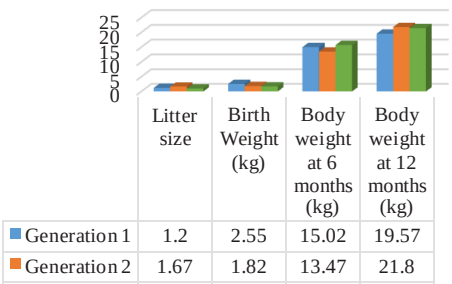
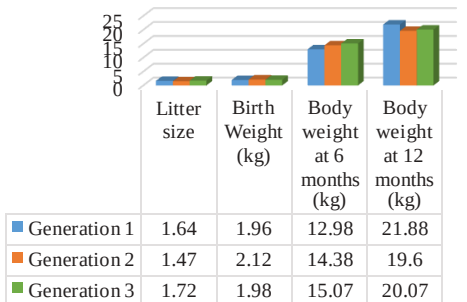


Fig4. Damara crossbred sheep performance



In conclusion, superior rams and ewes will be selected by the individual performance generation after generation to attain the selection goal. These findings give us more attention for continuing further research program to produce crossbreds sheep in our country.

Conservation and improvement of Black Bengal Goat at Bangladesh Livestock Research Institute
Sub title: Conservation and improvement of Black Bengal goat and its color variants at Bangladesh Livestock Research Institute

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Executive Summary

The Black Bengal goat (BBG) is the heritage and pride of Bangladesh. Higher prolificacy, a shorter generation interval, and better adaptability to adverse environmental conditions are the key features of the BBG. The purity and originality of this breed are being genetically diluted due to disorganized crossings throughout the country. Considering this fact, the project has been designed with the objectives: i) To conserve and improve Black Bengal goat through selective breeding; ii) To evaluate the performance of different coat color variants of BBG (Solid Black, White Bengal, Dutch belt and Toggenburg) and iii) To produce frozen semen to inseminate BB does. An open nucleus breeding system (ONBS) was practiced to avoid inbreeding in order to improve the genetic and phenotypic traits of existing breeding goat stock at the Bangladesh Livestock Research Institute (BLRI), Savar, Dhaka. The selection objectives of the study were to improve the prolificacy, milk production, and growth rate of the breed. The minimum 2 kids per kidding; 0.5 litter milk /day/doe, and 12 kg at 6 month of age were the selection criteria of the aforesaid breeding objectives. The selection index was calculated by the following equation, $I_B = b_1x_1 + b_2x_2 + \ldots. + b_nx_n$. Where, b_1, b_2,.., b_n were phenotypic values for the traits and x_1, x_2,…, x_n were relative economic values given to each of the traits. Semen was collected from the superior BB bucks based on their pedigree records. Frozen semen was produced after evaluating fresh semen by the computer assisted semen analysis (CASA). Furthermore, frozen semen was used to inseminate in heated does with different pre-scheduled single doses, both for on-station (211 doses AI) and on-farm (53 doses AI) conditions. All the recorded data were analyzed using Statistical Package for the Social Sciences (SPSS) version 20.0. The mean comparison test was determined by Duncan's multiple range test (DMRT).

Table 1 shows the productive and reproductive performance of different coat color variants of BBG. All the measured traits had significant effect ($p<0.001$ and $p<0.05$) on the different coat color variants of BBGt except the litter size. The highest milk production was found in white Bengal goat followed by Dutch Bengal, Toggenburg and Black coat color, respectively. In case of body weight at different age, Dutch belt coat colors performed better, followed by white Bengal, Solid black, and Toggenburg, respectively. The yearly performance of different traits indicates positive trend of improvement of the selection traits. Table 2 shows the conception rate of different single doses at different areas. Among the different doses, a better conception rate was found at 30 and 36 hours after showing heat rather than 24 and 48 hours after showing heat. The highest conception rate was found at 30 hours after showing heat (83.33%) in both the BLRI goat research farm and the BLRI Regional Station (RS), Rajshahi goat research farm. But, at the community level at Rajshahi, the highest conception rate was found at 36 hours after showing heat (80%).

Table 1: Least-squares means (LSM) with standard errors (SE) of productive and reproductive traits in different coat color variants of BBG-

Parameters	Average value	Coat color variants				Sig. level
		Solid Black	White Bengal	Dutch Belt	Toggenburg	
Litter size (no.)	2.19±0.03 (347)	2.22±0.05 (92)	2.21±0.05 (76)	2.11±0.07 (44)	2.19±0.07 (135)	NS
Milk production (lt/d)	0.42±0.009 (169)	$0.33±0.01^{c}$ (51)	$0.52±0.02^{a}$ (37)	$0.45±0.02^{b}$ (27)	$0.43±0.02^{b}$ (54)	***
Birth weight (kg)	1.32±0.01 (349)	$1.30±0.02^{c}$ (92)	$1.39±0.04^{b}$ (76)	$1.49±0.05^{a}$ (44)	$1.23±0.02^{c}$ (135)	***
3 months body weight (kg)	6.61±0.05 (230)	$6.63±0.11^{ab}$ (64)	$6.82±0.10^{a}$ (47)	$6.83±0.20^{a}$ (24)	$6.60±0.07^{b}$ (95)	*
6 months body weight (kg)	10.92±0.10 (151)	$10.12±0.18^{c}$ (40)	$11.58±0.14^{b}$ (36)	$12.34±0.22^{a}$ (23)	$10.46±0.12^{c}$ (52)	***

Number in the parenthesis indicate the number of observations. ^{abc} *different superscript in the same raw differ significantly. ***= significant (p<0.001), *= significant (p<0.05), NS= non-significant (p>0.05).*

Table 2: Conception rate of artificial insemination (AI) in BBG-

Time duration after showing heat		BLRI goat research farm		BLRI RS, Rajshahi goat research farm		Rajshahi community area	
		Conception rate (%)	Repeat Heat (%)	Conception rate (%)	Repeat Heat (%)	Conception rate (%)	Repeat Heat (%)
Single dose	24 Hours	73.68 (56)	26.32 (20)	70.59 (12)	29.41 (5)	72.73 (8)	27.27 (3)
	30 Hours	83.33 (25)	16.67 (5)	83.33 (15)	16.67 (3)	79.17 (19)	20.83 (5)
	36 Hours	82.5 (33)	17.5 (7)	77.78 (14)	22.22 (4)	80 (12)	20 (3)
	48 Hours	50 (1)	50 (1)	60 (3)	40 (2)	66.67 (2)	33.33 (1)
Total		77.39 (113)	22.6 (33)	73.84 (48)	26.15 (17)	77.36 (41)	22.64 (12)

Number in the parenthesis indicate the number of observations.

It can be concluded that, white Bengal genotype may be developed as milk type black Bengal goat. In the case of single dose AI 30-36 hours after showing heat may be suggested to obtain better conception rate. For better understanding in single dose AI, further research is needed to conclude a concrete result. Therefore, the research program should continue for the coming years to achieve the targeted breeding goals.

Performance evaluation of crossbred buffalo under on-station and on-farm conditions

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Executive Summary

Buffalo is increasingly becoming popular in several parts of the world because of its quality milk and meat, better adaptability in extreme climatic conditions and better utilization capacity of poor quality crop residue based fibrous diets. Bangladesh possesses about 1.5 million head buffaloes. They are mainly indigenous type, concentrated in the coastal and riverine char lands. Productive and reproductive performances of the indigenous buffaloes are poor. Therefore, the crossbreeding program has been taken to improve the production performance of indigenous buffalo since 2013 in Bangladesh as well as in Livestock Research Institute (BLRI). A number of crossbred buffalo calves have been born in the country. However, the adaptability of these crossbred buffaloes at existing management practices is yet to be evaluated. Considering the above facts, the main objectives of the research program were i) to evaluate the productive and reproductive performance of crossbred buffaloes under on-station condition and ii) to develop a feeding regime for attaining puberty between 24 to 28 months of age of buffalo heifers. To achieve the above-mentioned objectives, an experiment was conducted at Buffalo Research Farm, BLRI, Savar, Dhaka to prepare frozen semen from pure Murrah breeding bulls for artificial insemination or naturally mated with indigenous buffalo cows to produce F_1 crossbred buffalo calves (50% Murrah x 50% Local). Data on body weight gain from birth to 30 months of age, age and live weight at first heat, calving interval, gestation period, milk yield and disease incidence were recorded to evaluate the performance of Murrah×Local crossbred buffaloes reared under Buffalo Research Farm at BLRI. Moreover, a feeding trial was conducted so that the crossbred buffalo heifers attain puberty between 24 to 28 months of age. A total of twelve crossbred heifers were considered for feeding trial and randomly divided into three equal groups (T_1, T_2 and T_3) having 4 animals in each group based on their different body weight (332.66±35.07 vs 215.25±7.5 vs 173.75±7.5 kg) and age (29.25 vs 19.25 vs 16.43 months). Group T_1 was reared under routine management, while groups T_2 and T_3 were under better management practices. Group T_1 was grazed on natural pasture land for 4-6 hours daily and provided a concentrate feed mixture@1% of body weight. Groups T_2 and T_3 were reared in an intensive management system and had access to a 10% higher energy supplement compared to the NRC standard ration and CP was 15-16%. The feeding trial was continued for nine (9) months. Daily feed intake, monthly body weight gain and blood samples were collected and analyzed statistically in an ANOVA of a Completely Randomized Design (CRD) using SPSS program. A total of 123 crossbred buffalo calves were born at BLRI since 2016. Age group of crossbred buffaloes were shown in Table 1. Body weight of crossbred buffaloes at birth, 3, 6, 9, 12, 15, 18, 24 and 30th months were 29.26±4.16 (40), 59.5±5.8 (24), 113.33±23.05 (24), 179.56±28.83 (24), 212.63±23.58 (24), 238.65±33.66 (24), 255.96±30.5 (18), 293.28±35.17 (18) and 351.73±55.95 (11) kg, respectively. Age at first heat, age at first calving and gestation period were 1142.9±211.1, 1450.4±215.8 and 307.5±11.27 days, respectively.

Table 1. The age group of crossbred buffaloes at BLRI research farm

Age group	Murrah × Indigenous (F_1)		Total
	Male	Female	
Below 12 months	11	13	24
12 to 24 months	11	6	17
24 to 36 months	15	7	22
36 months and above	24	36	60
Total	61	62	123

The average milk production of crossbred buffalo cows was 3.28±0.44 kg. About 25 crossbred calves were infected with parasites (ascariasis, coccidiosis, nematode and mite infestation under three months of age. Ten calves died among the infected calves. Hence, the overall calf mortality was 8.13%.

Picture 1. Feeding trial of buffalo heifer at BLRI Research farm.

On the other hand, the result showed that age at first heat of heifer was found delayed in group T_1 (36.53±1.0 months) and earlier in group T_2 (27.35±0.9 months) and T_3 (24.5±0.8 months), respectively. Body weight at the age of puberty was higher in group T_2 (379.3±17.8 kg) followed by group T_1 (362.75±6.3 kg) and T_3 (323.0±9.5 kg). Body weight gain of crossbred heifers during the trial period was also found higher in group T_2 (0.6±0.02) followed by group T_3 (0.5±0.03 kg) and T_1 (0.15±0.28 kg). The average dry matter intake of groups T_2 and T_3 were 8.03±0.43 and 7.55±0.37 kg/heifer/day, respectively (What about the DMI of T1.

Table 2. Blood metabolites of heifer in different treatment groups

Parameter	Treatment (Mean±SD)			P-value
	Group T_0	Group T_1	Group T_2	
Glucose (mg/dL)	87.29±3.2^{a}	98±13.83^{ab}	107.75±6.0^{b}	0.005
Tri (mg/dL)_	53.57±7.07^{a}	28.75±10.34^{b}	37.25±6.95^{b}	0.001
TP (g/L)	70.14±7.17	78.5±6.86	77.25±5.44	0.122
BUN (mg/dL)	31.53±8.77	28.4±5.6	27.03±4.05	0.576
Chol (mg/dL)	71±6.48	58.5±14.73	66.5±1.91	0.114
Creatinine (mg/dL)	1.33±0.17^{a}	1.88±0.19^{b}	1.7±0.18^{b}	0.001
ALT (U/L)	32.06±8.52^{a}	51.53±13.06^{b}	47.33±4.18^{ab}	0.010
GGT (U/L)	26.14±8.03^{a}	14.5±3.32^{b}	17.25±0.5^{ab}	0.017

$^{a, b}$ Mean in the same row with different superscripts differ significantly (P<0.05); SD-Standard Deviation; Tri-Triglyceride; TP-Total Protein; BUN-Blood urea nitrogen; Chol-Cholesterol; ALT-Alanine aminotransferase; GGT-Gamma-glutamyl Transpeptidase.

Blood plasma biochemicals of different treatment groups were shown in Table 2. Significantly (P<0.05) lower in glucose level but higher in triglyceride was found in group T_1 compared to group T_2 and T_3. Total protein was lower but cholesterol was higher in group T_1 compared to group T_2 and T_3 but not significantly (P>0.05) differed. Significantly (P<0.05) lower creatinine and ALT but higher GGT was found in group T_1 compared to group T_2 and T_3. Plasma biochemical profiles of delayed puberty buffaloes differed from those of early puberty heifers of different treatment groups. Considering the above finding, this study summarized that early puberty in buffalo heifers may be attained with better management practices at an early stage.

Research First

TECHNICAL SESSION: II

ANIMAL AND POULRY DISEASES AND HEALTH

ARRW-2023

Monitoring and evaluation of Peste des Petits Ruminants virus circulating in Bangladesh and development of vaccine seed

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[2,3] Transboundary Animal Disease Research Center, BLRI, Savar, Dhaka-1341

Executive Summary

Peste des Petits Ruminants (PPR) is a highly fatal infectious viral disease of small ruminants, mainly in goats and sheep. It is a World Organization for Animal Health (WOAH) listed transboundary disease of small ruminants. The disease is also known as "Goat plague". It has high morbidity (100%) as well as high mortality rates (up to 90%). PPR is prevalent in Bangladesh and many parts of Africa, Asia, and the Middle East. In Bangladesh, PPR was first detected in 1993 in Meherpur District. Because of the massive socio-economic impacts of this disease, the global scientific community emphasized the requirement to eradicate PPR globally by 2030. In this connection, the Food and Agriculture Organization and the WOAH jointly initiated the strategic plan for the control and eradication of PPR globally. The Government of the People's Republic of Bangladesh took an initiative for the eradication of PPR by 2027. Sero-monitoring of this disease from different geographical locations may help in formulating effective and appropriate control strategies under the ongoing PPR control and eradication program. In the present study, we executed sero-monitoring and outbreak investigations of PPR in goats in selected areas of Bangladesh and maintained the PPR virus in a repository at the SAARC PPR laboratory, BLRI, Savar, Dhaka.

In sero-monitoring, a total of 681 serum samples were collected from goats in selected areas in Bangladesh, namely Jashore (n =145), Rangpur (n=145), Chuadanga (n=131), Rajshahi (n=130), Dhaka (n=130). Among 681 serum samples, 250 and 280 were from male and female goats aged more than one year, respectively, and 151 samples were from kids between 2 and 3 months old. The collected sera were labeled and transported in an ice-cool container to the SAARC PPR laboratory in BLRI, Savar, Dhaka and the samples were stored at −20°C until use. All the sera were tested by competitive ELISA (ID Screen @PPR Competition, IDVet, France), which is being employed for the sero-monitoring of PPR for the detection of PPRV-specific antibodies, which were measured in terms of percentage inhibition (PI) according to the kit protocol, and samples with a PI of ≥50% were considered positive. In the outbreak investigation of PPR, a total of 78 suspected PPR samples were collected aseptically from goats in the different outbreak areas of Bangladesh, namely Jashore (n=27), Rangpur (n=15), Chuadanga (n=16), Mymensingh (n=12), Dhaka (n=8). Of the 78 PPR suspected samples, 58, 06, and 14 were swabs, tissue and feces samples, respectively. All the samples were labeled, transported to the SAARC PPR laboratory, BLRI, via maintaining a proper cool chain, and stored at −20°C until use. All the samples were processed, and then RNA was extracted using the protocol of the RNA extraction kit (Invitrogen, Thermo Fisher Scientific®, USA). Subsequently, RT-PCR was performed targeting the N gene (352 bp) and the F gene (448 bp) of the PPR virus. From RT-PCR-positive samples, inoculum was prepared (OIE, 2017) and inoculated into a primary lamb testicular cell (LTC) that was prepared from 7-day-old lamb for the isolation of PPRV.

In the results of sero-monitoring, overall 69.3% (472/681) samples were sero-positive. According to sex, we found 71.2% (178/250) and 74.6% (209/280) samples were antibody-positive for PPR in male and female goats, respectively. On the other hand, in unvaccinated kids between 2 and 3 months of age, we found 56.3% (85/151) of the samples were antibody-positive for PPR. In the outbreak investigation, 37.18% (29/78) field samples were found to be PPRV positive by RT-PCR targeting the N and F gene. The expected PCR amplicon was 448 bp for the F gene and 352 bp for the N gene (Figure 1) of PPRV.

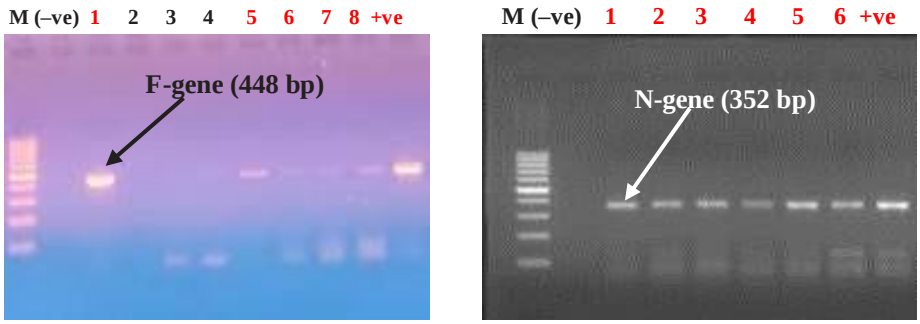

Figure 1: Amplification of the portion of F gene (448 bp) and N gene (352bp) of PPR virus.

For the isolation and propagation of PPRV, five serial blind passages were carried out on the primary LTC. At each passage, we regularly observed the cytopathic effect (CPE) under a microscope, and when more than 70% CPE was observed (Figure 2), we harvested virus-containing cell culture fluid, labeled it, and finally stored it at -80˚C. At each blind passage, reconfirmed PPRV from harvested samples (CPE produced by PPRV in the LTC) by RT-PCR. A total of three RT-PCR-positive samples were sent for gene sequencing to identify the partial F and N genes of PPRV.

Monolayer of primary LTC CPE on LTC at 7 dpi

Figure 2: Confluent cell monolayer of LTC (left) and cytopathic effect on LTC (right) at 7 days of post inoculation (dpi).

From our sero-monitoring investigation, it was found that both male and female goats carried protective level of antibody against the PPRV after being vaccinated more than a year ago. It might have happened due to a proper vaccination, using a quality vaccine with a proper cool chain, or a recovered natural infection. In the case of kids between 2 and 3 months old, they also carried a PPR-specific antibody (56.3%), but not at the expected level, so we need to vaccinate our kids at the age of 2 months. The outbreak investigation of our study indicated that the prevalence rate of PPR in different parts of Bangladesh is declining. So, we found a positive correlation between outbreak of PPR disease and its antibody level. Proper vaccination and herd immunity can decrease the incidence rate of PPR outbreaks, which will also help the ongoing PPR eradication program.

Ongoing research and monitoring of the virus are necessary for understanding the epidemiology of the PPR virus and developing more effective control strategies. So, we can say that the current study will be helpful for the eradication program of PPR in Bangladesh by 2027.

Development of Lumpy Skin Disease Vaccine Seed from Circulating Strain in Bangladesh

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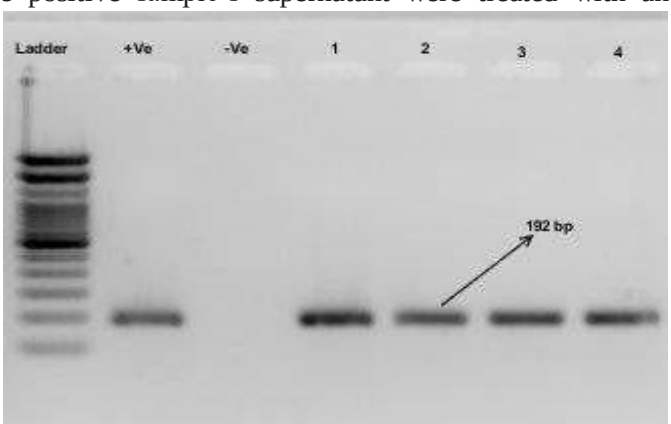
Executive Summary

Lumpy skin disease (LSD) is a viral disease caused by the LSD virus (LSDV) that belongs to the family Poxviridae and genus Capripoxvirus. The disease affects a wide range of domestic animals, mainly cattle. The clinical signs are fever and nodular lesions on the skin, mucous membranes of the respiratory and digestive tracts. Transmission occurs mainly by biting arthropods such as mosquitoes, flies and ticks. The World Organization for Animal Health (WOAH) included the disease in the notifiable transboundary disease list due to its substantial economic losses in terms of reduced productivity, poor hide quality, poor growth rate, infertility and even death. In Bangladesh, the first outbreak of LSD occurred in mid-2019 in the Chattogram district, and then rapidly spread throughout the entire country. To overcome the present situation, mass vaccination is essential for the prevention of LSD outbreaks in our country. In Bangladesh, yet there has not been developed any lumpy skin disease vaccine seed using local strain**.** Considering this national issue, the project is undertaken with the objectives of molecular characterization of the circulating lumpy skin disease virus in Bangladesh and development of its live attenuated vaccine seed from the circulating strain.

A total of 146 clinically suspected LSDV samples were collected from suspected outbreaks in 21 different areas of Bangladesh. After collection, the samples were immediately transported to the vaccine and biologics laboratory, Animal Health Research Division, BLRI, Savar, Dhaka maintaining proper cool chain. The samples were stored at -20^{0}C for further processing. For identification of LSDV, the tissue samples were minced with mortar and pastel, and 10 % tissue suspension (w/v) was made with PBS and centrifuged at 3000 rpm for 10 mins and the supernatant was collected for molecular confirmation of LSDV. The genomic DNA was extracted from the supernatant by Pure Link™ Viral RNA/DNA Mini Kit, Thermo Fisher Scientific, USA, according to manufacturer protocols. PCR was done with the LSD virus-specific primers targeted at the envelope protein P32 gene recommended by World Organization for Animal Health (WOAH). For virus isolation, 500 microliters of the positive sample's supernatant were treated with an antibiotic and filtered with a 0.45 µm filter and inoculated into a flask containing a confluent monolayer of primary lamb testicular cells (LTC) prepared from one-week old lamb testis. The cytopathic effects (CPE) were observed regularly under a microscope until 14 days of post inoculation (dpi). The growth of the isolates was further confirmed by PCR. The expected PCR amplicon size was 192 bp (Fig.1).



Out of 146 samples, 81 (55.47%) samples were found PCR positive and 10 LSDVs were successfully isolated from different field outbreaks in Bangladesh. After isolation, adaptation and attenuation of LSDV isolates (60 passages) were done in multiple cell lines (up to 40 passages in the vero cell line and 41-60 passages in the MDBK cell line. LSDV was quantified by Plaque Assay and $TCID_{50}$. The Plaque forming Unit (PFU)/ml of LSDV was 1.6 x 10^6 at 60^{th} passage. The $TCID_{50}$ was determined in every 5^{th} passage (10^{th}, 15^{th}, 20^{th}, 25^{th}, 30^{th}, 35^{th}, 40^{th}, 45^{th}, 50^{th}, 55^{th} and 60^{th} passage) of LSDV attenuation (Fig. 2). The value of Plaque forming Unit (PFU)/ml and $TCID_{50}$ of LSDV vaccine seed were very similar. Sterility and purity test of developed live attenuated LSD vaccine were done followed by vaccine safety, efficacy and potency test in xenogeneic animals (mice) and experimental calves as per WOAH guideline. The efficacy test of developed LSD vaccine in calves was performed by indirect ELISA (Table 1). In indirect ELISA, mean antibody titers (S/P %) of single dosages of LSD vaccine in calves were 98.11 ± 6.83, 177.86 ± 23.61 and 269.09 ± 54.23 on 7-, 14- and 21-days post vaccination respectively whereas in 10 times dosages animal did not show any adverse effects with the exception of fever. Antibody titers (S/P %) less than 30 was considered as negative. The efficacy tests were also performed by virus neutralization test (VNT).

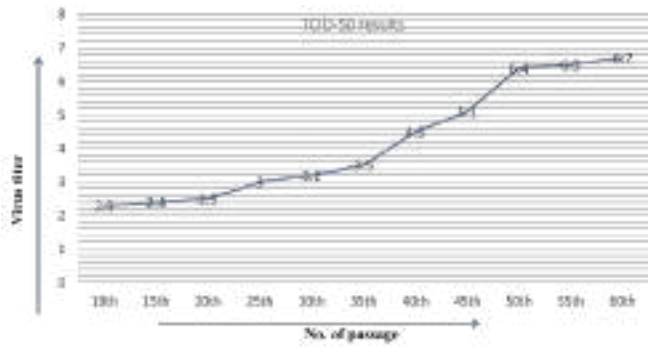


Fig 2: $TCID_{50}$ of LSD virus in different passages

SL No.	Sample ID	Animals	Dosages	S/P (%)				Remarks
				0 days	7 days	14 days	21 days	
1	1301	Bovine calf	Single dose	.78	98.45	164.96	308.69	Positive
2	1302	Bovine calf	Single dose	2.85	88.52	173.44	306.80	Positive
3	1303	Bovine calf	Single dose	.30	106.11	146.63	164.96	Positive
4	1304	Bovine calf	Single dose	-1.15	105.10	220.77	311.53	Positive
5	1305	Bovine calf	Single dose	-.66	91.05	186.93	284.45	Positive
6	1306	Bovine calf	Single dose	-1.27	102.33	187.46	279.08	Positive
7	1307	Bovine calf	Single dose	0.27	95.27	164.85	228.13	Positive
8	1308	Bovine calf	10 times	.30	131.06	228.27	312.75	Positive
9	1309	Bovine calf	10 times	3.94	146.63	270.12	348.69	Positive
10	1310	Bovine calf	10 times	1.17	130.29	274.98	349.79	Positive
11	1311	Bovine calf	Control	0.27	0.37	0.34	0.19	Negative
12	1312	Bovine calf	Control	-1.55	-1.01	-1.89	-1.57	Negative
13	1313	Bovine calf	Control	2.66	2.84	3.26	1.98	Negative
14	1314	Bovine calf	Control	0.64	0.93	0.76	0.69	Negative
15	1315	Bovine calf	Control	0.09	0.51	0.84	0.39	Negative

Table 1: Antibody titre of BLRI developed LSD vaccine in calf (Indirect ELISA)

In conclusion, BLRI developed cell culture based live attenuated LSD vaccine develop protective level of antibody and highly effective against lumpy skin disease (LSD). The vaccine is completely safe and protective against LSD, and ready for use in the field. We hope that this vaccine would be an effective tool to control and eradication of LSD in Bangladesh.

Genomic Mapping and Elucidating the Antimicrobial Resistant Pathogens Evolution in Companion and Farm Animals

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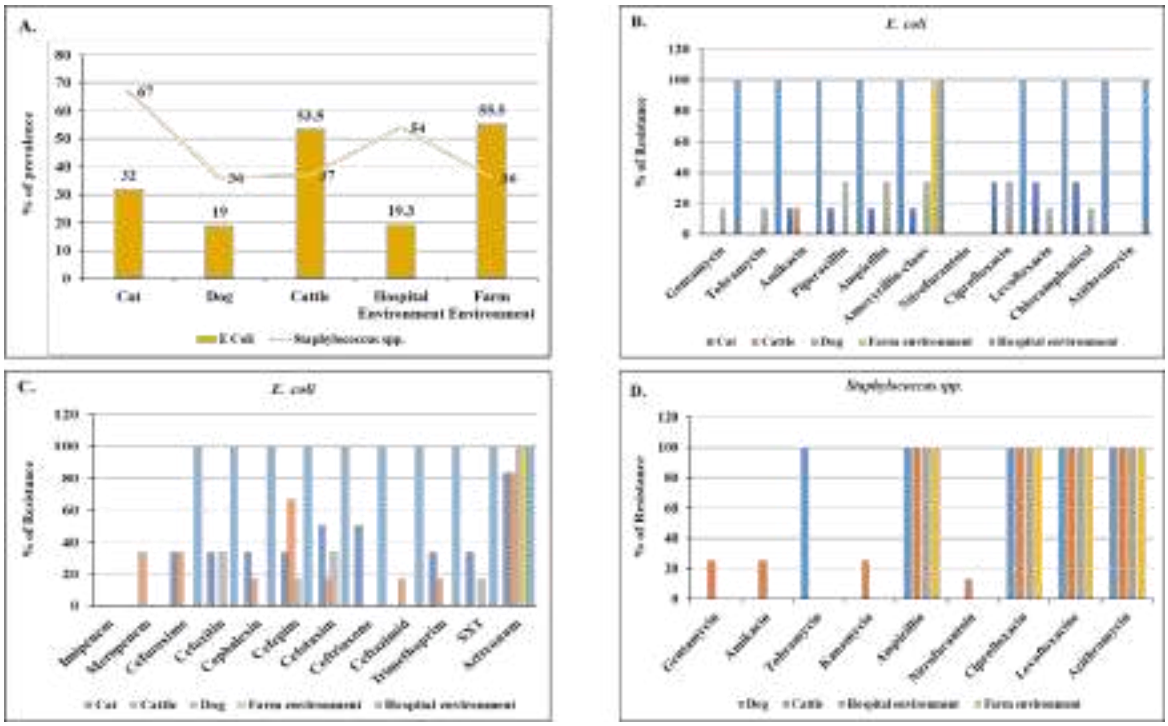
Executive Summary

The increasing occurrence of antimicrobial resistance (AMR) is of great concern globally. While the majority of the focus is placed on human clinical settings, the data on AMR, spread and reservoirs of antimicrobial resistance genes (ARGs) within the non-human niches such as companion and farm animals remain unknown. To address those issues, this study was undertaken to explore the AMR status in companion and farm animals and to uncover the mechanism of ARGs spreading from one place to another. In order to do this, a total of 220 samples (cat=50, dog=50 and environment linked to companion animals' hospital setting=20) and farm animals (cattle=56 and farm environment=44) were collected from different regions (Chattogram, Dhaka, Barishal and Rajshahi) of Bangladesh. The samples were then subjected to diverse microbiological and molecular assays including PCR to identify and isolate the target bacterial pathogens that have zoonotic importance such as *Escherichia coli* and *Staphylococcus* spp. The results showed that the distribution of *Staphylococcus* spp. and *Escherichia coli* were 67% and 32% in cats, 36% and 19% in dogs, 37% and 53.5% in cattle, 54% and 19.3% in the environment linked with companion animals' hospital settings, and 36% and 55.5% in farm animals' environment, respectively (Figure 1. A). The antimicrobial sensitivity test (AST) was done against 25 antibiotics for *E. coli* and 17 antibiotics for *Staphylococcus* spp. following the CSLI guidelines (2022).

The sensitivity test results showed that the *staphylococcus* spp. isolated from cats were 100% sensitive towards Amikacin, Kanamycin, Nitrofurantoin, and Cefoxitin, whereas 100% resistant towards Linezolid, Levofloxacin, Clindamycin, Tetracycline, Ampicillin, Pen G, and Sulphonamide-Trimethoprim combination (SXT). Other than that, the highest sensitivity was shown in case of Gentamicin (87.5%), Tobramycin (75%), and Aztreonam and Erythromycin (12.5%) accordingly. The isolates collected from pet owners and farm environments showed 100% sensitivity towards Gentamicin, Amikacin, Kanamycin, Tobramycin, Cefoxitin, Trimethoprim and Nitrofurantoin while 100% resistance towards other antimicrobials. In case of dog, 100% resistance was shown towards Tobramycin, Ciprofloxacin, Linezolid, Levofloxacin, Azithromycin, Clindamycin, Tetracycline, Ampicillin, Erythromycin, Pen G, and SXT whereas 100% sensitive towards Nitrofurantoin, Gentamicin, Amikacin, Kanamycin, and Cefoxitin. In case of cattle, 100% sensitivity was shown towards Nitrofurantoin, Cefoxitin, and Trimethoprim. Resistance against Gentamicin, Amikacin, and Kanamycin was 75%, and 100% against all other tested antimicrobials (Figure 1. D and E).

In terms of *E. coli*, isolates from cattle were 100% sensitive towards Gentamicin, Tobramycin, Piperacillin, Ampicillin, Nitrofurantoin, and Ciprofloxacin. However, resistance percentage towards other tested antimicrobials varied principally in case of cephalosporins. The resistance percentage towards Aztreonam and Cefepime was 83.33% and 66.67% respectively. While 33.33% resistance was shown towards Meropenem and Cefuroxime, 16.67% resistance was shown against Trimethoprim, Cefotaxime, Amikacin, Ceftazidime, and Cefalexin. In case of farm environment, all *E. coli* isolates were 100% resistant towards Amoxicillin-Clavulanic Acid, and Aztreonam, and 100% sensitive to other tested antimicrobials. In case of dogs and cats, the highest resistance was displayed against Aztreonam (84% and 83%) followed by Sulphonamide-Trimethoprim combination (83.3% and 66.7%), Cefotaxim (33.3% and 50%) and other antibiotics with different percentage but not more than 40% (Figure 1. B and C). Resistant to Gentamicin (15.7%),

Tobramycin (17%) and Ceftazidime (16.77%) were found in dog samples, whereas resistant to Cephalexin (38.1%), Cefuroxime (29.8%) and Ceftriaxone (50%) were found in cat samples only. The environmental samples showed highest resistance to all antibiotics except nitrofurantoin, azithromycin, meropenem and imipenem which showed the highest sensitivity against all the isolated *E. coli*. Although genomic study has not been completed yet, however, the above findings anticipate that multi-drug resistant *E. coli* and *Staphylococcus* spp. are circulating in the companion animals and also in the environment which can easily disseminate to owners of animals, veterinary personnel and to the environment that can create serious public health issue.



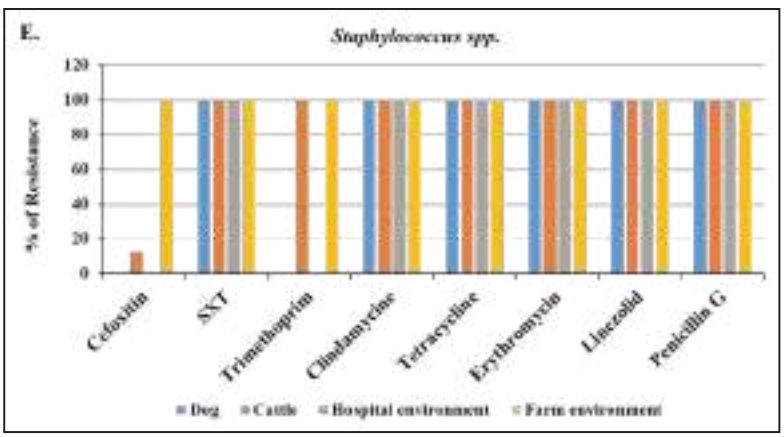


Figure 1: Prevalence and antibacterial resistance pattern of *E. coli* and *Staphylococcus spp*. in companion and farm animals. Graph A represents the prevalence of *E. coli* and *Staphylococcus spp*. in companion and farm animals and the environment linked with companion animals' hospital and farm. Graphs B and C represent the percentage of resistance of *E. coli* against different antibiotics; whereas graphs D and E show the percentage of resistance of *Staphylococcus spp*. against diverse set of antibiotics.

Development of Avian Influenza H9N2 vaccine from circulating strain

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Executive summary

Avian influenza virus (AIV) subtype H9N2 is the most widespread AIV in poultry world-wide, causing great economic losses in the global poultry industry. In Bangladesh, the AIV H9N2 has become prevalent widely in poultry, causing huge economic losses due to secondary infection with other pathogens. Recent studies on the H9N2 subtype have shown that there may be a greater risk to human health because of the possibility of novel avian influenza subtypes emerging as a result of genetic development. Vaccines are considered an effective strategy for fighting A/H9N2 infection and its associated complications. Research and clinical data have shown that inactivated whole-virus H9N2 vaccines can provide protection for immunized chickens by alleviating clinical symptoms. The purpose of the project was determination of evolutionary genetics of avian H9N2 viruses in Bangladesh and development of inactivated A/H9N2 vaccine seed from circulating strain.

The oropharyngeal swab samples were collected from commercial farms of different geographical locations and outbreak investigation. Samples were tested for the presence of AIV and its subtypes H9N2 by RT-qPCR assays. Positive A/H9N2 samples were cultured into 9-11 days old Specific Pathogen Free (SPF) embryonated chicken eggs. The A/H9N2 virus was inactivated with 0.2% formaldehyde and inactivation was confirmed following standard protocol. During the preparation of the vaccine Montanide ISA 71 VG was used as an adjuvant. Developed A/H9N2 vaccine was administered as single dose in trial-1 and booster dose in trial-2. In both trial, twenty-eight-day-old A/H9N2 sero-negative Sonali chickens were randomly divided into two groups (ten per group): an immunized group and a negative control group following WOAH guidelines. After vaccination, all birds were observed for signs of any abnormalities or disease, and sera were collected weekly for antibody detection by HI test with H9N2 reference antigen.

Out of 337 samples, 44 (13.06%) samples were found positive with A/H9N2 virus of which 26 samples were from clinical cases and 18 samples were from commercial farms. Then 44 samples were cultured in SPF chicken embryos and H9N2 virus was grown successfully in 25 samples in which 16 cultured samples were found positive for only A/H9N2 virus. Furthermore, 10 isolates with greatest HA value were cultured up to 10 passages and found to have an average 8 log2 HA value. The EID_{50} value of cultured A/H9N2 virus was $10^{7.63}EID_{50}$/ml. In sterility and purity test, it was found that there is no bacterial contamination and other than A/H9N2 virus in A/H9N2 cultured isolates.

The vaccinated group of BLRI developed A/H9N2 vaccine showed rapid increases of antibody against A/H9N2 following vaccination (Figure 1). In both single and booster doses experiments, the HI titre of A/H9N2 antibody in chickens was started to raise within the first week of vaccination and it has crossed protective 6 log2 value in the second weeks of immunization. In the single dose trial group, the peak HI titre in chickens was 11 log2 at 4 weeks after immunization and the HI titre was static above 10log2 up to 8 weeks of vaccination. After that HI titres in chickens was started to decline and were still higher than 6 log2 at 16 weeks of post-immunization. The chickens in the control groups did not elicit HI antibodies. Whereas in the booster doses trial group, the peak HI titre in chickens was 11.78 log2 at 5 weeks after immunization. The HI titres in chickens were still higher than 6 log2 at 16 weeks of post-immunization. Both the trials are on-going.

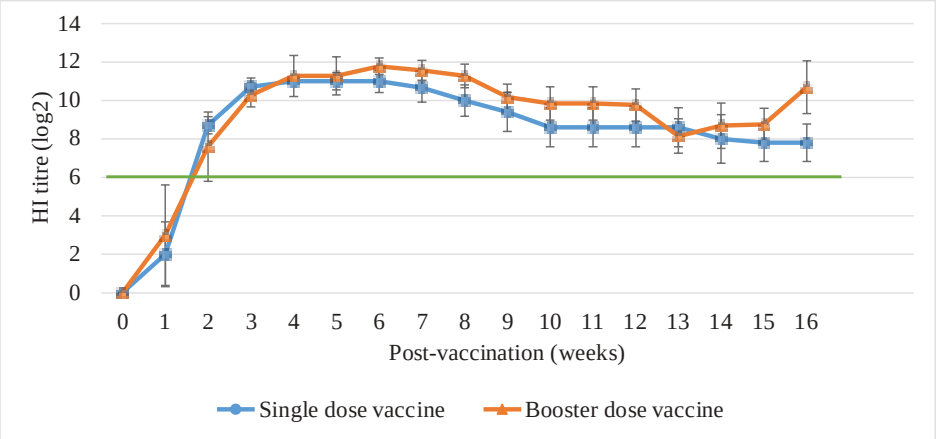

Figure 1: Antibody responses in chickens immunized with inactivated vaccine. Red and blue line indicate antibody responses in the trial-1 and trial-2 vaccination, respectively; and green line indicates the protective value.

In conclusion, it was found that the BLRI developed inactivated A/H9N2 vaccine elicited significant H9N2 specific antibodies in chickens, and immunized chickens exhibited a longer duration of antibody presence. In addition, no swelling or induration was observed at the inoculation site throughout the experimental period, suggesting that this vaccine was effective and safe.

Development of Chitosan-Graphene-based Nanobiosensor for Curving Buffalo Mortality through Early-stage Detection of Haemorrhagic Septicaemia

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Executive summary

Haemorrhagic septicaemia (HS) is an acute, septicaemia, and fatal disease of buffalo calf caused by *Pasturella multocida*. The infected buffalo usually dies within 24-36 hours after clinical onset without allowing adequate time for treatment resulting huge economic losses in Bangladesh. In this regard, a fast, sensitive, real-time diagnostic device for sensing bacteria would offer adequate time for therapies to avoid case fatality. Although several colorimetric biosensor devices, such as fluorescent biosensors, Graphene-based potentiometric sensors, Surface Plasmon Resonance (SPR) sensors, etc. are available for such purpose which often show false negative or positive results. Recently introduced bio nanotechnology-based label-free electrochemical biosensor holds promise for fast, sensitive, real-time, and on-spot detection of bacteria. Hence, this research focused on developing a chitosan-graphene- (Chit-GO) based Nanohybrid sensor-patch with contact-printed graphene electrodes for label-free electrochemical detection of HS. Therefore, the research was aimed to (i) Fabrication of thin layer graphene transferred chitosan-based Nano biosensor; (ii) Isolation identification and molecular characterization of *P. multocida* from the field samples; (iii) Characterization of electrochemical signal from *P. multocida* and their analytes using nanobiosensor and (iv) Evaluation of sensing performance of nanobiosensor from clinical specimens. A thin layer chitosan membrane was prepared with the cast printing method while its aqueous stability was achieved through Glutaraldehyde and graphene oxide cross-linking (Fig. 1a). A nanoscale layer of graphene interconnector was contact printed on the cross-linked chitosan substrate for establishing interdigitated graphene interconnect that serves as gap electrode for sensing bacteria trapped on it. For analytes holding, a microfluidic device was fabricated using Polydimethylsiloxane (PDMS) solution drop casted on the predesigned substrate and cured in a microwave oven at 80°C overnight. The fabricated chitosan membrane was functionalized using Glycine and Silver nanoparticles for enhancing surface-analytes interactions (Fig. 1e). For optimizing the sensitivity, different ration of Chitosan-Graphene Oxide (Chit-GO) composite (3:1, 6:1, 9:1,12:1, and 15:1) were drop casted during the fabrication of cross-linked membrane (Fig. 1b). The fabricated membrane was characterized by UV-vis spectroscopy and Scanning Electron Microscopy (SEM) for realizing the surface topography (Fig 1c). The physically confirmed substrate was electrochemically characterized using PBS, KCL and mammalian cell culture (Vero cell). The physically and electrochemically confirmed electrodes were subjected to electrochemical detection of *E. coli* for confirming the signal acquisition of the fabricated sensor. Thus, the suitable Chit-GO composite was prepared for electrochemical detection of *Pasturella multocida* using the gap-electrode integrated with the developed microfluidic chamber (Fig. 1d). For that, the two *Pasturella multocida* isolates was isolated from 40 nasal swabs of buffalo calves collected from Madarganj at Jamalpur in Mymensingh (Fig 1f),

The physical and electrochemical characterization of Chit-GO electrode revealed that the peak current of PBS (Fig. 1g) and KCL (Fig1h) decreased with the increase of the Chit-GO composite ratio (3:1, 6:1, 9:1, and 15:1) while that was stable when 12:1 Chit-GO was applied. Thus, the 12:1 Chit-GO composite was selected for electrochemical detection of known *E. coli*. The Cyclic Voltammetry (CV) and Linear Swipe Voltammetry (LSV) results revealed that the redox peak potential of the bacteria was found at 0.1V while the oxidation peak potential was at -0.2V. Whereas, the redox current peak was maximum (2.5×10^{-4}) and oxidation peak was (-3.5×10^{-4}) for bacteria. Whereas, such potential peak was absent for PBS. Such signal acquisition was further verified with the electrochemical detection of Vero cell. The Vero cell signal revealed that, the redox peak potential was found at 0.1V, while the oxidation peak potential was at -0.1V which is completely different from the *E. coli* peaks (Fig 1i and 1j). The intensity of the redox current peak was maximum (1×10^{-6}) and oxidase was (-2.5×10^{-6}) for Vero cell. Whereas such peak intensity was absent for PBS. Thus, the analytes specific

signal acquisition was confirmed using the developed chit GO sensor. Therefore, we are confident in detecting *P. multocida* using the developed sensor. Meanwhile, the Non-haemolytic mucoid colonies of 1-3mm in diameter, Gram-Negative, Small rod or coccoid rods in pairs, Ring formation in Indole test, and the amplified band at 460 bp of the primer KMT1T7 and KMT1SP6 for PCR confirmation of *P. multocida*. the species-specific primers. This culturally, biochemically and molecularly confirmed *P. multocida* are under electrochemical characterisations using this shift in peak potential. The *P. multocida* specific electrochemical signal will be employed for the detection of HS from buffalos in the future. The as fabricated layer Chit-GO with a thin layer graphene interconnect employ chitosan and graphene oxide a ratio of 12:1, while the multilayer graphene nano-sheet showed several layers during SEM investigation. The CV and LSV of fabricated Chit-GO (12:1 ratio) also showed an excellent peak potential window because the 12:1 ratio of the Chit-GO composite does not show any background current. Thus 12:1 Chit-GO composite was selected for electrochemical detection of bacteria. The electrochemical detection results of PBS, KCL, *E. coli*, and Vero cells using 12:1 Chit-GO composite also revealed that the fabricated sensor could be suitable for electrochemical detection of any analytes in the future.

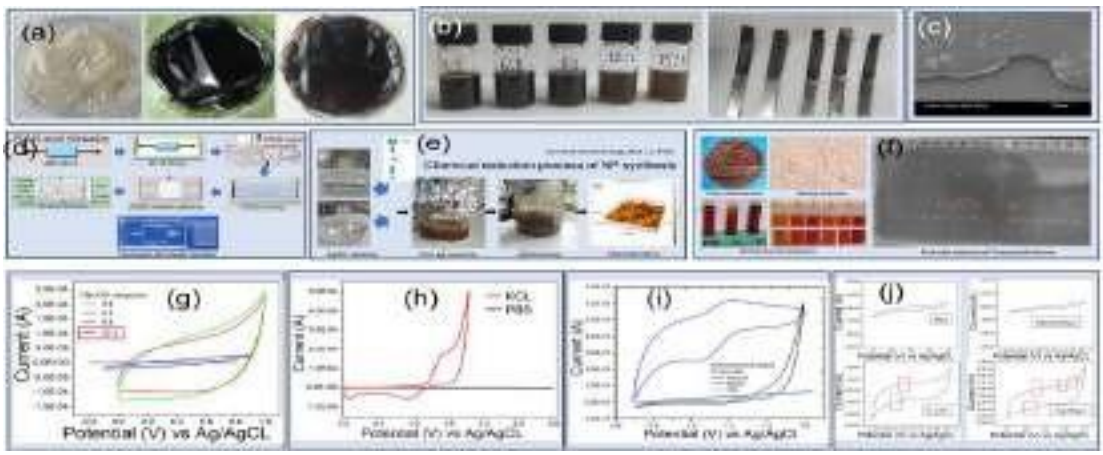

Fig. 1 Overall activities for of the development of nano biosensor a) development od crosslinking of chitosan membrane, b) preparation of Chit-GO composite, c) physical characterization of Chit-GO by SEM, D) Microfluidic device fabrication, e) NPs synthesis for functionalization of developed membrane, f) isolation and identification of *P. multocida*, g) electrochemical characterization of Chit-GO, h) CV of KCL, i) CV of Vero cell, and j) and CV *E. coli*, tap water and mineral water

This research developed an aqueous-stable, glutaraldehyde and graphene oxide cross-linked chitosan membrane on which chitosan-graphene oxide composite (Chit-GO) was established for signal acquisition of the analytes. The fabricated Chit-GO was functionalized with AgNPs and CuONPs were successfully for enhancing the signal acquisition ability. The predesign microfluidic chamber was established on the fabricated Chit-GO sensor analytes for holding the analytes. Two- and Three-electrode electrochemical systems were employed for electrochemical sensing. The cultural, morphological, biochemical, and molecular characterization of *P. multocida* was performed for their electrochemical characterization. While, serotyping and sequencing of the PCR-confirmed *P. multocida* will be performed this year. Electrochemical characterizations of the identified *P. multocida* from the nasopharyngeal cavity of buffalo are under progress. The *P. multocida* will also be detected electrochemically from the suspected field samples. Validation of Electrochemical data will be performed with the traditional diagnostic methods.

Development of Goat pox vaccine seed from circulating local strain

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Executive Summary

Goat pox (GP) is a highly infectious disease of goats caused by the enveloped double stranded DNA virus of the family Poxviridae. This disease may be mild in indigenous breeds in endemic areas, but it is often fatal in newly introduced exotic breeds as well as crossbreds and hybrids. The disease causes huge economic losses. The economic losses result from decreased milk production, damaged skin quality, abortion of a fetus, weight loss, and other production losses. It also limits trade and inhibits the development of intensive goat farming in Bangladesh. Although GP has been prevalent in Bangladesh for more than decades, the property of the prevalent goat pox virus (GPV) has not yet been characterized. Besides, the goat pox vaccine can be used to control the lumpy skin disease. Hence, the government has prioritized developing GP vaccine seed from circulating local strains along with other vaccines. Therefore, the present study was executed to detect, isolate, and characterize the circulating field strains of GPV and to adapt the virulent GPV strain in the cell line for the development of live attenuated GP vaccine seed.

A total of 121 clinically suspected GP samples (cutaneous papules, nodules, and skin) were collected aseptically from Meherpur, Jhenaidah, Chuadanga, Dinajpur, Rangamati, Naogaon, Bagherhat, Chapai Nawabganj, Cox'sbazar, and Sylhet districts. A structured questionnaire was developed and administered to the farmers during sample collection to record farmer's demographic information, farm information, and management practices. After collection, the samples were labeled and immediately transported in an ice-cold container to the vaccine and biologics laboratory, BLRI. Subsequently, the genomic DNA was extracted by DNA extraction kit (Invitrogen, Thermofisher Scientific, USA) according to the manufacturer's protocols. Samples were tested by PCR with the specific primers and protocol recommended by World Organization for Animal Health (WOAH) targeting DNA polymerase gene and P32 gene of GPV. Inoculum was prepared from fresh PCR positive samples, and then inoculated into primary lamb testicular cell (LTC) for the isolation of GPV. After isolation, adaptation and attenuation of GPV were done in Vero cell line and MDBK cell line.

Out of 121 samples, 76 (62.82%) were found PCR positive. The expected PCR amplicon size was 289 bp for DNA polymerase gene and 969 bp for P32 gene. For the isolation, we have cultured the fresh PCR positive field samples in primary LTC.

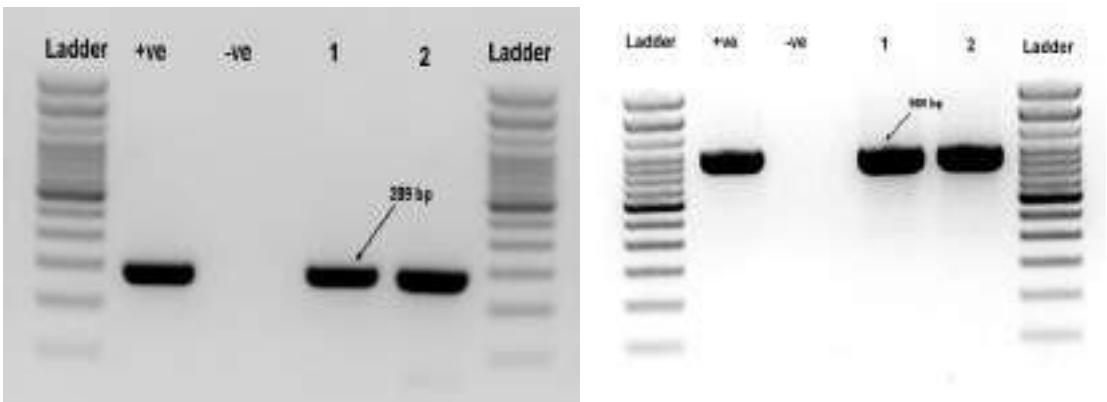

Fig.: Amplification of DNA poly gene and P32 gene of cultured GPV in Vero cell line of 52nd passage.

In primary LTC, infected cells developed a characteristic CPE consisting retraction of the cell membrane from surrounding cells, eventually rounding of cell and aggregation of cell at 7-8 dpi. After each passage, cytopathic effect (CPE) produced by GPVs in the primary LTC were reconfirmed by PCR and harvested and stored at -80^{0}C. Till now, we have successfully isolated 8 goat pox viruses from the field samples. Adaptation and attenuation of representative two GPV isolates in Vero cell line is underway in order to develop a live attenuated GP vaccine seed, and currently 52nd passage has completed (Fig.1). Simultaneously, adaptation and attenuation of GPV isolates in MDBK cell line is also going on from 35th passage for the development of live attenuated GP vaccine seed and currently 50th passage has completed (Fig.2). After each passage, cytopathic effect (CPE) produced by GPVs in the Vero/MDBK cell line were reconfirmed by PCR and harvested and stored at -80^{0}C. For the quantification of GPV, $TCID_{50}$ was determined in every 5th passage (5th, 10th, 15th, 20th, 25th, 30th, 35th, 40th, 45th, 50th, and 52nd passage of GPV attenuation (Fig.3). Partial gene sequencing of representative 4 GPV from 4 outbreak areas was done and it revealed that our identified GPV are identical to each other and may have a common ancestral relationship with Indian isolates. In addition, whole genome sequencing of GPV was performed, and analysis is underway.

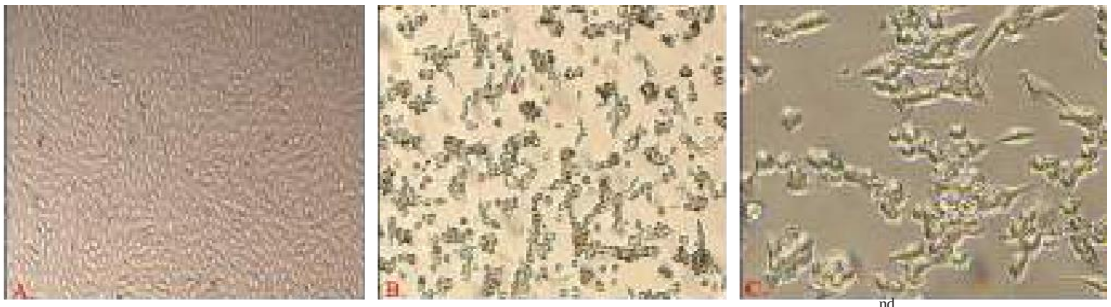

Fig.1: (A) Confluent vero cell line, (B) CPE of 52ndpassage at 4 dpi (4x), (C) CPE of 52nd passage at 4 dpi (10x)

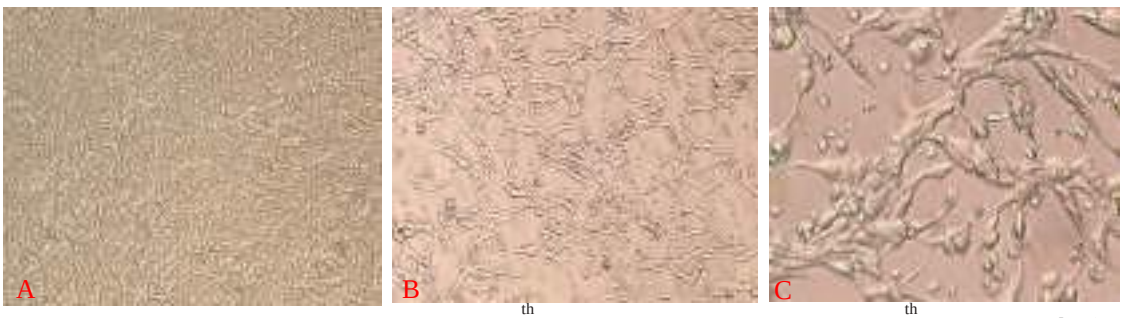

Fig.2: (A) Confluent MDBK cell line, (B) CPE of 50th passage at 4 dpi (4x), (C) CPE of 50th passage at 4 dpi (10x)

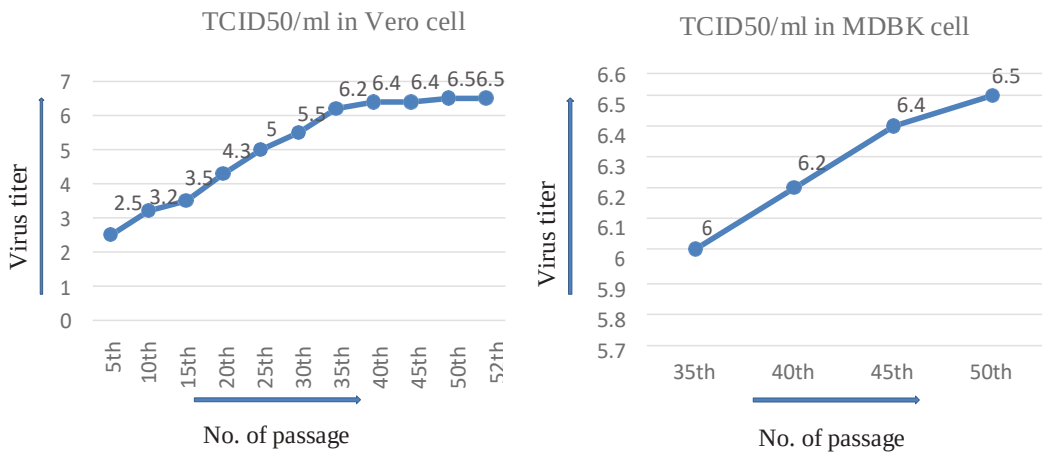

Fig.3: Line graph showing $TCID_{50}$ of GP virus titer in different passages

Project title: Identification of major goat health problems and their mitigation in different agro-ecological zones of Bangladesh

Subtitle 1: Sero-prevalence and molecular identification of Contagious caprine pleuropneumonia (CCPP) in goats of Bangladesh

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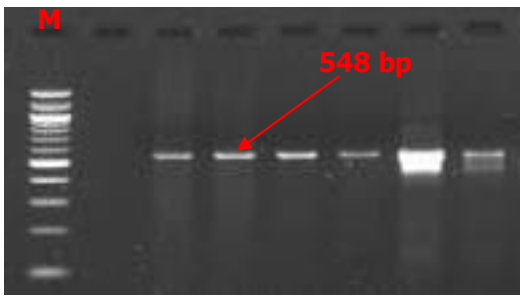
Executive Summary

Contagious caprine pleuropneumonia (CCPP) is an extremely contagious mycoplasmal respiratory infection affecting mainly goats and sheep caused by *Mycoplasma capricolum* subspecies *capripneumoniae* (Mccp). The disease is known for its high mortality, morbidity and significant economic losses. Thus far, no information is available both on the serological and molecular identification of Mccp in Bangladesh. The study was aimed to assess the seroprevalence of CCPP and related risk factors and identify the causal agent (Mccp) molecularly for the first time in Bangladesh. To estimate seroprevalence, 402 goat serum samples were randomly collected and for molecular confirmation, 90 clinically suspected lung samples were aseptically collected in the study area from July, 2022 to June, 2023. Goat owners were interviewed by using a pretested questionnaire to determine risk factors. A commercial cELISA kit (IDEXX, France) was used to screen blood serum for anti-CCPP antibodies. The genomic DNA was isolated using a DNA extraction Kit (Thrmofisher, USA) as per the manufacturer's instructions and then conventional PCR performed for molecular detection of Mccp. Logistic regression models (univariate and multivariate) were used to analyze risk factors and serological data for identifying the potential risk factors. The 16S rRNA gene was used to identify *Mycoplasma* mycoides cluster (Mmc) and the Mccp specific-gene was used to identify the *Mycoplasma capricolum* subsp. *Capripneumoniae* (Mccp) from suspected lung samples.

Out of 402 serum samples 29 samples were seropositive towards CCPP. The overall seroprevalence was 7.21% (95% CI: 1.90-12.53). Univariate and multivariate logistic regression analysis on the assumed risk factors showed that animal age (>18 months; OR: 2.14, 95% CI: 0.92-4.98), sex (Female; OR: 5.80, 95% CI: 1.70-19.69), Farm size (Large; OR: 6.28, 95% CI: 1.17-35.74), and body condition scores (BCS) (Poor BCS; OR: 5.58, 95% CI: 1.36-22.92) were the major risk factors associated with the occurrence of the disease (Table 1 and Table 2). From the 90 clinically suspected lung samples, 41 (45.56%) were identified to be Mycoplasma mycoides cluster (Mmc) by PCR targeting the 16S rRNA gene (Figure 1) and Mccp-specific gene amplification identified 24 of 41 mycoplasma mycoides clusters as *Mycoplasma capricolum* subsp. *Capripneumoniae* (Mccp) (Figure 2).

This study confirming both the serological evidence and molecular existence of Mccp in the selected goat prone areas of Bangladesh for the first time. However, vaccine import and immunization of the goats as well as proper choice of antimicrobials should be given for decreasing the rate of prevalence of CCPP in goat herds and to prevent their serious economic losses.



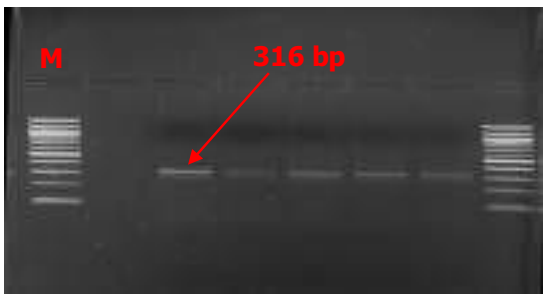


Fig. 1 PCR results of *Mycoplasma* mycoides cluster with amplicon size of 548 and Fig. 2 PCR results of *Mycoplasma capricolum subsp. Capripneunomiae* with amplicon size of 316. M= 100 bp ladder

Table 1. Univariable logistic regression analysis of risk factors for CCPP seropositivity of goats

Variable	Category	No. of tested (% positive)	95% CI	OR (95% CI)	*P*-value
Breed	Jamunapari	65 (4.62)	0.96-12.90	Ref.	
	BBG	155 (5.81)	2.68-10.73	1.27 (0.33-4.86)	0.723
	Cross breed	182 (9.89)	5.96-15.17	2.26 (0.64-7.97)	0.201
Age (month)	Kid (<6)	52 (5.77)	1.20-15.94	1.05 (0.27-3.97)	0.939
	Growing (6 to 18)	182 (5.49)	2.66-9.87	Ref.	
	Adult (>18)	168 (10.12)	6.0-15.70	1.94 (0.86-4.35)	0.110
Sex	Male	159 (4.40)	1.78-8.86	Ref.	
	Female	243 (9.47)	6.09-16.86	2.27 (0.95-5.42)	0.035
Rearing system	Free	189 (5.82)	2.94-10.17	Ref.	
	Semi Intensive	213 (8.92)	5.45-13.57	1.58 (0.73-3.42)	0.241
Farm size	Small	187 (4.81)	2.22-8.93	1.14 (0.23-5.45)	0.872
	Medium	47 (4.26)	0.51-14.54	Ref.	
	Large	168 (11.31)	6.94-17.09	2.86 (0.64-12.79)	0.167
BCS	Good	117 (6.84)	2.99-13.02	Ref.	
	Medium	189 (6.88)	3.71-11.47	1.006 (0.40-2.50)	0.989
	Poor	96 (9.38)	4.37-17.05	1.4 (0.52-3.80)	0.041
Location	Jashore	43 (9.30)	2.59-22.13	3.48 (0.37-32.72	0.274
	Jhenidah	31 (3.23)	.08-16.70	1.13 (0.06-18.91)	0.931
	Chuadanga	39 (7.69)	1.61-20.87	2.83 (0.28-28.57)	0.377
	Meherpur	43 (11.63)	3.88-25.08	4.47 (0.49-40.22)	0.181
	Kustia	35 (8.57)	1.80-23.05	3.18 (0.31-32.24)	0.326
	Rajshahi	38 (7.89)	1.65-21.37	2.91 (0.28-29.41)	0.365
	Mymensingh	32 (3.13)	.07-16.21	1.09 (0.06-18.29)	0.949
	Savar	42 (11.90)	3.98-25.63	4.59 (0.51-41.34)	0.174
	Bandarban	34 (11.76)	3.30-27.45	4.53 (0.47-42.82)	0.187
	Gaibandha	35 (2.86)	0.07-14.91	Ref.	
	Tangail	30 (0)	-	-	

Table 2. Results of multivariable logistic regression analysis of potential risk factors associated with CCPP Seropositivity of goats by cELISA

Variable	Category	Adjusted OR (95% CI)	*P*-value
Age (month)	Kid (<6)	1.47 (0.36-5.87)	0.582
	Growing (6 to 18)	Ref.	
	Adult (>18)	2.14 (0.92-4.98)	0.047
Sex	Male	Ref.	
	Female	5.80 (1.70-19.69)	0.005
Farm size	Small	1.37 (0.18-10.14)	0.755
	Medium	Ref.	
	Large	6.28 (1.17-35.74)	0.038
BCS	Good	Ref.	
	Medium	2.39 (0.77-7.36)	0.127
	Poor	5.58 (1.36-22.92)	0.017

Project title: Identification of major goat health problems and their mitigation in different agro-ecological zones of Bangladesh

Subtitle 2: Molecular detection and phylogenetic analysis of Contagious Ecthyma virus for the prerequisite of vaccine seed development

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Executive summary

Contagious Ecthyma (CE), or Orf, is a highly contagious viral skin disease in goats and sheep caused by the Orf or CE virus in the genus Parapoxvirus. CE is characterized by proliferative skin lesions in the lips, muzzle, ears, and eyelids, around the mouth, udder and nostrils of lambs. Transmission of the virus within the herd is carried out through direct contact of sick animals or suckling. All breeds and age groups of goats and sheep are susceptible to this disease, however young animals are highly susceptible and more commonly affected. The disease has been reported in many countries around the world including Bangladesh. However, the epidemiology of the disease remains unknown in this country. In addition, there is limited study on the molecular characterization, isolation in primary lamb testicular cells (LTC), and attenuation and adaptation of CEV in the Vero cell line for the development of vaccine. Hence, the present study was undertaken to isolate and identify CEV from suspected field samples of goats and to characterize the viruses. A total of 49 clinically suspected CE field samples (scab materials) were collected, labeled, and transported in an ice-cold container during the period of July 2022 to June 2023. Of the 49 samples, 17, 09, 06, 11 and 07 were collected respectively from Savar, Rajshahi, Faridpur, Meherpur and Chuadanga. During collections of samples goat`s age, sex and seasons were considered. Samples were minced using sterile scissors and forceps and then triturated in a sterile pestle and mortar with phosphate-buffered saline to make a 10% suspension. DNA was extracted using the DNA extraction kit (Monarch®, USA) according to the manufacturer's instructions. Polymerase chain reaction (PCR) was done for the detection of the CEV using three sets of primers targeting three different genes (VIR, GIF and vIL)of the CEV. Amplicons were analyzed by gel electrophoresis in a 1.0% agarose gel using TBE buffer with ethidium bromide. The PCR-positive samples were used for partial gene sequencing afterthat sequencing was done in both forward and reverse directions using an automated DNA sequencer (3500 Genetic Analyzer, Applied Biosystems, USA). In addition, inoculum was prepared from PCR-positive samples (OIE, 2017) and inoculated into primary LTC for the isolation of CEV. At each time, primary LTC infected with CEV were harvested and confirmed by PCR.

Out of 49 clinically suspected CE samples, 34.69% (17/49) were found positive for CEV (Table-1) by PCR. Our study on the GIF and vIL gene sequences provides evidence of the close relationship as well as genetic variation among the CEV strains that are circulating in Bangladesh and worldwide (Figure 1). In addtion, it is observed that almost all age groups of goats are susceptible to CE (Table-1) and young animals (less than months and of age) are more susceptible than the adults. We also found winter season is more vulnerable than others season. The cell culture result showed that in primary LTC, positive isolates produced a cytopathic effect (CPE) at 6-7 days of post inoculation (dpi), and CPE was characterized by rounding and detachment of cells.

Table-1: Prevalence of CEV from suspected field samples by PCR.

Variable	Category	No. of sample tested	No. of Positive (%)	95% CI
Location	Savar	17	06 (35.29%)	30.31% - 40.27%
	Rajshahi	09	03 (33.33 %)	24.17% - 42.49%
	Faridpur	06	02 (33.33 %)	17.85% - 48.81%
	Meherpur	11	04 (36.36 %)	28.81% - 43.91%
	Chuadanga	07	02 (28.57 %)	17.33% - 39.81%
Age	1-3 Months	23	07 (30.43%)	27.04% - 33.82%
	3-6 Months	13	05 (38.46%)	31.32% - 45.58%
	6-12 Months	08	03 (37.5%)	28.27% - 46.77%
	>1 Year	05	02 (40%)	25.14% - 54.86%
Sex	Male	21	05 (23.81%)	21.65% - 25.97%
	Female	28	12 (42.86%)	37.69% - 48.03%
Season	Summer	13	02 (15.38%)	9.45% - 21.31%
	Rainy	11	03 (27.27%)	20.13% - 34.41%
	Winter	25	12 (48%)	46.04% - 49.96%
Total		**49**	**17 (34.69%)**	**32.71% - 36.67%**

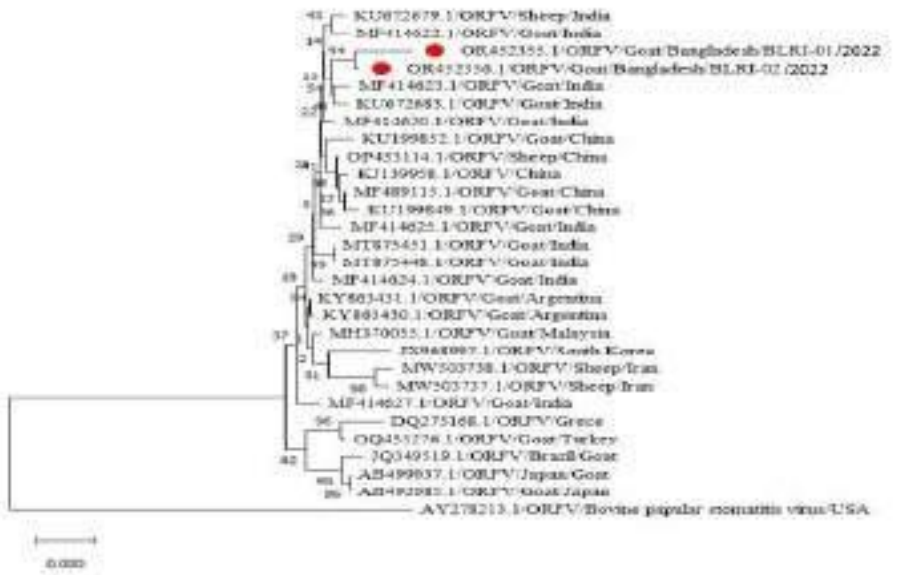

Figure 1: Picture showing the phylogenetic analysis of goats CEV isolates constructed using neighbour joining methods.

In conclusion, seventeen contagious ecthyma virus were detected by PCR and Phylogenetic analysis showed that Bangladeshi isolates of CEV was closely related to each other's and also high homology with the CEV isolates of Indian variant. It indicates that the CEV prevalent in the environment and some factors including stress condition, repeated exposure to the virus laden areas during winter season due to limited grazing land most probably responsible for the spread of infection.

Investigation of Pneumonic Pasteurellosis in sheep and their mitigation to develop a model sheep health management package for ideal farming

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Pneumonic pasteurellosis in sheep is an important bacterial disease caused predominantly by *Mannheimia haemolytica* and *Pasteurella multocida* (PTM). Once infected, these diseases cause serious health deterioration increasing treatment costs with obligatory use of systemic antimicrobials amidst of increased Antimicrobial Resistance. Prevention of this disease can be done by effective vaccination. In Bangladesh, Govt. produced Hemorrhagic Septicemia (HS) vaccine is used in small ruminants but the vaccine effectiveness study has not been done yet. Investigation of HS vaccine efficacy in sheep would be helpful in outlining information about antibody titer fluctuation, booster dosing, or the necessity of using different vaccine seeds. Hence a vaccine efficacy study was designed with twenty HS seronegative growing apparently healthy female sheep (equally divided into treatment and control groups) aged 3 to 4 months for on station experiment. Following deworming and acclimatization, blood was collected at 0 day from all the animals and serum was preserved accordingly. The next day, the treatment group was vaccinated with formalin-killed oil adjuvant HS vaccine at 1 ml per sheep subcutaneously. Blood samples were collected at 7, 14, 21, 28, 35, 42, 49, 56, and 63 days preserving serum at -20°C for performing Indirect ELISA. The highly prevalent dermonecrotoxin *P. multocida* ToxA protein (P17452) was targeted as coating antigen. A Two-Sample t-test was performed using Microsoft Excel Data Analysis Toolkit (Microsoft Office LTSC Professional Plus 2021). It was found that the mean ±SD of the unvaccinated and vaccinated group's OD were 0.05965±0.0025 and 0.07269±0.0092 respectively. Both the mean differed significantly ($P<0.001$) in each case of the variance assuming equal and unequal. While performing predictive mathematical modelling, the selection bias was taken into account due to the dataset distribution pattern and successive odds ratios of the generated equation. We allowed $OR\geq0.5$. Though the exponential model provided OR of both groups in this range, the logarithmic model showed much better fitness in case of the treatment group while reducing OD below 0.5 nullifying the prerequisites. A natural logarithmic equation of $Y=0.0116LN(X)+0.0552$ gives a good prediction with OR=0.7693 (Figure 1). However, due to the complexity of the vaccine distribution pattern, a polynomial equation with a more robust dataset based on field trials with multiple categorical parameters and protective antibody titer would serve better in deduction. This study reveals that the LRI-produced formalin-killed oil adjuvant HS vaccine generates a significantly increased level of antibody titer from day 14 that increased logarithmically up to 42 days and starts to decline by 49 days and maintains a static course from 56 to 63 days (Figure 2). To investigate the protection level, C-ELISA will be developed to suggest the booster dosing, duration of protection in the future research.

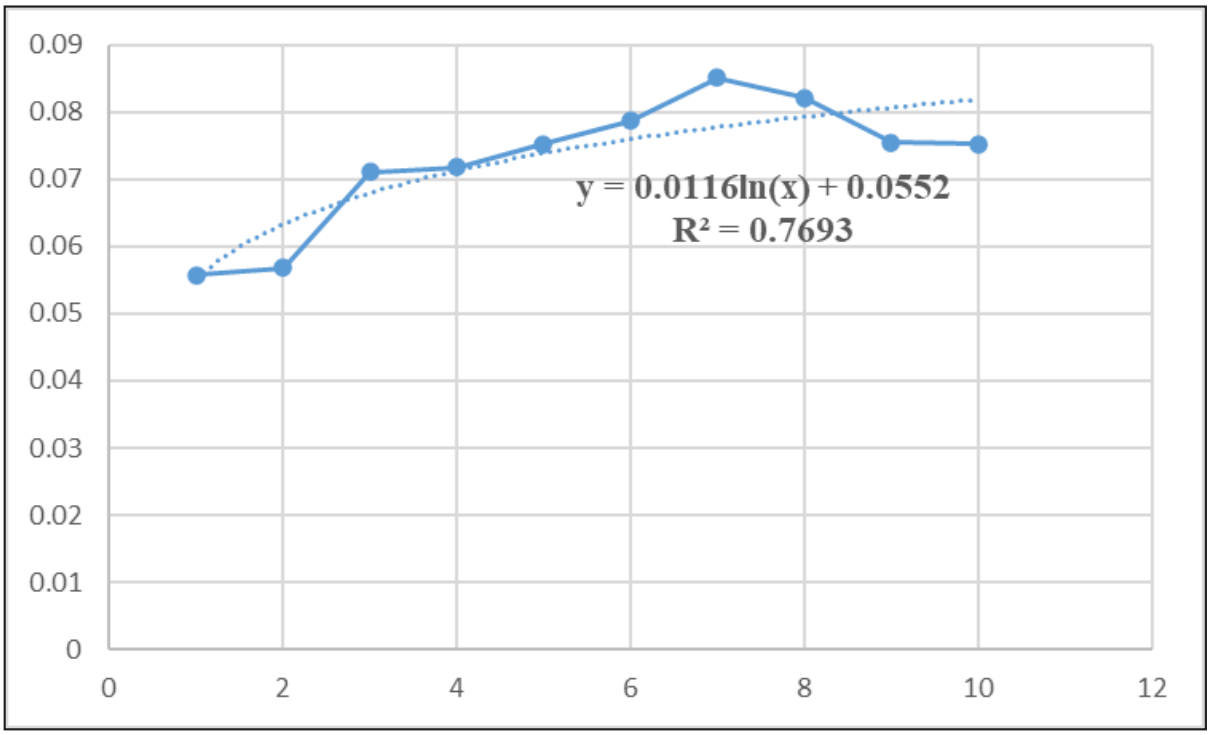

Figure 1: Scatter Plot of Vaccinated Group Sera OD Value (Logarithmic Equation)

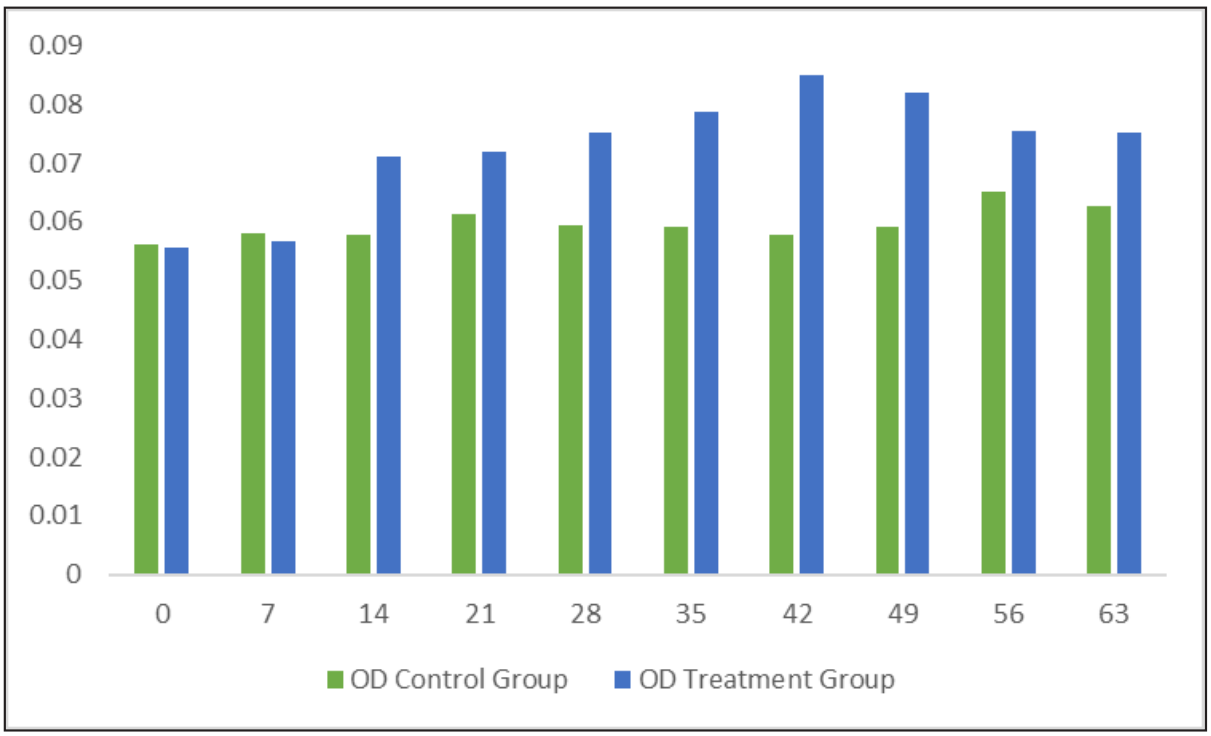

Figure 2: Serum OD Value of Unvaccinated and Vaccinated Group

Surveillance and Molecular evolution of avian influenza virus in Bangladesh

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Executive Summary

In Bangladesh, the poultry industry is an economically and socially important sector, but it is persistently threatened by the H5N1 Highly Pathogenic Avian Influenza (HPAI) causing severe disease with a high death rate. Avian influenza, known informally as avian flu or bird flu, is a variety of influenza caused by viruses adapted to birds. It is a highly contagious viral disease and it has caused tremendous economic losses to the poultry industry over the last decade. It is very difficult to control this disease because of its huge number of serotypes and mutation nature. The virus is zoonotic in nature that easily mutates from LPAI to HPAI. The formation of the International Partnership on Avian and Pandemic Influenza was announced in order to elevate the importance of avian flu, coordinate efforts, and improve disease reporting and surveillance for a better response to future pandemics. As of June 2023, a total of 548 outbreaks of HPAI H5N1 have been reported; these outbreaks have resulted in serious economic losses in the poultry sector in this country. Furthermore, 7 cases of human infection with HPAI H5N1 were confirmed emphasizing the public health aspect of the ongoing 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, and co-circulation with other infectious respiratory pathogens is also reported. In light of these facts, the ongoing study aims to examine the objectives-detection, isolation and molecular evolution of avian influenza virus circulating in Bangladesh, and development of reference antisera from circulating A/H5N1 Clade 2.3.2.1a.

To achieve the objectives, the research activities in the financial year 2022-23 were considered as sample collection from commercial farms and outbreak investigation, then subtype determination by RT-qPCR. AIV antigen (A/H5N1) was prepared from the isolated A/H5N1. Finally, an antigenic cartography experiment was performed against the current circulating A/H5N1virus. A total of 151 (Oropharyngeal swabs, and post-mortem specimens) samples were collected from commercial chicken farms in Gazipur, Dhamrai and Rajshahi. Samples were labeled and placed within an insulated ice-box and transferred to the National Reference Laboratory for Avian Influenza, Bangladesh Livestock Research Institute, Dhaka, and stored at -80 °C for testing.

The magnetic bead-based RNA isolation technology was applied for RNA extraction from collected samples individually by using MagMAX™-96 AI/ND Viral RNA Isolation Kit (Applied Biosystems™, USA) in KingFisher™ Flex 96 well robot (Thermo Scientific™, USA) according to manufacturer protocol. Samples were tested for and evaluated for the presence of AIV and its subtypes by RT-qPCR assays. The samples were screened first for the presence of the M gene by RT-PCR test using reference primers.

A total of 27 (17.88%) positive avian influenza (AIV) samples were analyzed for AIV subtypes like H5, H9 and other combinations of H5 and H9 subtypes. Out of 27 AIV positive samples, 6 H5 and 14 H9 subtypes were identified. Highly positive 3 H5 samples were cultured in SPF chicken eggs and isolated H5 virus were re-confirmed by RT-PCR test.

For the development of reference antisera from circulating H5N1 Clade 2.3.2.1a (NRL-AI archived isolates), a total of 10 AIV sero-negative chickens were selected and infected by formalin killed A/Chicken/Bangladesh/NRL-AI-8323/2017 and A/Chicken/Bangladesh/NRL-AI-2214/2022 virus. Then booster dose was given after 30 days of 1st inoculation. Finally, prime sera and boosted sera (30 days of 1st infection) were collected for further antigenic cartography study according to

standard protocols. Therefore, a total of 8 antigens including two reference antigens of H5N1 and H5N6 (collected from CSIRO, Australia) were used for the cross-HI test. After that, the Cross-HI test of the developed national antisera with reference antigen and local antigen. In antigenic cartography, it was found that the circulating A/H5N1 virus from 2023 is antigenically close to the 2019 virus (Figure 1).

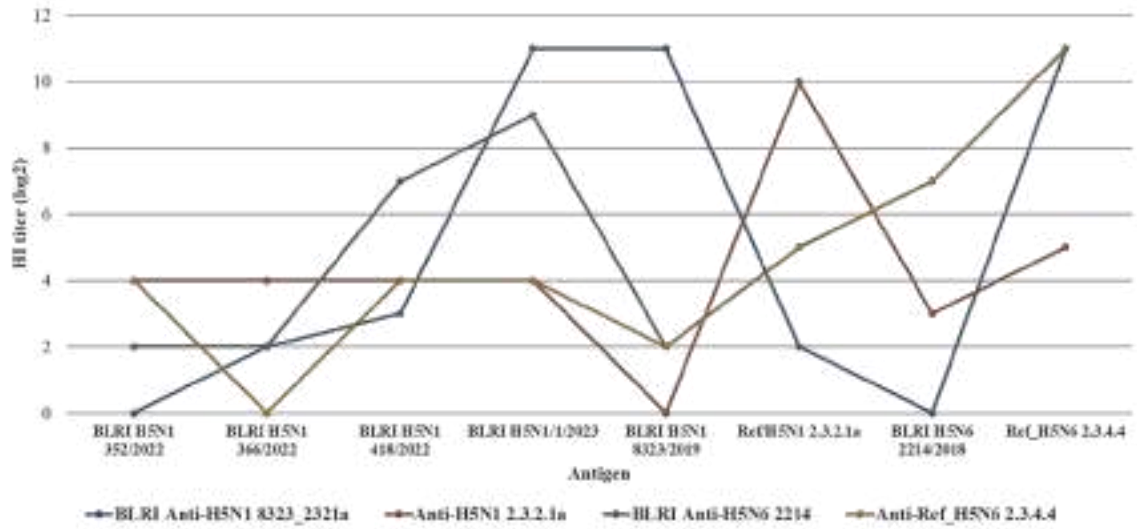

Figure 1: Antigenic cartography showing the relationship among reference antisera and antigen with field isolates A/H5N1 virus.

In conclusion, diverse antigenicity is noted in circulated HPAI in Bangladesh. So, it is needed to monitor HPAI regularly for its prevention and control.

Epidemiological investigation of major buffalo diseases and evaluation of effectiveness of deworming against buffalo diseases in Bangladesh

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Executive Summary

Buffalo is one of the significant livestock species in Bangladesh's economy considering its production potential and adaptability over high-yielding cattle. Livestock diseases are one of the impediments to livestock productivity, which results in severe economic loss. The majority of buffalo diseases are infectious and parasitic in origin, posing substantial risks to the animal's productivity. Therefore, the current study aimed to conduct an epidemiological investigation to know the prevalence of buffalo diseases and to determine the on-farm effectiveness of deworming and vaccination for developing a strategic deworming and vaccine calendar. A cross-sectional survey was conducted regarding health care practices, disease risk factors and treatment costs with pretested questionnaire at 10 buffalo pocket areas (Madarganj, Bauphal, Char Fashion, Companiganj, Ramgati, Anowara, Fenchuganj, Kaliganj, Gangachara, Ishurdi) of Bangladesh. Alongside this experimental study was also conducted using a randomized control trial to determine the farm-level effectiveness of deworming in water buffaloes raised under semi-intensive and extensive farming systems. A total of 705 fecal samples of 4 different age groups of A (<1 year), B (1-3 years), C (3-6 Years) and D (>6 years) were tested during the pre and post-deworming period applying combined Triclabendazole and Levamisole drug. A modified McMaster technique was applied for the fecal egg count (FEC). The flotation technique was used for demonstrating gastrointestinal nematodes, cestode eggs, and coccidian oocysts, and the sedimentation technique was used for detecting the trematode eggs.

According to the active (physical and electronic) surveillance on the basis of clinical signs of the diseases in the last 3 years of 10 project areas, infectious disease prevalence was higher than non-infectious diseases in buffalo farms (Table 1). Results showed that the occurrence of FMD (41.3%) was highest among the infectious diseases, followed by HS (17.8%), Mastitis (4.9%), Anthrax (3.4%), and BQ (2.7%). Among the metabolic diseases, Acidosis (20.3%) was higher in the project areas. Most of the buffalo farmers reported unfamiliarity with the importance of proper deworming (92.8%; CI: 91.6-92.8) and vaccination (99.2%; CI: 98.6-99.9) practice.

Table 1. Prevalence of diseases in different buffalo pocket areas

SL	Traits	N	Prevalence (%)	SE	95%CI
1.	FMD	526	41.3	0.021	0.371-0.455
2.	BQ	526	2.7	0.007	0.015-0.044
3.	Anthrax	526	3.4	0.007	0.021-0.053
4.	HS	526	17.8	0.016	0.148-0.213
5.	Gastrointestinal diseases	526	22.2	0.018	0.188-0.260
6.	Mastitis	526	4.9	0.009	0.033-0.071
7.	Acidosis	526	20.3	0.017	0.171-0.240
8.	Other diseases	526	8.5	0.012	0.064-0.112

The geometric (G) mean of EPG is higher in semi-intensive farms than in Bathan farms, possibly due to rotational grazing land in the extensive rearing system of Bathan farms (Figure 1). EPG was significantly higher at 5 months post-deworming (P = 0.01, CI: 0.02-0.24) than at 3 months. Among the 4 age groups (Figure 2), the G mean of EPG is higher in Calves (<1 Year) in both control (n=951) and treatment (n=716) buffaloes, which resemble buffalo calves are more vulnerable to parasitic diseases. Lower G mean EPG was observed in 1 to 3 year buffaloes in both control (n=593) and treatment (n=425) groups.

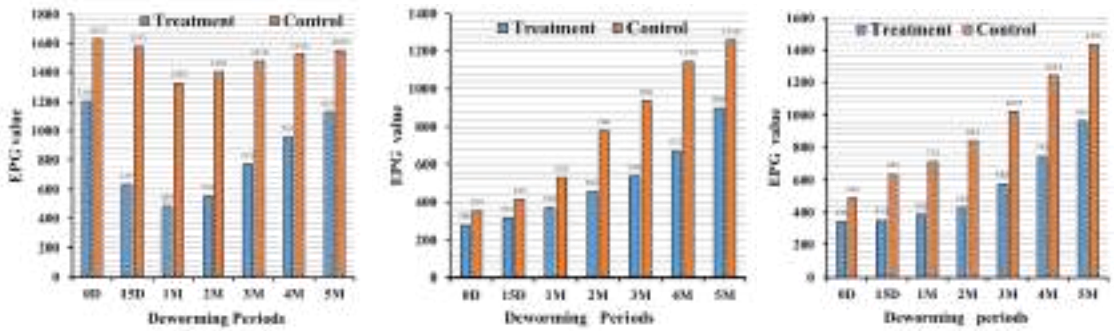

Figure 1. G mean of EPG in pre and post-deworming periods in Semi-intensive (Savar) and extensive (Kaliganj and Baufol upazila) rearing system of buffaloes, respectively.

Bangladesh's sub-tropical monsoon climate is classified into six meteorological seasons: Summer, Rainy, Autumn, Late autumn, Winter, and Spring. We have collected and analyzed data of four seasons. Among the four seasons, G mean of EPG is higher in Autumn (late September to early October) (1415), followed by Late Autumn (late October to early December) (702), Spring (late February to early April) (586), and Winter (late December to early February) (490) (Figure 3).

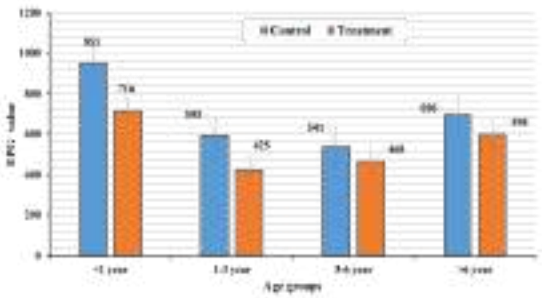

Figure 2. G Mean of EPG among age groups of buffaloes at Semi-intensive and extensive rearing system

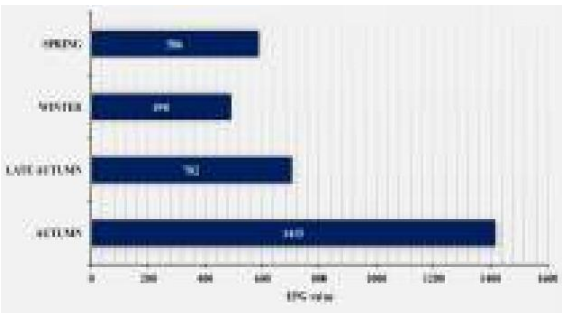

Figure 3. G mean of EPG among different seasons

Among the nematodes, a high prevalence of *Trichuris spp*. and *Strongyloid spp*. was observed in the fecal samples (Table 2). However, the prevalence of protozoa such as *Coccidia spp*. (28%) was higher than cestodes such as *Moniezia spp.* (20%) in post-deworming periods.

Table 2. Overall prevalence of gastrointestinal parasite eggs at three months after deworming

SL	Parasites	Prevalence (%)	SE	95% CI
1.	*Strongylid* spp.	9	0.01	0.07-0.12
2.	*Trichuris* spp.	70	0.02	0.66-0.74
3.	*Coccidia* spp.	28	0.02	0.25-0.32
4.	*Moniezia* spp.	20	0.02	0.17-0.23
5.	*Ascaris* spp.	3	0.01	0.02-0.04
6.	*Toxocara* spp.	2	0.00	0.01-0.03

Buffalo calves are more vulnerable to parasitic diseases than adults. EPG is going to the maximum level in autumn, so Buffaloes should be dewormed during the rainy season and every 3-month interval to better control parasitic infestation in all age groups. Thus, a proper deworming calendar will help control parasitic diseases of buffaloes as well as production losses of the buffalo farmers. A vaccination calendar development to control infectious diseases in buffaloes is also ongoing in the project areas.

Research First

TECHNICAL SESSION: III

SOCIOECONOMICS AND FARMING SYSTEM RESEARCH

ARRW-2023

Establishment of "BLRI Technology village" at BLRI Regional station

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The Technology based Model Villages Idea (TMV) implemented by Bangladesh Livestock Research institute (BLRI) has been established with the goal to disseminate livestock services among people at doorsteps. In this context, BLRI had chosen Dhamrai upazila under Dhaka District for piloting model village concept disseminating of BLRI developed technologies. After that the same TMV concept was implemented in five regional stations (RS) of BLRI. The objectives of this concept were to disseminate BLRI developed livestock-based technologies for increasing productivity; to identify the region-based problems and level of technology adoption at farm communities.

A baseline survey was carried out by a pre-designed objective based questionnaire through face-to-face interview with total 143 households (HHs) from Rajshahi, 242 from Faridpur, 220 HHs from Jashore, 150 HHs from Naikongchhari and 130 HHS from Sirajganj. Among 885 HHs under baseline survey, a total of 150 committed farmers from five RS were chosen and were trained up on need based technologies. Collected data were tabulated and organized into Microsoft Excel sheet. Then data were statistically analyzed by Statistical Package for the Social Sciences (SPSS), Version-25. After giving hands on training a total of 400 pure hilly chickens were distributed among 20 farmers and 12 native sheep among 04 farmers in Naikhongchhari TMV 180 pure naked neck chickens among 18 farmers in Rajshahi TMV, 200 ducks (Rupali and Nageshwari) among 24 farmers in Faridpur TMV. In the Community Approach Diseases Control Model, a total of 4013 cattle, 2741 goats and sheep were dewormed. Under the same model a total of 21542 animals and poultry were vaccinated. Two farmers in each TMV were developed for establishing High Yielding Fodder Nursery (HYFN). From those HYFN 372500, 190000, 85000, 3000 and 5000 numbers of fodder cuttings were distributed to Dhaka, Barishal, Rangpur, Chattogram and Khulna division, respectively. Two Local Service Providers (LSPs) in each RS were developed to monitor field level activities.

Table-01: Disease outbreak and Mortality rate (FMD and PPR) in BLRI technology villages:

Area	Population		No. of vaccinated		Outbreak (%)		Mortality (%)	
	Cattle	Goat	cattle	Goat	FMD	PPR	FMD	PPR
Rajshahi	701	443	607	425	1.28	0.82	-	-
Sirajganj	412	188	360	148	0.97	1.06	-	-
Faridpur	477	336	420	320	0.83	1.48	-	0.59
Jashore	358	558	309	500	0.55	1.25	-	0.53
Naikhongchhari	149	153	128	153	-	-		-
Dhamrai	468	146	400	100	4.91	-	1.49	-

In the TMV, a total of 6031chicken and 1416, Ducks were vaccinated against ND and DP, respectively. Sero-monitoring of PPR was done and the results of c-ELISA revealed that before vaccination, the overall PPRV-specific antibody in the goats were 30.43% in Faridpur (n_1=7/23) and 39.13% in Naikhongchhari (n_2=9/23). After 21 days of post-vaccination, 82.60% (n_1=19/23) and 86.95% (n_2=20/23) goats were found seropositive.

Cost effective pellet feed technology for goats was validated at Naikhongchhari and their daily weight gain was 85.62±5.16 gm in the treatment group (N=5) and 52.52±6.42 gm in the control group (N=5). Pure hilly chicken rearing model was validated in Naikhongchhari TMV (Table-2) and BLRI-1 duck (Rupali) BLRI-2 duck (Nageshwari) were validated in Faridpur TMV to observe productive and reproductive performance at community level (Table-3). The average age at first laying, egg production (per clutch), egg weight and hatchability (%) of hilly chicken were 184 days, 18.33±1.75 nos, 42.71±1.02gm and 62.5% at Naikhongchhari TMV. The average age at first laying, egg production (per clutch), egg weight in Rupali duck were 180 days 26.00±0.42 nos and 65.14±0.23gm and in Nageshwari, the same were 174 days, 32.00±0.16 nos and 57.24±0.38gm. A total of 22 farmers were categorized into 2 treatment groups in which 11 farmers reared duck fed

with duckweed (Azola) and 11 farmers were practicing in a conventional feeding system. The performance of ducks at growing stage (05-20 weeks) for those groups is presented in Table-4.

Table-2: Body weight (mean±SE) of hilly chicken at Naikhongchhari TV

Age (wks)	Male BW(kg) (n=100)	Female BW(kg) (n=136)
6	0.53±0.01	0.46±0.01
9	0.60±0.04	0.47±0.03
11	0.62±0.05	0.52±0.04
13	0.87±0.08	0.69±0.05
15	0.98±0.10	0.86±0.07
17	1.12±0.12	1.00±0.09

Table -3: Body weight (Mean±SE) of BLRI-1 and BLRI-2 duck at different ages in Faridpur TV

Age (wks)	BLRI-1(Rupali)		BLRI-2(Nageshwari)	
	Male(n=51)	Female(n=74)	Male(n=24)	Female(n=50)
DOC	40.92±0.35	38.85±0.27	38.37±0.41	36.75±0.45
4	520.50±25.9	441.71±16.4	537.50±63.5	476.62±55.87
8	820.00±82.6	696.96±72.2	827.25±108.3	695.37±81.56
12	1047.64±85.7	869.42±105.4	987.25±131.3	904.12±116.6
16	1205.00±72.2	1007.07±103.0	1216.37±121.1	1099.37±113.8
20	1351.42±60.9	1132.28±102.4	1383.62±102.1	1270.87±96.9
24	1486.07±52.7	1261.78±108.1	1505.62±94.9	1378.50±89.4

Table-4: Average daily weight gain of Rupali and Nageshwari duck

Duck type	Treatment group		Control		P value
	Male (n)	Female (n)	Male (n)	Female (n)	
Rupali	7.76±0.71 (30)	7.23±0.68 (39)	6.08±0.20 (21)	5.03±0.56(35)	0.013
Nageshwari	8.36± 0.49 (13)	8.02± 0.52 (27)	5.74±0.37 (11)	5.21±0.33 (23)	0.000

P<0.01= Significant at 1% level, P<0.05= Significant at 5% level, P>0.05 =Non-significant

In Rajshahi TMV, the average mature BW of male and female chicken age at first laying, egg production (per clutch), egg weight and hatchability (%) in naked neck chickens were 1233.18±49.35gm, 1513.26±61.02gm, 145 days, 20.77±1.55 nos, 43.85±1.22gm and 77.77, respectively. In Jashore TMV, Urea Treated Straw (UTS) based feeding trials with 1% of body weight concentrate were conducted for a period of 45 days in growing goats. The results revealed that the average daily weight gain (mean±SE) in the UTS group was significantly (p<0.001) higher (98.66±3.67gm) than the existing feeding group (34.44±10.0gm).

In Jashore TMV, a feeding experiment was carried out with 30 growing geese providing 40% concentrate and 60% roughage adlibitum. After 40 days of feeding, the average daily weight gain was 22.66±1.34gm. In Baghabari TMV fodder based TMR (n=06) and straw based TMR (n=06) were validated for a period of 60 days on growing beef cattle and there was a control group (n=03). The average daily weight gain was found 519.44±10.90gm in fodder based TMR and 497.2217±19.44gm in straw based TMR and 388.89±14.69gm in the control group. Both treatment groups were significantly (p<0.001) higher than the control group.

It may concluded that dissemination and adaptation rate of these technology will come in impact phase. Zero mortality and FMD and PPR outbreaks will not found and also hard Immunity will be increased through Community Approach Diseases Control Model. Finally a Hub of improved animal, poultry and fodder germplasm will be developed to start a new farm through a community business model. Also it may be concluded that the validated technologies have created a positive impact among TMV community farmers which will encourage other farmers to adopt those technologies.

Reinforcement of Regional Livestock Research at Naikhongchhari

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Executive Summary

The present research was undertaken for the conservation and improvement of livestock, poultry and fodder germplasm in the hilly region of Naikhongchhari. The objectives were to conserve and improve different livestock, poultry and fodder germplasm suitable for hilly region; to promote the various high yielding fodders (HYFs) in hilly area; to develop a tick control package for livestock in hilly region and to promote the feed technologies at the research farm. A total of 46 does and 5 bucks were selected from the Hilly Brown Bengal Goat (HBG) based on their birth weight, 3 and 6 months body weight, prolificacy, and milk yield and kid survivability. The breeding program was conducted through selective breeding at the research farm Naikhongchhari. The selection and breeding program was followed according to the breeding plan. A total of 40 male and 120 female hilly chickens were selected as foundation stock and the selection was done at 40 weeks of age by determining the selection index in each female's egg production record while males were selected based on family average. A total of 200 eggs were collected from the foundation stock and used for hatching. In the 1st generation (F_1), a total of 136 day-old-chicks (DOC) were hatched and had 46 growing hens and 44 growing male hilly chickens. In the conservation and multiplication of fodder germplasm at the fodder bank, a total of 15 fodders with 02 acres of land were cultivated to feed all farm animals. To study the comparative production performance and the nutritional composition, BLRI Napier-3, Napier Pakchong and Red Napier fodder of three Napier varieties were cultivated at hill slopes with each plot size of $25m^2$ where line to line distance was 70 cm and plant to plant distance was 30 cm. The first cutting was completed for Napier varieties in 60 days. The environment of hilly areas is favorable for ticks. A total of 360 goats, 170 sheep and 60 cattle were selected as a sample from BLRI regional station farm, Naikhongchhari. At the beginning of the study, ivermectin @0.2mg/kg body weight s/c once time was given on day- 1 to all sample animals at a time. Then on day- 7, dipping with 0.5% malathion was practiced and on day- 14, repeat ivermectin @0.2mg/kg body weight s/c was given once time. From day 110-170, repeatedly check the animal body physically. A feeding experiment was conducted on 3 different groups: Urea-treated straw (UTS), Urea-molasses straw (UMS) and Control group of sheep at the BLRI regional station, Naikhongchhari. Before starting the feeding trial, initial body weight was taken for each group and feed was provided at ad-libitum basis then weight was taken every 15 days at intervals up to 75 days of age.

The average litter size was 1.8±0.01 (n=37), average birth weight, 3 months body weight and average daily gain up to 3 months for male and female kids were found 1.36±0.06kg (15), 1.30±0.03kg (27), 5.27±0.61kg (6), 4.99±0.35kg (14), 41.41±5.95g (6) and 40.18±3.97g (14), respectively. The average egg weight was 44.91±3.1g, fertility and hatchability rate were observed as 82%, 68.5%, average DOC weight, average male and female body weight at 60 days were found 30.85±2.46 g, 539.5±83.5g and 494.0±76.3g, respectively. The body weight of the F_1 generation of hilly chicken at different ages is shown in Table 1. The average fresh biomass yield of BLRI Napier-3, Napier Pakchong and Red Napier was found as 34.84t/ha, 30.84t/ha and 27.49t/ha, respectively (Table 2). The dry matter (DM%) and crude protein (CP%) of BLRI Napier-3 were significantly higher than other Napier cultivars. The highest tick free duration was observed in sheep for the second time treatment protocol and the lowest tick free duration was observed in goats for second time treatment protocol. The impact of using ivermectin and malathion to control ticks with a maximum long duration time was observed (figure 1). Therefore, this study reveals that a minimum of three times of ivermectin with malathion administration is needed to control ticks over the year which is more cost effective for the livestock farm than the usual practice of dipping at 1- month interval. The highest average daily gain (182.21g) was found in the UTS group and the lowest ADG (108.27g) was observed in the control group. The findings of the experiment (Table-3) revealed that among these three groups, UTS feeding in a regular diet gives better results than the two other groups. The highest body weight (15.69±0.34kg) was found in the case of the UTS feeding group whereas 15.46±0.27kg and 10.16±0.55kg were observed in the UMS and control feeding group, respectively.

Table 1. Average body weight of F_1 generation of hilly chicken at different ages (Male, n= 44; Female, n=46)

Parameters (g)	Body weight of hilly chicken	
	Male (Mean±SE)	Female (Mean±SE)
Body weight at 6 weeks	546.9±9.71	506.52±6.76
Body weight at 10 weeks	920.18±29.14	811.26±18.67
Body weight at 14 weeks	1419.5±34.78	1153.2±21.46
Body weight at 18 weeks	1972.13±49.25	1422.72±22.59
Body weight at 22 weeks	2327.52±51.06	1637.65±25.25
Body weight at 26 weeks	2538.43±51.47	1808.96±27.8

Table 2. Biomass yield, morphological characteristics and botanical fractions (Mean±SE) of Napier Pakchong, BLRI Napier-3 and Red Napier at hill slopes in hilly areas (1st cutting)

Parameters	Napier Packchong	BLRI Napier-3	Red Napier	P Value
Biomass yield (ton/ha)	61.68^{b}±1.34	69.68^{a}±1.44	54.99^{c}±0.81	≤0.001
No.of Hill (thousand/ha)	18.93±1.16	19.33±0.87	16.80±0.92	0.233
No. of tiller/hill	8.90±1.43	11.80±1.90	9.10±1.21	0.346
Plant height (ft.)	7.08±0.77	8.02±0.35	6.44±0.54	0.231
No. of leaf/plant	13.57±2.06	11.50±1.65	13.17±1.35	0.688
Leaf length (cm)	94.00^{b}±7.17	112.33^{a}±3.08	117.83^{a}±3.68	0.010
Leaf width (cm)	4.08±0.26	3.42±0.15	3.75±0.28	0.179
Steam weight (g/kg)	425.67^{b}±6.06	493.00^{a}±6.81	410.00^{b}±6.93	0.000
Sheath weight (g/kg)	223.67±4.49	212.33±4.09	232.33±5.04	0.073
Leaf weight (g/kg)	350.66^{a}±5.81	294.67^{b}±9.68	357.67^{a}±7.31	0.002

p<0.01=Significant at 1% level, p<0.05= Significant at 5% level. P>0.05=Non significant; Different superscripts in the same row differ significantly, p<0.01 or p<0.05.

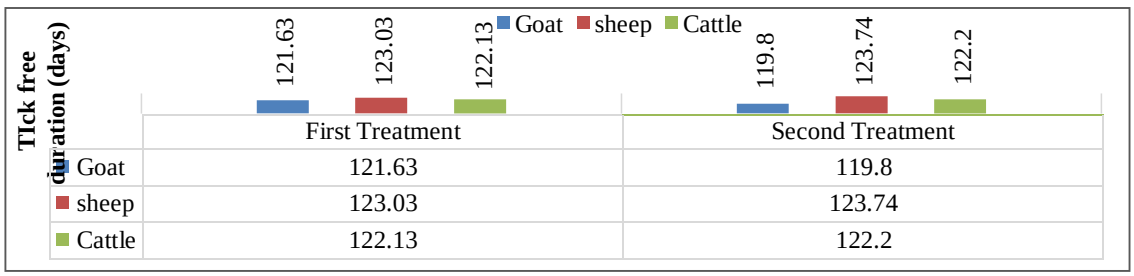

Figure 1.: Observation of tick free duration for goat, sheep and cattle at BLRI research farm, Naikhongchhari

Table 3.: Growth performance (Mean±SE) at 3 different feeding groups of sheep (n=15)

Parameters (kg)	UTS feeding group (n=5)	UMS Feeding group (n=5)	Control feeding group (n=5)	P value
Initial body weight	10.14±0.41	9.54±0.64	7.88±0.25	0.014
Body weight at 15 days	11.41±0.54	10.98±0.57	8.16 ±0.31	0.001
Body weight at 30 days	11.66±0.37	11.45±0.53	8.19± 0.29	≤0.001
Body weight at 45 days	13.36 ±0.35	13.24 ±0.51	8.64 ±0.27	≤0.001
Body weight at 60 days	14.97±0.38	13.98±0.30	9.19±0.26	≤0.001
Body weight at 75 days	$15.69±0.34^{a}$	$15.46±0.27^{a}$	$10.16±0.55^{b}$	≤0.001

Standard error (SE), number of samples (n), p<0.01=Significant at 1% level, p<0.05= Significant at 5% level. Different superscripts in the same row differ significantly, p<0.01.

Considering the above findings, it can be concluded that using these promising hilly livestock and fodder germplasms there is a possible scope to develop and adaptation of region specific technology, production and disease control packages through conducting a systematic research at research farm and communities in the hilly region.

Marketing of beef in selected areas of Bangladesh

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Executive Summary

Beef is one of the most popular dietary items for Bangladeshi consumers. As the disposable income of the people is increasing, the demand for beef at the local and national levels is also increasing. For this, a good number of people are connected with meat meat-selling business as it is a good income-generating and employment-creation activity in a country like Bangladesh. By doing this business as a main profession, they are serving their livelihood. But, the price of beef is now going beyond the purchasing power of the general consumers. As a result, the profit margin and the cost associated with beef selling by the meat seller remain under pressure. On the other hand, meat selling in open meat shops has some negative aspects. Taking this view as a research problem, the study encompassed the objectives to identify the profitability of beef marketing by meat sellers as well as explore marketing channels for beef marketing. In addition, this study seeks consumers' opinions regarding safety issues of beef selling in open meat shop. The study was conducted in eight (8) administrative districts namely Rajshahi, Dhaka, Chattogram, Khulna, Barisal, Sylhet, Rangpur, and Mymensingh from eight (8) divisions and two Upazilas were selected from each district for data collection. The samples consisted of 10 meat sellers and 15 consumers from each Upazila and the total sample size was 420 (180 meat sellers and 240 consumers). A simple random sampling technique was followed for collecting primary data. Before collecting data, a set of questionnaires was prepared and pre-tested for finalization. Primary data collection for this study was conducted during the months of January to June 2023. Profitability analysis was done by adopting descriptive statistics.

The findings revealed that about 10% of meat sellers were up to 30 years old, about 26.7% were between the ages of 30-39, 33.33% were in the age group of 40-49, and 30% were in the age group of 50- 59. Following an analysis of the main occupation of the sample respondents, 73.33% of respondents' main occupation was meat selling and only 26.67% of those do both meat selling and agriculture-related work. From the study, we found that most meat sellers completed only a primary level of education. This means that they are very poor in education as well as knowledge. From the results, it was evident that meat sellers bore a total cost of BDT 70,031 per quintal (100 kg) whereas they earned BDT 2,551 as a net return. The benefit-cost ratio (BCR) was estimated at 1.04 which means beef marketing is a profitable business. We also found that the total cost of beef marketing was higher in the Dhaka division (BDT 73,217 per quintal) and lower in the Rajshahi division (BDT 66,381 per quintal) (Table 1 and 2). The reasons behind the higher price in the Dhaka division are a good number of consumers i. e. high demand and the capital city. On the contrary, livestock production is very high in the Rajshahi division. In addition, the production cost was also lower compared to other divisions. The study identified some prospective marketing channels in the areas for beef cattle. The highest percentage (36%) of beef cattle channeled through farmer to consumer followed by farmer-meat seller-consumer (24%) (Fig. 1). It was also assessed that 67.92% of consumers were not satisfied with quality issues of open beef selling due to mosquitoes sit and leave larvaes, dust fall, bacteria grow at the end of the day, loss of test, discoloration, mixing state meat etc. (Fig. 2 and Fig. 3). From the beef sellers' point of view, the main problem of open meat selling was the lack of hygienic places for slaughtering (38%) and lack of operating capital. Since meat sellers earned limited profit (as of BCR), they urged the authorities for loans with low-interest rates that enabled them to resolve the problems of working capital. In the light of above findings, we recommend to minimize marketing tools and taxes and increase leather prices. In addition, the government should establish a modern slaughterhouse in each Upazila for facilitating meat selling.

Table 1. Cost incurred by meat seller (per quintal)

Items	Rajshahi	Chittagong	Dhaka	Khulna	Sylhet	Rangpur	Barishal	Mymensingh	Overall
Variable cost									
Initial beef price	64412	70581	70958	69068	67623	66326	70898	69120	68049

Transportation cost	235	244	301	208	252	257	328	283	259
Labor cost	1002	1015	1105	1058	857	800	1123	1009	988
Marketing tools	226	267	199	175	94	206	259	194	204
Intermediate cost	210	186	178	163	184	193	179	169	186
Others	150	155	170	148	147	117	165	147	149
A. Total variable cost	**66235**	**72449**	**72912**	**70827**	**69157**	**67899**	**72953**	**70923**	**69834**
Fixed cost									
Chopping board	9	9	10	8	9	7	10	8	9
Knives and clamps	9	8	11	18	9	7	10	9	10
Shop rent	127	157	284	158	200	159	238	176	178
B. Total fixed cost	**145**	**175**	**305**	**185**	**218**	**173**	**259**	**193**	**197**
C. Total cost (A+B)	**66381**	**72624**	**73217**	**71006**	**69375**	**68072**	**73211**	**71116**	**70031**

Table 2. Returns from the beef sale (per quintal)

Items	Rajshahi	Chittagong	Dhaka	Khulna	Sylhet	Rangpur	Barishal	Mymensingh	Overall
Beef sold	65334	72629	72691	70000	68227	67049	73833	70249	69327
Intestine sold	959	1114	1319	1025	871	878	1172	989	1021
Leg sold	935	938	975	954	1133	854	1006	825	947
Head meat sold	974	985	1215	907	903	716	985	837	932
Leather sold	398	387	3383	369	301	255	408	323	353
D. Total return	**68601**	**76054**	**76586**	**73256**	**71437**	**69755**	**77404**	**73226**	**72582**
E. Gross margin (D-A)	**2365**	**3604**	**3674**	**2435**	**2279**	**1855**	**4452**	**2303**	**2748**
F. Net return (D-C)	**2220**	**3430**	**3369**	**2250**	**2061**	**1682**	**4193**	**2110**	**2551**
BCR (D/C)	**1.033**	**1.047**	**1.046**	**1.032**	**1.03**	**1.023**	**1.05**	**1.03**	**1.04**

Channels	Market Actors	%
I	Farmer-Consumer	36
II	Farmer-Butcher-Consumer	24
III	Farmer-Bepari-Consumer	19
IV	Farmer-Supershop-Consumer	11
V	Farmer-Bepari-Butcher-Consumer	6
VI	Farmer-Online shop-Consumer	4

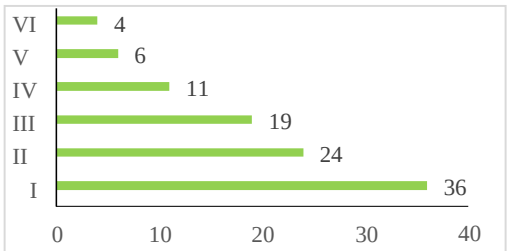

Fig. 1 Prospective marketing channels

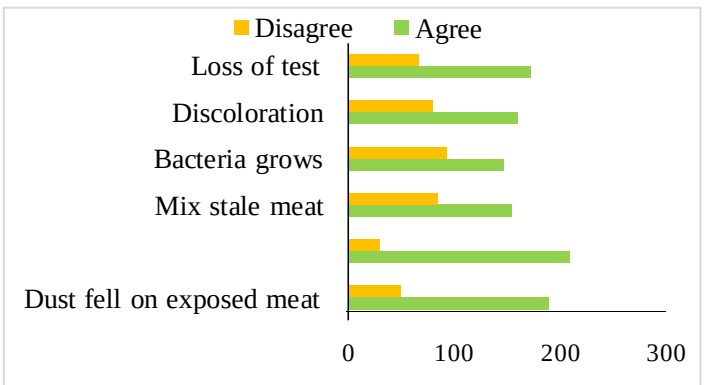

Fig. 2 Issues related to beef selling in the open market

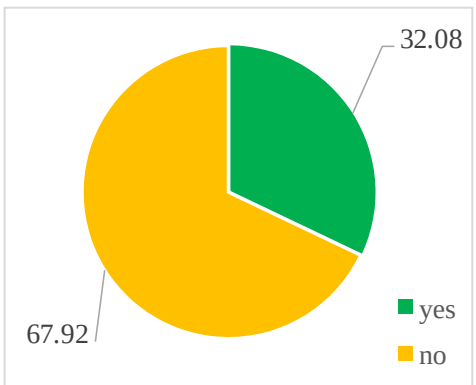

Fig. 3 Opinion based on stated issues

Assessing livestock rearing knowledge, attitude and practice in the coastal belt of Bangladesh

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Executive Summary

Livestock is the most important part of agriculture which plays a vital role in promoting households' nutritional security as well as cash income. In Bangladesh, almost 20% of people directly and 50% partially depend on the livestock sector for their livelihood. However, livestock production and the returns from it vary over regions due to the availability of modern technological facilities and agro-climatic factors. Nowadays the coastal zones of Bangladesh are facing various pivotal challenges regarding livestock production and management. In contrast, the coastal belt of Bangladesh covers 32% of the country and is home to more than 35 million people. Cyclones, saline water intrusion, and sea level rise are major environmental issues that threaten livestock production adversely in the areas. Considering the above facts, the present study took the objectives to identify the present livestock management scenario; analyze knowledge, attitudes and practices for livestock rearing of the farmers and find potential opportunities for improving livestock production practices. As study areas, we covered 8 Upazilas from 4 districts of Barishal division. We randomly collected data from 35 households from each Upazila and total sample size was 280. Before collecting primary data, we constructed a questionnaire and pre-tested it in Kalapara Upazila under the Patuakhali district. Data were being collected from December 2022 to May 2023. A face-to-face interview method was followed during the whole data collection process. We used tabular analysis i. e. descriptive statistics.

We found that farmers were less educated (49% had primary level only) and aged enough compared to other areas. They usually reared less productive livestock species as they were mostly local breeds (73%) followed by crossbreds (17%). On the other hand, about 71% of farm households reared goats and they had approximately 4 goats/household (Table 1). This indicates that there is a scope to promote goat production in areas such as Dhaka division. Here, there is a huge shortage of straw and green grasses due to limited agricultural practices and salinity. Farmers managed 76% of straw from their own sources and the rest was acquired by purchasing. On the other hand, 100% of farmers were dependent on pasture land for green grasses (Table 2). In case of housing, we found 62% was tin-shed followed by 23% mud-house and 16% semi-paka (Table 3). This means that housing management for their livestock was very poor and farmers should give proper attention to the improvement. Though the farmers had a good score on attitude (>70%) regarding livestock management and practices, they had enough knowledge and practice gap (<50%). **Results from farmers' knowledge on livestock farming:** 78.57% of livestock farmers had an idea about BLRI or DLS (Department of Livestock Services), 77.5% had an idea about the services such as treatment, training, distribution of fodder cutting, vaccination, etc. of DLS, 78.78% respondents knew that the government, NGOs, private sectors, and private entrepreneurs were working for the development of livestock sectors, 82.85% knew about the training provided by the government and NGOs for the development of livestock sectors, 76.07% knew about the various vaccination program, and deworming for livestock by the DLS, 82.14% had idea about the public awareness activities such as world milk day, world egg day, livestock exhibition, farmers field day, mobile sales service of milk, meat and egg operated by the Department of Livestock Services (DLS) and 87.85% agreed about a smooth marketing system for livestock and livestock products in locality. **Results from farmers' attitude to livestock farming:** 88.57% of livestock farmers agreed to take training on livestock rearing and management, 77.50% were willing to take high-yielding fodder, 100% were interested in taking vaccines and deworming, 87.50% were interested in joining the farmers' group and 88.57% were interested to rear improved livestock species (RCC, crossbred and pure breed). **Results from farmers' practice of livestock farming:** 21.43% of livestock farmers reared improved livestock species (RCC, crossbred and pure breed), 34.28% applied vaccines and deworming to livestock regularly, 12.86% cultivated high-yielding variety (HYV) fodder, 17.86% participated in livestock-related training programs organized by the government and private organizations, 7.5% used silage, urea molasses straw (UMS), total mixed ration (TMR) etc., 38.21% communicated with the Upazila livestock office and veterinary hospital for consultation regularly, 60.36% took advice from a

registered doctor when their livestock falls sick, none produced biogas from cow dung and livestock wastage, 16.43% gave their livestock regular showering (Fig. 1).

Finally, it can be said that farmers had enough knowledge gaps in livestock management and practices. Therefore, our recommendations are hands-on training is very crucial regarding up-to-date livestock technologies and innovations and the introduction of improved livestock species and saline-tolerant high-yielding variety of fodder for the coastal regions of Bangladesh.

Table 1. Livestock scenario in the study areas

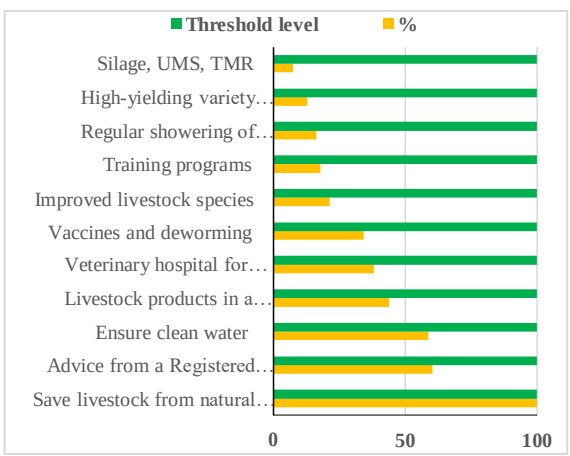
Species		Livestock/household (n)	(%)
Cattle	Local	4.31 (205)	73.21
	Cross	3.45 (49)	17.5
Buffalo		3.08 (12)	4.29
Goat		4.35 (199)	71.1
Sheep		4.00 (16)	5.71
Chickens		16.78 (233)	83.21
Ducks		12.65 (249)	88.93
Pigeons		25.52 (54)	19.23

Table 2. Feeds and fodder

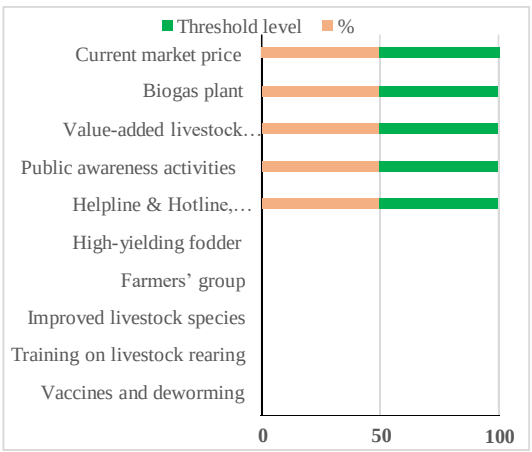
Feeds	Source	
	Own (%)	Buy (%)
Straw	76	24
Green grass	100	0

Table 3. Housing types

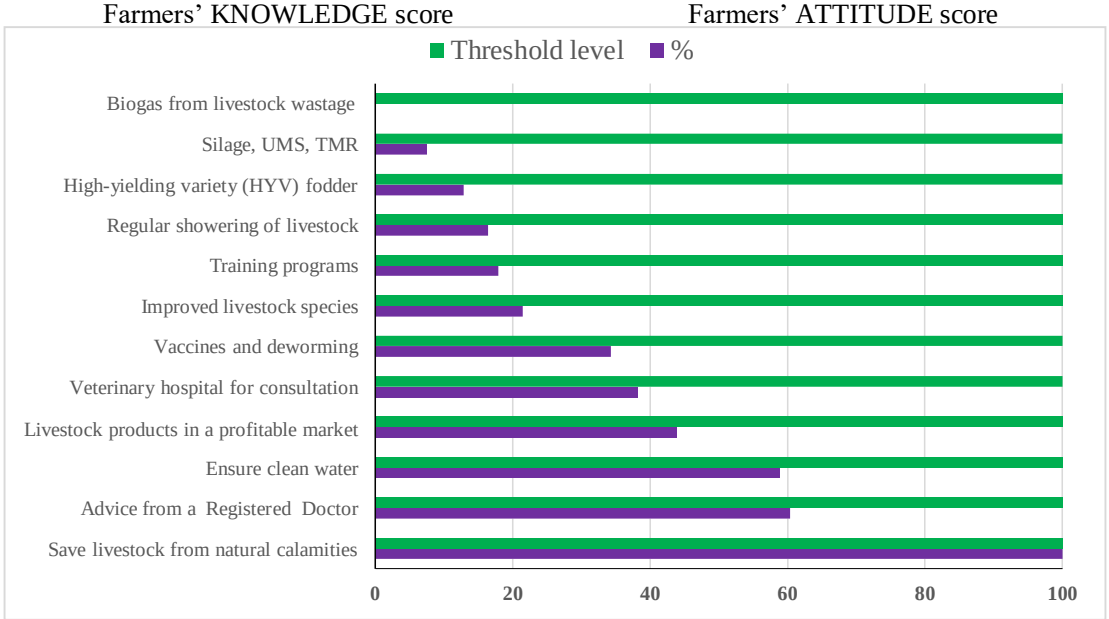
Types	(%)
Mudhouse	23.21
Tin shade	61.43
Brick-built (Semi Paka)	15.36



Farmers' KNOWLEDGE score



Farmers' ATTITUDE score



Farmers' PRACTICE score

Fig. 1 Farmers' knowledge, attitude and practice score

Adoption and Economic Analysis of Improved Feeding Technologies of Buffalo Rearing in Some Selected Char Areas of Bangladesh

Running title: Analysis of Farmers' Willingness to Pay (WTP) and Perception for Improved Feeding Technologies in Buffalo Rearing: Evidence from Field Experiment

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Executive Summary

Livestock is considered a living money bank for farmers and it has a vital role in the agricultural intensification process through the provision of a source of protein, draught power, and manure for organic fertilizer. They are also closely linked with the social and cultural lives of millions of resource-poor rural farmers and animal ownership ensures varying degrees of sustainable farming and economic stability. The poor nutrition of farm animals is a severe constraint to better production performance as well as smooth returns for the farm households. Free grazing in char areas is the common form of feeding practice in the case of buffalo rearing in Bangladesh. For this, they are not accustomed to improved feeding practices. On the other hand, grazing lands are reducing due to an increase in human population, urbanization, and industrialization. Therefore, grazing buffaloes do not meet their optimum nutritional requirement. To resolve the issue of poor nutrition, a shift from extensively grazing to stall feeding using improved feeding (TMR, UMS, and UTS) should be practiced. Considering the facts, the research was designed to analyze the farmers' willingness to pay (WTP) and perception, adoption, and dissemination of improved feeding (TMR, UMS, and UTS) in buffalo rearing in selected areas. For the analysis of WTP, a total of 250 farmers were randomly selected from purposively selected five Upazilas (Ishurdi, Ramgoti, Gangachara, Anowara, and Fenchugonj) of 5 districts (Pabna, Laxmipur, Rangpur, Chattogram, and Sylhet) under the project areas using Cochran's sample size formula. A field experiment and survey were conducted in selected Upazilas in 2022-23. Contingent Valuation Method (CVM) and the close-ended double-bound dichotomous choice question were used to assess WTP. The results revealed that the socio-demographic characteristics of buffalo rearing farmers were age (46.60±0.84 years), gender (male- 100%, female- nil), marital status (single- 5.2%, married- 94.8%), occupation (farming 86.0%), farm size (128.69±14.37 decimals), year of schooling (5.52±0.27 years), experience (17.73±0.93 years), family size (5.76±0.13), family member under 5 years (1.48±0.06), earning member (1.51±0.04), the dependency ratio (3.81), family member completed primary education (2.90±0.10), and got training facility (94.0%) in the study areas. However, the annual family income, income from buffalo, and income from other livestock was BDT 702624.00±50288.91, BDT. 331521.92±40496.93 and BDT 141057.55±25342.34, respectively. The share of income from buffalo to the total annual income was 47.18%. Moreover, the buffalo herd size was 11.52±0.98, and the rearing system was intensive (only stall feeding): 6.4%, semi-intensive (stall feeding and bathan system): 43.0%, and extensive (bathan system): 50.6% found in the selected areas. The purpose of buffalo rearing was dairy: 43.4%, fattening: 16.9% and both purposes were 32.9%. However, only 11.2% of farmers use improved feed supplements for buffalo, and the highest 4.8% of farmers provided ready-made feed followed by 2.8% high-yielding fodder irrespective of study areas. The farmers were willing to pay for TMR: 50.4%, UMS: 45.2%, and UTS: 34.8% found in the study areas (Figure 1). However, the overall mean WTP premium for one kg of TMR (highest: BDT 46.73, lowest: BDT 39.05), UMS (highest: BDT 26.86, lowest: BDT 20.11), and UTS (highest: BDT 20.62, lowest: BDT 11.47) (Figure 1). The annual household income positively and significantly influenced farmers' WTP for TMR, UMS, and UTS, implying that higher income levels influenced WTP for feeding technologies for the buffaloes. Conversely, the respondents' membership in NGOs had a detrimental and significant impact on their WTP, suggesting that farmers who had previously taken out loans were less ready to pay for buffalo-feeding technology because they needed to set up loan installments and did not want to spend additional cost for buffalo (Table 1). However, the mean perception scores found ranged between 2.94 and 4.47 with values closer to 5 indicating more favorable

perceptions and values closer to 1 suggesting less favorable perceptions of TMR, UMS, and UTS feeding technologies (Table 2).

Table 1. Factors influencing farmers' willingness to pay

Explanatory variables	TMR	UMS	UTS
	Coefficient	Coefficient	Coefficient
Age	-0.059	-0.004	0.054
Occupation	0.037	0.015	0.025
Education	0.110	-0.028	-0.010
Experience	0.035	-0.051	-0.037
Farm size (Land)	0.020	-0.019	-0.105
NGO membership	-0.297***	-0.200***	-0.119
Family size	-0.035	0.046	0.008
HH income	0.239***	0.172**	0.198***
Market distance	-0.137	-0.070	-0.053
Herd size	-0.003	-0.080	-0.031
Contact with LSP	0.001	0.329***	0.366***
Constant	0.505	0.038	-0.243
Adjusted R^2	0.124	0.183	0.158
Number of observations (n)		250	

***p <0.01 and ** p<0.05 significant level.

Table 2. Farmers' perceptions of TMR, UMS, and UTS feeding technologies

Statements	TMR	UMS	UTS
I am willing to accept the technology	3.51 (0.08)	3.09 (0.08)	3.19 (0.06)
It will be acceptable in my region	2.94 (0.06)	3.12 (0.07)	3.34 (0.05)
I shall accept it if provides a subsidy	4.05 (0.08)	4.47 (0.04)	4.32 (0.05)
It is totally different from the existing practice	3.93 (0.06)	3.79 (0.05)	3.74 (0.05)
It will be safe for buffaloes	3.66 (0.03)	3.56 (0.03)	3.26 (0.04)
It will lead to increased feed cost	3.65 (0.04)	3.54 (0.04)	3.37 (0.04)
It will lead to better growth performance	3.76 (0.03)	3.69 (0.03)	3.48 (0.03)
It will lead to better milk production	3.77 (0.04)	3.61 (0.04)	3.40 (0.03)
Raw feeds are available	3.17 (0.07)	3.47 (0.05)	3.46 (0.05)

Note: Scale ranging from 1= strongly disagree to 5= strongly agree, Standard errors are in brackets.

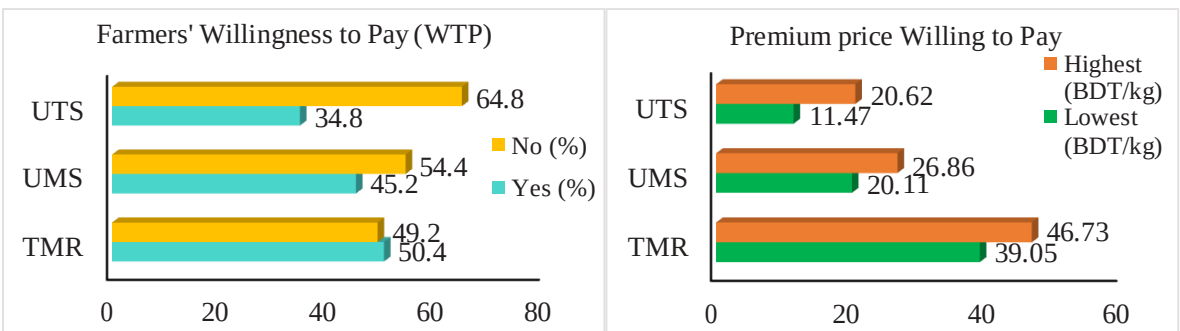

Figure 1. Farmers' willingness to pay for TMR, UMS, and UTS feeding technologies

It may be concluded that the above findings demonstrated lower WTP and marginally favorable patterns of buffalo-rearing farmers' perceptions of improved feeding technology. It is recommended that to improve farmers' perceptions and WTP training, technology demonstration and incentives should be provided.

Identification of Research gap of Native chicken in some selected areas of Banglaesh

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Executive Summary

The present research was carried out for the identification of research gap of Native chicken in selected areas of Banglaesh.The objectives was to evaluate the current scenario of native chicken in the selected regions of the country and to formulate a feasibility study report for including in the prepared development project proposal of native chicken. A structured questionnaire and key informant Interviews format was developed with relevant scientists, experts, and research team about the production and potentialities of native chicken garmplasm to conduct a baseline survey. Collected data were tabulated and organized into Microsoft Excel sheet. Then data were statistically analyzed by Statistical Package for the Social Sciences (SPSS), Version-25. A total of 260 data were collected from at least one upazila of 8 selected districts with 3 previous project area (Joypurhat, Sherpur and Feni) and 5 newly proposed area (rest of upazila) through face to face interviewing of every family head. Key Informant Interviews (KIIs) as well as physical visits for qualitative assessment was also carried out of supplement the survey data. Parameters were considered on Socio-economic status of farmer, Housing condition, Productive and reproductive performance, Disease and health management, Marketing status, Benefit-cost ratio, Problems and prospects of Native chicken farming in the research areas.

Table 1: Socio-economic status (Mean±SE) of the farmers in selected areas

Upazila	Age	Family size	Earning member	Dependancy Ratio (%)	Family income/Tk in Lakh
Pabna	40.40±1.15	4.23±0.29	1.26±0.12	3.35	0.98±0.08
Rangpur	38.30±0.98	4.03±0.14	1.00±0.00	4.03	0.49±0.02
Joypurhat	39.23±1.11	4.06±0.20	1.20±0.08	3.38	1.57±0.14
Sherpur	46.86±2.29	4.36±0.26	1.33±0.13	3.27	1.96±0.14
Pirojpur	42.36±1.98	4.50±0.17	1.23±0.07	3.65	2.22±0.09
Feni	42.60±2.05	4.30±0.17	1.16±0.06	3.70	3.46±0.37
Sunamgonj	44.33±1.60	5.36±0.20	1.30±0.08	4.12	1.99±0.12
Patuakhali	39.62±0.99	4.44±0.14	1.18±0.05	3.76	1.59±0.08

Native chicken rearing farmers are engaged in agriculture (34.6%) as well as daily labor (21.5%) while most of the farmers are 32.7 % literate and own minimal land. The experience of farmers rearing native chickens varied from 5.65±0.33 to 18.38±0.70 years.The native chicken farm were categorized into 3 groups among them 36.9% small (<10), 31.9% medium (10-15) and 31.2% large (>15) sized farm was observed. About 95% farmers involved in rearing common deshi chicken. Moreover, 2.3% hilly, 1.2% naked neck and 1.5% naked neck with common deshi chicken rearing farmers were available in selected areas. The average common deshi chicken population (number/household) was 2.81±0.15 roaster, 6.06±0.25 hen and 9.13±0.40 chick. This population trend of previous project areas was 4.59±0.70, 7.53±0.69, and 9.63±1.29 in previous year but current trend is 2.91±0.34, 5.73±0.32, and 8.05±0.83 respectively which is comparatively lower than previous years. Chicken rearing system in those areas was mainly Semi-extensive 53.8%, Scavenging 35.8% and 3.1% farmers not to provide any housing or provide minimum shelter only at night. The house were made of tin 59.6%, Wood 13.8%, brick 10.4%, bamboo 9.2%, soil 5.4% and net 1.5%. The floor of chicken house was mainly made of wood 39.2%, soil 33.1%, Brick 8.8% and bamboo 18.8%. House was cleaned regularly by 70.4% farmers by using broom 86.5%. Native chicken mainly fed from farmer premises and natural environment by scavenging. Farmers only supplied average 34.16±0.25g, 59.01±0.25g, 71.55±0.40g feed to chick, grower and layer respectively. Most of the farmers (72.3%) do not follow the selection criteria for hatching egg, they store their hatching eggs for 10 (61.5%) to15 (33.1%) days in clay pots (85%) and also they are hatching their eggs naturally (97.7%). Broodiness during laying period is the major problem in study area where farmers do not use any method (76.9%) to remove the broodiness but 22.8% farmer follow the technique of tie up with rope and bath in water. The mature body weight of male and female, average egg production/year, age of 1st laying (days), Laying/clutches time (days), number of broodiness/year, egg laying interval after natural incubation with brooding and chick hatching by natural system were 1.45±0.29, 1.15±0.02, 106.15±1.11,

177.98±0.41, 16.83± 0.28, 4.56± 0.25, 64.70±1.56 and 97.7 days respectively. Native chicken rearing become challenging for farmers due to regular outbreak of diseases like Newcastle 76.2%, Fowl cholera 55.8%, Gumboro 13.5%, fowl pox 19.6%, brooder pneumonia 24.2%, infectious bronchitis 5%, and other diseases 23.5%. Parasitic infestation during broodiness was observed 41.5% and no parasite control measure was taken by 75% farmers. The disease outbreak mainly occurred in winter season 81.2% and chicks were mainly affected 66.9% followed by grower 12.7%, and layer 1.5%. Farmers were not aware about deworming and vaccination. Only 23.8% and 23.1% farmer use anthelmintic and vaccine to protect their animal from disease out of which most of the farmers are from previous projects. Mortality rate of chick was very high 91.5% followed by grower 46.2%, adult hen 48.5% and roaster 13%. Dead bird management practice was not good. About 50.4% farmers thrown their dead bird in field, 7.3% thrown in water and only 42.3% farmer buried and burnt it. Treatment facilities of native chicken were not so standard. Treatment of sick bird was done by veterinary hospital only 22.7%, Quack 20.8%, farmer himself 22.3%, medicine shopkeeper 6.2% and no treatment of bird were 28.1%. The main purpose of native chicken rearing were both extra income and own need about 76.5%. But 61.5% famer had no training knowledge on native chicken rearing. Women (100%) were mainly reared native chicken. The average egg consumption/week was 4.59±0.17 and chicken consumption/month was 1.15±0.03 was recorded. Native chicken were mainly sold from farmer's house 85.7% and its demand was 30.8%. Price of native chicken egg (hali) was 61.07±0.58tk. Patient 53.8%, pregnant 22.3%, children 20% and 3.8% old people mainly prefer native chicken egg and demand of native chicken egg was 28.1% at the selected areas. Average current market value of Native chicken was 329.68±7.20 roaster, 302.22±2.66 hen and 68.23±2.28 taka whereas was 303.01±6.36, 262.39±4.35 and 53.46±1.51 taka respectively in previous year in study areas. So the market price of domestic chicken is increasing day by day. For native chicken rearing the Benefit Cost Ratio (BCR) was found 2.64 (Table-3).

Table 3: Benefit Cost Ratio (BCR) of native chicken farm in study area

Gross income (Tk.)	Total expense (Tk.)	Net Benefit (Tk.)	Benefit Cost Ratio (BCR)
15324.03	5802.95	9521.08	2.64

Farmers are facing various constrains for native chicken rearing in the research areas but comparatively lower in previous project areas of native chicken project. From field survey data, farmers faced the challenge of disease outbreak, attacking predators, lack of vaccine, chick mortality, feed price was 86.5%, 82.4%, 66.5%, 60.0%, 48.8% in previous project area whereas 68.8%, 74.4%, 50.0%, 34.44%, 26.6% in newly proposed area of native chicken project. In this regards, we have observed that now the farmers in the previous project areas of the indigenous chicken project are managing their crisis situation because native chicken farmers are trained in their chicken rearing. A total of 41.8% and 35.5% farmers mentioned that the Govt. vaccine were not available in their areas and 50% and 38.9% farmer did not get good quality chick for rearing in previous project area and newly proposed area respectively.

To solve all the constraints and challenges, farmers were recommended some suggestions. Total 61.2% famer from newly selected area and 36.6% from previous project area demanded training program to the authority for native chicken rearing. Govt. vaccine supplying should be available and of free cost was desired by 62.2% and 38.2% framer from the both selected areas. Good quality chicks were also needed for 32.2% project areas farmer and 26.5% newly proposed areas farmer for native chicken farming. Also 41.8% farmers in newly selected areas and 28.8% farmers in project area were demanded loan/incentives from Govt.or Bank officials for beginners and smallholder Native chicken rearing farmers/entrepreneurs. From this study data, we found various research gap in native chicken rearing, management and production. Farmers reared native chicken in backyard farming with poor management facilities. Smart native chicken rearing and management system need to be established through proposing new development and research project for native chicken.

Considering the above findings, it can be concluded that the Native chicken farming is a promising business. Although some constraints and knowledge gap among the farmers but there is lots of scope and prospects in native chicken rearing all over the country. Therefore, a development project is needed to improve the productive and reproductive performance, minimizing disease outbreak and death of chicken by establishing community approach disease control model as well as to overcome the possible constraints in native chicken farming.

Project title: Need assessment, technology intervention and livestock advisory development for increasing climate resilience in livestock production system

Study Title: Assessing the baseline status and knowledge, service and technology needs of livestock farmers in selected saline and drought affected areas

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Executive summary

The coastal area of Bangladesh suffers from salinity, especially in the dry season (October to May) due to the lack of freshwater flow from upstream. Due to increased salinity there is a shortage of grazing land and fodder crops for livestock production. Drought is another most complicated and recurrent extreme weather events, can result in significant economic loss for agriculture and livestock. The direct and indirect effects of salinity and drought on livestock are mediated mainly through scarcity of water for drinking, fodder cultivation and other farm uses. Indirect effects include feed scarcity through hampering crop production, lack of grazing pasture and reduced production, disease incidence and other health issues, and reproductive problems in the long-term. The present research was designed to assess the baseline status, and knowledge, service and technology needs of flood, drought, saline and cyclone-affected livestock farmers in selected regions. The selected flood affected regions were covered last year. In the present year, a total of 200 farmers were interviewed directly from Dacope, Khulna, Shyamnagar, Shatkhira as saline and cyclone prone region, while Godagari, Rajshahi and Nachole, Chapainababgonj as drought- prone region. A pretested, structured questionnaire was used to collect the data. Collected data were inserted into the MS Excel software, organized, and analyzed for mean, standard deviation, range etc.

Table 1: Mostly affected livestock species by flood in different regions

Livestock Species	Saline affected region						Drought affected region					
	Khulna		Satkhira		Overall		Rajshahi		Chapainawabganj		Overall	
	% Resp.	*Intensity (1-4)	% Resp.	Intensity (1-4)	% Resp.	Intensity	% Resp.	Intensity (1-4)	% Resp.	Intensity (1-4)	% Resp.	Intensity
Dairy cattle	68.0	4.0	48.0	3.0	58.8	3.6	60.0	3.7	73.0	3.8	67.6	3.8
Beef cattle	42.2	3.0	46.0	3.0	52.9	3.3	52.0	3.9	43.0	3.6	46.0	3.8
Goat	15.5	3.0	20.0	3.0	18.0	3.0	20.0	4.0	43.0	3.6	34.0	3.8
Sheep	6.6	2.0	0.0	0.0	4.0	3.0	44.0	3.5	8.0	3.5	22.0	3.5
Duck	22.2	3.0	13.0	2.5	18.0	3.4	12.0	3.6	48.0	3.0	34.0	3.5
Chicken	11.1	3.0	15.0	2.5	13.0	3.0	16.0	3.0	45.0	3.0	34.0	3.0

Resp., Respondents. *Intensity scale: 0, not affected; 1, slightly affected; 2, medium; 3, high & 4, very highly affected

It was found that the cattle enterprise is the most severely affected enterprise due to both salinity and drought, while other animal/poultry enterprises have some sort of resilience to cope with the adverse effects (Table 1). Among the livestock and poultry diseases, foot and mouth disease (FMD), lumpy skin disease (LSD), Duck plague and Newcastle disease (ND) were

found to affect people intensely in both salinity and drought affected region's in adverse time period's. The farmer's experiences extreme salinity from November to May with an intensity level of 4.3 (means very severe), and on an average they face and economic loss of 8537 Tk/farm household during that period (mixed livestock species). On the other hand, in drought affected mostly from April to May, with an intensity of 4.6 (very severe) and an average loss of 10004 Tk/farm household. The supply of different feed ingredients as well as their prices were affected by salinity and drought. Green grass supply was mostly reduced during the period, and straw supply was increased because of the land salinity and drought. The cultivation cost of fodder, and cut and carry green grass from the furthest area resulted in an increase of price. The Prices of most of the ingredients increased during hazard periods.

Figure 1. Effect of salinity on feed supply and price

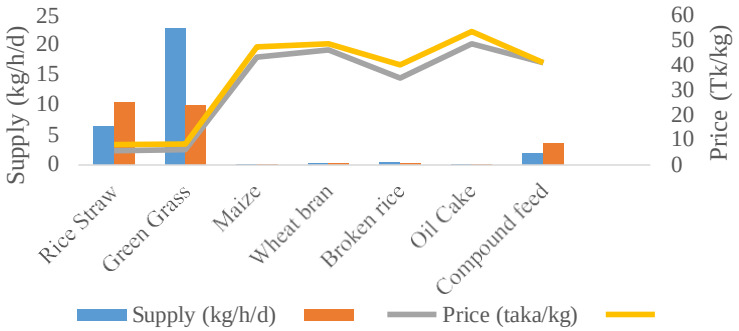


Table 2: Kinds of support needed by the farmers irrespective of categories during flood in different regions

Support/ Need	Saline affected region						Drought affected region					
	Khulna		Satkhira		Overall		Rajshahi		Chapaina wabganj		Overall	
	% Resp.	*Need (1-4)	% Resp.	Need (1-4)	% Resp.	Need (1-4)	% Resp.	Need (1-4)	% Resp.	Need (1-4)	% Resp.	Need (1-4)
Suitable technology to tackle disaster	100.0	4.0	100.0	4.0	100.0	4.0	100.0	3.9	100.0	4.0	100.0	3.9
Training to acquire relevant knowledge and use of technology	92.0	4.0	90.0	4.0	90.0	4.0	92.0	4.0	90.0	4.0	90.0	4.0
Feeds as relief material	90.0	2.5	100.0	2.5	93.0	2.5	90.0	3.0	100.0	4.0	93.0	3.7
Cash support	30.0	2.5	40.0	2.0	36.0	2.3	30.0	1.0	40.0	1.0	36.0	1.0
Livestock keeping facilities in existing shelters for human	25.0	2.4	20.0	3.0	21.0	2.7	-	-	-	-	-	-
Vaccine, medicine, treatment	45.0	3.8	55.0	3.5	51.0	3.6	45.0	3.9	55.0	3.5	48.0	3.6
Pure drinking water	80.0	4.0	90.0	4.0	87.0	4.0	80.0	4.0	90.0	4.0	83.0	4.0
Establishment of milk chilling centre	20.0	3.5	45.0	3.0	34.0	3.2	20.0	3.5	45.0	3.0	34.0	3.2
Irrigation facility	-	-	-	-	-	-	93.0	3.6	90.0	4.0	90.0	3.7

Resp., Respondents. *Need level: 0, no need; 1, slightly needed; 2, medium; 3, highly needed & 4, extremely needed

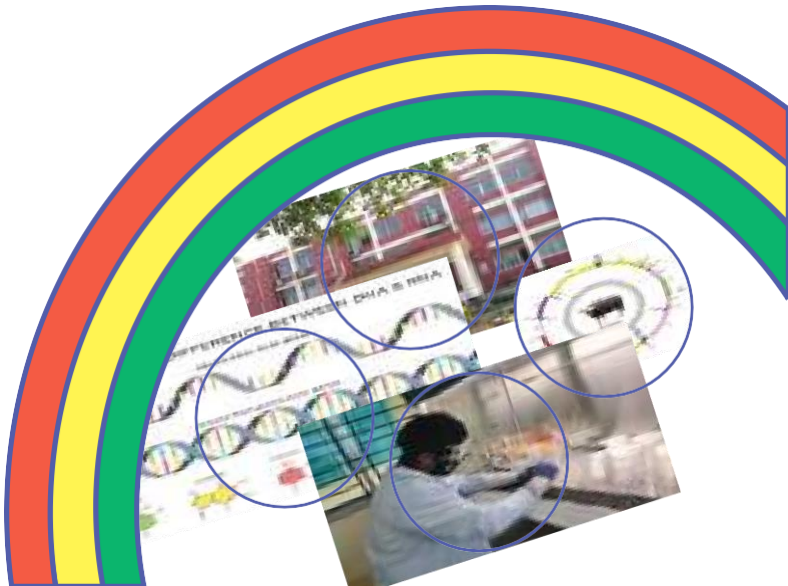
To increase resilience against flood farmers thought they intensely needed suitable technology support, training to acquire relevant knowledge and the use of technologies, feed support and supply of pure drinking water for their livestock and poultry (Table 2). Farmers in drought affected regions expressed the necessity of irrigation support during the drought season. Therefore, climate-smart resilient technologies, together with hands-on training for farmers are recommended for supporting livestock farmers to increase their resilience against salinity and drought.

Research First

TECHNICAL SESSION: IV

BIOTECHNOLOGY, ENVIROMENT CLIMATE RESILIENCE AND WASTE MANAGEMENT

ARRW-2023



Project Title: Analysis of Candidate Genes for Growth, Prolificacy and Milk Production Traits in Black Bengal Goat of Bangladesh
Sub Title: Analysis of Candidate Genes for Prolificacy Trait in Black Bengal Goat of Bangladesh

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Executive Summary

Black Bengal goat (BBG) is an important livestock genetic resource after cattle in Bangladesh and has worldwide reputation for their early sexual maturity, higher fertility rate, adaptability and superior meat and skin quality. Candidate gene-based approach has been widely used to select better performed animals with known genetic make-up even at earlier age and thereby, precise selection of animals would be possible within shortest possible time. Despite the potential impacts of candidate genes on genetic improvement, limited studies so far conducted involving livestock of Bangladesh where it is almost absent in Black Bengal goat. Considering the above stated scenarios, the project has designed to quantify and evaluate data on prolificacy trait of BBG goat, to detect genetic polymorphisms (SNPs) in selected candidate genes related to prolificacy trait in goat and to investigate association between identified SNPs and prolificacy trait in order to develop molecular marker(s) with commercial impacts in BBG of Bangladesh. To achieve the objectives, this study was conducted to detect polymorphisms in the entire coding sequences of the Bone Morphogenetic Protein 15 (BMP15) and Growth Differentiation Factor 9 (GDF9) genes and its possible association between the identified polymorphisms and investigated traits like age at first conception, weight at first conception, mature body weight, age at first kidding, average days open, service per conception, litter size and kidding interval up to 3rd parity in BBG of Bangladesh. A total of 238 blood sample were collected with phenotypic data (173 Black Bengal, 50 Black Bengal crossbred, and 15 Jamunapari goats) from 7 different regions namely Naikhongchari, Bhaluka, Rajshahi, Savar, Chuadanga, Meherpur, and Kushtia. All sorts of descriptive statistics were performed using the agricole package and Mean separation was tested using pastecs package in R. The following statistical model was used for association analysis; $Y_{ijkmn} = \mu + G_{ii} + L_{jj} + M_k + GL_m + GM_n + e_{ijkmn}$. Where Y_{ijkmn} is the dependent variable (reproductive traits); μ is the mean of the population, L_i is the fixed effect of i^{th} locations and age, G_i is the fixed effect of ii^{th} genotype (1, 2 and 3 represents for Black Bengal, Black Bengal crossbred and Jamunapri goats); L_{jj} is the fixed effect of jj^{th} location (1, 2, 3 and 4 denotes for BLRI and Bhaluka, Bandarban, Rajshahi, and Chuadanga and Meherpur); M_k is the fixed effect of k^{th} management system (1 and 2 for on-station and farmers' level); GL_m is the interaction between the fixed effects genotype and location; GM_n is the interaction between the fixed effects genotype and management system and e_{ijkmn} is the random residual error.

The sequencing analysis revealed three SNPs in exon 2 of the BMP15 gene, including g.5875A>G, g.6051G>A and g.6124C>G, and only one SNP in exon 2 of the GDF9 gene, g.3764C>T. The GDF9 gene's polymorphism g.3764C>T was non-synonymous in nature, changing the amino acid alanine to valine (A273V). Besides, BMP15 had only one non-synonymous mutation (g.6124C>G) that resulted in the amino acid, glutamic acid being changed to glutamine (E270Q). The genotypic and allelic frequencies differed largely for each SNP genotypes. In addition, the derived genotypes

of three BMP15 polymorphisms showed a significant (P<0.05) association with litter size at third kidding and average litter size.

Table 1: Identified polymorphisms in GDF9 and BMP15 genes of Black Bengal goat of Bangladesh

Gene	Location	SNP position[1]	Consequence	Amino acid substitution
GDF9	Exon 2	g.3764C>T	Non-synonymous	A273V
BMP15	Exon 2	g.5875A>G	Synonymous	I186I
	Exon 2	g.6051G>A	Synonymous	K245K
	Exon 2	g.6124C>G	Non-synonymous	E270Q

[1]SNP position is based on the reference sequences of *Capra hircus* GDF9 (NC_030814) and BMP15 (NW_017189516).

Table 2: Genotypic and allelic frequencies of four SNPs of GDF9 and BMP15 genes in Black Bengal goat

Gene	SNP	Genotype frequency[1]			Allele frequency	
		II	ID	DD	I	D
GDF9	g.3764C>T	CC 0.54 (39)	CT 0.33 (24)	TT 0.13 (09)	C 0.71	T 0.29
BMP15	g.5875A>G	AA 0.84 (68)	AG 0.15 (12)	GG 0.01 (01)	A 0.91	G 0.09
	g.6051G>A	GG 0.42 (34)	GA 0.35 (28)	AA 0.23 (19)	G 0.59	A 0.41
	g.6124C>G	CC 0.46 (37)	CG 0.37 (30)	GG 0.17 (14)	C 0.64	G 0.36

[1]Values in the parentheses indicate the number of observations in the respective genotypes. CC, AA, GG, CC=dominant; CT, AG, GA, CG= heterozygous; TT, GG, AA, GG=recessive

Table 3: Least-squares means (LMS) with standard errors (SE) of productive and reproductive traits in different goat populations of Bangladesh

Traits[1]	Genotype[2]			Level of Sig.
	Black Bengal	Black Bengal Crossbred	Jamunapari	
MBW (kg)	19.75^{c}±0.31 (164)	24.02^{b}±0.62 (48)	32.28^{a}±1.46 (15)	***
AAFC (d)	200.07±4.44 (96)	374.40±8.37 (40)	-	***
WAFC (kg)	10.99±0.21 (112)	15.53±0.30 (49)	-	***
AAFK (d)	356.79^{c}±4.52(111)	525.71^{a}±6.19(35)	447.88^{b}±16.55(08)	***
LS1 (no.)	1.59^{b}±0.05 (172)	2.00^{a}±0.00 (30)	1.18^{c}±0.12 (11)	***
LS2 (no.)	1.90b±0.05 (145)	2.53a±0.12 (19)	1.40b±0.24 (05)	*****
LS3 (no.)	1.90±0.07 (79)	2.67±0.33 (3)	2.00±0.00 (01)	NS
ALS (no.)	1.72b±0.04 (172)	2.18a±0.04 (30)	1.20c±0.08 (11)	***
ASC (no.)	1.38±0.04 (114)	1.93±0.14 (30)	-	***

[1]MBW, mature body weight; AAFC, age at first conception; WAFC, weight at first conception; AAFK, age at first kidding; LS1, LS2 and LS3, litter size at first, second and third kidding, respectively; ALS, average litter size and ASC, average service per conception. [2]Values in the parentheses indicate the number of observations in the respective genotype. The different superscript within the same row differs significantly at P<0.001.

This is the first report to explore the entire coding sequences of the BMP15 and GDF9 genes in the Black Bengal goat population of Bangladesh. The present findings suggest that the ascertainment of a major fecundity gene for reproductive traits, specifically litter size in a flock can be affected using molecular marker-assisted selection. Finally, the findings stated that BMP15 and GDF9 were polymorphic in Black Bengal goats and that it would be allowable to avail of the molecular information in long-term selection program to accelerate genetic gain, particularly reproductive traits, in the Black Bengal goat population of Bangladesh.

Production and utilization of Gelatin from bovine hides

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Executive Summary

Meat animal's hides and skin (cattle, sheep, goat etc.) are valuable byproducts of slaughterhouses that are primarily used for leather production. In Bangladesh, recently tanneries have been unable to pay the government set price when it comes to hides. It might be that there are lot of alternatives of leathers in international market (Patel *et al.,* 2022) which might decrease the demand and price of hide domestically. Therefore, hides are no longer in demand as they once were for leather production. Nowadays, even sometimes farmers or butchers cannot sell their cattle hides to traders, so they bury them or send them to landfills which ultimately increase environmental pollution. A boost in the market price and commercial value of these naturally nutritional rich hides is imperative in order to prevent environmental pollution and to ensure their commercial viability. Due to the high collagen content in hides, it is also an excellent source for Gelatin extraction (Roy *et al.,* 2021) and bioactive peptide extraction (Hong *et al.,* 2021). Mammalian Gelatin is one of the most popular kinds of Gelatin (Gudmundsson, 2002). Gelatin is a type of hydrocolloid that is used in a variety of food applications. Therefore, the present study was undertaken to determine the present scenario of hides and also extraction of Gelatin from hides pretreated with different level of acetic acid. At first a field study was conducted in three (03) selected areas namely Savar, Dhaka & Mymensingh (denoted as Mym.) to know the socio-economic condition of butchers, present market price of hides, their uses etc. Before Gelatin extraction, proximate composition of hides were measured followed by AOAC, 2005 then Gelatin was extracted at Meat Processing Laboratory of BLRI, Savar, Dhaka where hides treated with 1% acetic acid considered as T_1 group, hides treated with 3% acetic acid considered as T_2 group & hides treated with 5% acetic acid considered as T_3 group and each group or treatment containing three (03) replications. Data were collected, tabulated and analyzed statistically in an ANOVA of a completely randomized design (CRD) and the means were compared using Duncan's multiple range test.

Socio-economic condition of butchers in three (03) areas are shown in Table 1. All butchers were male and overall age was 42.60 years. 59.3% butcher had secondary level of education, 36.1% had primary level of education and maximum (94.40%) butcher had solely depend on meat processing. The overall market price of hides in 3 selected areas are given in figure 1. It showed that selling price of a small size cattle hide in current market were Tk. 285.00 & Tk. 295.00, medium size were Tk. 518.00 & Tk. 561.00 and for large size hide were Tk. 744.00 & Tk. 885.00, respectively for household & butcher. Tannery bought small, medium & large size cattle hides at Tk. 443.00, 758.00 & Tk. 1515.00, respectively. The chemical composition of raw hides are presented in Table 2. Raw hide's pH were 7.82 and contained 64.14% moisture, 35.86% dry matter,

Table 1: Socio-economic condition of butchers in three (03) areas

Parameters		Name of areas			
		Savar	**Dhaka**	**Mym.**	**Overall**
Gender	Male	100	100	100	100
	Female	-	-	-	-
Age (years)		50.0[a]	37.2[b]	43.6[ab]	42.6
Literacy (%)	Primary	24.7	33.3	50.3	36.1
	Secondary	68.7	64.7	44.6	59.3
	Higher secondary	6.67	2.00	5.01	4.56
	Graduation	-	-	-	-
Family member (No.)		6.00	5.66	5.69	5.75
Housing (%)	Own	25.5	13.3	90.00	42.94
	Rent	74.5	86.7	10.00	57.0
Source of income (%)	Meat processing	92.3	100	90.2	94.4
	Agriculture	-	-	-	-
	Business	7.65	-	9.08	5.60
Monthly income (Taka' 000)		46.4	43.3	34.6	40.5
Working experience (%)	1-2 years	12	13	9	11.33
	2-8 years	32	23	25	26.66
	8-16 years	35	47	44	42
	Over 16 years	21	17	22	20

30.45% crude protein, 99.68% organic matter. Curing with different concentrations of acetic acid (1%, 3% & 5%) was significantly affected ($p<0.001$) the Gelatin yield (Table 3). The higher the strength of acetic acid lead to an increase in gelatin yield. The highest Gelatin yield in terms both wet and dry tissue basis was found in T_3 (16.98% & 47.33%) group followed by T_2 (13.99% & 39.00%) & T_1 (11.57% & 32.27%) group, respectively. However, the chemical composition of Gelatin like moisture, crude protein, crude fat, organic matter & ash content did not differ significantly ($p>0.05$) among the treatment groups. The crude protein content varied from 95.97% to 97.38% and was highest in T_2 (97.38%) treatment group and then that of T_3 (96.49%) and T_1 (95.97%) group, respectively. The crude fat content of extracted Gelatin for T_1, T_2 & T_3 groups were 0.19%, 0.17% and 0.22%, respectively. The Gelatin strength/bloom was differ significantly ($p <0.001$) among the treatment groups. The highest bloom was found for T_2 (205.52g) treatment group as compared to group T_1 (154.90g) & T_3 (195.52g). In case of viscosity, it was found that the highest ($p<0.001$) viscosity was in T_2 (7.04 cP) treatment group than that of T_3 (6.77 cP) & T_1 (6.02 cP), respectively. The color of Gelatin also varied significantly among the treatment groups. Table 3 also showed that L*value is higher ($p<0.05$) for T_1 (43.64) that means T_1 is comparatively lighter in color than T_2 (42.00) & T_3 (42.36) groups. On the other hand a* value was higher ($p<0.001$) for T_3 (1.62) treatment group, so it was more red compared to others. As b* values of different Gelatin samples fall in the range between 9.68 and 12.08, it could be said to possess light yellow color. The production cost/kg Gelatin were Tk. 742.38, 790.00 & Tk. 909.00, respectively for T_1, T_2 & T_3 groups.

Table 2: Chemical composition (%) & pH of raw hides

Moisture, % fresh	64.14
Dry matter	35.86
Crude protein	30.45
Organic matter	99.68
Ash	0.32
Ether extract	0.20
pH	7.82

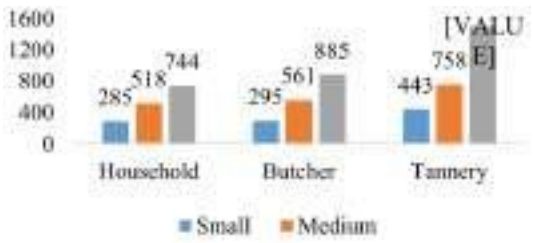

Fig1: Price of hides in tannery, butcher & household

Table 3: Physiochemical properties & production cost of extracted Gelatin

Parameters		Treatments			SED	Level of Sig.
		T_1	T_2	T_3		
Yield, %						
Wet tissue basis		11.57 ^{c}	13.99 ^{b}	16.98 ^{a}	0.31	***
Dry tissue basis		32.27^{c}	39.00^{b}	47.33^{a}	0.87	***
Chemical composition, %						
Moisture, % fresh basis		8.52	10.72	12.1	0.54	NS
Organic Matter		99.41	99.31	99.37	0.38	NS
Crude Protein		95.97	97.38	96.49	1.34	NS
Crude Fat		0.19	0.17	0.22	0.04	NS
Ash		0.59	0.69	0.63	0.38	NS
pH		4.05^{a}	4.17^{a}	4.12^{a}	0.03	NS
Bloom/Gel strength (g)		154.90^{c}	205.52^{a}	195.52^{b}	0.04	***
Viscosity (cP)		6.02^{c}	7.04^{a}	6.77^{b}	0.15	***
Color	L*	43.64^{a}	42.00^{b}	42.36^{b}	0.27	*
	a*	1.44^{b}	0.9575^{c}	1.61^{a}	0.02	***
	b*	10.48^{b}	12.08^{a}	9.68^{c}	0.05	***
Total production cost/kg (TK)		742.38	790.00	909.00	-	-

Based on the above results, it can be concluded that considering bloom and cost of production hides treated with 3% acetic acid was a cost-effective and efficient Gelatin extraction procedure from which more bloom, CP yield and considerable amount of Gelatin can produced.

De novo whole genome sequence of indigenous chicken (Hilly chicken) of Bangladesh and exploring the unique genome

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[2]Genomics Research Group, Faculty of Veterinary Medicine, Chattogram Veterinary and Animal Sciences University (CVASU), Chattogram, Bangladesh

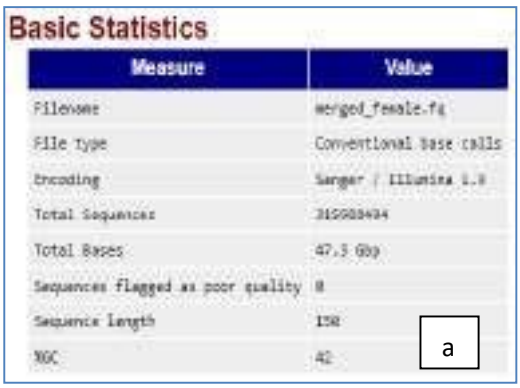
Executive summary

Hilly chickens, also known as indigenous or local chickens found in hilly or mountainous regions, can be classified based on various factors such as their physical characteristics, genetic traits and geographical distribution. The hilly chickens are reportedly comparably superior to other local chickens, according to phenotypic productivity tests. The chicken genome is incredibly useful and will be of enormous benefit to explore the potential as adaptable species and developing new suitable varieties. With the use of cutting-edge next generation sequencing (NGS) technology we successfully developed a whole genome dataset of Hilly chicken. In addition, we aimed to determine the functional genes and protein annotation to explore the comprehensive genome.

A total of 10 blood samples were collected from Naikkhonchari Hill tract chicken populations. Blood sampled collected from the brachial wing vein (or cutaneous ulnar vein) following standard procedure. Genomic DNA were extracted from the blood samples (n=10) using commercial DNA extraction kit (AddBio, Korea) according to manufacturer's instruction, and the quality of the extracted genomic DNA were assessed using Qubit 3.0 fluorimeter. The good quality genomic DNA (as evaluated by Agarose gel electroporesis) from two chickens were then sent to Illumina Sequencing platform (NextSeq 2000) for NGS data generation. The raw NGS raw data were then assembled and annotated using bioinformatics tools. Sequence data quality was assessed using FastQC tool (Fig 1a, b,c). Low quality reads were filtered & potential sequencing errors were removed. The high quality reads were assembled using Abyss tool (https://bio.tools/abyss). To assess the quality of assembly, QUAST tool was used. The annotation was done with GlimmerHMM software (https://ccb.jhu.edu/software/glimmerhmm/).

From the analysis of the whole genome sequencing of Hilly chicken performed on Quast, it was found that the N50, which represents the number of the contig such that 50% of the genome is in contigs of this size or larger, is 92506900. The largest contig size is 193063023. The total length of the genome is 1011599288 base pairs. The GC content, or the percentage of guanine and cytosine nucleotides in the genome, is 41.98%. The number of N's, or ambiguous bases, per 100 kbp is 618.65. Overall, these findings indicate that the Hilly chicken genome has been successfully assembled with high quality and integrity. The BUSCO analyses indicated 95% genome completeness.

The sequencing of the chicken genome is of significant importance as it provides crucial insights into the genetic makeup of one of the most widely domesticated and economically important animals in the world. Studying the genetic variations among different chicken populations can provide valuable insights into the evolutionary history of the species. The WGS analysis of Hilly chicken is the first study of its kind in the country as well as around the globe. The genetic tools and experiences from this current project may offer a new frontier towards conservation of genetic resources, the ability to more accurately select animals for specific purposes. The whole genome datasets will increase our understanding about genome organization, evolutionary divergence, conservation and overall endemic diversity.



Basic Statistics

Measure	Value
Filename	merged_female.fq
File type	Conventional base calls
Encoding	Sanger / Illumina 1.9
Total Sequences	315988494
Total Bases	47.3 Gbp
Sequences flagged as poor quality	0
Sequence length	150
%GC	42

a

Basic Statistics

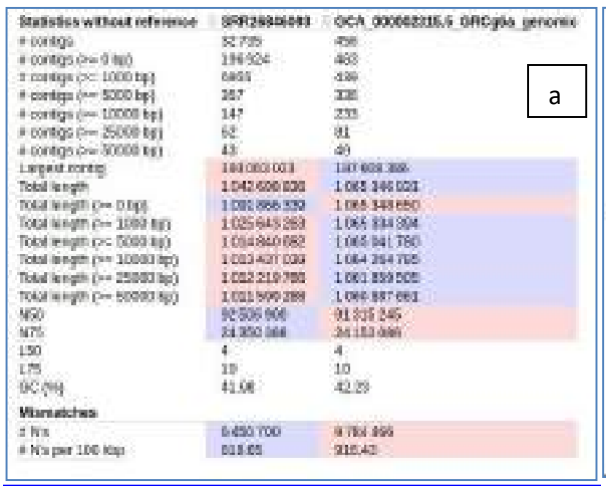
Measure	Value
Filename	merged_male_fq
File type	Conventional base calls
Encoding	Sanger / Illumina 1.9
Total Sequences	342998306
Total Bases	51.4 Gbp
Sequences flagged as poor quality	0
Sequence length	150
%GC	42

b

c

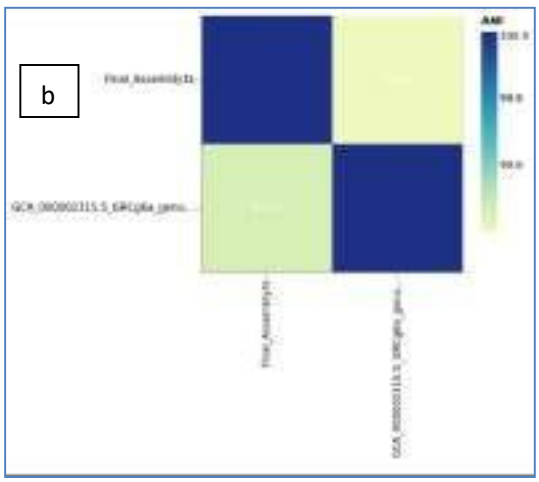
Sample Name	Clean Reads	Clean Base	Read Length	Q20(%)	Q30(%)	GC(%)
F5A	157,994,247	47,398,274,100	PE150	96.27	90.08	42.13
M1A	171,499,153	51,449,745,900	PE150	95.16	87.90	42.35

Fig.1. Basic statistics of raw NGS data of the female (a) and male (b) hilly chicken samples before and after FastQC quality control. The FastQC data quality report (c) is indicative of good quality NGS raw data to start with for assembly and annotation steps. The data is uploaded in NCBI Accession SRR26846093 and accessible at https://www.ncbi.nlm.nih.gov/sra?LinkName=biosample_sra&from_uid=38272021 (Fig 3a)

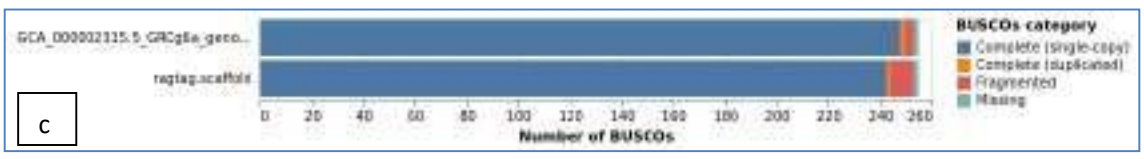


Statistics without reference	SRR26846093	GCA_000002315.5_GRCg6a_genomic
# contigs	32 735	456
# contigs (>= 0 bp)	194 524	463
# contigs (>= 1000 bp)	6801	439
# contigs (>= 5000 bp)	267	338
# contigs (>= 10000 bp)	147	235
# contigs (>= 25000 bp)	62	81
# contigs (>= 50000 bp)	43	49
Largest contig	180 083 003	197 608 386
Total length	1 042 600 020	1 065 346 023
Total length (>= 0 bp)	1 091 886 332	1 065 348 650
Total length (>= 1000 bp)	1 025 643 283	1 065 334 304
Total length (>= 5000 bp)	1 014 840 082	1 065 041 780
Total length (>= 10000 bp)	1 013 427 039	1 064 354 705
Total length (>= 25000 bp)	1 012 219 788	1 061 859 505
Total length (>= 50000 bp)	1 011 909 289	1 056 887 061
N50	92 536 906	91 915 245
N75	34 350 166	34 153 686
L50	4	4
L75	10	10
GC (%)	41.08	42.29
Mismatches		
# N's	6 450 700	8 784 899
# N's per 100 kbp	618.65	824.42

a



b



c

Fig.2. Quast assembly report (a) after using Abyss genome assembler. Analyses revealed a total of 32735 contigs with a large number of predicted genes following annotation with GlimmerHMM tool (Fig 3b). The heatmap (b) showed high similarity of predicted genes with that of the reference chicken genome (GCA_000002315.5). The genome completeness is evaluated by BUSCO tool (c) where it is indicating 95% of the completeness when compared with reference genome (https://www.ncbi.nlm.nih.gov/datasets/genome/GCF_000002315.5/).

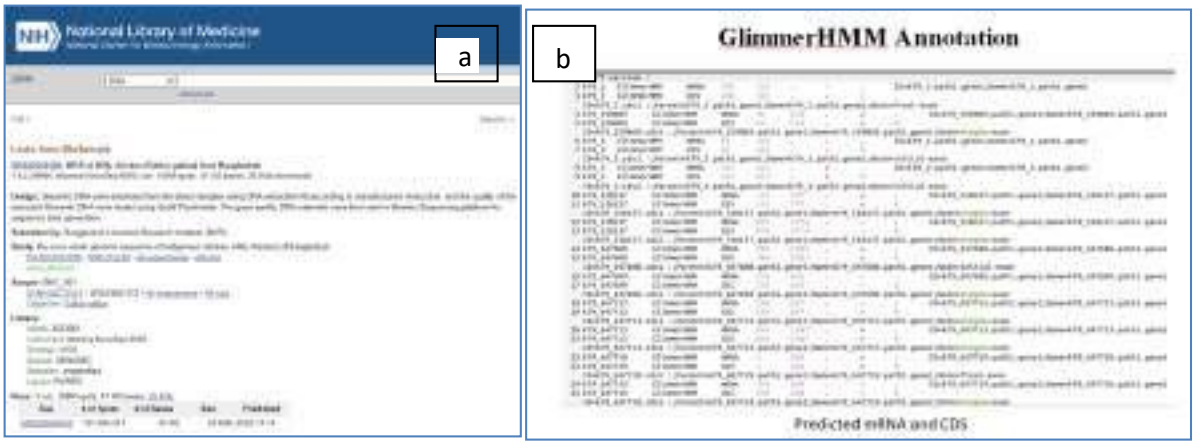


Fig.3. (a) The NCBI SRA site (Accession SRR26846093) where the assembly and annotation data is uploaded for use by other researchers. The annotation page (b) revealed 32735 contigs with a large number of predicted genes which is also uploaded in NCBI website https://www.ncbi.nlm.nih.gov/sra?LinkName=biosample_sra&from_uid=38272021 .

Determination of Oxalate content in Napier varieties and Identification of gene responsible for oxalate content in Napier

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Executive Summary

Napier grass (*Pennisetum purpureum*) is a valuable forage in the tropics and subtropics because of its high biomass yield containing high DM yield, moderate nutritional values, and ease of propagation. Despite having some good characteristics, unsafe concentrations of soluble oxalate in Napier grass (>2.0%) can lead to poisonous effects in livestock species. Considering these facts, this project was designed with the following objectives; to determine the oxalate content in different Napier varieties at different parts and at different stages, to identify genes responsible for the oxalate production in Napier, and finally to produce oxalate-free Napier grass. The experiment was conducted at Fodder Research Field, BLRI, Savar, Dhaka-1341. Firstly, twelve Napier varieties (35-40 days) (Table 1) of BLRI have been screened for the presence of oxalate content. Five Napier varieties (Napier-3, Napier-4, Napier-5 salt tolerant, Napier color Variety, and Pakchong) were selected for doing this experiment. A total of 10 plots were prepared using these 5 varieties. Each variety had 2 plots; one was control and another one was treated with the standard amount of fertilizer (50kg Urea/hectare). Soil samples were collected before plot preparation and analyzed for different parameters (pH, organic matter, texture, total nitrogen, available phosphorus, and potassium). Fodder samples were collected from Day 10 and continued up to Day 70 considering the existing season. CP, DM and 1 Square meter yield of each variety at every 10-day interval were also observed. Due to availability and popularity, raw Napier samples (Pakchong and Napier-5 salt tolerant variety) were sent to Beijing Genomics Institute (CNGB), Shenzhen, China for whole genome sequencing and identification of genes responsible for the production of oxalate in Napier grass. Experimental data was analyzed by SPSS (V.25).

From this study it revealed that the highest and lowest oxalate content observed in Dwarf Late varieties (3.16±0.02) and wrukwona (1.85±0.04) respectively. Among the 12 Napier varieties, Pakchong contains moderately low oxalate content (1.97±0.03) than the other Napier varieties of BLRI (Table 1).

Napier varieties	Oxalate content (%) (Mean±SD)	Oxalate Content (%) (Average±SD)
Napier 1	2.08±0.02	2.34±0.42
Napier 2	2.03±0.02	
Napier 3	2.23±0.06	
Napier 4	2.31±0.01	
Napier 5 salt tolerant	2.13±0.04	
Napier Color variety	2.08±0.02	
Pakchong	1.97±0.03	
Zara	2.74±0.04	
Markeron	2.46±0.06	
Wrukwona	1.85±0.04	
Dwarf Early	3.03±0.04	
Dwarf Late	3.16±0.02	

Table-1 Oxalate content of 12 Napier varieties

Soil Texture was LOAM, pH was relatively low (4.6± 0.1), organic matter (%) was medium (2.9± 0.1), available phosphorus (ppm) was optimum (36.87± 0.225), total Nitrogen (%) and others was relatively low. Higher oxalate content was observed at the early stage and it declined gradually with the progression of time. Day 10 shows significantly higher ($p<0.05$) oxalate content than Day 20 and declined significantly at Day 50 (Figure 1).

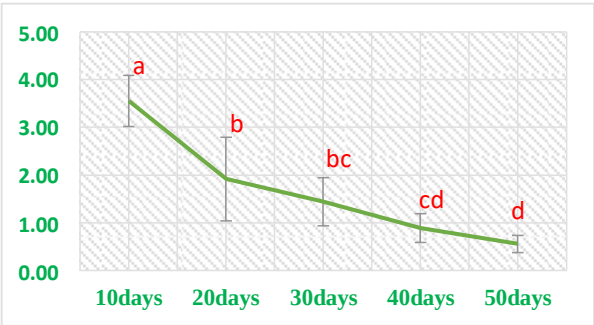

Figure 1: Average oxalate content (%) of selected Napier varieties at different stages

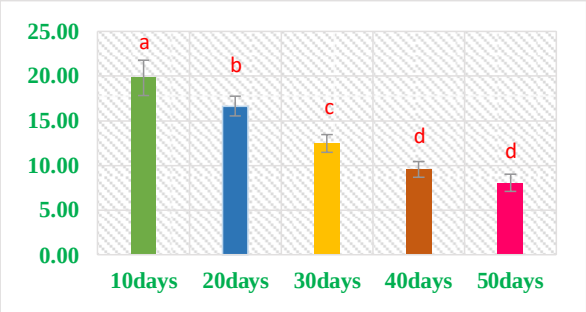

Figure2: CP content (%) of selected Napier varieties at different stages

Leaf (3.2±0.48%) contains significantly higher ($p<0.05$) oxalate than stem (1.8±0.72%) and whole (2.7±0.77%) samples (Day 20). Significantly higher CP content was observed on Day 10 than on Day 20 (Figure 2). DM gradually rises at the stage of maturity of fodder and a significantly higher ($p<0.01$) result was observed at day 40 (94.56±0.39). Similarly, yield increases gradually with the progression of time. Oxalate, CP, DM and yield were higher in the fertilizer-treated group. Genomic DNA (gDNA) of fodder samples were extracted (Table 2) and whole genome sequencing is on-going.

It can be summarized that oxalate levels of different Napier varieties are almost within the tolerable level (>2.0%). The highest CP content is obtained when the fodder is harvested at an early stage. Identification of the genes involved in oxalate-production and their successful elimination from the fodder genome may result in oxalate-free Napier.

Title: Establishment of milk processing facilities for the development of premium dairy products

Sub-title: Isolation, identification, and molecular characterization of lactic acid bacteria from traditional Dahi

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Executive summary

Lactic acid bacteria (LAB), a naturally occurring microbe found in fermented dairy products, can be employed to give an acceptable appearance and to enhance the color, flavor, and texture of its final products. Dahi, a traditional fermented milk product that is comparable to yogurt, is known for its nutraceutical and pharmacological properties, as well as its human gut microbiological value. However, LABs have historically been used as starter cultures for traditional Dahi production. Thus, a large investigation is needed to develop a new probiotic LAB that may be utilized as a starter culture to manufacture sustainable Dahi in Bangladesh. Therefore, the current study aimed to find certain probiotic LABs from traditionally fermented Dahi after studying the physico-chemical and microbiological attributes. Randomly twenty locally produced traditional Dahi samples were obtained from four distinct locations in Bangladesh (Dhaka, Tangail, Bogra, and Sirajganj). The samples were transferred to the lab in a large, wide-mouthed thermos flask and kept at 4-5 °C in an icebox until analysis for 6-10 h. The Dahi was tested for pH, acidity, moisture, total solids, fat, protein, sugar, and ash content by using official methods of analysis (AOAC,1995). Following "Standard Methods for Examination of Dairy Products" by the American Public Health Association (APHA, 1983), samples were examined for total viable bacterial count (TVC), yeast, and mold. TVC was counted using plat count agar, while yeast and mold were counted using potato dextrose agar (PDA). To isolate and identify LAB, Dahi samples were serially diluted and spread on MRS agar media for growing bacterial colonies by incubating at 37°C for 24 h. Based on colony and cell morphology and catalase reactions, selected colonies were subjected to purification through culturing in MRS agar and broth sequentially with the streak plating method. In addition, seven antibiotics were used to test antibiotic sensitivity (AST) for presumptive isolates to identify their food grade properties. Biochemical characterization, including growth at different temperatures, $NaCl_2$ concentrations, pH levels, and eight carbohydrate fermentation profiles, was used for species-level identification. Subsequently, matrix-assisted laser desorption/ionization time-of-flight mass spectrometry (MALDI-TOF MS) followed by polymerase chain reaction (PCR) assisted and amplified 16S rRNA gene sequencing (sangers sequencing) analysis were used for more accurate identification of the *Lactobacillus spp*. For molecular confirmation, out of 23 isolates, 13 LAB isolates conferred by MALDI-TOF MS and 5 were then purified and subjected to characterize by using 16S rRNA gene sequencing of the prokaryotic 16S ribosomal DNA universal primers 27F (5'-AGA GTT TGA TCM TGG CTC AG -3´) and 1492R (5'-CGG TTA CCT TGT TAC GAC TT -3´). The 16S rDNA sequences were aligned with 16S rRNA sequences from GenBank to identify organisms using BLAST analysis. Then, the sequence information from representative organisms was introduced into the MEGA 11 program for assembly and alignment using five aligned sequences. The 16S rRNA gene sequences of isolates were compared with sequences from LAB-type strains held in GenBank. Nucleotide substitution rates were calculated, and phylogenetic trees were constructed by the neighbor joining method.

The results demonstrated that in four locations, the average fat, protein, sugar, ash, total solids, pH, and titratable acidity content of Dahi were ranged as follows: 4.31-4.88%, 3.99-4.74%, 19.27-28.33%, 0.81-1.08%, 29.82-38.24%, 4.38-5.00%, and 0.63-0.92%, respectively, which were significantly varied among the locations studied. The total yeast count and TVC were significantly varied in four locations and ranged from 1.4×104 to 4.9×103 cfu/g and from 2.3×105 to 3.8×104 cfu/g, respectively (Table 1).

Table 1 Microbial profiles of Dahi samples collected from four areas in Bangladesh.

Parameters	Dhaka Mean ±SD	Tangail Mean ±SD	Bagura Mean ±SD	Sirajganj Mean ±SD	P-value
TVC (cfu/ml)	$3.8\times10^4 \pm 3.0$	$2.8\times10^4 \pm 2.7$	$3.0\times10^5 \pm 5.2$	$2.3\times10^5 \pm 4.4$	0.187
Yeast (cfu/ml)	$3.8\times10^4 \pm 2.6^a$	$2.3\times10^3 \pm 2.9^b$	$1.4\times10^4 \pm 1.0^b$	$4.9\times10^3 \pm 6.5^b$	0.000
Mold (cfu/ml)	$0.3\times10^2 \pm 0.5$	0	$0.8\times10^2 \pm 1.4$	0	0.119

Results indicated that a total of 23 isolates of LAB were identified from 20 Dahi samples that were collected from different areas of Bangladesh. Out of 23 isolates, 13 isolated colonies (56.52%) were *Lactobacillus spp*. based on their physiological, morphological, and biochemical tests, whereas 10 isolates (43.47%) were determined to be *coccus.* According to AST, most of the isolates (86.95%) were found to be sensitive, whereas only 3 isolates were resistant (13.04%) to the maximum antibiotics tested. According to the MALDI-TOF MS test, the colonies were identified as 4 distinct LABs. The identified isolates were confirmed as *Lactobacillus casei* (2), *Lactobacillus paracasei* (1), *Lacticaseibacillus rhamnosus* (1), and *Limosilactobacillus fermentum* (9).

Table 2 Bruker MALDI Biotype Identification Results

Sample ID	Organism (best match)	Score Value	Organism (second-best match)	ScoreValue
DRTC13	*Lacticaseibacillus paracasei*	2.33	*Lacticaseibacillus paracasei*	2.31
DRTC18	*Lactobacillus casei*	2.17	*Lactobacillus zeae*	1.82
DRTC14	*Lacticaseibacillus rhamnosus*	2.26	*Lacticaseibacillus rhamnosus*	2.25
DRTC 2	*Limosilactobacillus fermentum*	2.05	*Limosilactobacillus fermentum*	1.98

Molecular homological analysis was conducted, and the phylogenetic tree was constructed based on the 16S rDNA sequences for observing divergences. The isolates of DRTC 2 and DRTC 8 were most closely related to *Limosilactobacillus fermentum* supporting the query coverage of 98% from bootstrap analysis of the phylogenetic tree (not shown). With 98–99% resemblance, these two isolated LAB strains have the accession numbers HUMB19034 and TMPC 103E1, respectively. Amid 98–100% similarity in their 16S rDNA gene sequences, isolates DRTC 13, DRTC 14 and DRTC 18 were most closely related to *Lactobacillus casei*, *Lactobacillus paracasei*, and *Lacticaseibacillus rhamnosus* all supporting the 97% values from the bootstrap analysis of the phylogenetic tree having the accession numbers MN038016.1, MT463518.1 and CP136114.1, respectively.

Table 3 The identified strains accession number and resemblance in phylogenetic tree derived from 16s rRNA gene sequence blast analysis.

Isolates	Identified species	Reference strain		Resemblance (%)
		Name	Accession number	
DRTC 2	*Limosilactobacillus fermentum*	HUMB19034	OL434986.1	98.86
DRTC 8	*Limosilactobacillus fermentum*	TMPC 103E1	ON376968.1	97.52
DRTC 13	*Lactobacillus casei*	BCRC 17487	MN038016.1	99.74
DRTC 14	*Lactobacillus paracasei*	KCOM 3275	MT463518.1	98.90
DRTC 18	*Lacticaseibacillus rhamnosus*	LMG 23327	CP136114.1	97.26

It can be concluded that the isolated colonies from the Dahi samples were identified as four distinct LABs of *Lactobacillus casei*, *Lactobacillus paracasei*, *Lacticaseibacillus rhamnosus*, and *Limosilactobacillus fermentum* based on their morphological, biochemical, and molecular identification. However, the isolation and identification of probiotic LAB will be continued until the targeted isolates are characterized.

Assessment of environmental stresses on different genetic groups of dairy Cattle and development of their mitigation strategies

Sub-title: Effects of cyclic temperature humidity index on productive performance, physiological responses, and biochemical properties of different blood levels in Holstein Friesian dairy cows

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Executive Summary

Dairy farming is significantly impacted by environmental stress, which has an influence on animal health and physiology, reproductive health, milk output and productivity, disease susceptibility, and overall farm profitability. The most important tool for determining the level of environmental stress that animals experience is the Temperature-Humidity Index (THI). Therefore, the present study was undertaken to measure the cyclic environmental stresses through THI on different blood percentages of Holstein Friesian (HF) dairy cows and their effect on milk yield and composition, physiological responses, and biochemical blood properties. The research was carried out using Holstein Friesian crossbred dairy cows at Central Cattle Breeding Station and Dairy Farm, Savar, Dhaka. A total of 25 dairy cows with 5 genotypes (local, 50% HF, 62.5% HF, 75% HF and 87.5% HF) and 5 from each genotype were considered. To record the temperature and relative humidity, four Digital thermo Hygrometer were hung in four corners of the shed at the animal height, and data were recorded three times a day (6 a.m., 2 p.m., and 10 p.m.). The temperature humidity index (THI) was calculated by using the following equation: THI= [1.8×T+32]-[0.55-0.0055×RH] × [1.8×T-26] (Gantner et al. 2010).The duration of the experiment was 270 days (December 15, 2022, to September 14, 2023). THI≤68 were considered as comfort, 69≤THI≥74 were considered as thermo-neutral, and THI≥75 were considered a stressed condition. At the end of the experiment, the data were summarized in Microsoft Excel 2010 and analyzed using R Studio (Version 1.4.1564). The difference among treatments was determined with Duncan's new multiple range test (Steel and Torrie 1980), and significance will be declared when the probability is less than 5% ($P<0.05$). In results, average THI from December to February was found within the comfort range (THI≤68), March to May was in the thermo-neutral range (69≤THI≥74), and June to September was in the stress condition (THI≥75). Highest THI=89.81 was found in 10 June, 2023 and lowest THI=61.91 was found in 17 January, 2023. The results of this study revealed that cows with higher percentages of Holstein genetics (HF 87.5%) exhibited a significant elevation ($P<0.01$) in rectal temperature (102.58^0C), pulse rate (67.02 beats/min), and respiration rate (36.07 breaths/min) compared to cows with lower Holstein Friesian blood percentages (62.5% HF, 75% HF), and no significant difference was found in local and 50% HF blood levels (rectal temperature 102.25^0C, pulse rate 63.66 beats/min, and respiration rate 33.20 breaths/min) during the stress condition. The study also demonstrated a significant decrease ($P<0.05$) in milk yield and milk composition in response to heat stress on different blood levels of HF dairy cows. It was found that cows with higher HF blood (HF 87.5%) percentages exhibited a 31% decrease in milk yield (comfort 10.67 L/day; neutral 9.14 L/day; and stress). 7.32 L/day), 27% decrease in fat content (comfort 4%; neutral 3.64% and stress 2.92%), 7.78% decrease in protein content (comfort 3.21%; neutral 3.01% and stress 2.89%), 5.71% decrease in SNF (comfort 8.42; neutral 8.11% and stress 7.94%), and 5.21% decrease in lactose content (comfort 4.6%; neutral 4.53% and stress 4.36%). Moreover, the study found that local and HF dairy cows with lower percentages of Holstein genetics (HF 50%) exhibited non-significant changes in milk yield and composition. The study also revealed significant alterations ($P<0.05$) in the biochemical blood profiles of different blood percentages. HF dairy cows were subjected to heat stress, and variations were observed in glucose, total protein, uric acid, cholesterol, calcium, HDL, SGPT, and SGOT levels (Table 1). Cows with higher Holstein genetics exhibited more pronounced changes in these parameters compared to cows with lower HF blood percentages under heat stress conditions (Table 1).

Table 1: Effect of temperature humidity index (THI) on biochemical blood properties

Blood %	(THI) Range	Parameters							
		Glu	TP	UA	Cho	Ca	HDL	SGPT	SGOT
Unit		mmol/l	g/dl	mg/dl	mg/dl	mg/dl	mg/dl	U/I	U/I
Local	Comfort	3.57^{a}	6.48	1.14	80.41	4.62^{bc}	92.02	16.35^{f}	36.10
	Neutral	3.50^{ab}	6.55	1.68	215.28	4.38^{c}	145.12	28.96^{bcd}	30.01
	Stressed	2.98^{cde}	7.50	1.08	164.37	2.72^{cde}	85.52	30.01^{ab}	36.10
HF 50%	Comfort	3.05^{cde}	7.02	1.16	102.07	3.16^{cde}	100.06	24.43^{cde}	34.56
	Neutral	3.15^{bcd}	7.02	1.18	247.08	4.52^{bc}	159.42	26.52^{abc}	32.46
	Stressed	3.01^{cde}	9.03	1.07	142.10	2.11^{de}	62.76	28.62^{abc}	25.13
HF 62.5%	Comfort	3.49^{ab}	6.84	1.24	130.22	4.21^{c}	120.73	23.73^{de}	31.47
	Neutral	2.65^{e}	6.80	1.60	273.00	4.57^{bc}	127.26	24.08^{cde}	35.25
	Stressed	3.03^{cde}	7.73	1.34	180.92	3.12^{cde}	71.31	28.97^{abc}	25.48
HF 75%	Comfort	3.25^{abc}	6.93	1.14	118.35	6.33^{ab}	150.01	23.03^{e}	32.46
	Neutral	3.33^{abc}	6.93	1.27	233.72	3.74^{cde}	113.07	24.43^{cde}	38.39
	Stressed	3.00^{cde}	8.99	0.97	161.52	4.14^{c}	61.96	29.31^{abc}	31.57
HF 87.5%	Comfort	3.25^{abc}	7.10	1.08	118.33	6.56^{a}	118.15	30.71^{ab}	37.34
	Neutral	3.11^{bcd}	7.05	1.19	243.54	1.87^{e}	132.36	25.48^{bcd}	35.95
	Stressed	2.79^{de}	7.91	1.31	117.94	3.97^{cd}	53.15	31.76^{a}	34.55
Main Effect									
Blood %	Local	3.35^{a}	6.84	1.30^{ab}	153.35^{b}	3.908^{ab}	107.55^{a}	25.15^{b}	33.67^{ab}
	HF 50%	3.07^{b}	7.69	1.14^{b}	163.75^{ab}	3.265^{b}	107.41^{a}	26.57^{ab}	30.71^{b}
	HF 62.5%	3.06^{b}	7.12	1.39^{a}	194.71^{a}	3.969^{ab}	106.43^{a}	25.59^{b}	30.73^{b}
	HF 75%	3.19^{ab}	7.64	1.13^{b}	171.19^{ab}	4.739^{a}	108.34^{a}	25.59^{4b}	34.14^{ab}
	HF 87.5%	3.05^{b}	7.35	1.19^{ab}	159.94^{ab}	4.136^{ab}	101.22^{a}	29.31^{a}	35.94^{a}
(THI) Range	Comfort	3.32	6.87^{b}	1.15	109.87^{c}	4.978	116.19	23.65^{b}	34.38
	Neutral	3.15	6.87^{b}	1.38	242.52^{a}	3.817	135.44	25.89^{b}	34.41
	Stressed	2.96	8.23^{a}	1.15	153.37^{b}	3.215	66.94	29.73^{a}	30.32
(p-value)	Blood %	0.001	0.1	0.001	0.0001	0.0004	0.0001	0.0001	0.032
	THI	0.065	0.001	0.061	0.228	0.130	0.981	0.051	0.098
	Blood %×THI	0.025	0.1	0.211	0.772	0.001	0.071	0.003	0.157

Data with different superscripts are significantly different, (*) =significant different (p<0.05), (**) =significant different (p<0.01), (***) =significant different (p<0.001), NS=non-significant. Mean in columns followed by the same letters are different by DMRT test (p≤0.05).Here, Glu=Glucose, TP=Total Protein, UA=Uric Acid, Cho=Cholesterol, Ca=Calcium, HDL= High-density lipoprotein, SGPT= Serum glutamic pyruvic transaminase and SGOT= Serum Glutamic-Oxaloacetic Transaminase.

In conclusion, this study revealed a strong relationship between THI, cow physiology, biochemical blood properties, productivity, and overall cow performance. According to this study, HF cows with higher blood percentages are less resilient to stress than those with lower blood percentages. Apart from the alterations in the physiological reactions and blood metabolites of cows under stress, there is also a significant decrease in milk production as well as composition. This decline is particularly pronounced in HF cows with higher blood percentages. By implementing proper management and mitigation strategies and leveraging the most suitable blood level for the native climate, the dairy industry can enhance the adaptability of HF dairy cows, ensuring their health, productivity, and the overall sustainability of dairy farming practices.

Standardization of estrus synchronization techniques for improvement of reproductive efficiency of native buffaloes in Bangladesh

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Executive summary

This study aimed to improve the reproductive efficiencies of native buffaloes using the estrus synchronization technique. In experiment 1, a total of 32 buffalo cows of second to fifth parity with a good body condition score (3.0-4.0) were selected at Madarganj Upazilla, Jamalpur for estrus synchronization to examine the effect of season on estrus synchronization in buffaloes. The estrus of buffaloes was synchronized with the Ovsynch protocol. In this protocol, buffaloes were injected with 5 ml Gonadorelin (GnRH; Unibiotech Co. Ltd., Korea) on day 0, and next, 5 ml Dinoprost (PGF2α; (Unibiotech Co. Ltd.) on day 7, and the second Gonadorelin injection was given on day 9, and artificial insemination (AI) was performed with frozen semen prepared by Bangladesh Livestock Research Institute (BLRI) at 16 hours after the final dose of Gonadorelin injection. Blood samples were collected from the jugular vein of the buffaloes for analysis of total protein, albumin, cholesterol, glucose, triglyceride (TG), alanine amino transferase test (ALT), aspartate transferase (AST), and alkaline phosphatase (ALP). All buffaloes showed estrus in breeding season, which was significantly ($P>0.05$) higher than non-breeding season (86.67%). Again, 90.91% buffaloes conceived successfully in the breeding season, whereas 73.33% conceived in non-breeding season, but the values also did not differ significantly ($P>0.05$). Glucose and total protein (TP) levels were significantly ($P<0.05$) higher in the breeding season than in the non-breeding season. Levels of TG, Cholesterol, ALT, ASP, and ALP were higher in the breeding season than in the non-breeding season but did not differ significantly. In experiment 2, a total of 59 female native buffaloes were selected at Madarganj Upazilla under Jamalapur district to examine the effect of mineral supplementation on the reproductive efficiencies of buffaloes. For this, 10 gm of DCP plus (Opsonin Pharma, Dhaka) was offered daily to 18 buffaloes, while a number of 20 buffaloes were examined as non-treated control group, and 21 buffaloes were selected for estrus synchronization with the ovsynch protocol. All buffaloes were offered 1 kg of concentrate feed mixture (60 % maize crushed + 40 % wheat bran) daily. Blood was collected one month after the treatment from the jugular vein for analysis of glucose, total protein, albumin, TG, cholesterol, ALT, ASP, and ALP to know the nutritional status of buffaloes. Estrus was recorded in 83.33%, 91.67%, and 35% in mineral supplemented, GnRH treated, and non-treated (control) buffaloes, respectively. Estrus was significantly ($P<0.05$) higher in mineral supplemented and GnRH treated buffaloes than the control group. Conception rates were significantly ($P<0.05$) higher in mineral supplemented (70.83%) and GnRH treated buffaloes (83.33%) than the control group (30%). Calving rates were also significantly ($P<0.05$) higher in the mineral

supplemented group (65.83%) and estrus synchronized buffaloes (77.78%) than the control group (30% buffaloes). Glucose, albumin, TG, and cholesterol levels were significantly ($P<0.05$) higher in the mineral supplemented and estrous-synchronized groups than in the control group. In experiment 3, the buffalo cows (n=42) of second to fifth parity with a good body condition score were selected for estrus synchronization at Companiganj, Noakhali. Buffaloes were randomly assigned to one of the three different groups. Buffaloes from group 1 (n=13), group 2 (n=21) and group 3 (n=8) were inseminated at 16, 20, and 24 hours after administration of the second dose of GnRH, respectively. The results showed that conception rates were higher in group 1 (83.33%) than in group 2 (74.17%) and group 3 (53.33%). In conclusion, reproductive efficiencies of estrus- synchronized native buffaloes were influenced by season, blood metabolites, mineral supplementation, and the time of insemination, followed by a second dose of GnRH treatment. Further study will be conducted to examine the interaction between season and dietary protein levels in estrus-synchronized native buffaloes of Bangladesh.

Optimizing the process technology of manufacturing value added diversified buffalo milk cheese and rasomalai based on their nutritional and physicochemical profile

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Executive Summary

Milk and milk products are known for their nutritional profile, however, lack in dietary fiber and very poor source of omega-3 fatty acids. Dietary manipulation of cow and buffalo has very lesser to do with the omega-3 fatty acid content of the milk. Nowadays, consumers make their choice not only based of their taste but also consider the nutrient he/she going to have thorough a particular food item. Therefore, the present study was designed to - develop the manufacturing technology/SOP of diversified value added cheese from buffalo milk with improved texture, flavor and nutritional profile; cultivate the suitable manufacturing technology/SOP of fiber and healthy fat fortified value added buffalo milk rasomalai; monitor the shelf-life of diversified value added buffalo milk cheese and rasomalai and record the cost of production of different value added buffalo milk cheese and rasomalai. The project duration is March 2022 to June 2025 and conducting site is Laboratory of Dairy Chemistry and Technology, Department of Dairy Science, Bangladesh Agricultural University, Mymensingh-2202.

Figure 1: Activities related with the fiber fortified *rasomalai* manufacturing and quality assessment

The purchase of few of the laboratory instruments has been completed. With regards to cheese fortification with fiber, first we were tuning the method for process cheese manufacturing in general. So far we did 21 trials with various different ingredients and considering the taste, color, flavor and texture. Finally, we choose a blend of cheddar cheese, buffalo milk curd, buffalo milk cream, skim milk powder, carrot, water salt and tri-Na-citrate. Now the final trials will be conducted and required lab tests will be done on it to elucidate the quality aspects of the product. The work on *rasomalai* is illustrated in Figure 1.

In the carrot added *rasomalai*, 0, 3, 6 and 9% carrot was added with the *rasomalai*. With the increased addition of carrot cause a decrease in fat (10 to 7%), protein (14 to 13%) and total solids (49 to 40%) content of the *rasomalai* but increase the fiber content (0 to 5%). The results were also somewhat similar in the case of date added (@ same rate as of carrot addition) *rasomalai* as well. The addition of date caused 4 and 7% reduction in the fat and total solids, respectively and 2% increase in the fiber content of the product. A different level of *chia* seeds were also used in the manufacture of *rasomalai viz.* 0, 1, 2 and 3%. Fat, protein (2% increment in each) and total solids (7% more) content along with the fiber (2% higher) content were increased with the increased level of the chia seed.

Table 1: Changes in the color profile of the *rasomalai* due to added carrot, date and *chia* seed.

Sample	*Colour* Parameter	0%	3%	6%	9%	p-Value
Carrot	Lightness (L)	92.27±4.43	96.11±1.34	90.05±5.68	95.51±0.57	0.225
	Redness (a*)	-3.00±0.941	-2.90±1.35	-0.80±1.83	-0.88±0.73	0.116
	Yellowness (b*)	11.31^{b}±1.65	34.26^{ab}±11.16	45.24^{a}±13.67	48.63^{a}±3.66	0.004
Date	Lightness (L)	94.69^{a}± 1.58	81.03^{b}± 3.97	80.64^{b}± 1.94	80.36^{b}±0.77	0.000
	Redness (a*)	-3.46^{b}±0.42	1.83^{a}±1.49	4.41^{a}±1.29	4.64^{a}±1.13	0.000
	Yellowness (b*)	12.69±0.49	13.93± 5.79	20.75±1.08	21.28±1.21	0.015
		0%	**1%**	**2%**	**3%**	
Chia	Lightness (L)	99.33^{a}±2.26	86.56^{b}±0.77	84.66^{b}±1.77	78.28^{c}±4.41	0.000
	Redness (a*)	-3.01^{b}±0.68	-0.84^{a}±0.78	-1.03^{a}±0.76	-0.48^{a}±0.65	0.011
	Yellowness (b*)	8.15±1.00	16.13±3.98	13.44±4.97	14.32±2.84	0.106

Color profile of a product is important from consumer's point of view. The results on color profile are summarized in Table 1. With the increased level of added *chia* seed, the products become dark and there is a significant shift from green to red ($p<0.05$) but no variation was observed in case of blue to yellow axis of the color profile. The lightness of the product were also reduced with the increased addition of date ($p=0.000$) but showed similar lightness in case of carrot added *rasomalai* ($P>0.05$). Addition of carrot caused a non-significant reduction in redness but significant increase in the yellowness of the product. However, date caused a significant increase in both the redness and yellowness of the prepared *rasomalai*. The addition of 3% carrot and 3% date separately in *rasomalai* resulted in significantly ($p<0.05$) higher taste and flavor score (8.7 on 9.0) but *chia* addition did not cause any variation in this regard. All other attributes remained unaffected ($p>0.05$) in all three types (carrot, date and chia added) of *rasomalai*. In case of descriptive sensorial assessment, the 9% addition of carrot and date separately gave a significantly ($p<0.05$) higher bitterness and date flavor, respectively in the *rasomalai* and chia flavor in 3% chia seed added *rasomalai* was detected. All other variables in all types (carrot, date and chi added) of *rasomalai* were found statistically similar except texture and consistency in carrot added *rasomalai*. Though a higher yield (7% more) was obtained with the higher chia seed levels (2 and 3%) but tends to reduce the profit margin (BDT 50/kg less). The yield percentage showed a very little variation with a positive drift (44 – 46%) with the increased addition of carrot and date. In response, the profit margin of carrot added *rasomalai* varied within a reasonably similar range (BDT 2 – 4/kg less than the 0% carrot added *rasomalai*) but BDT 50/kg less in case of dates added *rasomalai* due to the high price of the dates.

Considering all qualitative and quantitative data including cost of production and profit margin, 3% carrot and 3% dates and 2% *chia* seed in *rasomalai* preparation was found better. Now the work on the omega-3 fatty acid fortification is ongoing. After finding the suitable level, product with both the dietary fiber and omega-3fatty acids will be prepared. The works on processed cheese are also on its way to elucidate the impact of fortification with fiber and omega-3 fatty acids. The manufacturing SOP will be fine-tuned and a leaflet will be published. Two MS thesis has already been produced on *rasomalai* and two on processed cheese will be submitted soon. The scientific manuscripts are under preparation, to be submitted in reputed journals.

Assessing the effect of postbiotics of lactic acid bacteria on improving the safety and quality of broiler meat

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Executive summary

Microbial degradation of meat impairs its hygienic quality and causes problems with human health. Recent research has focused on probiotic lactic acid bacteria (LAB) and their bioactive metabolites, or postbiotics, that can prevent meat deterioration and illness caused by multidrug-resistant pathogens. In the recent years, bacteriocins, or bacteriocin-like inhibitory substances (BLIS), in postbiotics of deferment stains of *Lactobacillus* and *Bifidobacterium* have shown potential as antibiotic alternatives to inhibit several pathogens in meat and meat products. Due to this, a substantial study is needed to screen and find new economically important LAB strains that can produce postbiotics with bacteriocins, or BLIS. Thus, the objective of the current research was to screen and identify the BLIS-producing LAB of five commercial species and strains and characterize the antimicrobial potentials of the BLIS produced. The information obtained from this study could suggest that the potential of these strains with antagonistic effects might lead to the exploration of some novel antimicrobial substances for meat bio-preservation. The antimicrobial activity of five commercially available probiotic LAB of *L. plantarum (NBRC 3070), L. acidophilus (ATCC 4356), L. casei (ATCC 393), L. rhamnosus GG (ATCC 53103), and Bifidobacterium animalis (ATCC 27673)* was tested against seven (07) indicator bacterial strains of *E. coli* ATCC 25922, *S. typhimurium* ATCC 14028, *Staph. aureus* ATCC 43300, *Sh. Sonnei* ATCC 25931, *P. aeruginosa* ATCC 10145, *Ser. marcescens* ATCC 14756 and *B. cereus* ATCC 14579. Before usage, the LABs and pathogens were reactivated in De Man, Rogosa and Sharpe (MRS) and Luria Bertani (LB) broth by incubating aerobically for 24 hours at 28°C to 37°C for three times. Finally, LABs and pathogens were cultured overnight until their cell densities were adjusted for 0.42-0.47 and 0.24-0.28 at DO_{600nm}, respectively. The bacterial whole cultures (WBC), cell-free supernatant (CFS), neutralized CFS (NCFS), and lyophilized CFS produced from LAB strains were used in the experiment to determine antibacterial activity by agar-well diffusion (AWDA) and broth microdilution assay. The lyophilized NCFS was enzymatically characterized to verify its proteinaceous nature after confirming the existence of bacteriocin or BLIS in CFS of LAB strains. The quantification of bacteriocins or BLIS activity (AU/ml) and minimum inhibitory concentrations (MICs) in lyophilized CFS from LAB strains against six indicator bacteria were determined using the two-fold serial dilution method. The antibacterial compounds in CFS were assessed and compared with fresh CFS after 15 and 30 days of storage at 4 ^{0}C and -20 ^{0}C. Protein concentrations were determined using the Bradford method, while lactic acid and hydrogen peroxide concentrations were determined using the titration method. Statistical analysis was performed using Duncan test (DMRT) for comparison, with IBM SPSS Statistics 25 software program where probability ($P < 0.05$) was considered as statistically significant.

The results showed that all five LAB strains tested for antimicrobial substances were antagonistic to indicator bacteria. Like LAB whole bacterial cells, antimicrobial compounds in CFS from LAB strains inhibited indicator bacteria in zones 14.75 to 23.67 mm (Table 1). The studied LAB strains are "extremely sensitive microorganisms" to pathogens, with an inhibition zone above 20 mm. *L. plantarum* displayed the strongest antibacterial spectrum, followed by *L. casei, L. rhamnosus GG*, and *Bifidobacterium animalis*, which was more sensitive to *E. coli* and *Ser. marcescens*. *Shigella sonnei* was the least sensitive to all LAB strains. Antimicrobial activity varied from 80-640 AU/ml with MICs of 25-3.12 mg/ml against pathogenic bacteria. *L. rhamnosus GG* produced active antimicrobial substances (160-640 AU/ml) with the lowest MIC (3.12-12.5 mg/ml), while *S. typhimurium* was more sensitive (640 AU/ml) with less MIC (3.12-6.25 mg/ml) values. *L.*

rhamnosus GG produced active antimicrobial substances (160-640 AU/ml) with the lowest MIC (3.12-12.5 mg/ml), while *S. typhimurium* was more sensitive (640 AU/ml) with less MIC (3.12-6.25 mg/ml) values.

Table 1: The inhibition zones of CFS obtained from LAB strains against selected pathogenic microorganisms for 24 h using a well diffusion assay.

Indicators	LAB Strains					SEM	P-value
	LP	LA	LC	LR	BA		
E. coli	23.67^{aA}	19.75^{bB}	23.00^{aA}	22.83^{aA}	22.98^{aA}	0.443	0.000
S. typhimurium	22.58^{aB}	17.67^{bcC}	18.50^{bC}	17.92^{bcC}	16.75^{cC}	0.195	0.001
S. aureus	20.25^{aC}	19.42^{bB}	20.42^{aB}	20.67^{aBC}	14.75^{cE}	0.557	0.000
Sh. Sonnei	17.50^{aF}	17.75^{aC}	15.00^{cD}	16.00^{bcD}	15.50^{bcDE}	0.279	0.001
P. aeruginosa	19.42^{aD}	17.50^{bC}	18.58^{aC}	17.75^{bCD}	15.83^{cCDE}	0.351	0.000
Ser. marcescens	22.75^{aB}	21.50^{bA}	20.09^{cB}	21.17^{bcB}	21.17^{bcB}	0.268	0.008
B. cereus	19.50^{aE}	18.08^{bC}	18.67^{abC}	17.50^{cCD}	16.17^{dCD}	0.281	0.006
SEM	0.522	0.313	0.508	0.579	0.727		
P-value	0.000	0.000	0.000	0.000	0.000		

LP, *L. plantarum;* LA, *L. acidophilus;* LC, *L. casei;* LR, *L. rhamnosus* GG; BA, *Bifidobacterium animalis;* Values are presented as the mean ± standard deviation (SD) (n = 3, P < 0.05); Uppercase letters (A, B, C, D) in different column represent significant difference among different indicator bacteria in each LAB strains; Lowercase letters (a, b, c) in different row represent statistically significant difference among different LAB strains within each indicator bacteria (n = 3, P < 0.05, Duncan's test).

The inhibitory activity of LAB metabolites was observed within 4 h of incubation with 12-15% inhibition when incubated at 30°C and 37°C. The maximum production of active substances was reached in 20-36 h of incubation at 37°C or 30°C. All LAB strains had highest bacteriocin activity during the optimal incubation duration (24 h at 37°C and 36 h at 30°C) with the lowest pH values, mostly due to intracellularly trapped or attached cell membranes. However, increased incubation temperature (37°C) accelerated bacterial cell growth, but increased substance activity did not correlate with prolonged cell growth. After eliminating the effects of organic acid and H_2O_2, the lyophilized CFS containing BLIS from *L. plantarum, L acidophilus, L. casei, and L. rhamnosus GG* strains showed inhibitory activity against all seven pathogens tested, suggesting the inhibitory effects are due to bacteriocin or BLIS. Though *S. typhimurium*, *Stap. aureus*, *Ser. marcescens*, and *Bacillus cereus* among the seven pathogens were found to be more sensitive to bacteriocin or BLIS. Besides, in all seven investigated indicators, BLIS from *L acidophilus* (13.75 to 17 m) showed the most activity, followed by *L. plantarum* (12 to 14.5 mm). However, digestion of lyophilized NCFS with trypsin and pepsin showed reduced activity, confirming the proteinaceous nature of bacteriocins or BLIS. When held at -20°C as compared to 4°C, the bacteriocins, or BLIS, in CFS showed greater antimicrobial stability; nevertheless, stability did not change significantly within a month. A noticeably high concentration of metabolites (mg/ml) were found in the recovered CFSs in this investigation, ranging from 0.010 to 6.010 lactic acid; 0.091 to 0.330 protein and 0.003 to 0.037 hydrogen peroxide (H_2O_2). A significant increase (P> 0.05) in lactic acid and protein was observed in the lyophilized CFS than liquid CFS. The variability of individual bacterial CFS constituents appears to be related to bacterial types and strains, analytical methods, and the nature of CFSs. The results also indicating that the loss of water molecules at high liquid-H_2O interfaces leads to a decrease in H_2O_2 content, with some lower molecules leaking during concentration.

In conclusion, the study found that *L. plantarum, L acidophilus, L. casei,* and *L. rhamnosus* GG are the best producers of bacteriocin-like inhibitory substances with potent antibacterial activity. These strains exhibited high antimicrobial activity at low concentrations, good storage stability, and could be produced under optimal fermentation conditions. This suggests that screening lactic acid bacteria for BLIS production is a promising approach for finding natural preservatives with strong antibacterial properties.

Production of beta-cyclodextrin for the development of low cholesterol milk and milk products

Sub-title: Effect of different levels of beta-cyclodextrin on the composition and cholesterol contents of milk

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Executive summary

Milk, which contains a smaller amount of cholesterol than cream is nutritionally beneficial for human. However, cholesterol-free milk would be desirable for those suffering from cardiac diseases such as hypertension and arteriosclerosis. Cholesterol-free milk can also be used as a material for the production of cholesterol-free ghee, cheese, yogurt etc. The beta cyclodextrin (β-CD), a cyclic oligosaccharide consisting of 7 glucose units, can easily absorb cholesterol at temperatures 4-8°C. β-CD is non-toxic and completely metabolized by the colon microflora. Therefore, the present study was undertaken to evaluate the effect of different inclusion level of β-CDs on the separation of cholesterol from milk; to produce β-CD from different starch materials & to develop the protocol for the production of low cholesterol milk and milk products. In 2022-23, a total of four activities were conducted including (1) separation of cholesterol from milk using β-CD, (2) development the method for the determination of cholesterol contents in milk, (3) determination of milk composition before and after treatment with β-CD and isolation of Cyclodextrin glucanotransferase (CGTase) enzyme producing bacteria from soil. In activity-1, a total of 45 milk samples (15 samples from each of raw milk, pasteurized, pasteurized and homogenized milk) were collected and treated with β-CD at different inclusion levels using five replications for each. The total inclusion level/treatment were 4 such as T_0 (control), $T_{0.5}$ (0.5% of β-CD), $T_{1.0}$ (1.0% of β-CD), $T_{1.5}$ (1.5% of β-CD) and $T_{2.0}$ (2.0% of β-CD). In activity-2, cholesterol content of milk was determined both before and after treatment with β-CD by using spectrophotometer. In spectrophotometer, calibration curve was made with five standard concentrations (2, 10, 20, 40 and 70 ppm) and maximum absorbance was monitored in the range of 350-550 nm with a standard concentration of 400 ppm. In activity-3, nutrient composition of milk was measured with the help of Funky Gerber and Lactoscan (Bulgeria) machine. In activity-4, a total of 9 soil samples were collected. Initially, the desired colonies were identified by Gram staining and spore staining and then sub-cultured. The soil samples were prepared by tenfold of serial dilution and subjected to heat treatment for 10 minutes in a water bath at 80°C. Pure microbial colonies were separated through repeated and successive screening of colonies by using Luria Bertani agar media. The isolates were examined for their colony and cell morphology, motility, Gram staining and standard biochemical tests (catalase, oxidase, nitrate reduction, methyl red reaction, acetoin production, citrate utilization by Simmon's), urease activity, indole production, hydrolysis of casein, gelatin, starch, arginine, and carboxyl methyl cellulose using Bergey's manual**.** In activity-1, cholesterol contents of milk were precipitated by using β-CD and after separation of precipitated portion, the cholesterol contents of the samples were found significantly different among the treatments ($p<0.05$). Cholesterol contents were reduced up to 38.44, 52.34, 58.36 & 73.09 in raw milk, 39.4, 54.59, 65.73 & 75.91% in pasteurized milk, and 41.97, 55.11, 65.69 & 79.42% in homogenized milk sample at the inclusion level of 0.5, 1.0, 1.5 and 2.0% of beta cyclodextrin respectively (Figure 1). During cholesterol analysis in spectrophotometer, maximus absorbance (λ_{max}) was found at 420 nm. Correlation coefficient (r) of absorbance and standard concentration was 0.998 for the calibration curve (Figure 2). In β-CD treated milk, fat, SNF, protein, lactose & mineral contents were found almost similar to the untreated milk (Table 2), while only TS content was found statistically higher than the later one ($p<0.05$). The higher total solid contents in β-CD treated milk might be due to the hydrophobic nature of β-CD. However, no change was observed in color, flavor, taste and smell of β-CD treated milk compared to that of untreated milk.

Table 1. Cholesterol concentration in milk after treatment with β-CD

Sample	Concentration (mg/L)					SEM	P value
	T_0	$T_{0.5}$	$T_{1.0}$	$T_{1.5}$	$T_{2.0}$		
Raw milk	219.3[a]	135.0[b]	104.5[c]	91.30[c]	59.00[d]	4.43	<0.001
Pasteurized milk	199.67[a]	121.0[b]	90.67[c]	79.60[d]	61.00[e]	3.45	<0.001
Homogenized milk	182.67[a]	106.0[b]	82.00[c]	62.67[c]	37.60[d]	3.74	<0.001

*T_0, $T_{0.5}$, $T_{1.0}$, $T_{1.5}$ & $T_{2.0}$ indicate 0, 0.5, 1.0, 1.5 & 2.0% inclusion rate of β-CD respectively; values with different superscripts are significantly different at p<0.050, comparisons are within columns.

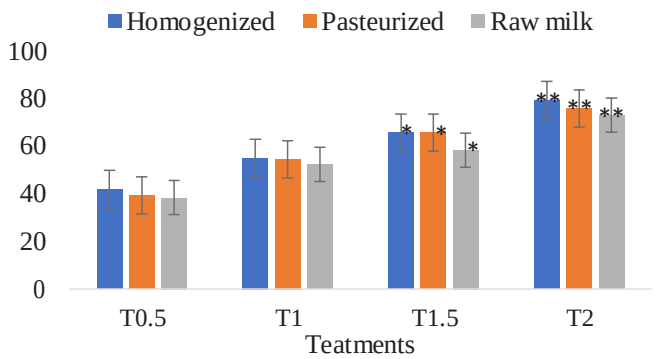

Fig 1. Cholesterol reduction (%) of milk at different treatment.
(*) = 5%, (**) =1% level of significance

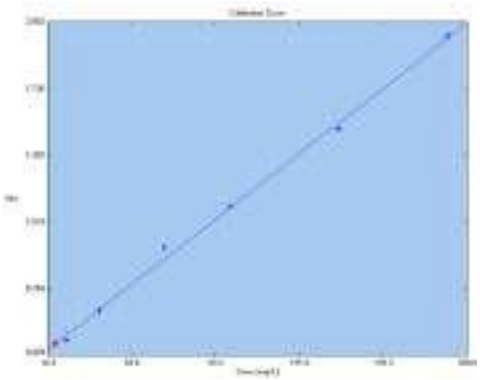

Fig 2. Calibration curve during cholesterol analysis in spectrophotometer

Table 2. Composition of milk after treatment with beta cyclodextrin at different inclusion level

Parameters	Concentration (mg/L)					SEM	P value
	T_0	$T_{0.5}$	$T_{1.0}$	$T_{1.5}$	$T_{2.0}$		
Fat (%)	4.31	4.32	4.35	4.34	4.34	0.009	0.06
Solids not fat (%)	8.05	8.08	8.12	8.13	8.18	0.036	0.19
TS (%)	12.36[c]	12.40[c]	12.47[ab]	12.47[ab]	12.52[a]	0.030	0.03
Protein (%)	2.76	2.80	2.79	2.81	2.79	0.021	0.47
Lactose (%)	4.73	4.71	4.72	4.74	4.72	0.026	0.93
Salt (%)	0.65	0.63	0.63	0.663	0.63	0.010	0.56

*T_0, $T_{0.5}$, $T_{1.0}$, $T_{1.5}$ & $T_{2.0}$ indicate 0, 0.5, 1.0, 1.5 & 2.0% inclusion rate of β-CD respectively; values with different superscripts are significantly different at p<0.050, comparisons are within columns.

In activity-4, a total seven (7) colonies were isolated as *Bacillus sp*. based on their morphology and biochemical tests. The colonies were of different sizes such as small, medium and large. They were appeared to be flat, circular or irregular edges, opaque, moist, white or greyish white in color. In spore staining, all the isolates had central endospores, vegetative cells were pink and spores were green in color. After Gram staining and microscopic examination, it was observed that the isolates were Gram positive as purple color rods. Biochemical analysis revealed that all the seven isolates showed positives results for Catalase, Motility, Urease and Oxidase tests.

The study concluded that cholesterol contents of milk were precipitated by using β-CD and efficiency of cholesterol reduction from milk was found highest at inclusion rate of 2% (w/v). On the other hand, seven pure colonies of CGTase producing bacteria (*Bacillus sp.*) were isolated from soil based on morphology and biochemical tests, but for further confirmation isolates are being analyzed for 16S rRNA gene sequencing.

SNP Analysis and Gene Expression Profiling for Milk Fat and Protein Related Traits in River Buffalo Populations of Bangladesh

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Executive Summary

River buffalo is an important livestock species distributed in the river basins and coastal regions of Bangladesh. It is the second most livestock in Bangladesh, supplying milk for human consumption. Buffalo milk has specific physiochemical and taste characteristics. Buffalo milk contains higher fat, protein, lactose, vitamin and mineral as compared to cow's milk. The thicker consistency and white in color make it suitable as one of the perfect raw materials for the manufacture of various fat-based dairy products such as butter, ghee, yogurt, cheese and ice cream. Earlier studies reported candidate genes polymorphisms and their associations with buffalo milk composition, more particularly with milk fat, protein and solids not fat (SNF). Therefore, molecular marker-assisted selection followed with appropriate breeding methods can accelerate the genetic gain for better milk composition in buffalo. Considering the above stated circumstances, one of the main objectives was to investigate polymorphisms in several candidate genes and their association with milk fat and protein related traits in river buffalo of Bangladesh. Accordingly, phenotypic database on morphology, morphometry, milk production and milk composition related traits were established through Herdbook based record keeping system. Data were collected from 239 lactating animals from six different locations namely Madarganj, Jamalpur; Ishwardi, Pabna; Godagari, Rajshahi; Buffalo Breeding and Development Farm, Bagerhat; Milk Vita Buffalo Farm, Laxmipur and BLRI, Savar, Dhaka. Milk composition data (milk fat, protein and SNF) were generated using a portable Lactoscan milk analyzer. Besides, a total of 242 blood samples were collected from the recorded animals from six different regions. Genomic DNA extraction was performed using commercial kit (ADDBIO INC, Daejeon, South Korea). One or two fragments of three well annotated candidate genes (PPARGC1A, FASN and DGAT1) were selected for milk fat and protein related association studies. Accordingly, five primer pairs were used for PCR amplification and sequencing of the gene fragments [Amplicon size: FASN (660 bp), DGAT1 (330 and 230 bp) and PPARGC1A (724 and 789 bp)]. PCR amplification was carried out in a 20 µl reaction comprising 1.5 µl of genomic DNA, 10 µl of 2× master mix (ADDBIO INC., Daejeon, Republic of Korea), 2.0 µl of each primer (10pmol/µl) and 4.0 µl deionized water. The PCR thermal profiles are initial denaturation for 10 min at 95°C; 35 cycles of denaturation at 95°C for 30 sec, annealing at 60~62°C for 45 sec, extension step at 72°C for 1 min with a final extension at 72°C for 10 min. Single marker association analysis was performed using mixed model equation where SNP genotype, location and management system considered as fixed effects.

Multiple sequence analysis revealed 11 single nucleotide polymorphisms (SNPs) in the fragments of three candidate genes. Among them, two SNPs were identified in the FASN gene (g.7163G>A and g.7271C>T), two were in DGAT1 gene (g.7809C>T and g.8525C>T) and the remaining seven SNPs were in PPARGC1A gene (g.387642T>C, g.387714G>A, g.387758A>G, g.387966A>T, g.409354A>G, g.409452G>A and g.409614C>T). All identified SNPs were located in the exon regions except g.7163G>A SNP of FASN gene which is located in intron region. Genotypic and allelic frequencies deviated significantly from HWE for all of the investigated SNPs that depicted assortative mating and selection have been exerted in the studied populations. The genotype and allele frequencies of three SNPs (one SNP from each gene) are illustrate below as for example. The frequencies of GG, GA and AA genotypes were 0.49, 0.46 and 0.06 for g.7163G>A SNP of FASN gene and the corresponding allele frequencies were 0.72 and 0.28 for G and A alleles, respectively. In case of g.7809C>T SNP of DGAT1 gene, the frequencies were 0.42, 0.42 and 0.17 for CC, CT and TT genotypes, and 0.62 and 0.38 for C and T alleles, respectively. The g.387758A>G SNP of PPARGC1A gene resulted 3 genotypes with frequencies 0.41 (AA), 0.52 (AG) and 0.07 (GG), respectively. Association analysis revealed that the

g.7271C>T SNP of FASN gene had significant association with milk fat (P<0.05). The average milk fat of CC, CT and TT genotypes was 8.38±0.30, 7.92±0.37 and 9.64±0.71, respectively. The g.7809C>T SNP of DGAT1 gene was highly significant with SNF of the investigated buffalo milk samples (P<0.01) where the SNF% of CC, CT and TT genotypes were 9.73±0.20, 9.60±0.13 and 10.08±0.27, respectively.

Moreover, three SNPs g.387758A>G, g.409354A>G and g.409614C>T of PPARGC1A gene had significant association with protein (P<0.01), protein (P<0.001) and SNF (P<0.05), and fat (P<0.05) and SNF (P<0.05) content of milk. For example, the average protein content of AA, AG and GG genotypes of g.387758A>G SNP was 3.45±0.69, 3.40±0.62 and 4.07±1.82, respectively. In conclusion, the identified significantly associated SNPs could be used as potential molecular marker(s) for improving milk composition traits in river buffalo of Bangladesh upon validation of the results with large number of samples.

Unlocking the microbial diversity in artisanal 'Buffalo Milk Curd' to formulate probiotic based bio-functional starter culture towards developing healthy Dahi

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Executive Summary

Buffalo milk constitutes 12% of global milk production and is the second most consumed type after cow's milk. In Bangladesh, artisanal fermented dairy product, 'Buffalo Milk Curd,' is made from raw buffalo milk at cottage level in coastal areas. Traditional dairy products like this curd are considered as a potent niche of probiotics and valuable metabolites. Understanding the microbial and biochemical changes in artisanal fermented products is the first step towards developing technologies for their safety and quality improvement. Therefore, the proposed study was designed to disclose the microbial communities present in this artisanal product and also to formulate a probiotic based value-added dahi. During the fiscal year 2022-23, the project aimed to commence sample collection for microbial diversity analysis as well as isolation and identification of probiotic potent bacteria. Samples of 'Buffalo Milk Curd' were collected from Char Fasson (n=6) and Companiganj (n=4) Upazila of Bhola and Noakhali districts, respectively during the pre-monsoon season. Soon after the preparation, the curd and corresponding milk samples were mixed properly onsite and transported to the laboratory with maintaining cool chain. For metagenomic analysis, the DNA was extracted from each sample and preserved at -20°C after being pooled in triplicate based on the two collection areas. The collected samples from each area were further pooled and analyzed for enumerating mesophilic group bacteria (both aerobic and anaerobic), total anaerobic bacteria, lactococci, lactobacilli (both aerobic and anaerobic), leuconostocs, Enterobacteria and coliforms, yeasts and molds, and bifidobacteria using different selective medium. After incubation, viable cells of each group bacteria were counted. The pure isolates were obtained from randomly selected colonies and preserved at -80°C for further analysis. The molecular identification of pure isolates was carried out by partial 16S rRNA gene analysis. The identified strains were tested for three different types of in vitro probiotic potential including survival against bile and simulated gastric condition and antimicrobial competence against *Salmonella* sp. The safety of the isolates was confirmed by conducting antibiotic resistance profile and hemolysis characteristics. The bacterial strains were also investigated for their bio-active properties such as antioxidant and exopolysaccharide production ability. The antioxidant activity was carried out by three different methods (DPPH, ABTS, and FRAP). The exopolysaccharide from each strain was extracted from cell-free supernatant using the ethanol precipitation method and quantified by phenol sulfuric acid method. Additionally, the whole genome sequencing of three promising strains was carried out.

The analysis of various bacterial groups in the collected samples from Bhola and Noakhali indicated no significant differences between the two regions. The enumeration results showed that both aerobic (at 10.9 log cfu/g) and anaerobic (at 11.0 log cfu/g) mesophilic bacteria, as well as aerobic (at 11.2 log cfu/g) and anaerobic (at 11.1 log cfu/g) lactobacilli, were dominated by a different category of bacteria. Furthermore, another dominant group of bacteria prevalent in the curd samples was total anaerobic count, which measured at 11.2 log cfu/g. Enterobacteria and coliforms were found at 5.8 log cfu/g and 4.4 log cfu/g, respectively. Additionally, the viable cell numbers of lactococci and leuconostocs were recorded at 6.3 log cfu/g and 7.9 log cfu/g, respectively. These findings suggest a complex microbial composition in the curd samples, with the existence of specific bacterial groups. A total of 85 pure isolates from different bacterial groups were obtained during the study period. Of these pure isolates, 35 from presumptive leuconostocs group and 20 from lactobacilli group were identified by partial 16S rRNA gene sequencing. The resulting nucleotide sequences were compared to similar sequences found in GenBank database using the Basic Local Alignment Search Tool (BLAST) to determine the species of the bacteria. The majority of the isolates, constituting 77.14%

(27 out of 35 isolates), were identified as *Leuconostoc citreum*. A smaller portion, 5.71% (2 out of 35 isolates), belonged to the species *Leuconostoc holzapfelii*. Additionally, 17.14% (6 out of 35 isolates) of the leuconostocs group were identified as *Leuconostoc mesenteroides*. In the lactobacilli group, the majority of the isolates, accounting for 65% (13 out of 20 isolates), were identified as *Limosilactobacillus reuteri*. The remaining 35% (7 out of 20 isolates) of the lactobacilli group were classified as *Ligilactobacillus salivarius*. These findings provide a clear understanding of the specific species composition within both the leuconostocs and lactobacilli groups, highlighting the diversity present in these bacterial populations. Ten randomly selected *Leuconostoc* strains and ten *Limosilactobacillus* strains were examined for their in vitro probiotic potential as well as their safety, and bioactive properties. All the tested *Leuconostoc* strains exhibited varying degrees of inhibition against *Salmonella* sp., resulting in inhibitory zone diameters ranging from 8 to 15 mm. Similarly, the growth inhibition of *Salmonella* sp. displayed isolate-dependent variability, spanning from 18.2 to 55.6%. In contrast to the *Leuconostoc* strains, the *Limosilactobacillus* strains displayed a notable inhibitory zone, with the highest inhibitory zone of 20 mm. However, it is worth noting that three specific strains within the *Limosilactobacillus* strains did not exhibit any inhibitory zone against the tested pathogen, indicating a variation in the antimicrobial activity within these bacterial strains. A similar trend was observed in the growth inhibition assay, with inhibition percentages ranging from 6.8% to 67.4%. The study revealed that five *Limosilactobacillus* strains and four *Leuconostoc* strains exhibited remarkable resilience, with over 50% survival rates in simulated gastric and intestinal conditions, as well as in the presence of bile salt. The average viable cell count at 0 h was 8.1±0.8 log cfu/ml. These results are indicative of the strains' ability to withstand the harsh acidic environment of the stomach and the subsequent conditions of the intestines, essential traits for potential probiotics. Neither of the *Limosilactobacillus* and *Leuconostoc* strains was able to hydrolyze sheep blood, indicating that these strains are nonhemolytic. All the ten *Leuconostoc* strains displayed resistance to nalidixic acid, penicillin G, and vancomycin, indicating their resilience against these antibiotics. Conversely, they were susceptible to erythromycin and tetracycline, suggesting these antibiotics could effectively inhibit the growth of *Leuconostoc* strains. The inhibition zone diameters varied significantly among the *Leuconostoc* strains, ranging from 6 to 23 mm. This variation suggests diversity in their response to antibiotics, with some strains being more susceptible than others. In the case of *Limosilactobacillus* strains, their sensitivity to the tested antibiotics exhibited a broader range, with inhibition zone diameters spanning from 15 to 27 mm. This variability implies differences in their susceptibility to antibiotic. However, it is noteworthy that these *Limosilactobacillus* strains displayed resistance against gentamicin and, to some extent, neomycin. This resistance suggests that these bacterial strains have developed mechanisms to withstand the effects of these antibiotics. The radical scavenging activity of all the tested strains exceeded 50% in the DPPH assay, ranged from 18 to 62% in the ABTS assay, and fell between 26% and 67% in the FRAP assay. Furthermore, the exopolysaccharide production by all the *Leuconostoc* strains were higher (ranged from 342 to 686 g/L) than that of *Limosilactobacillus* strains (ranged from 128 to 408 g/L) indicating bioactive potential of these tested strains. Additionally, three strains belonged to three different species, *Leuconostoc citreum*, *Leuconostoc holzapfelii* and *Leuconostoc mesenteroides* were subjected to the whole genome sequencing. The sequencing result generated different results than that of 16S rRNA. Except *Leuconostoc citreum*, the *Leuconostoc holzapfelii* was identified as *Leuconostoc citreum* and the *Leuconostoc mesenteroides* was identified as *Leuconostoc falkenbergense*, highlighting the complexity of bacterial identification. The whole genome sequence of these three strains already received accession from GenBank (JAVUPW000000000, JAVUPX000000000 and JAVUPV000000000). It is noteworthy that *Leuconostoc falkenbergense* has recently (2020) been identified as a novel species of *Leuconostoc*.

The traditional buffalo milk curd showed consistent dominance of lactic acid bacteria, indicating no regional differences. The curd harbored diverse beneficial bacteria, including *Leuconostoc* and *Limosilactobacillus* strains. The strains exhibited varying levels of probiotic potential as well as bioactive properties. They also identified as safe in terms of hemolytic activity and antibiotic resistance profiles. These features highlight their promising role as probiotics with health-promoting benefits.

Research First

TECHNICAL SESSION:V

NUTRITION, FEEDS AND FEEDING MANAGEMENT

ARRW-2023

Improvement of feeds and fodder for development roughage-based feeding strategy for Dairy and Beef Cattle production

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Executive Summary

The shortage of livestock feeds and the unavailability of balanced rations are the major causes of low productivity of livestock in Bangladesh. Therefore, the present study was undertaken to develop region-based fodder calendar including fodder production system and roughage based low -cost feed. A field survey was conducted in different areas (7 Upazilas namely *Godagari, Nachole, Sirajgonj, Bhanga, Saltha, Patuakhali and Kalapara*) of Bangladesh for collecting the information about existing livestock status, agricultural cropping pattern, available feeds and fodder, feeding practices and manure management system. A total of 30 farmers were selected for surveying from each Upazilas based on animal numbers [small (1-4 animals), medium (5-10 animals), large (>10 animals)] with the help of Department of Livestock Services (DLS). The information about agricultural cropping pattern was collected from respective (Department of Agriculture Extension) DAE office to develop area specific fodder production calendar. The project activity was initiated in the fiscal year 2021 -22 with the collaboration of BLRI and ACDI-VOCA by providing fodder cuttings and training of 82 farmers at the initial stage in Barishal Division. After that, the selected fodder farmers by ACDI-VOCA were supplied fodder cuttings from BLRI headquarter and BLRI regional station (Faridpur, Jashore, and Naikhongchari). Besides these, ACDI - VOCA organized the training at field base among the fodder farmers and entrepreneur and BLRI facilitated the training as resource personnel. Another survey activity was conducted at Barishal division among the farmers who received fodder cutting and training from BLRI and ACDI-VOCA in 2021-22 fiscal years. The results of field survey indicate that, the cattle farmers do not follow a standard feeding system due to lack of information on the nutrient composition of feed ingredients and scientific knowledge to formulate balanced rations to satisfy the nutrient requirements of dairy and beef cattle. The identified available local grass and legumes in study area is present in Table 1.

Table 1: Identified available local grass and legumes in different study areas

Parameters	Godagari	Nachole	Sirajganj	Patuakhali	Kalapara	Bhanga	Saltha
Local grass	Jawna, Durba, Motha, Shyma	Uri Dal, Dhan Mayna, Shyma, Durba, Motha, Bashpata, Binnah	Durba, Shyma, Water hyacinth	Bottle grass, Paccha, Chauchra, Hechi grass, Rana, Jangra, kolmi	Bottle grass, Hechi grass, Jangra, Kolmi	Hechi, Kalmi, Durba, Dal, Baksha, Malancha	Hechi, Kalmi, Durba, Dal, Baksha, Helencha, Water hyacinth
Legume	Khesari, Gram, Dhaincha, Fellon, Lentil, Maskalai, Mung bean	Maskalai, Khesari, Lentil	Maskalai, Gram, Khesari, Dhaincha, Fellon, Lentil, Mung bean	Khesari, Gram, Mung bean, Maskalai	Khesari, Gram, Mung bean, Maskalai, Dhaincha	Khesari, Gram, Fellon, Groundnut, Soybean, Lentil	Khesari, Gram, Fellon, Soybean, Lentil

The region and season based available feeds and fodder were also identified from the survey. In the Southern part, especially in Barishal, the Mung Bean is cultivated extensively. Keeping this point in view, a study was undertaken to assess the feasibility of Mung bean hay production for animal feeding. A total of 10 farmers were selected of which 5 (five) farmers were considered as control for regular mung bean

grain production and 5 (five) farmers were selected for mung bean hay production. The cost and return analysis of Mung bean pulse and mung bean hay were presented in table 2 and table 3. The Gross Margin and BCR of mung bean hay production group was BDT 109597.85 /ha and 2.04 higher than control pulse production group BDT 63502.02 /ha and 1.18, respectively.

Table 2: Cost of Mung bean cultivation in terms of grain and hay production per hectare

Cost item	Grain production group	Hay production group
Land preparation (Tk/ha)	6800	6800
Labor (Tk/ha)	42000	42000
Seed (Tk/ha)	2000	2000
Fertilizer and insecticides (Tk/ha)	3000	3000
Total Variable Cost (TVC) (Tk/ha)	53800	53800

** Considering 70 labors @600 Tk/ha, 20 kg seed @/100Tk/ha, Fertilizer @2000 Tk/ha and Insecticides @1000 Tk/ha

Table 2: Profitability of Mung bean cultivation in terms of grain and hay production per hectare

Items	Grain production group	Hay production group
Fresh basis total Biomass yield (ton/ha)	1.47	23.1
Average Yield (kg/ha)	1466.28	4668.51
Gross Return (Tk/ha)	117302.02	163397.85
Gross Margin (Tk/ha)	63502.02	109597.85
Benefit Cost Ratio (BCR)	1.18	2.04
Cost of Production (Tk/kg)	36.69	11.52

** Considering 20.21 % DM of fresh mung bean plant, Selling price of mung bean pulse 80 Tk/kg, Price of Mung bean hay 35Tk/kg

The cost of production was also lower in mung bean hay production (11.52 Tk/kg) than mung bean grain production group (36.69 Tk/kg), the CP content of Mung bean whole plant was 17.23%, indicating that the future scope of utilizing mung bean plant as hay for animal feeding. In the fiscal year 2022-23 a total of 2.5 lakh fodder cuttings of BLRI Napier-3, Napier Pakchong, German, Jara, Zamboo and Red Pakchong were distributed at Barisha among the 107 selected farmers covering 3050 decimals land.

A total of 361 (New) farmers started fodder production by getting motivation and fodder cutting support from previous 82 fodder farmers (BLRI provided fodder cuttings support to 82 farmers in 2021-22). It was found that the fodder cultivation land increased by 14.54% or 2.47 times than baseline survey at Barisal Division. Besides these, five types of hybrid Sorghum (Baif Bajra-1 (*Rafter*), Sweet Sorghum (*Sweet Spot*), Sorghum Sudan grass (*Infinity*), Forage Pearl Millet (*Wonder Leaf*), Forage Sorghum (*Fat Boy*) were collected from Lal Teer Seed and cultivated at research farm of BLRI to evaluate the production quantity and quality (Figure-1).

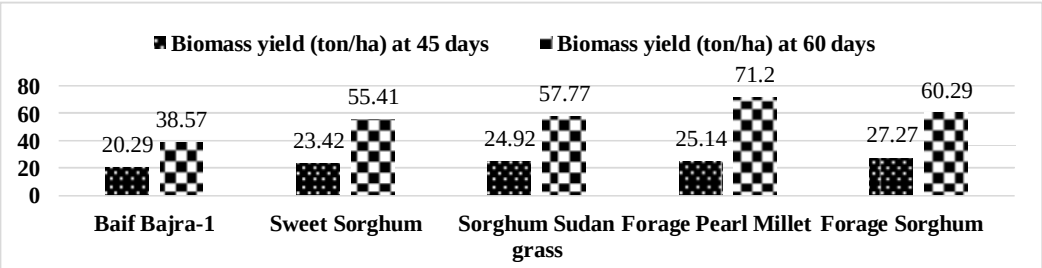

Figure 1: Biomass production (ton/ha)

While the biomass yield of Napier, maize and Jamboo (available in Bangladesh) was 28.67 ton/ha, 28.78 ton/ha and 23.6 ton/ha at 45 days and 55.23 ton/ha, 42.38 ton/ha and 33.43 ton/ha at 60 days, respectively (Hazary et al, 2015 and Rahman et al, 2008). The nutrient composition of the present study is ongoing.

Development of aTMR based Feeding Strategy for Dairy Cattle

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Executive Summary

Dairy cattle feeding practices at smallholder farmers in the country are extremely poor because of the knowledge gap on feeds and fodder and its nutrient composition, the lack of scientific knowledge to formulate a balanced ration and the high feed cost. The low-quality feed may be nutritionally improved through nutritional manipulation and the efficient use of available feed ingredients and expansion through exploring local feed resources are key to develop cost-effective Total Mixed Ration (TMR). TMR is an expedient strategy to overcome the feed shortage of dairy as well as beef cattle by utilizing available feed resources effectively and efficiently, considering different region and season throughout the year. It allows better feed intake, reduces feed wastage, maintains a stable rumen environment and improves the digestibility of animal's resulting improved production performances. Therefore, the present study was undertaken to formulate various composition of TMR using different regional and seasonal feed ingredients and the evaluate nutrient composition, shelf-life and feeding value of the formulated TMR. Locally available feeds and fodder were identified from the Barishal division through a survey activity. High-yielding Napier, German, and dhal fodder and leguminous like Khesari, Gram, Mung bean, and Maskalai are available at the Barishal division. Besides this, farmers use Maskalali, Khesari, Soybean, and Groundnut straw as cattle feed. Mung bean was cultivated at a farmers' field in Dinar village of Barishal Sadar upazila of Barishal district of Barishal division for making hay to use as an ingredient for TMR formulation. Maskalali, Khesari, Soybean, Groundnut straw were bought from farmers for the same purpose. Maize stover was collected from the Rangpur Division of the country. Moringa fodder was taken from BLRI Research Farm and used as ensiling or dry mash or fresh in TMR preparation. Besides this, Soyabean meal, Mustard oil cake, Wheat bran, Maize crush, molasses and DCP which are available at the market throughout the country were used to prepare TMR. Mung bean was cultivated in the Barishal division by negotiating with selected farmers. Other leguminous fodder i.e., Maskalali, Khesari, Soybean, Groundnut were cultivated on farmers land and after harvesting the Mung bean grain, farmers sold the residue of Mung bean at 15Tk/kg, which is named hay. But, after the collection of pulses from plants at the mature stage, the residue may be termed straw because of its low nutrient content (Table-1). The straw residue of Maskalali, Khesari, Soybean, Groundnut straws was collected from southern (Barishal) region for prepering of the TMR of this area. Leguminous fodders were harvested at the pre-flowering stage followed by hay making through sun drying. Besides this, Moringa and other perennial high yielding fodder were allowed for ensiling or used as fresh. After the collection of Mung bean, Moringa, Maskalai, Khesrai, Soybean, Groundnut straw and Maize stover were chopped, grinded or milled. The nutritional composition of different feed ingredients was investigated through chemical analysis and present in Table 1.

Table 1: Chemical composition of different feed ingredients

Name of the feed ingredient's	DM (%)	Ash (%)	CP (%)	CF (%)	NDF (%)	ADF (%)	Lignin (%)
Mung bean hay	91.09	14.66	17.23	29.25	45.65	32.64	7.06
Maskalai straw	84.73	9.68	11.61	38.84	62.02	51.44	13.11
Khesari straw	84.7	7.18	8.46	58.51	80.71	54.59	18.17
Soyabean straw	84.36	7.88	4.38	43.32	79.97	54.54	7.1
Groundnut straw	83.46	19.65	8.35	45.45	70.91	52.51	14.14
Maize stover	83.75	8.96	5.14	45.14	81.98	55.25	18.16
Moringa Mash (dry)	90.73	8.66	16.53	45.94	76.66	53.61	11.06

The highest CP content was observed in Mung bean hay (17.23%) followed by Moringa hay (16.53%). In case of straw of different leguminous fodders, the highest CP was found in Maskalai straw (11.61%) followed by Khesari straw (8.46%) and Groundnut straw (8.35%). However, the lowest CP was 4.38% observed in Soybean straw. After nutritional evaluation of selected feeds and fodder, different formulations of TMR were prepared using the locally available roughage and concentrates at a ratio of 30:70, 60:40 and 45:55 in TMR_1, TMR_2 and TMR_3 for Barishal region.

Figure: Collection of Mung bean hay, Khesari straw, Maskalai straw

Table 2: Different formulations of TMR forthe Southern region based on locally available feed ingredients

Name of the feed ingredient's	TMR_1	TMR_2	TMR_3
Maskalai straw (%)	-	50	-
Khesari straw (%)	30	-	-
Soyabean straw (%)	-	-	35
Moringa hay (%)	-	-	10
Mung bean hay (%)	-	10	-
Soyabean meal (%)	25	-	22
Mustard oil cake (%)	-	21	6
Wheat bran (%)	16	14	14
Maize crushed (%)	20	-	6
Molasses (%)	7	3	5
DCP (%)	0.5	0.5	0.5
Vitamin-mineral premix (%)	1	1	1
Salt (%)	0.5	0.5	0.5
Total (%)	100	100	100
DM (%)	**86.81**	**88.49**	**87.95**
CP (%)	**16.12**	**16.11**	**16.49**
ME (MJ/kg)	**11.34**	**10.63**	**10.28**
Price (Tk/kg)	**46.27**	**36.23**	**43.67**

The Dry Matter (DM) content was 86.81%, 88.49% and 87.95%; Crude Protein (CP) content was 16.12%, 16.11% and 16.49%; and Metabolizable Energy (ME) was 11.34 MJ/Kg, 10.63 MJ/Kg and 10.28 MJ/Kg in TMR_1, TMR_2 and TMR_3 respectively. After preparing different formulations of TMR, 5 replicates from each treatment group and a total of 15 replicates were taken to determine the appropriate shelf-life of TMR and to select the best formulation of TMR. Parameters like Dry matter (before & after), Proximate (DM, CP, Ash, EE & CF), Lactic acid, Acetic acid, Ethanol, IVDMD, Organic matter (OM), Fiber (ADF, NDF), Energy (GE, ME), Mineral (Ca, P & Mg and if need any more), Mash quality (color, odor), Rottenness/ Visual appraisal, pH, Yeast & mold count and Maximum temperature at 15 d, 30 d, 45 d, 60 d, 75 d, 90 d, 105 d and 120d for the determination of shelf life of TMR are ongoing. After 15 days, no significant changes occur in TMR Mash quality (color and odor) or visual appraisal. Moreover, season and region based potential conventional and unconventional feeds and fodder will be collected and brought into the research. Finally, region specific formulations of TMR will be prepared considering their nutrient composition and seasonal availability. The project is ongoing.

Assessment of supplementing maize grain with best management practice (BMP) of Napier grass on intake, digestibility and growth performance of RCC bulls

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Executive summary

The animal production industry in tropical and sub-tropical regions, particularly in Bangladesh, is experiencing a notable shift towards a commercial production system for both dairy and meat products. Nevertheless, Napier grass (*Pennisetum purpureum*) plays a significant role in supporting animal performance in these places. However, the current management approach makes the quality of the grass unprofitable for cattle's live weight gain (Heuze et al., 2016). According to Islam et al. (2023), CP content of Napier grass may be increased from 9.60% to 25.7%, DM and ME content from 8.70 to 10.8 MJ/kg DM, by effective simple management techniques. These improvements in nutritional composition have the potential to increase the daily live weight gain of animals by 450-500 g without the need for additional supplementation. There is a lack of available data regarding the utilization of BMP Napier grass, which typically contains roughly 15% CP, combined with the supplementation of grain at graded level, as an energy source for the growth of bulls. In light of all of the aforementioned factors, the current study was conducted to assess the effects of supplementing crushed maize with BMP Napier grass (Pakchong) on the intake, nutrient utilization, and growth performance of RCC bulls. For testing the graded level of crushed maize with BMP Napier grass, twenty RCC bulls of average live weight 260±0.2 kg and their age between 28 to 32 months were selected and divided into four dietary groups having five animals in each considering their live weight. A group of growing bulls fed control (T_0) diet consisting of sole 100 cm Napier grass (containing 14-15% CP and 12-13% DM) at *adlibitum* (Table 1). The animal under T_1, T_2 and T_3 group were supplemented crushed maize at a level of 0%, 0.5% and 1%, respectively of total live weight with BMP of Napier grass of 100 cm cutting height and severity height 10 cm above the ground level. The T_1, T_2, and T_3 groups, excluding the control group, were administered same quantities of salt, limestone, and vitamin-mineral premix. The experiment continued for a total of 120 days, which encompassed a seven-day digestibility trial. The animals' weights were recorded at ten-day intervals. Feeding response of different diets on different parameters was analysed in an ANOVA of a Completely Randomized Design (CRD) through SPSS-22 computer software packages.

Table 1: Chemical composition of experimental diet of RCC growing bulls

Parameters	Nutrient composition (%, DM))				
	Napier grass(100cm)	Crushed Maize	Salt	Lime stone	Vitamin premix
DM	12.4	88.0	88.6	99.7	97.5
OM	90.2	95.6	42.6	3.02	18.9
CP	14.3	9.06	-	-	-
ADF	43.3	3.90	-	-	-
NDF	70.5	29.0	-	-	-
Ash	9.75	4.43	57.4	96.9	81.1

The T_3 group exhibited a significant rise in dry matter (DM) intake, organic matter (OM) intake, and crude protein (CP) intake, with the addition of 1% crushed maize of animal live weight ($p<0.001$) relative to the other groups (Table 2). However, a opposite pattern was observed in relation to acid detergent fibre (ADF) consumption, as there was a substantial increase ($p<0.01$) in the crushed maize to BMP Napier grass. In terms of metabolisable energy (ME) intake, the T_3 group exhibited the highest value (40.2 MJ kg/day), which was roughly twice as much as the control group ($p<0.01$). The DM intake of per 100 kg body weight, the T_0 had the lowest (1.58 kg) followed by T_1 (1.59), T_2 (1.77 kg) and T_3 (2.14 kg). A

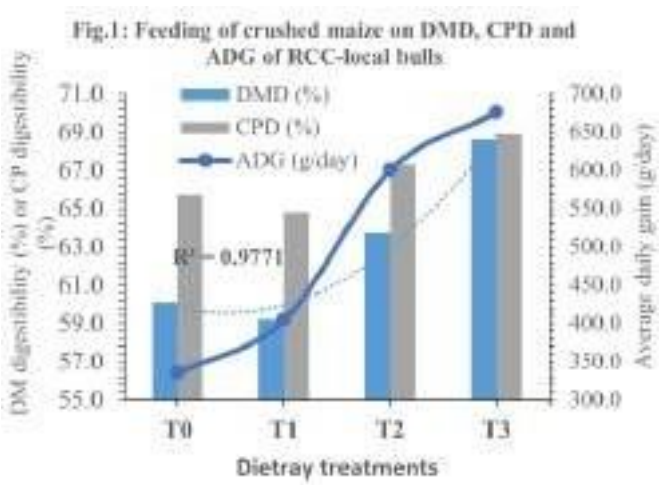
comparable pattern was noted in terms of metabolizable protein intake (MPI), with the greatest value (218 g/day) being recorded in the T_3 group ($p<0.01$).

Table 2: Nutrient intake, feed conversion efficiency, and cost-benefit analysis of bull fed different experimental diets

Parameters	Different dietary groups				SEM	Level of Sig.
	T_0	T_1	T_2	T_3		
TDMI (kg/day)	4.96^{c}	4.83^{c}	5.89^{b}	7.28^{a}	0.16	***
TOMI (kg/day)	4.55^{c}	4.39^{c}	5.43^{b}	6.74^{a}	0.15	***
TCPI (kg/day)	0.68^{c}	0.71^{bc}	0.76^{b}	0.89^{a}	0.02	***
TADFI (Kg/day)	2.14^{a}	2.08^{ab}	1.93^{bc}	1.90^{c}	0.04	**
TNDFI (Kg/day)	3.48^{b}	3.39^{b}	3.49^{b}	3.81^{a}	0.08	*
DMI (kg/100 kg BW)	1.58^{c}	1.59^{c}	1.77^{b}	2.14^{a}	0.04	***
MEI (MJ/day)	26.2^{b}	25.7^{b}	29.6^{b}	40.2^{a}	2.26	**
MPI (g/day)	142^{b}	139^{b}	161^{b}	218^{a}	2.26	**
FCR	9.75^{bc}	8.32^{c}	12.3^{a}	11.2^{ab}	0.52	***
Feed cost (kg, DM)	8.85c	9.15c	16.6b	21.3a	1.20	***
Feed cost/kg LW gain, Tk	117d	143c	169.b	235a	11.02	***
Days Req.for Kg LW gain	2.50a	3.03a	1.67b	1.48c	0.15	***
Total cost	7534.7	7588.5	16780.9	26576.6	439.5	***
Net profit	8712.8^{a}	5878.5^{a}	7372.5^{a}	558.4^{b}	1042	***
BCR	2.15^{a}	1.77^{b}	1.44^{c}	1.03^{d}	0.083	***

TDMI, Total Dry Matter Intake; TOMI, Total Organic Matter Intake; TCPI, Total Crude Protein Intake; TADFI, Total Acid Detergent Fibre Intake; TNDFI, Total Neutral Detergent Fibre Intake; MEI Metabolisable Energy Intake; MPI, Metabolisable Protein Intake; T_0, Only Best Management Practice (BMP) Napier grass (sole); T_1, BMP Napier grass + Vitamins & minerals ; T_2, BMP Napier grass + 0.5% of BW maize grain + Vitamins & minerals; T_3, BMP Napier grass + 1.0% of BW maize grain + Vitamins & minerals; SEM, Standard error of the mean; *=P<0.05, **= P<0.01; ***=P<0.001, $^{a-c}$ means with different superscripts in the same row are significantly different.

Fig.1 shows that, with the increase of crushed maize to the BMP of Napier grass, DM digestibility and CP digestibility increase linearly (R^2=0.97) and T_3 group shown the height ($p<0.001$) live weight gain (675 g/day) followed by T_2 group (600 g/day), T_1 (404 g/day) and T_0 group (335 g/day). There was no significant difference of ADF digestibility and NDF digestibility among the dietary groups. The average feed conversation ratio (FCR) for the four groups were 9.75, 8.32, 12.3, and 11.2 ($p<0.001$). These findings suggest that only the group of bulls given BMP Napier grass exhibited superior feed conversion compared to the other groups' diets. The T_3 group incurred the greatest overall cost, consisting of feed cost and management cost, amounting to 26575.6 TK. This cost was found to be approximately four times greater than that of the control group, with a statistically significant difference ($p<0.001$). In terms of net profit, it is observed that the T_3 group exhibited a significantly lower value of 558.4 TK, while the BMP Napier grass group demonstrated the greatest net profit of 8712.5 TK.



It concluded that, According to the FCR, the bulls fed BMP Napier grass (100cm) without supplementation of grain performed better than the bulls fed BMP Napier grass along with different graded level of grain. In terms of cost-benefit analysis, as such feeding sole BMP Napier (100 cm) is profitable for beef production. However, supplementation of grain with 0.5% of live weight may also be profitable as considering to less requirement of days to achieve 1 Kg live weight.

Field validation of stress tolerant mutant lines of fodder developed by BLRI

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Executive Summary

Improvement or development of new stress tolerant fodder germplasms will help to increase production and productivity of farm animals in the country. As for the reason a series of experiment was conducted at BLRI fodder research field using seven Napier, water logged perennial fodder, winter fodder crops Oat and Barley and a tree fodder, Moringa. The cuttings of each cultivar of Napier were irradiated with ten different doses of Gamma rays as 10 Gy, 20 Gy, 30 Gy, 40 Gy, 50 Gy, 60 Gy, 70 Gy, 80 Gy, 90 Gy and 100 Gy from 60Co source from BINA, Mymensingh. Similarly, the seeds Oat were irradiated with seven doses of Gamma rays as 100 Gy, 150 Gy, 200 Gy, 250 Gy, 300 Gy, 350 Gy and 400 Gy. After the experiment salt tolerant Napier (BLRI grass -5) showed good performance in saline prone region. In relation of that one nursery was established at Shyamnagar upazila in Satkhira district, and another was established at Koyra, Khulna, as part of the on-farm activity and as part of on station activity a total of 50 dcm size salt tolerant Napier (BLRI grass -5) nursery at BLRI for distribution and front line extension of salt tolerant Napier grass. A 5×3 (Variety× Plant Height) factorial design was followed to compare the performances of stress tolerant mutant lines (Pakchong 20, Pakchong 60, Pakchong 90, Napier 4 and Napier 1) of Napier fodder at different plant heights (50, 100 and 200 cm). A 4×4 factorial design was followed to evaluate the performance of Gamma radiated mutant line of winter fodder 'Oat" (Gy 0, Gy 300, Gy 350, Gy 400) at different cutting stages (60 days, 75 days, 90 days and 105 days) of plant. To evaluate the feeding effect of salt tolerant Napier (BLRI grass-5) on beef production performance of local growing bulls under on station and on farm condition. Total 8 Pabna growing bulls were randomly divided into two equal dietary groups (T_1 & T_2). Group T_1 was considered as control offered sole Pakchong (Napier) grass and animals under T_2 groups were supplied BLRI 5 (Salt tolerant) grass. The animals were housed individually and fed the experimental diets for a period of 120 days including a 7 days digestibility trial. The animals were weighed at an interval of 10 days, and their feed intake, digestibility of nutrients, FCR, growth performances were recorded. To evaluate the feeding impact of salt tolerant Napier (BLRI grass-5) on beef production performance of local growing bulls under on farm condition a total 3 local bulls were fed BLRI 5 (Salt tolerant) grass for a period of 50 days and the animals were weighed at an interval of 10 days, and their feed intake growth performances were recorded. All the recorded data were analyzed statistically in an ANOVA of a completely randomized design (CRD) using the compare means with SPSS, 20 computer software packages.

Comparative production performance and nutrient composition of stress-tolerant mutant line of Napier grass using the BMP System is presented in Table 1. The results revealed that Fresh biomass yield ($p<0.05$), DM yield ($p<0.05$) and CP yield ($p<0.005$) Ton/Ha/cut of different Napier variety differ significantly and highest Fresh biomass yield, DM yield and CP yield observed for Pakchong 60 variety 40.6, 6.26 & 0.87 Ton/Ha/cut, respectively. In case of plant height the DM and CP percentage of different Napier variety differ significantly ($p<0.001$) and highest CP percentage was observed when grass cut at 50 cm height (17.9%) followed by 100 cm height (15.3%) and 200 cm height (12.8%). Effect of harvesting days (HD) and Gamma Radiation Level on Production Performance and Nutrient Composition of Oat grass is presented in Table 2. The results showed that Fresh biomass yield ($p<0.01$), DM yield ($p<0.001$) and CP yield ($p<0.001$) Ton/Ha/Year of Oat differ significantly when harvested at different days and for variation of radiation. Highest fresh biomass yield was observed when oat fodder harvested at 90 days and when seed radiated at 400 Gy. Intake, body weight gain, digestibility & feed conversion efficiency of Pabna bulls fed solely Pakchong and BLRI 5 grass at on-station and on-farm condition is presented in Table 3. The result showed that the CP ($p<0.05$) intake of bulls vary significantly between the treatment groups but the DM and OM intake was not significantly ($p>0.05$) differ between the groups at on-station. The DM and CP digestibility did not differ significantly ($p>0.05$) between the groups. However, animals fed BLRI 5 grass had higher ($p<0.05$) average daily gain of 0.12Kg compared to 0.0.09 Kg of the animals feeding Pakchong grass. The results of on-farm study revealed that Fresh Intake (Kg/d), DMI (Kg/d), DMI (Kg; % LW) and CPI (Kg/d) of local growing bulls were 20.9±0.04, 3.20±0.02, 1.81±0.01 and 0.43±0.01, respectively.

Table 1: Comparative production performance and nutrient composition of stress-tolerant mutant line of Napier grass using the BMP System

Density, Plant Height (PH) and their Interac ions		Biomass Yield (Ton/Ha/cut)			Cumulative Biomass Yield (Ton/Ha/Year)			Nutrient Composition (%)	
		FBY	DMY	CPY	FBY	DMY	CPY	DM	CP
Vari ty	Pakchong 20	35.1[b]	5.14[b]	0.79[b]	149.4[d]	21.3[b]	3.66[b]	14.1	16.9
	Pakchong 60	40.6[a]	6.26[a]	0.87[a]	167.6[a]	25.1[a]	3.89[a]	14.5	16.1
	Pakchong 90	35.9[b]	5.09[b]	0.69[c]	155.5[c]	21.7[b]	3.40[c]	13.8	15.8
	Napier 4	35.7[b]	4.94[b]	0.69[c]	161.2[b]	22.3[b]	3.69[b]	13.7	15.6
	Napier 1	34.1[b]	5.74[b]	0.79[b]	162.3[b]	24.2[a]	3.60[b]	14.3	15.4
PH	50	10.2[c]	1.36[c]	0.26[c]	110.3[c]	14.6[c]	3.04[c]	13.1[c]	17.9[a]
	100	25.9[b]	3.74[b]	0.61[b]	153.7[b]	22.2[b]	3.81[b]	14.4[b]	15.3[b]
	200	73.3[a]	11.2[a]	1.43[a]	225.5[a]	34.3[a]	4.68[a]	15.3[a]	12.7[c]
SED		0.85	0.18	0.02	3.35	0.62	0.09	0.26	0.05
Sig	Variety	*	*	*	***	***	***	NS	NS
	Plant Height	***	***	***	***	***	***	***	***
	Variety×PL	***	***	***	***	***	***	NS	***

Table 2: Effect of harvesting days (HD) and Gamma Radiation Level on Production Performance and Nutrient Composition of Oat grass

Harvesting Days, Gamma Radiation Level and their Interaction		Biomass Yield (Ton/Ha/Year)			Nutrient Composition (%)	
		FBY	DMY	CPY	DM	CP
Harvesting Days (HD)	60	26.8[d]	3.15[d]	6.29[b]	11.7[bc]	23.4[a]
	75	50.1[c]	5.25[c]	9.55[a]	10.5[c]	18.9[b]
	90	64.5[a]	8.52[b]	6.62[b]	13.2[b]	10.2[c]
	105	55.3[b]	13.38[a]	4.66[c]	24.10[a]	8.35[d]
Radiation	0	39.4[d]	6.14[b]	5.06[d]	14.9[ab]	14.4[c]
	300	50.6[b]	7.99[a]	7.02[b]	15.2[a]	15.3[b]
	350	47.7[c]	6.92[b]	6.58[c]	14.2[b]	15.2[b]
	400	58.8[a]	9.25[a]	8.46[a]	15.2[a]	15.9[a]
SED		0.68	0.29	0.17	0.41	0.27
Sig	HD	***	***	***	***	***
	Radiation	***	***	***	NS	*
	Radiation×HD	*	NS	NS	NS	NS

Table 3: Intake, body weight gain in digestibility & feed conversion efficiency of Pabna bulls fed solely Pakchong and BLRI 5 grass at on-station and on-farm condition

Parameters	**On-station Data**				**On-farm Data**	
	T_1	T_2	**SED**	**Sig. level**	**Parameters**	**Mean±SE**
DMI	3.94	4.00	0.03	NS	Fresh Intake (Kg/d)	20.9
DMI (Kg; % LW)	2.17	2.18	0.01	NS	DMI (Kg/d)	3.20
CPI(Kg/d)	0.29	0.33	0.01	*	DMI (Kg; % LW)	1.81
OMI(Kg/d)	3.53	3.61	0.03	NS	CPI (Kg/d)	0.43
DM dig. (%)	58.9	58.2	1.66	NS	Initial LW (Kg)	169.6
CP dig. (%)	57.2	59.5	1.03	NS	ADG (Kg)	0.36
ADG (kg)	0.09	0.12	0.02	*	Final LW (Kg)	186.0
FCR	39.1	33.6	8.85	Ns	FCR	8.80
CP% of Feed	5.80	6.10	0.03		CP% of Feed	13.5
DM% of Feed	23.0	23.3	0.07		DM% of Feed	15.4

Establishment of nurseries enables distribution of salt-tolerant Napier (BLRI Grass-5) cuttings to business owners and farmers. The study's findings made it evident that the defoliation height and harvesting age of fodder affect its nutritional value and among the various Napier varieties, Pakchong holds the highest ranking in terms of both biomass yield and nutrient quality. By harvesting the oats 400 Gy at 75 days of age, can guarantee the highest biomass yield and optimal nutrient quality. Salt-tolerant Napier (BLRI grass-5) has no negative effects on cattle's ability to produce beef.

Project Title: Fattening of Castrated Male Goat in Bangladesh
Sub Title: Effect of complete pellet feed on the growth, carcass and meat quality characteristics of different age group of castrated Black Bengal Goat

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Executive Summary

Bangladesh is a goat-rich country where most of the goats are reared on natural pastures. Due to the decreasing of grazing land, farmers are getting encouraged to rear goats in stall feeding system. According to farmers demand, BLRI has already developed a roughage based complete pellet feed for goats and already established as a suitable feed for goat (Ahmed et al.2020). But the effect of complete pellets on meat quality of goats that has not yet been determined. So, the present study was designed to determine the effect of complete pellet feed on carcass and meat quality of goats. A total twenty four (24) healthy castrated male goat of 3 months of age of with similar body weight (8.3±0.43kg) were divided into two groups where sixteen (16) goats in treatment group (T_1) and remaining eight was in control group (T_0) and reared under the same intensive management system. The T_0 goats were fed grass based diet (German grass) with a concentrate mixture to satisfy their nutrient requirement whereas T_1 goats were fed complete pellet feed. From the both groups, 2 representative animals were slaughtered at 06 months and 09 months of age to analyse carcass and meat quality characteristics. The pellet was supplied as adlibitum basis and it composed with rice polish, maize crushed, soybean meal, molasses, salt, DCP, vitamin-mineral premix with a DM of 91.6%, 16.43% CP, 23.69% ADF and 45.13% NDF and 7.26% ash. Animals were fed individually in pens and refusals were collected daily. Weekly weight gain was taken in the early morning before feeding. Animals were fasted for 12 h, weighed and then slaughtered for Carcass and Meat Quality analysis. The parameters like, DMI, ADG, FCR, hot carcass weight (HCW), dressing percentage, different primal cut, meat bone ratio, non-carcass yield, physical and chemical composition of meat were recorded and analysed. All the data were statistically analysed with Completely Randomized Design (CRD) using Statistical Package of SPSS version 23.

Table-1: Effect of complete Pellet feed on the productive Performances of Goat at 06 and 09 months of age (Mean±SE)

Parameters	6 months Age		P Value	9 months Age		P Value
	T_1	T_0		T_1	T_0	
Initial weight (kg)	8.21±0.37	8.4±0.74	0.74	8.21±0.37	8.4±0.74	0.74
Final weight (kg)	14.78±0.37	11.54±0.37	0.000	21.53±0.35	14.96±0.37	0.000
Dry matter intake(DMI)/d	334.32±2.31	251.74±2.97	0.000	530±1.7	472.61±1.2	0.000
Intake of BW (%)	4.02±0.06	3.06±0.03	0.000	3.58±0.04	3.19±1.92	0.000
ADG (gm/day)	73±0.0	37±0.0	0.000	75±0.0	38±0.0	0.000
FCR (Kg)	5.13±0.03	7.49±0.01	0.000	7.97±0.07	13.1±0.1	0.000

Table-2: Effect of complete pellet feed on the meat yield performances of Goats at 06 and 09 months of age (Mean±SE)

Parameters	6 months Age		P value	9 months Age		P value
	T_1	T_0		T_1	T_0	
Live weight (Kg)	14.83±0.08	11.78±0.30	.001	21.32±0.35	14.80±0.37	.000
Hot carcass wt. (kg)	7.12±0.04	4.48±0.11	.000	10.36±0.15	6.07±0.15	.000
Dressing %	47.83±0.44	39.26±0.21	.000	49.23±0.14	41.47±0.14	.000
Meat:bone	3.63±0.24	2.4±0.10	.010	4.31±0.11	2.44±0.03	.000

The production performances of experimental animals at different ages are shown in Table-1. The ADG was almost 50% higher (72gm/day) for T_1 goats compare to T_0 goats (36 gm/day) and FCR significantly reduced in T_1 group although CP intake not differ significantly between the groups for both six and nine months of age, respectively. Significantly higher meat yield parameters like, hot carcass weight, dressing percentage and meat:bone ratio were also observed in T_1 group both for 06 and 09 months of ages (Table-2). Most of primal cut values significantly higher in T_1 group for both ages compare to T_0 group (Table-3). The results of physico-chemical attributes of goat meat presented in the Table-4. Although light intensity and water holding capacity (WHC) not differ significantly at six months of age but at nine month of age clear significant differences were observed. The lower drip loss ($p<0.5$)) in T_1 group for both ages also indicate better meat quality. The chemical composition of meat content not differ significantly between the treatment group at different ages. Significantly higher ($p<0.01$) ash content was observed in T_0 group.

Table-3: Effect of complete pellet feed on the primal cut of carcass at 06 and 09 months of age (Mean±SE)

Parameters (gm)	6 months Age		P-value	9 months Age		P-value
	T_1	T_0		T_1	T_0	
Neck	454±11.54	290±17.32	.001	692±50.80	576±23.09	.106
Shoulder	2501±142.60	1530±77.36	.004	3752±248.30	2376±191.70	.012
Fore shank	271±4.04	191±3.00	.000	395±14.40	288±13.90	.006
Rack	500±15.00	299±21.40	.002	804±17.30	574±34.64	.004
Loin	618±45.03	403±36.37	.021	1057±6.30	635±13.20	.000
Brisket	268±35.80	155±5.20	.035	306±0.00	215±5.20	.000
Flank	187±34.06	112±2.30	.093	434±19.60	255±8.60	.001
Hind leg	1903±68.70	1215±43.30	.001	3085±25.90	2155±155.30	.004

Table-4: Effect of complete pellet feed on the physico-chemical properties of meat at six and nine months of ages (Mean±SE)

Parameters	6 months Age		P-value	9 months Age		P-value
	T_1	T_0		T_1	T_0	
pH	5.61±0.01	5.71±.01	.005	6.71±0.09	6.51±0.01	.097
Color intensity	19.54±0.81	21.28±1.73	.190	24.11±0.19	21.17±0.67	.014
WHC	22.93±0.34	17.57±4.90	.340	16.21±0.58	14.28±0.04	.030
Drip loss, %	6.85±0.16	10.07±0.97	.031	8.03±0.27	10.15±0.42	.014
Cook loss	30.02±4.80	26.9±0.22	.555	28.21±0.13	26.05±2.40	.430
DM	21.52±0.03	20.29±1.60	.489	23.19±0.45	23.52±0.32	.610
Ash	12.84±0.05	8.32±0.69	.063	4.79±0.02	4.5±0.02	.001
CP	19.68±0.30	19.25±1.00	.705	21.25±1.45	19.16±0.22	.228
EE	1.41±0.02	1.56±0.41	.726	1.31±0.94	1.97±0.15	.002

In conclusion, complete pellet feeding enhances DMI, ADG and reduce FCR. Complete pellet feeding also improve the meat and carcass related characteristics. Finally, It can be shorten the fattening time without any negative impact on meat quality and helps to enhance profitability.

Development of feeding and nutritional management practices for optimization of dairy performances in buffalo

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Executive Summary

About 40% of indigenous, Swamp, and River types of buffalo are distributed in the coastal part of Bangladesh. In this region, the majority of farmers supplied their buffalo with crop residues, dry roughages (straw), grazing in char land, and some concentrates like wheat bran, rice polish, etc. Lack of feeds and fodder, grazing land, fresh water during floods and delayed puberty, seasonal breeding, long calving intervals, and poor estrus detection are the main constraints in buffalo production. Introducing high-yielding fodder production, and preservation techniques, and implementing the scientific technique of pasture management can mitigate these limitations. This is an ongoing project and it was designed with three different objectives viz. to know the existing feeding management practices for improving the productive and reproductive performance of buffalo, introduce high-yielding fodder variety in char land and effect of nutrient composition on different ages of pakchong grass at rotational grazing plot. To fulfill the first objective of this study, a baseline survey was conducted in geographically different locations of Bangladesh which were Bauphal, Patuakhali; Companiganj, Noakhali; and Gangachara, Rangpur. A pretested questionnaire were used to collect data from 120 buffalo rearing farmer's farms. On the other hand, two feeding trial of lactating buffalo were conducted whereas one as community based feeding trial to find out the suitable and low cost production management of buffalo at Godagari, Rajshahi. Another was to evaluate the production performance of lactating buffaloes through feeding pakchnong at 25 days of age from a rotational grazing plot. At community feeding trial, thirty mid lactating buffalo cows were selected based on their average days in milk (90±10d), daily milk yield (2.11±0.52) and parity (2^{nd} & 3^{rd}) for a period of 90 days. Ten buffaloes in each group (n=10) were categorized into three dietary treatments followed by completely randomized design; Control (T_0) - Existing feeding system (grazed in the bathan of mixed natural grass + 300g/day concentrate supplement); T_1- Grazing in bathan (Padma char, Rajshahi)+ 1.5 kg concentrate supplement containing 25% more CP and ME than T_0 group and T_2- 70% roughage + 30% concentrate supplement containing 50% more CP and ME than T_0 group. Another feeding trial, ten lactating buffaloes were selected at BLRI research farm for a period of 75 days. Five buffaloes in each group (n=5) were categorized into two dietary treatments followed by completely randomized design; Control (T_0) – Only grazing pakchnong at 25 days of age at rotational grazing plot and T_1- supplied cut and carry pakchnong at 25 days of age from rotational grazing plot. To calculate average daily gain, experimental buffaloes were weighed before morning feeding on the first and last day of the feeding period. The amount of feed offered was recorded daily. Milk sample were collected and analyzed by automatic milk analyzer. Milk fatty acid profiles were analyzed by gas chromatographic methodology in BCSIR lab, Dhaka.

The survey result revealed that majority of the farmers at Gangachara (61.76%) and Bauphal (82.35%) were practiced semi-intensive farming system whereas at extensive (58.82%) in Companiganj upazila. Farmers practiced intensive farming system were higher in Companiganj (8.82) followed by Bauphal (5.88) and Gangachara (2.94%). The large herd size was found in extensive farming system followed by semi-intensive and intensive system. The productive traits considered for the study were age at first heat, estrous cycle and gestation period were relatively lower in intensive farming system followed by semi-intensive and extensive system (Table 1).

Table 1. Productive and reproductive performances of buffalo at different farming system

Parameter	Farming System (Mean±SD)		
	Intensive	Semi-intensive	Extensive
Herd Size (Nos.)	16.00±7.01	17.35±10.48	28.16±13.74
Age at 1^{st} heat (Month)	39.95±2.16	40.66±1.50	40.642±3.16
Estrous Cycle (Days)	21.966±0.99	22.16±0.75	22.035±1.29
Gestation Length (Days)	303.33±4.08	308.08±4.82	308.714±4.95
Calf birth weight (Kg)	30.00±6.06	25.25±2.00	25.535±2.58
Dry Period (Days)	76.16±9.49	81±8.91	78.714±8.40

Lactation Length (Days)	230.00±10.95	224.41±14.49	216.25±9.39
Milk yield (Kg/d/buffalo)	3.216±0.44	2.876±0.67	2.321±0.30
Avg. DM Intake/100 kg LW	2.87±0.76	2.65±0.68	2.45±0.85
Feed cost(TK.)/kg milk production	47.07±5.26	37.07±4.34	31.07±6.32

Higher birth weight was found in intensive farming system followed by semi-intensive and extensive system. Higher milk yield and lactation length were found in intensive farming system compared to semi-intensive and extensive farming system. Feed cost (BDT.) against per kg milk production was higher in intensive farming system compared to semi-intensive and extensive farming system.

Table-2: Nutrient intake and production performances of buffalo at community

Parameter	Treatment (Mean±SD)			Level of Sig.
	T_0	T_1	T_2	
DMI from Roughage (Kg)	9.779^{a}±0.68	9.754^{a}±0.62	9.280^{b}±0.87	*
DMI from Concentrate (Kg)	0.264^{c}±0.00	1.320^{b}±0.00	3.168^{a}±0.00	**
Total DMI (Kg/d)	10.043^{c}±0.68	11.074^{b}±0.62	12.619^{a}±0.92	**
DMI/100 Kg LW (Kg)	2.088^{c}±0.14	2.485^{b}±0.13	2.657^{a}±0.19	**
Average daily gain (Kg)	0.126^{c}±0.06	0.306^{b}±0.07	0.413^{a}±0.10	**
Milk Yield (Kg/d)	2.118^{c}±0.57	2.811^{b}±0.29	3.180^{a}±0.52	*
ECM (Kg/d)	2.987^{c}±0.63	4.069^{b}±0.63	5.234^{a}±0.74	**
∑Saturated Fatty Acid	64.396±0.28	62.686±1.47	63.220±0.208	NS
∑Unsaturated Fatty Acid	31.356±0.17	31.886±0.49	31.843±0.17	NS
Conjugated Linoleic Acid (CLA)	1.16±0.01	1.19±0.01	1.1±0.02	NS

[a, b] Mean in the same row with different superscripts differ significantly; **=significant (P<0.01); *=significant (P<0.05); NS=Non significant (P>0.05); ECM-Energy corrected milk.

Additionally, results from community based feeding trial showed that dry matter intake (%LW) was lower (P>0.05) in T_0 followed by T_1 and T_2 group (Table 2). The lactating buffalo cows of all three groups were gaining body weight (P<0.05) during the trial period. Higher milk yields (P>0.05) were recorded in T_2 group followed by T_1 and T_0 group. Due to improved feeding, milk productions were increased 50.14% in T_2 and 32.7% in T_1 compared to T_0 group. Energy corrected milk yields were also significantly higher in T_2 group followed by T_1 and T_0 group. Milk fat contents (g/100g) were higher (P>0.05) in T_1 (8.818±0.55) compared to T_2 (8.200±0.92) and T_0 (7.890±0.87) groups, respectively. However, protein, lactose and SNF content did not differed among the treatment groups (P<0.05). Milk fatty acid profile were not significantly (p>0.05) differed among treatment groups but saturated fatty acid was slightly lower in T_1 and T_2 group compared to control group (Table 2).

Table-3: Milk yield and composition of buffalo at rotational grazing plot

Parameter	Treatment (Mean±SD)		Level of Sig.
	T_0	T_1	
Total DMI (kg/d)	$9.017±0.425^{a}$	$9.75±0.135^{b}$	*
Milk yield (kg/d)	2.550±0.54	2.319±0.41	NS
Fat (g/100g)	6.017±1.08	6.592±0.96	NS
Protein (g/100g)	3.765±0.07	3.635±0.27	NS
Lactose (g/100g)	5.627±0.11	5.432±0.42	NS
SNF (g/100g)	10.282±0.19	9.935±0.71	NS

[a, b] Mean in the same row with different superscripts differ significantly; **=significant (P<0.01); *=significant (P<0.05); NS=Non significant (P>0.05).

Another feeding trial of grazing at rotational grazing plot **T_0** group showed significantly lower DMI compared to T_1 group. Milk yield increased in **T_0** group compared to T_1 group but not significantly differed. Milk composition of fat, protein lactose and SNF were not significantly (P>0.05) differed between treatment group, although fat content is lower, probably due to lower acetate production in rumen. Considering the above findings, it may be concluded that milk yield and composition of buffaloes were improved with increased supplementation of ME and CP in diet. Additionally, buffaloes performed better fed 25 days of age's pakchong at grazing rotationally grazing plot compared to cut and carry system.

Project Title: Piloting castrated male goat fattening through low-cost grass based TMR under stall-feeding condition
Sub title: Fattening castrated male goat through cost effective grass based TMR under stall-fed condition

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Executive summary

In Bangladesh, most of the goat reared through subsistence farming by rural women. They grassed their goats mostly in the fellow lands. Due to decreasing grassing land day by day, farmers' attention gain in stall feeding. Now a days, goat meat price increasing as concentrate feed ingredients' price increasing. On the other hand, farmers fattened their castrated male goat for its huge demand to sacrifices this animal during Eid-UL-Adha festival. So, it is therefore important to develop a cost-effective grass based TMR feed for commercial goat production as well as fattening. Hence the project was implemented to develop a cost-effective grass based TMR and animal performance evaluation. For achieving the objectives of the study 3×3×3 (Age×Area×Ration) factorial design was employed to evaluate the performance of castrated male goat through cost effective grass based TMR under stall-feeding condition. Rajshahi (Komlapur, Godagari), Dhamarai (Sharifbug) and BLRI were selected area where different age group (3-6 months, 6-9 months and 9-12 months) animals grouped in three group and continued a feeding trail with 3 (Control, TMR 1- Roughage: concentrate = 60:40 and TMR 2- Roughage: concentrate = 70:30) types of feed for a period of 120 days. The animals were weighed at an interval of 10 days, and their feed intake, FCR, growth performance and cost-net profit calculation were analyzed statistically in an ANOVA of a completely randomized design (CRD) using the compare means with SPSS, 20 computer software packages.

The chemical composition and ration formulation of the diets used in this experiment are shown in Table 1. It shows that, the dry matter (DM), crude protein (CP) and ash percentage of TMR1 diets were 19.5. 18.54 and 8.09, respectively whereas, the dry matter (DM), crude protein (CP) and ash percentage of TMR2 diets were 21.4, 19.08 & 8.24, respectively and 16.4, 13.9 & 9.31, respectively for control diet. Feed intake, FCR, growth performance and cost-net profit of castrated male goat responding in different diets are presented in Table 2. Results showed that age significantly affected the average daily gain, feed conversion efficiency and dry matter intake ($p<0.001$) of goat. Highest ADG was found for 3-6 months (80 gm/day) age group animal following 6-9 month (70 gm/day) and 9-12 months (70 gm/day) respectively. The FCR was increased with the increase in age, so the FCR for 3-6 months animal was 3.95 kg, followed by 6-9 month (5.47 kg), and 9-12 month (6.93 kg). According to Table 1 area has a significant impact on average daily gain ($p<0.001$), feed conversion efficiency ($p<0.001$) and dry matter intake ($p<0.001$) of goat. The ADG was the same in Dhamrai and BLRI (80 gm/day), but slightly lower in Rajshahi (60 gm/day). FCR and DMI were highest in Rajshahi at 7.30 and 0.42, followed by BLRI at 5.45 and 0.40, and Dhamrai at 5.23 and 0.39. Diet or ration have a significant influence on average daily gain ($p<0.001$), and dry matter intake ($p<0.001$), except for feed conversion efficiency ($p>0.05$). ADG and DMI were highest in goats fed a 60:40 roughage and concentrate ratio combined effect of area and age group, area and ration, age and ration & area, ration and area have significant effect on average daily gain ($p<0.001$), feed conversion efficiency ($p<0.001$), and dry matter intake ($p<0.001$) of goats however, there is no significant effect ($p>0.05$) on benefit-cost ratio in comparison with the combination of age and ration which significantly differ at 0.5 level of confidence.

Table 1: Composition of diet supplied to the animals during feeding trial

Parameter	Diet/Ration		
	Control	TMR 1	TMR 2
DM (%)	16.4	21.4	19.5
CP (%)	13.9	19.08	18.54
Ash (%)	9.31	8.24	8.09
Roughage (kg)	-	60	70
Wheat Bran (kg)	-	12.8	9.6
Khesari Bran (kg)	-	8	6
Soybean Meal (kg)	-	16	12
Mollases (kg)	-	1.6	1.2
DCP (kg)	-	1.2	0.9
Salt (kg)	-	0.4	0.3
Total (kg)		100	100

DM=Dry matter, CP=Crude protein, TMR=Total mixed ration

Table 2: Feed intake, FCR, growth performance and cost-net profit of castrated male goat

Age, Area and Diet		Initial BW	Final BW	ADG	DMI	FCR	Price/kg LW
Age	3-6 Months	7.37	17.38^{c}	0.08^{a}	0.32^{c}	3.95^{c}	255.12
	6-9 Months	12.98	21.88^{b}	0.07^{b}	0.39^{b}	5.47^{c}	261.43
	9-12 Months	14.35	22.46^{a}	0.07^{c}	0.45^{a}	6.93^{b}	264.90
Area	Rajshahi	13.15^{a}	20.59^{a}	0.06^{b}	0.42^{a}	7.30^{a}	272.20^{b}
	Dhamrai	10.48^{b}	19.87^{b}	0.08^{a}	0.39^{b}	5.23^{c}	298.27^{a}
	BLRI HQ	11.62^{a}	20.58^{a}	0.08^{a}	0.40^{b}	5.46^{b}	261.65^{c}
Diet	Control	12.29	19.67^{b}	0.06^{c}	0.45^{a}	7.63^{a}	268.05
	TMR 1	12.49	21.88^{a}	0.08^{a}	0.44^{a}	6.02^{b}	242.98
	TMR 2	11.00	18.82^{c}	0.07^{b}	0.37^{b}	5.97^{c}	227.76
SED		0.01	0.03	0.01	0.01	0.02	1.89
Level of Sig.	Age	***	***	***	***	***	NS
	Area	***	***	***	***	***	**
	Ration	***	***	***	***	NS	**
	Age×Area	***	***	***	***	***	NS
	Age×Ration	***	***	***	***	***	*
	Area×Ration	***	***	***	***	***	NS
	Age×Area×Ration	***	***	***	***	***	NS

BW=Body weight, ADG=Average daily gain, DMI=Dry matter intake, FCR=Feed conversion ratio, LW=Live weight; NS= non-significant, *=p<0.05, **=p<0.01, ***=p<0.001

The results obtained so far indicate that goats under the age of 3-6 months have a faster growth rate, while goats the ages of 6-9 months have a higher feed conversion ratio. Using a diet consisting of 70% roughage and 30% concentrate for fattening castrated male goats under stall feeding conditions is beneficial in terms of feed conversion ratios, dry matter intake, as well as benefit-cost ratios.

Project Title: Improvement of feeding system for Black Bengal Goat in different selected areas in Bangladesh

Sub title: Nutritional assessment of some selected tree fodder for goat feeding

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Executive Summary

Goat plays a significant role for the small holder farmer especially in the tropic and sub tropic country where goat farming faces several constrains including feed and nutrition. Goat rearing mainly depends on grazing outside (natural pasture) for a certain period of time daily and reducing this practices day by day due to land scarcity. Moreover, in dry season, critical conditions of grass scarcity prevail everywhere, which worsens the production efficiency of goat. According to the results of global research, the supplementation of tree fodder to the basal diet of goats could represent a valuable economic alternative to improve the quality of diet and reduce nutritional and health related problems compared to purchased concentrates and agro industrial by-products. Considering these, the present study was designed in CRD to evaluate some selected tree fodder using *In-Vitro* Gas Production Technique aiming to introduce tree leaf or fodder based feeding system for goat. Previously a survey was conducted in eight different locations of Bangladesh (Vhaluka, Muktagacha, Rajsahi sadar, Kustia, Meherpur, Chuadanga, Joshore sadar and Naikhongchori) to identify the plants and leaves most commonly used by farmers as goat feed. A representative amount of widely used tree leaf samples were collected and brought to Animal Nutrition Laboratory of BLRI and analyzed for proximate component first (table-1). Then the *In vitro* gas production analysis of the previously prepared feed sample was done in the same laboratory following the Menke and Steingass (1988) method. A systematic review on anti-nutritional factors was studied and specific tree leaf based functional anti-nutritional factor was listed of which only tannin content were analyzed at Bangladesh reference Institute for Chemical Measurement (BRICM) laboratory, Laboeatory road, Dhaka (Table-2). The Menke and Steingass (1988) equeations were used to determine the

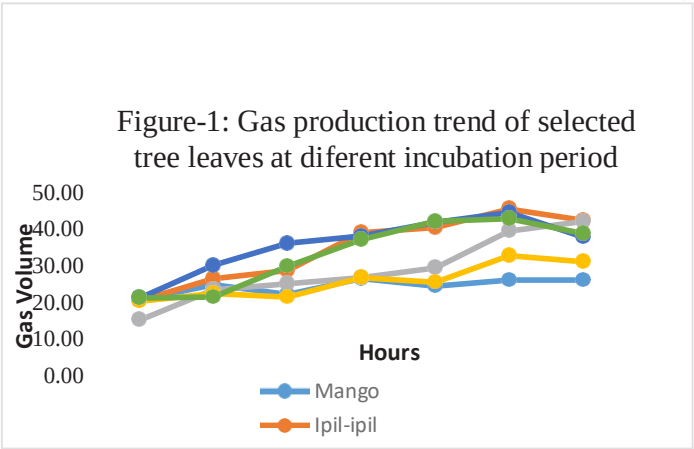
Table-1: Chemical composition of Selected Tree Leaves (%/Kg DM)

Item	Leaf (Mean±SE)						P value
	Mango	IpilIpil	Jackfruit	Mahogany	Banana	Hilinchi	
DM	48.12±0.3^{b}	38.13±0.3^{c}	36.9±0.30^{c}	52.1±0.3^{a}	29.33±0.8^{e}	33.7±0.2^{d}	.000
Ash	11.10±0.1^{bc}	9.28±0.3^{c}	12.3±1.2^{ab}	7.38±0.9^{d}	10.56±0.4^{bc}	13.21±0.1^{a}	.000
CP	10.67±0.08^{d}	23.77±0.2^{a}	13.84±0.3^{c}	7.75±0.1^{e}	11.08±0.2^{d}	21.13±0.2^{b}	.000
EE	1.49±0.03^{cd}	1.43±0.03^{d}	1.20±0.1^{e}	1.97±0.02^{b}	1.53±0.06^{c}	2.47±0.02^{a}	.000
ADF	33±0.3^{cd}	35.23±0.5^{c}	46.3±1.8^{a}	45.8±0.8^{a}	38.90±0.1^{b}	32.41±0.1^{d}	.000
NDF	49.4±0.3^{b}	45.06±0.3^{d}	50.6±0.5^{a}	49.23±0.3^{b}	47.30±0.3^{c}	44.20±0.3^{d}	.000
Silica	7.36±0.1^{b}	8.07±0.1^{a}	5.9±0.07^{d}	3.07±0.1^{e}	2.66±0.3^{d}	6.73±0.1^{c}	.000
Lignin	25.9±0.09^{c}	35.65±0.1^{b}	10.5±0.8^{bc}	10.55±0.9^{bc}	54±2.31^{a}	25.30±0.5^{c}	.000

Table-2: Potential anti-nutritional factors present in collected tree leaves and their Tanin Content

Tree leaves	Anti-nutritional factors	Tanin Content (% of DM)
Mango (*Mangifera indica*)	Tannins, Saponins	1.69
Ipil-ipil (*Leucaena leucocephala*)	Mimosine and Tanin	0.82
Jackfruit (*Artocarpus heterophyllus*)	Phytic acid, Oxalate, Tanin	0.08
Mehogany (*Swietenia mahagoni*)	Glycosides, Tannins,	1.4
Banana (*Musa acuminate*)	Tannin, Flavonoids	0.84
Hilinchi (*Enhydra fluctuans*)	Saponin, Tannin, Oxalate	0.05

metabolism energy (ME) and net energy for lactation (NEL). Data related to *in vitro* and laboratory studies were analyzed in a Completely randomized Design (CRD) using statistical program SPSS, version 20.0. The chemical contents of the selected tree leaves are presented in Table-1 and accordingly values were varied different Highest DM content (52.1%) was found in Mahogany ($p<.001$) and the lowest was in banana (29.33%). Results show that the level of CP, one of the essential nutrients for productivity, is promising in most commonly used Jackfruit leaves (13.84%), but beside Ipilipil (23.8), Hilinchi is a surprising source of CP (21.1%) among the leaves of the selected trees, of which Hilinchi is a locally available popular tree in the hilly regions. Since tannins are found in the leaves of most plants as an anti-nutritional factor that impairs animal productivity, the tannin content of all the selected leaves were analyzed. From Table-2, higher tannin content was observed in Mango (1.69%) and Mahogany (1.4%) where the lower was in Jackfruit (0.08%) and Hilinchi (0.05%). Intermediate level of tannin was found in Ipilipil (0.82%) and Banana (0.84%). To determine the quality of the leaves of the plants considered were incubated for 72 h and gas production measured at different time intervals and the amount of gas produced by them was recorded. From the obtained data, the trend of their gas production is shown in figure-1. Data reveals that maximum amount of gas was obtained at 60 hours irrespective of leaves. In case of total volume of gas production maximum was noted in Banana and minimum was in Mango. Gas production data of Ipil-ipil was also so impressive. The calculated value of digestibility (%) and ME (MJ/Kg DM) of tree leaf is been presented in Table-3. In terms of quality, Ipil Ipil can be recognized as a supreme quality tree fodder and jackfruit and banana leaf as next in line whose respective Digestibility (%) and ME (MJ/Kg DM) value is 71.72, 68.13, 64.04% and 9.4, 8.57 and 7.91 MJ/Kg DM, respectively. No significant difference was observed in the Digestibility and ME value of Mango, Mahogany and Hilinchi leaf.



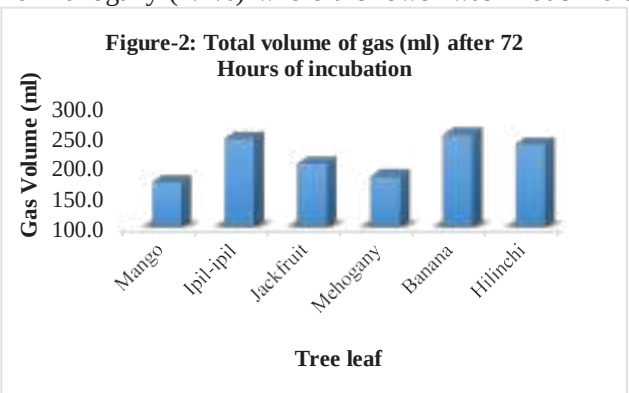


Table-3: Digestibility and Metabolizable Energy of different tree leaves

Item	Leaf (Mean±SE)						P value
	Mango	IpilIpil	Jackfruit	Mahogany	Banana	Hilinchi	
Digestibility (%)	50.09±0.9^{c}	71.72±2.3^{a}	68.13±1.6^{ab}	50.81±1.0^{c}	64.04±1.9^{b}	49.59±0.9^{c}	.000
ME (MJ/Kg DM)	6.13±0.1^{c}	9.4±0.4^{a}	8.57±0.3^{b}	6.76±0.2^{c}	7.91±0.3^{b}	6.0±0.1^{c}	.000

Finally, it can be said with certainty that there is a profound ability tree leaves to ensure production efficiency as supplementary fodder in goat diet as per obtained data on Digestibility and ME through this study. But it requires a series of studies regarding its anti-nutritional factor, processing, inclusion level and animal feeding with production performance.

Development of buffalo fattening model for quality meat production Running Title: Development of community-based buffalo fattening program

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Executive Summary

In Bangladesh, about 50 to 60 percent of the total buffaloes are reared in the coastal areas and the remaining majority of the buffaloes are reared in the Padma, Jamuna, Brahmaputra River basins and various haor land areas of the country. Coastal pastures typically have abundant grass for six months (April to September) and no grass for the remaining six months (October to March). Farmers cultivate vegetables, watermelon, paddy and other crops during this time and they cannot use the chor land for buffalo grazing. For the buffaloes, these six months are a serious grass crisis. As a result, buffaloes become malnourished and the production is severely reduced and the buffaloes become emaciated. Buffalo meat is regarded as a healthy red meat but in our country most of the buffalo meat is produced from aged and emaciated buffaloes. As a result, the meat is generally of poor quality and is often unattractive in appearance and bone and meat ratio are high. The growing male buffaloes are normally not taken care with special feeding and dietary allowance for faster growth, consequently quality and quantity of buffalo meat is not up to level of expectation. If buffalo fattening at the aged of 18-36 months, the amount of intramuscular fat increases slightly due to some fat deposition in the meat, the meat becomes lean and soft, the tenderness and juiciness of the meat increases and the palatability of the meat increases. Buffalo meat has 40 percent less cholesterol, 12 percent less fat, 55 percent fewer calories, 11 percent more protein and 10 percent more minerals than beef. Buffalo meat contains 3.42 mg of iron, which is much more than beef (2.72 mg). Buffalo meat contains 2.86 mg of vitamin B-12, more than beef (2.50 mg), which is essential for children's physical growth and mental development. In addition, buffalo meat contains high levels of omega-3 and omega-6 polyunsaturated fats that are very beneficial to the human body, which can help lower blood cholesterol levels. As a result, regular buffalo meat eaters have a lower risk of heart disease, stroke and other inflammatory diseases. If buffalo fattening technology can be expanded in large scale in the buffalo dense areas of the country, then the negative perception about buffalo meat will change a lot in the mind of the consumers, which will be able to play an important role in increasing the acceptance of buffalo meat. The hope is that buffalo fattening has started in various districts of the country especially in Bhola, Patuakhali, Noakhali, Chattagram, Sylhet, Mymensingh, Jamalpur, Rajshahi, Pabna and Sirajganj in the form of farms and families, and it is increasing day by day. Therefore, the research was taken with three different objectives viz. i) To determine suitable duration and appropriate feeding system & management practices for buffalo fattening program, ii) To determine the production performance and quality of meat and iii) To determine the functional herd size for sustainable buffalo fattening program. To fulfill the objectives twelve buffalo bulls from eight farmers at Bauphal upazila under Patuakhali district that have high buffalo population density were selected for community-based fattening program. Buffalo bulls were 2 years old and divided into two group; group A (n=6) and group B (B=6). Their average body weights were 189.17±24.71 and 188.67±28.64 kg respectively. The bulls were housed environment friendly bull shed in separate pens and offered daily rations. At the onset of feeding trial, bulls were de-wormed for internal parasites and vaccinated against contagious diseases (Foot and Mouth Disease and Hemorrhagic Septicemia). The feeding trial was continued for a period of 120 days including a 15 days conventional digestion trial. Rations were supplied to Group A: Concentrate 30% + UMS 70%; and Group B: Concentrate 15% + UMS 85%. The dry matter (DM) and crude protein (CP) content of UMS and concentrate mixture used in experimental ration were 57.15 vs 88.10%, and CP 9.27 vs 18.08%, respectively. The bulls were weighed at fortnightly, and their feed intake, FCR, growth performance and cost-net profit were analyzed. Feed intake, growth, feed conversion efficiency and net profit of buffalo bulls were shown in Table 1. Result showed that dry matter intake of group A were significantly ($p<0.05$) higher compared to group B. There was no significant difference of initial and final body weight between treatment groups but final body weight was higher in group A than B.

Table 1: Feed Intake, growth, feed conversion efficiency and net profit of buffalo fattening at community

Parameters	Group A	Group B	Sig.
DMI (Kg/d)	8.15	7.17	*
DMI (Kg) (% LW)	2.90	2.55	*
Initial LW(Kg)	189.17	188.67	NS
Final LW (Kg)	281.17	257.92	NS
ADG (Kg)	0.767	0.577	*
FCR	7.12	8.20	*
Total cost/Kg gain (BDT)	383.35	332.86	*
Net profit (BDT)	6131.80	8111.95	*

Average daily body weight gain was significantly higher ($p<0.05$) in group A than group B. Significantly ($p<0.05$) feed conversion ratio (FCR) was lower but total cost/Kg gain was higher in group A compared to group B. Net profit was significantly ($p<0.05$) lower in group A compared to group B. Considering the above findings, it may be concluded that UMS with 15% concentrate diet should profitable for buffalo fattening.

Production of value added poultry meat through dietary manipulation of selected herbal plants

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Executive summary

It is well known that dietary lipid manipulation can alter lipid composition of different tissues of animals. Poultry can synthesize long chain n-3 fatty acids such as eicosapentaenoic acid (EPA, C20:5) and docosahexaenoic acid (DHA, C22:6) from linolenic acid. The global omega 3 market size was estimated at USD 7.5 billion in 2022 and it is projected to hit around USD 15.1 billion by 2032. Daily a minimum of 250-500mg of Omega 3 is needed, although depending on health conditions, requirement changes. WHO predicts that by 2030 cardiovascular disease will be the cause of death for approximately 23.6 million people in the world and account for about 25% of the number of cases of death. The value added products especially poultry products are very much beneficial for human health to combat many health problems. So that this study is conducted to produce value added broiler meat enriching with ω-3 fatty acid, oxidative stability and reduce cholesterol content using *M. oleifera* and *L. usitatissimum* as feed additives. An experiment was conducted to evaluate the effects of *Linum usitatissimum* (Flaxseed) with Moringa *oleifera* leaf (Moringa) on carcass quality, fatty acids profile, and oxidative stability in broiler chicken. A total of 240 day-old mixed-sex 'Cobb 500' broilers were assigned to a 35-day production period. Cholesterol determination was done in broiler meat according to the method described by Sharmin et al. (2017) with some minor modification. Cholesterol separation was conducted by Agilent 8890 with an HP-5 capillary column and a flame ionizing detector, FID. Broiler chicks were assigned to four dietary treatments as follows: T_1-control diet; T_2-flaxseed 0.5% + moringa1%; T_3-flaxseed 1%+ moringa 1%; and T_4-flaxseed 1.5% + moringa 1%. The moringa level (1%) was kept fixed with addition of fluxseed at the gradual increment levels for synergistic effect.

The final body weight gain was similar in all groups in 35 days with significantly ($P < 0.05$) reduced feed intake in T_4 than control. The TBARS values of meat were reduced in the flaxseed and moringa-added groups ($P < 0.05$) than the control. Cholesterol content in thigh meat decreased significantly ($P < 0.05$) in T_3 and T_4 groups compared to the control. In breast and thigh meat, the sum ω3 fatty acids were higher, alongside significantly increased polyunsaturated fatty acids, and a lower ω6/ω3 ratio except T_2 group was observed in flaxseed and moringa added group ($P < 0.05$) in thigh meat. In our findings, both breast and thigh meat (Table 1 and Table 2) we have got significantly ($P<0.05$) increased ω - 3 PUFA after addition of flaxseed levels in corporation with moringa. This is might be due to the combined synergistic effect of both moringa and higher levels of flaxseed. Similar findings was reported earlier by Mirshekar *et al*., 2015, they had expressed that the total n-3 content of the breast and thigh showed a strong positive linear relationship with duration of flaxseed oil consumption prior to slaughter. The n-3 and n-6 polyunsaturated fatty acids (PUFAs) are essential components of the most vertebrate diet because most of them are unable to synthesize these fatty acids. The broiler breast and thigh meat samples were preserved in a refrigerator at 4℃ to determine the oxidative stability. Thiobarbituric acid reactive substances (TBARS) values of meat samples were assayed at 0, 4, 7, 14, 21, and 28 days according to the method described by Sarker et al. (2010) with slight modification. It was shown that TBARS values of broiler thigh meat T_2 group with the value of 9.95μmol MDA/100g was significantly lower TBARS values at 14 days compared to the control 25.95 μmol MDA/100g. However, after 21 days all additives groups both breast and thigh meat values were significantly lower than the control group.

Table 1. Effects of dietary flaxseed and moringa on fatty acid (g/100g fatty acids) composition and cholesterol (mg/100 g) of broiler breast meat

Parameters (g/100g)	T_1	T_2	T_3	T_4	SEM	*p*-Value
Linolenic acid (C18:3), ω-3	1.20^{b}	0.96^{b}	1.35^{b}	2.51^{a}	0.10	0.01
Eicosapentaenoic acid (C20:5), ω-3	0.03^{b}	0.04^{b}	0.08^{a}	0.04^{b}	0.03	0.001
Docosahexaenoic acid (C22:6), ω-3	0.05	0.07	0.06	0.06	0.05	0.15
SFA%	31.99^{a}	26.01^{b}	25.01^{b}	25.95^{b}	0.72	0.02
USFA%	71.09^{a}	70.90^{a}	64.53^{b}	70.55^{a}	1.09	0.01
MUFA %	40.37	42.50	37.49	41.66	0.51	0.16
PUFA %	27.71^{a}	24.75^{b}	26.02^{ab}	25.09^{ab}	0.65	0.01
ω-3	1.29^{c}	1.35^{bc}	1.49^{b}	2.61^{a}	0.01	0.01
ω-6	26.44^{a}	22.93^{c}	24.53^{b}	23.29^{b}	0.31	0.01
ω-6: ω-3	20.50^{a}	16.99^{b}	16.46^{b}	17.01^{b}	0.41	0.01
Cholesterol (mg/100g)	29.84	27.00	29.44	29.86	0.53	0.67

T_1-Control diet; T_2-flaxseed 0.5% + moringa 1%; T_3-flaxseed1% + moringa 1%; T_4-flaxseed 1.5% + moringa 1%. [1]Each value represents the mean of 4 replications with 2 birds/replication. Values are expressed as mean and standard error of means. SFA = saturated fatty acid; MUFA = mono-unsaturated fatty acid; PUFA = Poly-unsaturated fatty acid; ω - 3 = total omega 3 fatty acid; ω - 6 = total omega 6 fatty acid. $^{a, b, c}$ Mean with different superscripts within same rows are significantly different ($P < 0.05$) by Duncan's test.

Table 2. Effects of dietary flaxseed and moringa on fatty acid (g/100g fatty acids) composition and cholesterol (mg/100 g) of broiler thigh meat

Parameters (g/100g)	T_1	T_2	T_3	T_4	SEM	*p*-Value
Linolenic acid (C18:3), ω-3	0.86^{c}	0.98^{bc}	1.21^{ab}	1.44^{a}	0.07	0.01
Eicosapentaenoic acid (C20:5), ω-3	0.07	0.04	0.07	0.03	0.05	NS
Docosahexaenoic acid (C22:6) ω-3	0.07^{ab}	0.04^{b}	0.08^{a}	0.04^{b}	0.01	0.01
SFA %	31.05^{a}	28.97^{ab}	27.84^{ab}	28.74^{ab}	0.42	0.01
USFA %	67.06^{ab}	69.18^{ab}	70.52^{a}	68.63^{ab}	0.63	0.01
MUFA %	42.26^{a}	41.12^{ab}	40.69^{ab}	41.54^{ab}	0.34	0.01
PUFA %	22.59^{c}	27.14^{a}	27.31^{a}	24.86^{b}	0.59	0.01
ω-3	1.00^{d}	1.03^{c}	1.36^{b}	1.51^{a}	0.02	0.01
ω-6	21.35^{c}	26.11^{a}	25.95^{ab}	23.17^{bc}	0.51	0.01
ω-6:ω-3	21.35^{b}	25.34^{a}	16.65^{c}	16.20^{c}	0.73	0.01
Cholesterol (mg/100g)	34.92^{a}	28.61^{ab}	26.07^{b}	26.31^{b}	0.86	0.02

T_1-Control diet; T_2-flaxseed 0.5% + moringa 1%; T_3-flaxseed1% + moringa 1% ; T_4-flaxseed 1.5% + moringa 1%. [1]Each value represents the mean of 4 replications with 2 birds/replication. Values are expressed as mean and standard error of means. SFA = saturated fatty acid; MUFA = mono-unsaturated fatty acid; PUFA = Poly-unsaturated fatty acid; ω - 3 = total omega 3 fatty acid; ω - 6 = total omega 6 fatty acid. $^{a, b, c}$ Mean with different superscripts within same rows are significantly different ($P < 0.05$) by Duncan's test.

Overall, the results presented here indicate that the addition of diets with up to 1.5% flaxseed with a combination of moringa 1% improved the meat composition, ω3 fatty acid, and reduced lipid oxidation of broiler meat.

Research First

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POSTER SESSION

Evaluation of production performance and nutrient components of different fodder varieties and development of fodder germplasm bank at BLRI RS Rajshahi

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Executive summary

Availability and quality of green grasses are major constraints of cattle production in Bangladesh. In addition, fodder cultivation in Barendro region is a great challenge because of its high environmental temperature and lower rainfall condition. Farmers are not conscious about livestock feeding with green fodder and usually use the byproducts of paddy as livestock feed that remains in the field after harvesting. Bangladesh Livestock Research Institute (BLRI), regional station (RS), Rajshahi is the second largest regional station having about 26 acres of land among five RS's of BLRI. A replica of Red Chittagong cattle (RCC), Buffalo, Black Bengal Goat (BBG), three types of native chicken have already established at RS, Rajshahi. A replica of fodder germplasm like BLRI head quarter containing all economically important fodder varieties is immediately needed to establish at BLRI, RS, Godagari, Rajshahi. Then, evaluation of those conserved fodder varieties for selecting a suitable fodder variety for sustainable and profitable fodder production in this region. According to Sarker *et.al* (2021), Cultivars and locations had a significant ($p<0.001$) effect on biomass yield, plant height and leaf-stem ratio. Considering those points in mind, eight (8) new varieties of fodders such as Zara, Signal, C04, Guinea, Andropogan, Rozi, Plicatulum, and Dal have been conserved to the fodder germplasm bank. The objective of this experiment was to evaluate the production performance and nutrient components of three different varieties of Napier fodder. There were three treatments with four replications and treatments were T_1= BLRI Napier-3, T_2= Red Pakchang, and T_3= BLRI Napier-4, and each of the plot size was 150m.$^{2.}$ Three soil samples collected from each fodder plot were analyzed from the Soil Resource Development Institute, Divisional Laboratory, Rajshahi. Soil composition of experimental fodder plots is shown in Table 1. The production parameters of high yielding fodder variety at 1st, 2nd, and 3rd cutting were recorded. The collected data were analyzed through one-way analysis of variance using SPSS 22.0 statistical program. No significant differences ($p>0.05$) were found in biomass yield, plant height, leaf number, tiller number, and stem perimeter among the treatment's groups (Table 2). However, the production performance of BLRI Napier-4 showed numerically higher value compared to the average mean value. Significant differences ($p<0.05$) were found in at 1st, 2nd, and 3rd cutting (Table 3). Nutrient composition of three cultivars was varied significantly ($p<0.05$) (Table 4). In conclusion, BLRI Napier-4 is better in terms of production parameters and ADF value than other cultivars. Further investigations with more samples are needed to draw a precise conclusion.

Table 1. Soil composition of experimental fodder plots

Soil constituents	Measuring unit	Mean ±SD
pH		7.4±0.42
Organic matter (OM)	%	1.585±0.56
Total Nitrogen (N2)	%	0.0925±0.03
Potassium (K)	Millitulanko/100 g	0.1175±0.04
Phosphorus (P)	Micro-gram/g	18.175±6.18
Sulphur (S)	Micro-gram/g	15.475±4.75
Boron (Bo)	Micro-gram/g	0.35±0.44
Zinc (Zn)	Micro-gram/g	0.905±0.51

Table 2: Mean comparison of various production parameters among fodder cultivars

Parameters	BLRI-Napier 3	Red Pakchang	BLRI-Napier 4	Overall mean
	Mean ± SE	Mean ± SE	Mean ± SE	
Biomass yield (kg/ha)	144.67±46.19	176.93±61.81	184.87± 69.93	168.82±30.68
Plant height (inch)	19.13±7.68	22.00±7.64	25.67±9.25	22.27±4.22
Leaf number/plant	12.00±0.67	13.63±0.37	14.43±1.44	13.56±0.58
Leaf length (inch)	15.10±4.67	15.20±2.48	20.09±5.26	16.79±2.30
Tiller No/hill	14.90±6.91	17.53±8.27	19.27±10.47	17.23±4.38
Stem perimeter (inch)	2.31±0.18	2.49±0.14	2.25±0.32	2.44±0.12

Table 3: Mean comparison of various production parameters among different cuttings

Parameters	Cutting 1	Cutting 2	Cutting 3
	Mean ± SE	Mean ± SE	Mean ± SE
Biomass yield (kg/ha)	91.67± 3.28^{a}	129.43±9.59^{a}	285.37±25.52^{b}
Plant height (inch)	11.33±0.67^{a}	17.230±2.51^{a}	38.23±2.64^{b}
Leaf number/plant	12.33±0.88	14.33±1.45	13.35±0.45
Leaf length (inch)	10.67±0.89^{a}	15.11±1.83^{a}	24.62±2.99^{b}
Tiller No/hill	4.60±0.37^{a}	13.60±0.31^{b}	33.50±5.90^{c}
Stem perimeter (inch)	2.03±0.08^{a}	2.51±0.12^{b}	2.77±0.12^{bc}

Mean with uncommon superscript differ significantly at the 0.05 level ($p<0.05$)

Table 3: Mean comparison of nutrient composition of three fodder cultivars

Nutrient components	BLRI-Napier 3	Red Pakchang	BLRI-Napier 4	Overall mean
	Mean ± SE	Mean ± SE	Mean ± SE	
Dry matter (DM) %	21.24± 0.59^{a}	19.63±0.24^{a}	21.72±0.11^{c}	20.86±0.36
Ash%	13.90±018^{a}	17.09±0.09^{b}	13.67±0.08^{a}	14.89±0.55
Crude protein%	7.37±0.10^{a}	8.09±0.11^{b}	7.50±0.0.08^{a}	7.67±0.12
ADF%	42.20±0.27^{a}	41.07±0.01^{b}	39.51±0.11^{c}	40.92±0.40

Mean with uncommon superscript differ significantly at the 0.05 level ($p<0.05$)

Development of meat type quail through appropriate breeding

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Executive Summary

The present study was conducted at Bangladesh Livestock Research Institute, Savar, Dhaka and four genotypes of quail such as Black (Bl), Brown (Br), Dhakai (D) and White (W) with the objectives; (i) to increase the sixth week body weight of Dhakai and BB-white quail through selective breeding (ii) to select parental birds (males and females) and breed them using best to best mating plan for the production of 13th generation birds. In this study, 6th week body weight (BW) was using as a selection criterion and maintaining the precise pedigree records in each generation for developing meat- type quail. Single pair mating through selective breeding is also practicing to produce the chicks of the subsequent generation. The commercial poultry feed was provided to all birds from 0 to 4 weeks (starter feed: 24% CP, 3000 Kcal/kg DM ME), 4 to 5 weeks (grower feed: 21% CP, 2800 Kcal/kg DM ME), and 6 to 30 weeks (layer feed: 18% CP, ME 2600 Kcal/kg DM ME) of age, respectively. A total of 1184-day-old chicks comprising of 4 types of quail namely Black (Bl-344), Brown (Br-265), Dhakai (D-309) and White (W-266) were hatched to produce twelfth generation (G_{12}). Chicks were wing banded and reared separately according to genotypes. Ten (10) birds from each genotype of quail were slaughtered to evaluate carcass characteristics and determine the nutrient content of meat in twelfth generation (G_{12}) at fifth week of age. Expected genetic progress due to selection for the 6th week BW was estimated for the G_{12} using the equation given by *Falconer, 1981.* Data were analyzed by CRD using Statistical Package for the Social Sciences (SPSS) version 20.0.

Table 1 showed that higher day old chick weight was found in Bl (7.1±0.06g) compared to other genotypes. The 5th week BW and growth rate were significantly ($p<0.001$) found as the highest in D (140.2±1.4g and 3.8±0.04g) among the all genotypes. Feed conversion ratio (FCR) from 0 to 5 weeks of age was significantly better in D (3.3) compared to Br (3.7), Bl (3.8), and W (3.9). Genotype had no significant ($p>0.05$) effect on age at sexual maturity (ASM), egg production (No) (13-35 week), hen day egg production percentage (HDEP %) (6-35 week). Table 1 showed the mortality percentage of 0-4 weeks of age. Significantly ($p<0.001$) higher mortality% was found in W (3.4%) followed by Bl (1.2%), Br (1.1%), and D (0.3%). Dressing percentage was significantly ($p<0.001$) higher in D (75.18%) followed by W (71.92%), Bl (69.85%), and Br (67.85%) genotypes which was shown in Table 2. Breast meat percentage of live weight was found as the highest in W (24.06%), intermediate in D (22.10%) and Bl (22.18%) but the lowest in Br (21.20%). The highest crude protein content of quail meat was found in Br (24.8%) compared to D (23.7%), W (23.4%) and Bl (22.5%) genotypes (Table 3). Selection differential varied from 3.72 g BW in Br quail male to 13.84g BW in D quail female. The selection differentials for the males were 9.72, 3.72, 9.26, and 7.19 g for Bl, Br, D, and W quail genotypes, respectively. For the females, the corresponding values of the selection differentials were 8.62, 6.54, 13.84 and 7.38g (Table 4). Table 4 also showed that the 6th week BW of male quails of Bl, Br, D and W was expected to increase by 4.20, 1.79, 4.18 and 2.88, respectively. While in female quails of Bl, Br, D and W, the expected responses were 3.37, 3.11, 6.28 and 3.36, respectively. Finally, it can be concluded that Dhakai quail is superior based on body weight and dressing percentage. On the other hand white quail is superior for egg production. The further study is needed to produce standard population size of four quail genotypes in the thirteenth generation (G_{13}) for improving their target body weight at BLRI.

Table 1: Productive and reproductive performance of four quail genotypes

Parameter	Genotype (Mean±SE)				Level of significance
	Black	Brown	Dhakai	White	
Chicks weight (g)	7.1^{a}±0.06	6.4^{c}±0.05	6.8^{b}±0.05	6.8^{b}±0.05	P<0.001
5^{th} week body weight (g)	123.5^{b}±1.4	121.0^{b}±1.4	140.2^{a}±1.4	122.9^{b}±1.4	P<0.001
Growth rate (0-5 week)	3.3^{b}±0.04	3.3^{b}±0.04	3.8^{a}±0.04	3.3^{b}±0.04	P<0.001
FCR (0-5 week)	3.8^{a}±0.04	3.7^{b}±0.04	3.3^{c}±0.04	3.9^{a}±0.04	P<0.001
Age at first egg (days)	39±2.58	38±3.05	39±2.93	39±2.89	NS
EP (No)(13-35 week)	131.6±0.84	131.4±0.84	131.1±0.84	133.2±0.84	NS
HDEP (%) (6-35 week)	81.6±0.92	82.0±0.92	82.1±0.92	82.6±0.92	NS
Mortality (%) (0-4 wks)	1.2%	1.1%	0.3%	3.4%	P<0.001

FCR=Feed Conversion Ratio, EP= Egg Production, HDEP= Hen Day Egg Production, Least squares mean without a common superscript along the row within a factor differed significantly (p<0.001), NS=non significance

Table 2: Carcass characteristics of quail in twelfth generation (G_{12}) at fifth week of age

Parameter	Genotype (Mean±SE)				Level of sig.
	Black	Brown	Dhakai	White	
Live weight (g)	133.3^{c}±10.4	127.2^{c}±10.4	160.0^{a}±10.4	141.4^{b}±10.4	p<0.001
Dressing (%)	69.85^{b}±2.9	67.85^{b}±2.9	75.18^{a}±2.9	71.92^{a}±2.9	P<0.001
Drumstick WT % of LW	5.88±0.33	5.60±0.33	5.79±0.33	5.83±0.33	NS
Thigh WT % of LW	8.41^{a}±0.53	7.60^{b}±0.53	7.95^{b}±0.53	8.55^{a}±0.53	P<0.05
Breast meat WT % of LW	22.18^{b}±1.09	21.20^{c}±1.09	22.10^{b}±1.09	24.06^{a}±1.09	P<0.001

WT=Weight, LW= Live weight, Least squares mean without a common superscript along the row within a factor differed significantly (p<0.05), NS=non-significance

Table 3: Nutrient content of quail meat in twelfth generation (G_{12}) at fifth week of age

Parameter	Genotype (Mean±SE)				Level of sig.
	Black	Brown	Dhakai	White	
Crude protein (%)	22.5^{c}±1.14	24.8^{a}±1.14	23.7^{b}±1.14	23.4^{b}±1.14	P<0.05
Crude Fibre (%)	0.15±0.4	1.15±0.4	0.30±0.4	0.30±0.4	NS
Crude Fat (%)	0.70^{b}±0.13	0.50^{b}±0.13	1.0^{ab}±0.13	1.3^{a}±0.13	P<0.001
Ash (%)	1.07^{b}±0.5	1.9^{a}±0.5	1.3^{b}±0.5	2.3^{a}±0.5	P<0.05

Least squares mean without a common superscript along the row within a factor differed significantly (p<0.05), NS=non-significance

Table 4: Selection response for 6^{th} week body weight of quail at 12^{th} generation (G_{12})

Genotype	Sex	(SD) (g)	(h^2)	(R) (g)
Black	M	9.72	0.432	4.20
	F	8.62	0.391	3.37
Brown	M	3.72	0.482	1.79
	F	6.54	0.476	3.11
Dhakai	M	9.26	0.451	4.18
	F	13.84	0.454	6.28
White	M	7.19	0.401	2.88
	F	7.38	0.455	3.36

M = Male, F = Female, SD = Selection Differential, h^2 = Heritability, R = Response to selection

Development of meat type chicken utilizing native and exotic genetic resources suitable for climatic condition of Bangladesh

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Executive summary

The poultry sector is an integral part of farming systems. It has created both direct and indirect employment opportunities, improved food security, and enhanced the supply of quality protein to people's meals, contributing to the country's economic growth and reducing poverty levels in rural and urban areas of Bangladesh. As of now, we are fulfilling our protein requirements of 137.38 g meat and 134.58 nos of egg. As a developed country, to achieve the goals of SDG's and also Vision-2021 by the year of 2041, we will be turned into a developed country. In many developed countries, people consume almost double the number of eggs and meat every year. To be a developed country, we should increase our minimum protein requirement level to compete with them. In this view, this research has been undertaken to select the best-performing native chicken lines based on growth, productive and reproductive performance, and meat quality parameters. Three native lines (NL1, NL2, NL3) and three exotic lines (EL1, EL2, EL3) were selected here. About 250 birds of each genotypes were selected for this experiment. The birds were reared in an open-sided house with a semi-gable roof and concrete floor at BLRI regional station Godagari, Rajshahi, and BLRI, Savar, Dhaka . After receiving, birds were brooded properly for 6-8 weeks. All the requirements (bedding material, temperature, humidity and others) during the brooding period were appropriately maintained. The birds then shifted to the grower shed and held until 20 weeks of age. After 20 weeks, the birds transferred to the laying shed. The birds received appropriate management procedures in different stages. The birds were reared in a natural-ventilated poultry house under a 16h photoperiod. The experimental birds were fed starter (0-7 weeks), grower (8-20 weeks), and layer (20-above weeks) diets during brooding, growing, and laying periods, respectively. *Ad-libitum* feeding was practiced for first four weeks. After that, restricted feeding was practiced during the growing period. *Ad libitum* fresh water was supplied twice daily (morning and evening). Refusals of the feed were measured every day in the morning. The selected birds with high genetic merits were identified individually using leg and wing bands. Data on growth, productive and reproductive traits of individual birds were recorded properly during this experimental period. In addition, survivability and disease-resistant traits were recorded on a flock basis. All chicks were vaccinated and dewormed properly as per the standard schedule. Ata were anaalysed using SPSS statistical software, version, 22.

All data on feed intake of different chicken genotypes at different ages are shown in Table 1. Data show that lowest feed intake found in Line 3 (40.07 g) whereas highest in Line 2 (41.84 g) upto 10 weeks of age, at 11-20th week lowest in Line 2(91.44g) and highest in Line 1(92.44g) and at 21-30 weeks Lowest in Line 2(107.98g) and highest in Line 3(110.65g) in native genotypes. Whereas, In Exotic lines lowest feed intake found in lines l (38.12g, 88.17g,101.4g, 111.91g) and highest in Line 2(40.99g, 91.9g,102.03g,115.72g) at consecutive weeks. There are no significant differences found in feed intake of different chicken genotypes at different weeks of ages.

Table 1. Feed intake of different chicken genotypes at different ages (Mean±SE)

Lines	Upto 10 weeks	11-20weeks	21-30 weeks	31-40 weeks
		Native Lines		
Line 1	41.45±2.46	92.44±0.88	109.66a±0.58	111.01b±0.31
Line 2	41.84±2.47	91.44±0.78	107.98b±0.57	111.61ab±0.11
Line 3	40.07±2.366	91.83±0.94	110.65a±0.49	111.91a±0.33
		Exotic Lines		
Line 1	38.12±2.42	88.17±0.89	101.4±0.51	111.91±0.56
Line 2	40.99±2.46	91.9±0.87	102.03±0.4	115.72±0.12
Line 3	40.83±2.42	91.03±0.87	102.96±0.76	114.63±0.09
Level of	NS	NS	***	NS

Significance

Table 2 shows body weight of different chicken genotypes at different ages. This Table reveals that in native genotypes lowest body weight found in Line 1 (29.2g, 278.7g, 586.08g, 920.81g, 1567.06g and 1729.12g) in doc, 4th ,8th, 12th,20th and 40th weeks of age and highest in Line 2 (26.46g, 280.02g, 692.19g) at doc, 4th, 8th weeks and in Line 3(1254.74g, 2107g and 2970.53g) at 12th, 20th and 40th weeks of age. In exotic genotypes lowest body weight found in Line 2(29.27g, 173.36g, 681.31g, 887.04g, 1511.13g) and Line 1(1875.55g) at 0, 4th, 8th, 12th 20th and 40th weeks of age and highest body weight found in Line3 (30.3g, 342.94g. 757.61g, 1078.48g, 2027.22 and 3210.82g) respectively. There are significant differences in body weight among all genotypes of chicken at all ages.

Table 2: Body weight of different chicken genotypes at different ages

Breed	DOC	4th week	8th week	12th week	16th week	20th week	24th week	28th week	32th week	40th week
					Native Lines					
Line 1	29.2[a]± 0.26	278.7[a]1± 2.26	586.08[b]± 3.43	920.81[b]±12 .93	1208.22[b]± 12.59	1567.06[c]±1 1.04	1419[b]±17. 76	1682.63 [a] ±16.58	1731.6[c]±1 8.4	1729.12[b]± 27.77
Line 2	29.56 [a] ±0.24	280.02 [a] ±3.33	692.19 [a] ±8.53	926.44 [b] ±11.72	1207.68 [b] ±17.34	1685.58 [b] ±16.31	1446.16 [b] ±24.96	1961.74 [b] ±16.96	1505.81[b] ±26.53	1709.85 [b] ±28.57
Line 3	26.46 [b] ±0.68	201.92 [b] ±4.53	542.04 [c] ±9.27	1254.74 [a] ±128.48	1622.93 [a] ±20.81	2107±27.2	2607.58 [a] ±35.81	3001.22 [a] ±38.66	3278.3 [a] ±44.28	2970.53 [a] ±31.44
LS	***	***	***	***	***	***	***	***	***	***
					Exotic Lines					
Line 1	36.76 [a] ±0.58	238.74 [b] ±3.16	677.36± 8.61	962.24 [b] ±13.95	1248.66 [c] ±16.19	1584.66 [c] ±14.216	1654.64 [c] ±18.41	1660.96 [c] ±18.67	1535.68 [c] ±17.81	1875.55 [b] ±33.88
LIne 2	29.27 [b] ±0.19	173.36 [c] ±6.71	681.31± 2.56	887.04 [b] ±2.85	1187.04 [b] ±2.85	1511.13 [b] ±4.62	1714.9 [b] ±6.72	1520.35 [b] ±6.91	1404.52 [b] ±7.09	1906.87 [b] ±27.29
Line 3	30.3 [b] ±0.22	342.94 [a] ±6.26	757.61± 3.42	1078.48 [a] ±4.88	1428.48 [a] ±4.88	2027.22 [a] ±26.21	2246.82 [a] ±24.18	2391.37 [a] ±24.8	2692.32 [a] ±37.81	3210.82 [a] ±33.33
LS	***	***	***	***	***	***	***	***	***	***

Table 3: Reproductive Parameters in different chickens

LInes	Age at onset of lay(d)	Fertility(%)(%)	Egg Production(Nos)	Hatchability(%)	Mortality(%)
			Native Lines		
Line 1	135.6±1.69	84.5160	120±1.2	81.7300	0.74±0.22
Line2	139.8±1.77	89.0720	80±2.2	77.5000	0.94±0.22
Line3	142±0.83	58.8100	60±1.34	88.2900	0.04±0.02
			Exotic Lines		
Line 1	174±2.42	57.1180	180±0.02	62.5800	0.94±0.22
Line2	180.4±3.5	73.6100	140±0.09	60.9500	0.95±0.19
Line3	124.4±1.36	88.8400	190±0.09	62.9600	0.54±0.09
LS	NS				NS

Table 3 shows reproductive performances in different chicken genotypes. Lowest age at the onset of lay was found in Line 1(135.5 days), highest fertility and hatchability in Line 2 (89.07%) and Line 3(88.29%), lowest mortality in Line 3(0.94%) and highest egg production in Line 1(120nos) in native lines. In Exotic chickens, lowest age at onset of lay, highest fertility and hatchability, lowest mortality and highest egg production found in Line 3(124.4days, 88.84%, 62.96%, 0.54,190nos).

From this study it was observed that native lines 1 and 2 and exotic lines 2 & 3 performed better at marketing age (12th week) as well as for reproductive traits. So these lines can be used for production of F_1 generation having potential of better meat prouction.

Collection, conservation and improvement of specialized fowl (Turkey, Guinea fowl and Pigeon) production at BLRI

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Executive summary

An increasing number of farmers and business owners are becoming interested in Turkey, Guinea fowl and Pigeon farming; however, they are incurring financial losses as a result of their inexperience of proper variety selection, scientific housing, feeding, and healthcare management as well as the scarcity of scientific data. Even people are crossing haphazardly within these species which is causing such priceless poultry material to be genetically eroded. Thus, BLRI has taken initiative to collect, conserve and improve the production performance of these specialized poultry species through scientific breeding and management practices. The objectives of the study were to introduce and conserve available varieties of Turkey, Guinea fowl and Pigeon at BLRI research farm and to evaluate their productive and reproductive performance so that suitable variety/breed of these species can be determined. Total 315 and 186 hatching eggs of turkey and guinea fowl were collected and 142 poults and 111 keets were hatched out. This stock is referred as generation 2. They have been brooded up to 4 weeks and their productive and reproductive performance have been evaluated. Total 20 pairs of pigeons were introduced into the flock. Required nutrients were provided to the birds at all ages and proper vaccination schedule and bio-security were followed. Data were analyzed using the Statistical Analysis System (SAS) (version 9.4M7, 2020).

Results showed that highest body weight of turkey from day old to 20 weeks of age was observed consistently in Bronze variety (Figure 1). Highest fertility of egg was found in Bronze variety and highest hatchability was observed in Red variety. Numerically maximum hen day egg production was exhibited in Bronze variety and egg weight was significantly highest in White variety among four varieties of turkey (Table 1).

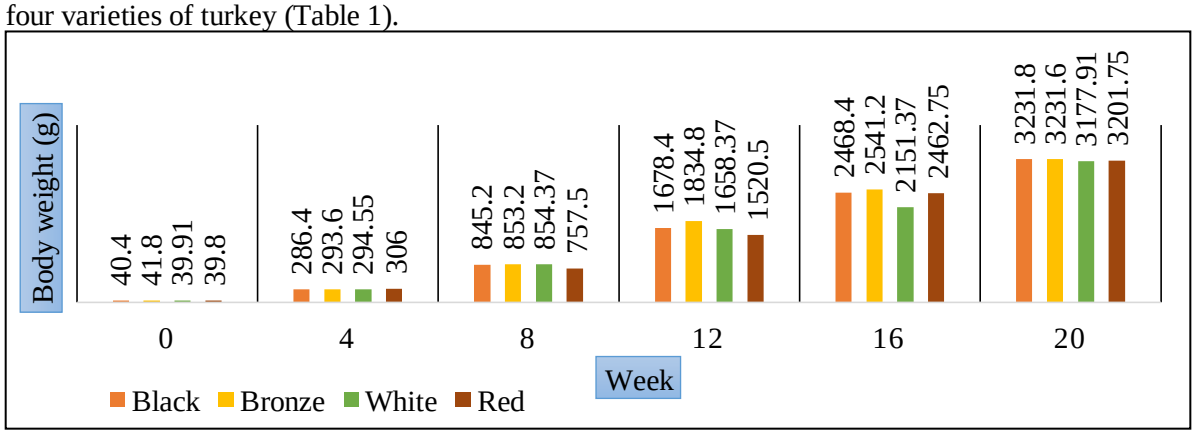

Figure 1: Body weight (g) of different varieties of turkey

Table 1: Reproductive and productive performance of different varieties of turkey reared under this study

Parameters	Black	Bronze	White	Red	SEM	P-value
Age at first laying (week)	23.37^{a}	23.10^{a}	23.20^{a}	23.90^{b}	0.10	0.002
Fertility(%)	82.67^{ab}	84.67^{a}	80.82^{b}	81.35^{b}	0.67	0.02
Hatchability(%)	62.35^{b}	53.48^{c}	51.22^{d}	70.43^{a}	0.58	0.001
HDEP (%)	33.93	38.32	28.27	35.00	5.10	0.59
Egg weight(g)	67.24^{c}	69.52^{bc}	75.86^{a}	72.67^{ab}	1.25	0.0002

$^{a\text{-}c}$Means with different superscript differ significantly ($p<0.05$); SEM= standard error of means; HDEP=Hen day egg production.

Numerically body weight observed from day old to 20 weeks of age was consistently higher in Pearl variety of guinea fowl (Figure 2). Numerically highest fertility of egg was found in Lavender variety and significantly highest hatchability was observed in White and Pearl variety. Numerically maximum hen day egg production and egg weight was exhibited in Lavender variety of guinea fowl (Table 2).

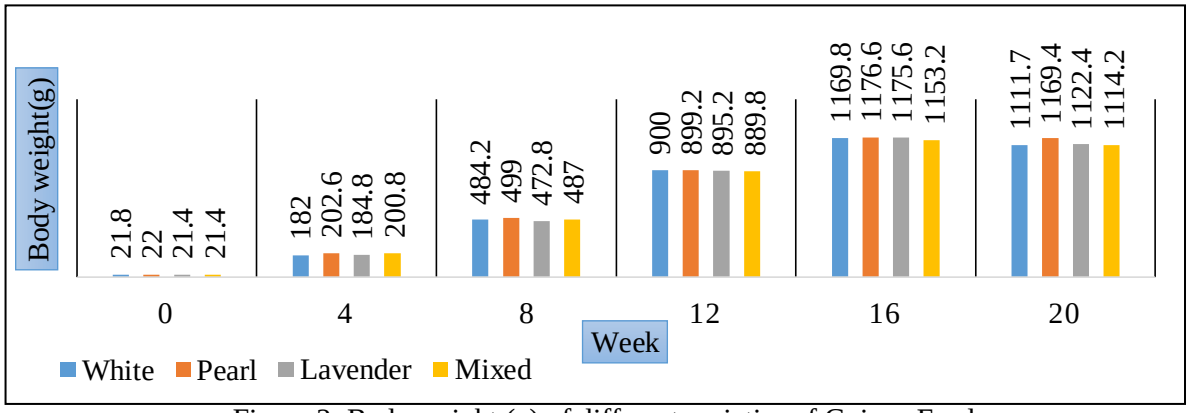

Figure 2: Body weight (g) of different varieties of Guinea Fowl

Table 2: Reproductive and productive performance of different varieties of guinea fowl reared under this study

Parameters	White	Pearl	Lavender	Mixed	SEM	P-value
Age at first laying (week)	18.6[a]	18.3[a]	19[b]	20[c]	0.12	0.001
Fertility(%)	59.20	65.72	65.74	59.66	6.10	0.77
Hatchability(%)	71.32[a]	76.75[a]	57.41[b]	39.61[c]	3.88	0.0006
HDEP(%)	23.54	28.71	33.46	30.67	9.92	0.91
Egg weight(g)	32.34	32.55	33.12	32.54	1.23	0.98

[a-c]Means with different superscript differ significantly ($p<0.05$); SEM= standard error of means; HDEP=Hen day egg production.

Highest body weight was observed in king breed and lowest body weight was found in Golla and Giribaz breed of pigeon (Table 3).

Table 3: Body weight (g) of different breeds of pigeon at the age of sexual maturity (6 months)

	Body weight (g)		
Breed	Male	Female	P-value
King	556.67[a]±21.53	539.33[a]±15.53	
Siraji	462.00[b]±18.64	417.50[b]±13.45	
Homer	371.50[c]±18.64	374.75[b]±13.45	
Mayurpankhi	359.67[cd]±21.53	315.67[c]±15.53	0.001
Golla	297.50[de]±26.36	235.00[d]±13.45	
Giribaz	255.50[e]±18.64	262.5[d]±19.02	

[a-c]Means with different superscript differ significantly ($p<0.05$); SE, Standard Error; g, gram.

In summary, the Bronze variety of turkey performed better compared to the other varieties in terms of growth and egg production. Pearl variety of guinea fowl exhibited better growth whereas egg production related traits were better in Lavender variety than that of other varieties. In case of Pigeon, King breed of pigeon displayed maximum body weight whereas our local Golla and Giribaz had the lowest body weight.

Conservation and performance evaluation of pure Red Chittagong cattle and their graded progeny at the community level

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Executive Summary

A progeny testing program is a prerequisite for continued genetic improvement in the cattle population of a country. It identifies bulls with superior genetic merit for economically important traits that are utilized by dairy producers to select future dams and sires. The Red Chittagong cattle (RCC) is one of the most promising indigenous cattle in Bangladesh. It is currently recognized as a natural heritage of cattle genetic resources for efficient cattle production in the country with changing climatic condition. Selection of some candidate bulls from the RCC herd to produce high quality frozen semen. The outstanding genetic potential of RCC bulls would then be explored using artificial insemination (AI) as a means of producing higher quality progeny throughout the country. Therefore, Bangladesh Livestock Research Institute (BLRI) has been conducting in-depth research on RCC for their genetic improvement by conserving (ex-situ) a small herd since 2006. Under the recently, completed ADP project of RCC (Phase-II), a total of 2995 AI were conducted and 279 pure RCC, and 386 graded RCC were produced during the project intervention. However, the performance of the first generation was not evaluated properly. Therefore, this study was undertaken to evaluate the performance of progressive generations of pure and graded RCC, at the rural community level.

The farmers were selected for progeny testing program after completing the farmer's communities consisting 200 farmers in 16 upazilas of 10 districts during RCC (Phase-II) project. 100 enlisted RCC farmers from Chattogram district (Hashimpur Village, Chandanaish) and 50 farmers from Rajshahi (Kamalapur Village,Godagari) were selected for pure RCC and graded RCC progeny, respectively. A total of 6 candidate bulls from 15 potential bulls were selected based on individual bull's performance and their pedigree records. The selection criteria of candidate bulls were semen volume>3.5 ml, sperm motility >75%, lactation length >180days, total milk yield >750L, avg. milk yield/d >4.5L. Collected semen from the candidate bulls were cryopreserved after semen quality evaluation. Then frozen semen were used to inseminate the cows at the community levels. A total of 300 herd books were provided to the farmers for recoding information. In Rajshahi, 60 AI was conducted on the 50 enlisted cows and 35 calves have been born, and 15 cows were pregnant. However, in Chattogram, 43 pure RCC calves were born, 16 calves were sold out, and 29 cows were pregnant. Independent sample t-test was used to compare mean body weight in different ages of pure RCC and graded RCC using SPPS program (version 20.00).

This study revealed that the birth weights were 16.21±0.19 kg and 13.27±0.21 kg for pure RCC and graded RCC calves, respectively, and differed significantly ($p<0.001$). Table 1 also shows the body weights at 3 months, 4 months, 5 months, and 6 months were significantly different between pure RCC and graded RCC under this investigation. Body weights were 39.08±1.40 kg, 49.32±1.70 kg, 56.60±2.08 kg, and 66.37±3.65 kg in pure RCC at 3, 4, 5, and 6 months of ages, whereas the values

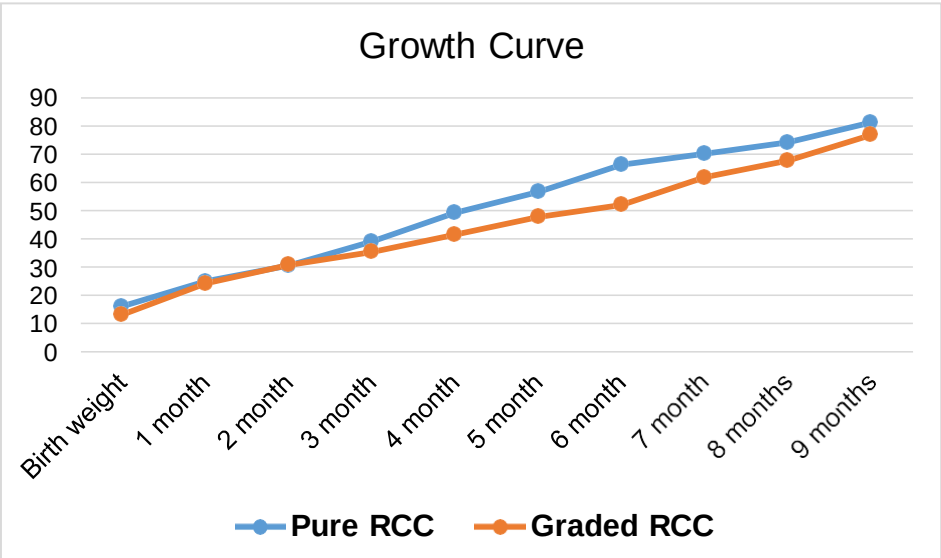
were 35.45±0.76 kg, 41.54±1.21 kg, 47.86±1.03, and 52.07±1.37 kg in graded RCC. However, no significant difference was found in pure RCC and graded RCC at the month of 1, 2, 7, 8, and 9 in this study. The growth curve makes it clear that the animals' body weight increased as they grew older.

This is an on-going project. However, this study would be helpful to establish pure RCC hub in Hashimpur Village, Chattogram and Graded RCC hub in Kamalapur village, Rajshahi.

Table 1. Comparative evaluation of the growth performance of pure RCC and graded RCC progeny (Mean±SE)

Genotype	Birth weight (kg)	1 month (kg)	2 months (kg)	3 months (kg)	4 months (kg)	5 months (kg)	6 months (kg)	7 months (kg)	8 months (kg)	9 months (kg)
Pure RCC	16.21± 0.19 (43)	25.07± 0.60 (42)	30.51± 0.85 (38)	39.08± 1.40 (35)	49.32± 1.70 (35)	56.60± 2.08 (32)	66.37± 3.65 (27)	70.28± 4.75 (18)	74.31± 3.16 (16)	81.39± 3.04 (13)
Graded RCC	13.27± 0.21 (34)	24.27± 0.35 (30)	30.80± 0.49 (30)	35.45± 0.76 (29)	41.54± 1.21 (28)	47.86± 1.03 (21)	52.07± 1.37 (15)	61.84± 2.20 (6)	67.80± 4.50 (5)	76.80± 4.22 (5)
Sig.	***	NS	NS	*	**	**	**	NS	NS	NS

Fig 1. Growth curve of pure RCC and graded RCC



Ex-situ conservation and improvement of native sheep at Bangladesh Livestock Research Institute

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Executive Summary

Sheep is a potential livestock species having some unique attributes such as high adaptability in marginal environments with low level of input, highly resistance to diseases and multiple births in each lambing; this species contributes much for sustaining rural livelihoods. These advantages need to be properly exploited to enhance the contribution of sheep in the national economy of Bangladesh. Continuous improvement by genetic selection, proper feeding and other management system may contribute to improve sheep genetic resources. The project has been designed to develop superior native sheep germplasm and to continue their improvement at BLRI and also to study the productive and reproductive performances of native sheep. The breeding program was conducted at Sheep Research Farm, BLRI, Savar, Dhaka with four different types of sheep viz. Coastal, Jamuna River basin, Barind and Garole. Ear tagging system was adopted for animal identification and record keeping. All the sheep were housed in slated floor permanent house raised above the ground level with sufficient space to keep them comfortable. Green grass (ad-libitum) and concentrate (17% CP, 11MJ/kg DM) were supplied twice daily (morning and evening) at the rate of 1.5% of the body weight of animal per day. The breeding program has been conducting through Open Nucleus Breeding System (ONBS) in such a way, which resists inbreeding. Rams were kept separately from ewes to avoid unplanned mating. Open Nucleus Breeding System was adopted in order to improve the genetic and phenotypic traits of existing breeding sheep stock. In this system, a Nucleus breeding flock (NBF) will be established by selecting superior native ewes and rams. Selection in the flock was done by simple procedures mostly on assessed fertility with some attention to size, body confirmation and condition. Animal were selected each year on the basis of individual performance, pedigree records and progeny performances. The subsequent data were recorded throughout the year. The selection targets of the study were to improve litter size, birth weight and 6 months body weight. The targeted litter size, birth weight and 6 months body weight were minimum 2 lambs per lambing, 1.5 kg and 14 kg. Data on productive and reproductive performances were recorded regularly. A completely randomized design (CRD) was executed for the experiment. Data were analysed with compare means procedure (One way ANOVA) and the differences among the means were determined with DMRT procedure using Statistical Package for the Social Sciences (SPSS) version 25.0.

Table 1 shows the productive and reproductive performance of different sheep genotypes. The average litter size, birth weight, 3 months and 6 months body weight of Coastal sheep were 1.42±0.05, 1.59±0.02 kg, 7.09±0.19 kg and 11.82±0.37 kg, respectively; in case of Jamuna River basin sheep, the values were 1.56±0.08, 1.25±0.03 kg, 6.87±0.29 kg and 10.98±0.47 kg, respectively; the values for Barind sheep were 1.63±0.07, 1.29±0.02 kg, 6.90±0.22 kg, 11.29±0.34 kg, respectively and in case of Garole sheep, the values were 1.41±0.07, 1.24±0.03 kg, 6.32±0.19 kg, 9.81±0.34 kg, respectively. There were no significant differences in terms of 3 months body weight (kg) but in case of litter size and 6 months body weight there were significant ($p<0.05$) differences among the genotypes. Furthermore, in case of birth weight there were highly significant ($p<0.001$) differences among four types of sheep.

Highest birth weight and 6 months body weight were found in Coastal sheep while the highest litter size was found in Barind sheep.

Table 1: Productive and reproductive performances of different traits of distinct types of indigenous sheep at BLRI (Mean±SE)

Parameters	Native sheep genotype				Significance level
	Coastal sheep	Jamuna river basin sheep	Barind sheep	Garole sheep	
Litter size	1.42^{bc}±0.05 (100)	1.56^{ab}±0.08 (52)	1.63^{a}±0.07 (56)	1.41^{bc}±0.07 (69)	*
Birth weight (kg)	1.59^{a}±0.02 (100)	1.25^{bc}±0.03 (50)	1.29^{bc}±0.02 (56)	1.24^{bc}±0.03 (61)	***
3 months body weight (kg)	7.09±0.19 (54)	6.87±0.29 (30)	6.90±0.22 (31)	6.32±0.19 (44)	NS
6 months body weight (kg)	11.82^{a}±0.37 (33)	10.98^{ab}±0.47 (23)	11.29^{ab}±0.34 (20)	9.81^{c}±0.34 (19)	*

Figure in the parenthesis indicate the number of observations. ***= significant (p=0.000-0.001), *= significant (p=0.01-0.05), NS= Non significance (p>0.05)

It can be concluded that superior rams and ewes will be selected for breeding purpose according to their individual performance score. The findings suggest further research until a significant level of improvement of the native sheep is achieved at BLRI.

Project Title: Conservation and Improvement of Black Bengal Goat at Different Community in Bangladesh
Sub title: Conservation and Improvement of Black Bengal Goat at Different Community in Bangladesh

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Executive Summary

Goat is now considered as the most promising livestock species for commercial meat production in the country. Among the goat population, more than 90 percent comprise of Black Bengal goats but the purity of this valuable breed is becoming extinct by the time being. Conservation and improvement of Black Bengal goat through community breeding can be one of the tools to overcome the problem as well as meet up the increasing demand of meat production. Considering the fact, the project has designed with the objectives- i) to improve the performances of Black Bengal Goat (BBG) at farmer's level ii) to establish and operate community based Buck park at farmer's level and iii) to improve community based data recording system for breeding purpose. The study was conducted at 8 selected areas viz. Naikhongchari, Godagari, Jashore, Kustia, Meherpur, Chuadanga, Valuka and Muktagacha. In each area, the community- based Buck Park already established to create a BBG community. Regular buck rotation was practiced to avoid inbreeding. A data recording software was also created to collect data from the different community. Data on different productive and reproductive parameters were taken to evaluate the performance of goat at different community. Data were analyzed by using Completely Randomized Design (CRD) through Statistical Package for the Social Sciences (SPSS) version 20.0. Mean comparison test was determined by Duncan's multiple range test (DMRT) program.

Table 1 and 2 shows the production performance of Black Bengal goat at different community using BLRI developed superior buck. The effect of community among all the traits was found significant ($p<0.001$ & $p<0.001$) except average daily gain$_{6\text{-}9}$ months ($p>0.05$). The highest litter size was found in Chuadanga community followed by Kustia, Godagari, Meherpur, Jashore, Muktagacha, Naikhongchari and Valuka, respectively. In case of body weight at different stages, the highest value was found in Meherpur community except the average daily weight gain $_{6\text{-}9}$ and the highest value for the trait was found in Chuadanga. Kid mortality at different community is shown in figure 1. The highest kid mortality was found in Chuadanga (4.67%) and lowest mortality was in Kustia community (3.39%). The kid mortality was lower due to different interventions through project activities.

Table 1: Least-squares means (LSM) with standard errors (SE) of performance of Black Bengal goat at different community-

Community	Parameter				
	Litter size (number)	**Birth Weight(kg)**	**3 months Body weight (kg)**	**6 months Body weight (kg)**	**9 months Body weight (kg)**
Chuadanga	2.3 ± 0.02^{a} (455)	1.68 ± 0.03^{b} (455)	4.82 ± 0.03^{c} (263)	8.58 ± 0.03^{bc} (213)	12.79 ± 0.06^{b} (186)
Godagari	2.08 ± 0.06^{b} (71)	1.25 ± 0.02^{d} (71)	4.41 ± 0.05^{de} (29)	7.68 ± 0.17^{bc} (29)	11.00 ± 0.25^{e} (28)
Jashore	2.05 ± 0.06^{bc} (183)	1.38 ± 0.02^{c} (183)	4.16 ± 0.04^{e} (130)	7.22 ± 0.09^{c} (91)	10.22 ± 0.41^{f} (38)
Kustia	2.24 ± 0.03^{a} (334)	1.81 ± 0.01^{a} (334)	5.38 ± 0.05^{b} (220)	8.68 ± 0.09^{bc} (171)	11.97 ± 0.14^{cd} (129)

Meherpur	2.07 ± 0.02^{b} (635)	1.82 ± 0.01^{a} (635)	6.09±0.06^{a} (282)	10.49±0.41^{a} (261)	14.16±0.1^{a} (256)
Muktagacha	1.94 ± 0.03^{cd} (95)	1.35 ± 0.03^{c} (95)	4.46±0.08^{d} (25)	8.16±0.17^{bc} (25)	11.72±0.22^{d} (25)
Naikhongchari	1.83 ± 0.05^{de} (288)	1.10 ± 0.00^{e} (288)	5.17±0.09^{b} (66)	8.13±0.12^{bc} (65)	10.96±0.2^{e} (60)
Valuka	1.75 ± 0.05^{e} (179)	1.18 ± 0.00^{de} (179)	4.88±0.12^{c} (50)	8.88±0.18^{b} (49)	12.51±0.2^{bc} (40)
Level of significance	***	***	***	***	***

*Figure in the parenthesis indicate the number of observations; ^{abcde} Different superscript in the same column differ significantly; ***= significant (p<0.001).*

Table 2: Least-squares means (LSM) with standard errors (SE) of average daily body weight gain of Black Bengal goat at different community-

Community	**Parameter**		
	Average daily gain (g/d) (0-3 months)	**Average daily gain (g/d) (3-6 months)**	**Average daily gain (g/d) (6-9 months)**
Chuadanga	35.86±0.35^{c} (254)	42.68±0.34^{ab} (212)	43.88±1.41(190)
Godagari	34.77±0.48^{c} (27)	36.32±1.55^{cd} (29)	36.39±1.11(28)
Jashore	34.36±0.35^{c} (80)	33.91±0.69^{de} (91)	38.15±1.14 (36)
Kustia	39.79±0.46^{b} (218)	36.71±0.74^{c} (167)	32.86±1.80 (130)
Meherpur	45.53±0.51^{a} (275)	48.33±4.45^{a} (263)	38.75±5.09 (264)
Muktagacha	35.11±0.72^{c} (25)	41.11±1.21^{b} (25)	39.6±0.71(25)
Naikhongchari	44.53±0.1^{a} (65)	33.33±1.28^{e} (65)	31.65±1.21(60)
Valuka	41.22±1.42^{b} (50)	44.2±1.00^{a} (49)	41.19±0.86 (40)
Level of significance	***	***	NS

*Figure in the parenthesis indicate the number of observations. ^{abcde} Different superscript in the same column differ significantly; ***= significant (p<0.001), NS= non-significant (p>0.05).*

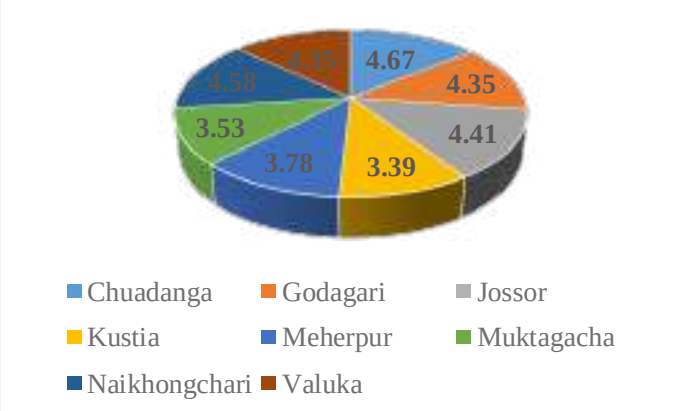

Figure 1: Kid mortality (%) of Black Bengal goat at different community area

It can be concluded that, among all the community, better performance of black Bengal goat was found at Meherpur. Superior goat will be selected from every community to improve the performance of goat. Therefore, the research program should continue for the coming years to conserve and improve the Black Bengal goat at community level.

Molecular identification of the Black Bengal Goat in Bangladesh using DNA barcoding

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Executive Summary

Black Bengal Goat (BBG) is an important indigenous genetic resource in Bangladesh. It is currently considered as a natural heritage and the pride of the country due to its high meat and skin quality. BBG has higher adaptability, resistance to local diseases and parasites, and is suitable for subsistence farming. The history of domestication, genetic background, and variability of the BBG populations in Bangladesh remain largely unknown. DNA barcoding is a method for the identification of different new species and varieties. Mitrochondrial deoxyribonucleic acid (mtDNA) sequences have many advantages as molecular markers. A small segment of DNA barcode based on the D-loop region has been used for species identification in goat varieties. The identification of goat breeds using DNA barcoding technology may help to identify the promising indigenous animal genetic resources, particularly in pre-screening valuable breeds for conservation in their pure form. Therefore, the aim of this study was to determine a characterization, possible origin, and genetic relations within the BBG breed and to find their genetic connections with the global goat breeds. Blood sample from a total of 105 BBG were collected representing seven region viz. Kustia, Meherpur, Bandarban, Savar, Rajshahi, Chuadanga, and Valuka. The genomic DNA was extracted from blood by the standard protocol of the Phenol-Chloroform-Isoamyl alcohol method. After DNA extraction, PCR was done by using CAP primers whose product size is 606 bp, corresponding to the positions 15635–16273 in the sequence of reference goat mitochondrial genome (NC_005044). The purified PCR product was used for DNA sequencing. The sequence polymorphism and maternal origin of two BBG populations were analyzed. Raw sequences were edited and trimmed out by using Mega11 to make homogenous fasta sequences.

All of the samples were found positive after amplification and the overall detection of mitochondrial hypervariable regions (HVR1) by this primer set was 100% (Figure 1). Sequence analysis revealed 56 variable sites that defined 26 haplotypes. Haplotype diversity (Hd) and nucleotide diversity (μ) were estimated at 0.95020 and 0.01225, respectably (Table 1). Furthermore, Analysis of molecular variance (AMOVA) revealed 83.48 % of the total genetic diversity was accounted for within population variation (Table 2). The median network and phylogenetic analysis indicated that individuals from all BBG populations were represented in clade A, except Bandarban population, whose maternal origins are presumed to be Asian, more particularly the Indian subcontinent. The goat population of Bandarban was in clade C indicating an origin near to China. These results inferred that BBG still have abundant genetic diversity and have originated from multiple maternal lineages, and further conservation efforts are warranted to maintain the diversity.

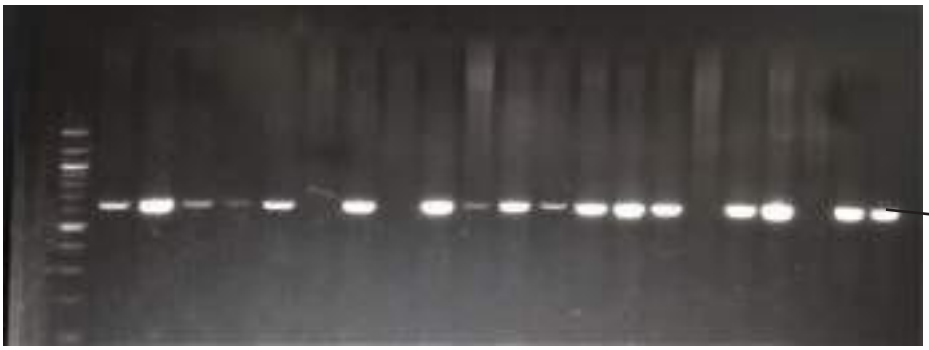

Figure 1: Amplification of mtDNA HVR1 region. Test samples of BBG t showed band at 638 base pair (bp). M= 100bp Marker, Number = Sample number.

Table 1: Genetic diversity measured in BBG populations of Bangladesh-

Population	N	S	Ht	Hd	π	K
Chuadanga	7	18	6	0.95238	0.01133	7.04762
Kustia	3	9	2	0.66667	0.00965	6.00000
Rajshahi	8	15	6	0.89286	0.00988	6.14286
Bandarban	7	17	3	0.52381	0.01118	6.95238
Meherpur	9	14	7	0.94444	0.00866	5.38889
Valuka	9	12	3	0.63889	0.00884	5.50000
Savar	7	12	4	0.80952	0.00658	4.09524

Number of sequences, N; Number of polymorphic (Segregating) sites, S; Number of overall haplotype, Ht; haplotype diversity, Hd; Nucleotide diversity, π; Average number of differences, K.

Table 2: Population wise AMOVA calculation -

Source of variation	D.F	Sum of squares	Variance components	Percentage of variation	p-value
Among populations	6	74.346	0.96762 Va	16.52	0.009
Within populations	48	234.745	4.89052 Vb	83.48	
Total	54	309.091	5.85813		
Fixation Index	FST :	0.16517			

The study provides basic insight into the possible origin and evolution of the caprine genetic resources of Bangladesh and closest part of India and china. A draft DNA barcode has been prepared against D-loop gene sequences that could be used to distinguish BBG from other species. These results inferred that BBG still have abundant genetic diversity and have originated from multiple maternal lineages, and further conservation efforts are warranted to maintain the diversity.

Conservation and improvement of indigenous buffalo for milk production through open nucleus breeding program

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Executive Summary

Buffalo is an integral component of the livestock in our nation contributing both milk and meat. But their contribution in production potentiality is declining due to decreasing their number as well as genetic aberration and management practices. Taking in the accounts of the above facts, this study was undertaken to improve dairy performance of indigenous river buffalo through selective breeding using open nucleus breeding system (ONBS) and to conserve indigenous buffalo for maintaining germplasm of indigenous stock as a part of maintaining bio-diversity. For this study, 11 project Upazilas were selected along with the BLRI buffalo research farm. A baseline survey was conducted in the project areas. From these areas, 1000 indigenous milking buffalo cows were selected considering their daily milk production (over 3.0 liter per day) and parity (maximum 2 nd). The selected buffalo cows were identified by tagging, deworming and vaccinated against common diseases. Data on body weight, age at puberty, age at 1st calving, calving interval and service per conception on station and on farm were recorded in a herd book and centrally maintained database software, regularly. The milk sample was analyzed by a Lactoscan Milk analyzer (Farm Eco, Bulgaria). Data were analyzed by using SPSS statistics 25.0 version.

From the survey, a total of 1442 buffalo rearing farmers were found in 11 Upazilas. The total population of buffaloes in the study areas was 48551 heads. For this study, 550 buffalo rearing farmers and 8148 heads buffaloes were selected in 11 Upazilas. About 5134 heads were tagged (63.19%) and 2836 buffalo's information was updated in software. A total of 330 buffalo calves were born in the project areas. The body weights of different ages of buffaloes at different areas were shown in Figure 1. Significantly (P<0.05) higher body weight of birth, 1 month, 3 months and 6 months of buffaloes were found in the char area than coastal area. Daily body weight gain of buffaloes was found higher in the char area (0.40±0.01) than coastal area (0.37±0.03 g).

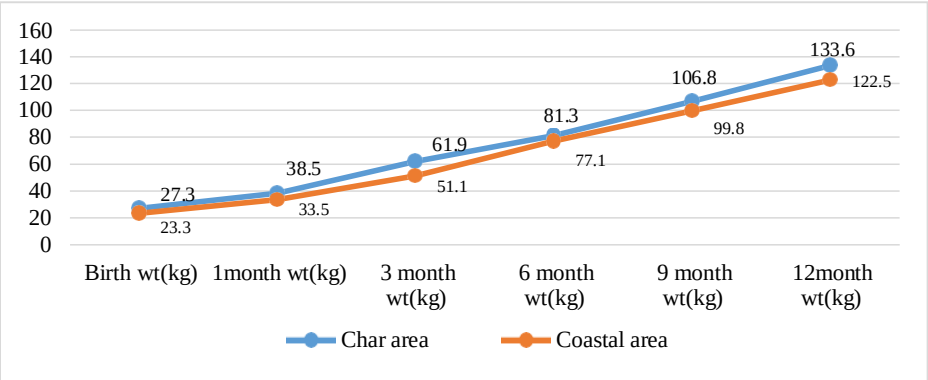

Figure 1. Body weight of buffalo calves in char and coastal area

Age at puberty was found earliest on station and delayed on farm (31.5±1.4 vs 36.8±0.4 months). A similar trend was observed in the case of age 1st calving (42.8±1.5 vs 48.05±0.33 months) and calving interval (14.1±1.3 vs 14.9±0.2 months). Service per conception was required least on station (1.2±0.084) and highest on farm (1.4±0.04). Herd has significant (P<0.001) effect on total adjusted 300 day milk yield (Table-1). Milk yield and its chemical constituents at 28-day intervals in different herds, stages of lactation and parity were shown in Table 2. Milk yield and its composition were significantly (P<0.05)

differed by the herd. Significantly (P<0.05) higher milk yield, milk protein, lactose and lower milk fat and SNF were found in the BLRI buffalo herd on station compared with on the farm. Buffalo parity had a significant (P<0.05) effect on milk yield and its composition. Significantly (P<0.05) highest buffalo milk yield, milk protein and lactose content were found in 4th parity than others. Although milk fat content was higher in the 3rd parity than others. The data in Table 2 showed that the stage of lactation has highly significant (P<0.001) effect on milk yield and its composition. Significantly (P<0.001) higher milk yield was found in early stage of lactation than others. However, milk fat content was found higher in the late stage of lactation than in others. Significantly higher milk protein and lactose content were observed in the early stage of lactation than others.

Table 1. Herd effect on adjusted 300 day Milk yield

Trait	Adj.300d milk yield (kg)	Max. milk yield (kg)	Min. milk yield (kg)	Av. daily milk yield (kg)	Max. av. daily milk yield (kg)	Min. av.daily milk yield (kg)
BLRI herd(13)	1032.15±37.1	1335.6	832.6	3.44±0.08	4.45	2.82
On Farm herd(66)	814.22±15.8	1308	608	2.71±0.08	4.38	2.03
Significant Level	***			***		

Table 2. Milk yield and its chemical constituents in different herd, stages of lactation and parity

Source of variation	Milk Yield (kg)	Fat (%)	Protein (%)	Lactose (%)	SNF (%)
Herd					
BLRI herd (95)	3.76±0.07	7.10±0.14	3.65±0.04	5.52±0.06	9.73±0.09
On Farm herd (702)	2.93±0.03	7.82±0.05	3.53±0.02	5.39±0.02	10.03±0.04
Overall (797)	3.03±0.03	7.72±0.05	3.55±0.02	5.40±0.02	9.99±0.03
Significant Level	**	**	*	*	**
Parity order					
1st (62)	2.65±0.13^{c}	7.47±0.16^{b}	3.39±0.07^{bc}	5.37±0.05^{ab}	10.18±0.13
2nd (170)	2.99±0.07^{b}	7.89±0.09^{a}	3.33±0.02^{c}	5.44±0.04 ^{ab}	10.0±0.09
3rd (241)	3.01±0.05^{b}	7.91±0.08^{a}	3.51±0.03^{b}	5.34±0.03^{c}	9.93±0.05
4th (220)	3.36±0.06^{a}	7.45±0.09^{b}	3.71±0.02^{a}	5.50±0.03^{a}	9.89±0.05
5th (104)	3.34±0.08^{a}	7.48±0.16^{b}	3.65±0.05^{ab}	5.42±0.05^{ab}	9.85±0.11
Overall (797)	3.1±0.03	7.65±0.04	3.56±0.01	5.43±0.01	9.95±0.03
Significant Level	**	**	**	*	NS
Stage of lactation					
Early ≤100 d(405)	3.25±0.05^{a}	7.08±0.07^{c}	3.72±0.03 ^{a}	5.47±0.03^{a}	10.16±0.06^{a}
Mid 100-200 d (235)	3.14±0.05^{a}	7.96±0.08^{b}	3.5±0.03 ^{b}	5.32±0.03^{b}	9.83±0.07^{b}
Late >200 d (157)	2.23±0.09^{b}	8.50±0.08^{a}	3.25±0.02 ^{c}	5.26±0.02^{b}	9.62±0.06 ^{c}
Overall (797)	3.02±0.03	7.62±0.05	3.56±0.02	5.38±0.02	9.96±0.04
Significant Level	***	***	***	***	***

$^{a, b,c}$ Mean in the same column with different superscripts differ significantly (P<0.05); **=significant (p<0.01), *= significant (p<0.05); Figures in the parenthesis indicate the number of observations.

Considering the above finding, this study summarized that variation in body weight in char and coastal areas may be nutritional management and individual variation for genetic makeup. The milk yield and its composition were influenced by the herd, parity and stage of lactation of buffaloes.

Development of Animal Recording and Genetic Evaluation System to Foster Indigenous Buffalo Selection Program

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Executive Summary

The breeding program aiming at the conservation and improvement of these Indigenous buffaloes is very much in alliance with the national (8th Five Year Plan, Delta Plan) Plan and international (MDG, SDG) plans and policies. While implementing a field-based buffalo breeding program, development of on-farm animal recording system (individual animal ID, pedigree and performance data), continuous use of generated data to estimate genetic parameters and development of a dynamic genetic evaluation system to facilitate purebred animal selection are the keys of success therein. This project was undertaken to: (a) investigate on-farm buffalo recording systems both off-line and online (digital devices) with regards to evaluate growth, reproduction, milk yield, milk composition and disease incidence in indigenous buffaloes under the prevailing systems of their management; (b) to estimate (co)variance components and genetic parameters of economic traits of indigenous buffaloes and (c) to develop a dynamic genetic evaluation system for indigenous buffaloes for use in replacement animal selection (mainly breeding bulls). Farmers who own river type indigenous buffalo(es) were identified from Bangladesh Livestock Research Institute (BLRI), Savar, Dhaka; Godagari, Rajshahi; Ishwardi, Pabna and Madarganj, Jamalpur and mature Indigenous females were individually identified, registered and all information was recorded in herdbooks. Records included both pedigree (sire and dam identity, if available) and performance (body weights, growth, reproduction, milk yield and composition, the incidence of diseases, etc). The data were recorded by Trained Animal Recorders in each project site/area. The buffalo owners were trained on improved methods of feeding, breeding, management and healthcare practices. The quality of collected data was checked with attention and recorded data were manually entered using Microsoft Excel sheets using standard formats. With the progress of time the database are becoming heavier with all expected information for primary analyses, genetic parameter estimation and genetic evaluation. With data gathered so far Restricted Maximum Likelihood analyses are being tested to estimate genetic parameters, especially heritability and genetic correlation. Thereafter single and multiple trait animal models with both direct and maternal additive genetic effects will be included in the model. Computer software of Variance Component Estimation (VCE) by Groeneveld (1998) are being used for parameter estimation and the breeding value will be estimated using Prediction and Estimation (PEST) of Groeneveld et al (1990). Data on a total of only 101 Indigenous mature female buffaloes (22 from Jamalpur, 33 from Pabna, 8 from BLRI and 38 from Rajshahi) were collected and are available for preliminary analysis as of today. Pedigree of all animals with the exception of only 5 animals from BLRI (which had their pedigree known) was unknown mainly due to the absence of an animal recording system. The average body condition score of Indigenous buffaloes were 3.50 ±0.03(83), parity ranged from 1-7, horn length of 39.49±1.56(73) inches, birth weight of 35.03± 1.31(30) kg, black coat colored, heart girth of 180.78±0.92(73) inches, body length of 143.18± 0.60(73) inches, wither height of 92.73±2.20(73) inches, rump height of 104.64±1.34(73) inches, body weight of 428.26±10.10(47) kg, postpartum heat at 84.69±3.31(32) days, service per conception of 1.00±0.00(32), calving interval of 388.13±3.24(32) days, daily milk yield of 3.00± 0.06(101) kg, peak daily yield of 3.99±0.08(33) kg, fat content of 8.59±0.18(89)%, protein content of 3.83±0.06(89) % and SNF content of 9.50 ± 0.12(89) % were observed. The obtained results indicate that Indigenous buffaloes are good resource of Bangladesh and have scope for their improvement through breeding (based on the scale of variation in analysed traits). However, this work needs to be continued in close monitoring of the sites/areas to obtain information from larger number of animals with their pedigree (through the use of known bulls in each site) and performance records over the generations to come.

Development of cost effective semen cryopreservation technique for indigenous Buffalo and Goat of Bangladesh

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Executive Summary

Semen cryopreservation, a technique for long-term semen preservation which is used for the establishment of a semen bank. During semen cryopreservation, a large number of sperm suffer physiological damage which leads to the loss of fertility. As a result, in the cryopreservation process, around 50% of sperm died and in the remaining 50% motile sperm undergo capacitation-like changes resulting from the poor fertilizing ability of buffalo and goat spermatozoa. To improve the fertilizing ability of frozen-thawed sperm, a number of procedures, cryoprotectants, and additives are being used in the semen extender with different success rates. Various extenders and supplemented chemicals can reduce cryo-damage or oxidative stress and can improve post-thaw viability and fertility of sperm. Considering the above fact, the objectives of the project were to improve the post-thaw viability and fertility of cryopreserved sperm of indigenous Buffalo and Goat as well as conservation of BLRI improved indigenous germplasm through semen bank.

In previous year (2021-22), different diluters (Steridyl, Triladyl, Andromed and Tris egg-yolk) were used for Cattle semen cryopreservation and after evaluating conception rate it was observed that Steridyl performed the best for Munshiganj cattle and Tris egg yolk diluter performed best for RCC and BCB cattle. Considering semen morphology and abnormality Tris egg-yolk was performing better and cost effective than Andromed and Triladyl. In case of microbial count, a number of microbial colony was found using Tris egg yolk citrate and Triladyl diluter in Munshiganj cattle semen. However, there was no significant microbial load found in RCC and BCB-1. Finally, 14000 doses (BCB1= 4000, RCC=8000, Munshiganj Cattle= 2000) straw were cryopreserved at BLRI semen Bank. The average total motility of this cryopreserved semen was 72.98% and the conception rate was at BLRI Farm: 75% (16); at Field level: Baghabari- 86.36% (22), Rajshahi- 84.24% (173); Jessore- 73.91% (23).

In this year, to fulfil the objective, at first, the best semen cryopreservation technique was developed for individual indigenous Buffalo and Goat. Subsequently, selection, management and training of breeding bulls and bucks were conducted. In this year, for developing the best semen cryopreservation technique five (05) breeding buffalo (Murrah, Nili Ravi, Niliravi cross, Murrah cross, Deshi Buffalo) bulls and 5 bucks were selected and trained up for semen collection. Semen was cryopreserved using different diluters (for Buffalo: Triladyl, Steridyl, Andromed, Tris-egg yolk and for Goat: Tris-egg yolk, Andromed, Triladyl) and different steps of cryopreservation i.e- Step one (From +5^{0}C to −100 °C (10.5^{0}C/min) and transfer into liquid nitrogen at −196°C), Step two (+5^{0}C to -10^{0}C (-0.3^{0}C/min);-10^{0}C to -130^{0}C (-25^{0}C/min)) and step three (+4^{0}C to -50C (20^{0}C/min); -5^{0}C to -110^{0}C (55^{0}C/min); -110^{0}C to -140^{0}C (35^{0}C/min)). Semen was collected by Artificial Vagina (AV) method and semen quality was evaluated using CASA (Computer Assisted Semen Analyzer) after cryopreservation. For data analysis, a two-way Analysis of Variance (ANOVA) at 3×4 factorial model (for buffalo) and 3×3 factorial model (for goat) was used and results were expressed as Mean ± Standard error using the SPSS program (version 20.0, SPSS) and the difference between the mean was determined using the Duncan method. Finally, the efficacy of diluter of semen was determined by evaluating live sperm recovery rate using the following formula:

Sperm Recovery Rate (%) = (Observed motility/ Fresh semen motility) x100.

There was no significant difference at semen quality of different breeds of buffalo (Murrah, Nili Ravi, Niliravi cross, Murrah cross, Deshi Buffalo). It was found that there was no significant effect in different steps and the interaction of step×diluter but a highly significant effect on different diluters. The motile motility rate of buffalo semen using Tris, Triladyl, Steridyl and Andromed were 76.97%, 74.74%, 76.43% and 43.83%, respectively (Fig-1). Although the motility rate of semen

using Tris and Steridyl diluter is almost same (Fig-1) but the semen straw production cost is lower in Tris diluter then Steridyl diluter. The conception rate of cryopreserved buffalo semen using Tris diluter was 83.33% whereas in Steridyl diluter it was 66.67% (Fig-2). The motile motility rate of goat semen using Tris-egg yolk, Andromed and Triladyl were 77.4%, 66.72% and 53.10%, respectively (Fig-3). The conception rate of goat semen was 79.62%. Considering the research results, it can be recommended that Tris-egg yolk diluter is best for both buffalo and goat semen cryopreservation. Total 5500 doses of buffalo semen and 2940 doses of goat semen has been conserved. LABS-20K cryocan (400L) has been installed in BLRI AI Lab. About 3 Lac doses of semen can be conserved at this cryocan.

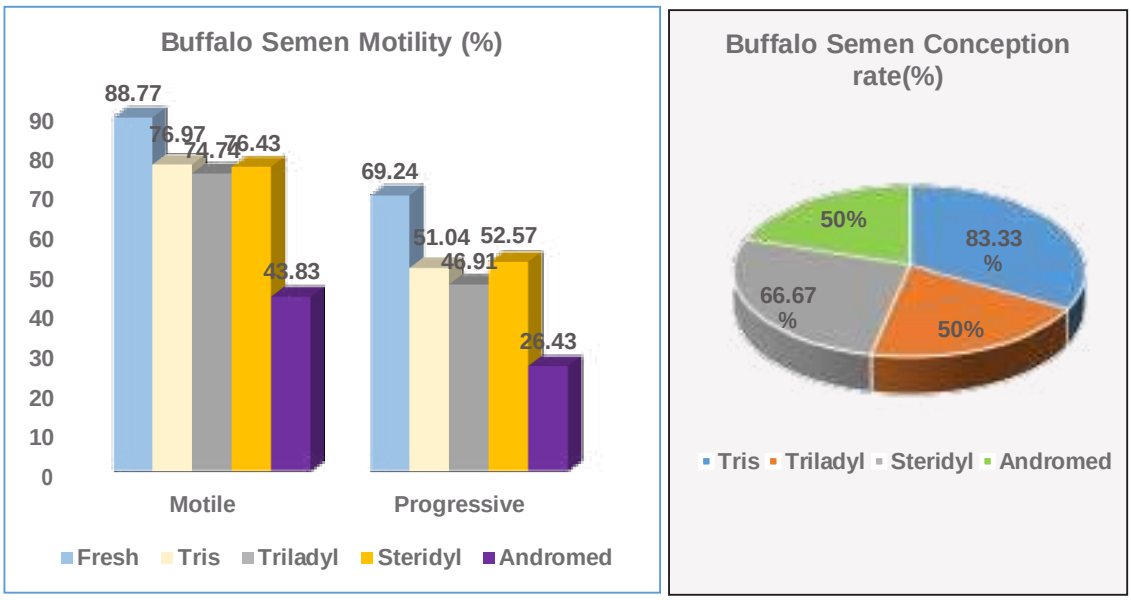

Fig-1: Buffalo Semen Motility (left) and Conception rate (right)

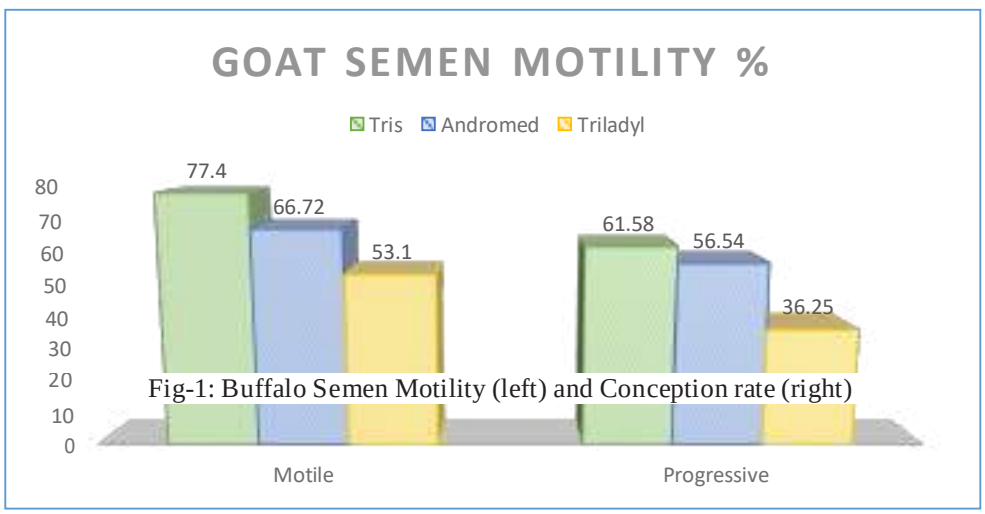

Fig-2: Goat Semen Motility

Quality and safety assessments of milk and the development of fortifying dairy products

Sub-title: Detection of heavy metals and antibiotic residues in raw milk collected from different locations

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Executive Summary

Milk contains all the essential nutrients, including easily assimilated fat, carbohydrate, protein, and vitamins, for the proper growth and nourishment of human beings. However, as an excretion of the mammary gland, milk can carry numerous xenobiotic substances (pesticides, antibiotics, drugs, and heavy metals). Therefore, the present study aimed to determine the concentration of heavy metals in cows' raw milk as well as in related sources and to measure the level of antibiotic residue in milk. The experimental design was completely randomized, and the treatments considered were area, location, and antibiotic treatment. For heavy metal detection, a total of 270 samples (54 milk samples, 54 feed samples, 54 fodder samples, 54 water samples, and 54 soil samples) were collected from the industrial areas of Savar, Chittagong, and Cumilla and the non-industrial rural areas of Sirajganj, Jessore, and Rangpur. Parameters observed were lead (Pb), cadmium (Cd), and chromium (Cr). Only milk samples that exceeded the maximum residue level (MRL) were considered for tracing the sources of these metals in milk. The samples were analyzed using flame atomic absorption spectroscopy. On the other hand, for antibiotic residue detection, four commonly used antibiotics for lactating cows (amoxicillin, gentamicin, ceftriaxone, and oxytetracycline) were considered. For each antibiotic treatment, 4 cows were considered treatment cows, and 1 cow was considered a control cow. Therefore, the total number of treatment and control cows was 16 and 4, respectively. After antibiotic treatment, milk samples were collected from the treatment cows each alternate day, starting from Day 1 to the withdrawal period (Day 9) and stored at -80^{0}C until analyzed. The samples were analyzed using liquid chromatography-tandem mass spectrophotometers (LCMS-MS). All the data were analyzed statistically in an ANOVA of a Completely Randomized Design (CRD) using SPSS version 25, and the mean differences were compared by the Duncan Multiple Range Test (DMRT).

The concentrations of Pb, Cd, and Cr in milk samples from industrial and non-industrial areas and their MRLs are shown in Fig. 1. The result showed that the concentrations of Pb and Cd were within the MRL limit. Whereas, the concentration of Cr exceeded the MRL in both industrial (0.2199 ppm) and non-industrial (0.2520 ppm) areas.

Table 1. The concentrations of Pb, Cd and Cr in milk samples from different locations

Location	Concentration in milk (ppm)		
	Pb	Cd	Cr
Savar	0.0057^{b}	0.0055^{c}	0.2145^{b}
Chittagong	0.0050^{bc}	0.0085^{a}	0.2259^{b}
Cumilla	0.0079^{a}	0.0068^{b}	0.2191^{b}
Sirajganj	0.0027^{de}	0.0020^{e}	0.2488^{a}
Jessore	0.0020^{e}	0.0017^{e}	0.2529^{a}
Rangpur	0.0039^{cd}	0.0031^{d}	0.2542^{a}
SEM	0.001	0.000	0.004
LS	***	***	***
MRL	0.02	0.01	0.05

Means with different superscripts in a column indicate significant difference ($p<0.05$), LS= Level of significance, ***= significant at ≤ 0.001

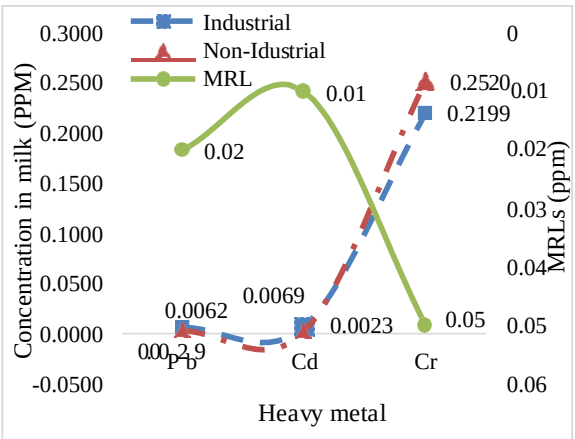

Fig 1: Comparison of the concentration of Pb, Cd, and Cr in milk from Industrial and Non-industrial area with the MRLs.

The concentrations of Pb, Cd and Cr in milk from different locations are shown in Table 1. The result found that the concentrations of Pb, Cd and Cr differed significantly ($p \leq 0.001$) among the locations. The result also found that only the concentration of Cr in milk exceeded the MRL limit in all six locations, and the concentration was higher in Sirajganj, Jessore, and Rangpur than the other three locations. The concentrations of Cr in the concentrate feed, fodder, water, and soil samples of different locations are shown in Table 2.The result determined that the concentration of Cr in concentrate feed, fodder, water and soil samples differed significantly ($p \leq 0.001$) among the locations. The study also found that the fodder and concentrate feed samples of Cumilla, Sirajganj, Jessore and Rangpur contained higher concentration of Cr than Savar and Chittagong.

Table 2. Concentration of Cr in soil, fodder, concentrate feed and water samples from different locations

Location	Mean concentration of Cr (ppm)			
	Concentrate feed	Fodder	Water	Soil
Savar	0.1957^{b}	0.1687^{b}	0.1977^{e}	0.0947^{e}
Chittagong	0.0583^{c}	0.0600^{c}	0.2287^{a}	0.0520^{f}
Cumilla	0.2630^{a}	0.2613^{a}	0.1990^{e}	0.1160^{c}
Sirajganj	0.2766^{a}	0.2653^{a}	0.2170^{bc}	0.1053^{d}
Jessore	0.3113^{a}	0.2480^{a}	0.2193^{b}	0.1333^{a}
Rangpur	0.3037^{a}	0.2427^{a}	0.2107^{d}	0.1290^{b}
SEM	0.018	0.014	0.003	0.000
LS	***	***	***	***

*Means with different superscripts using small letter in a column indicate significant difference ($p<0.05$), LS= Level of significance, ***= significant at ≤ 0.001*

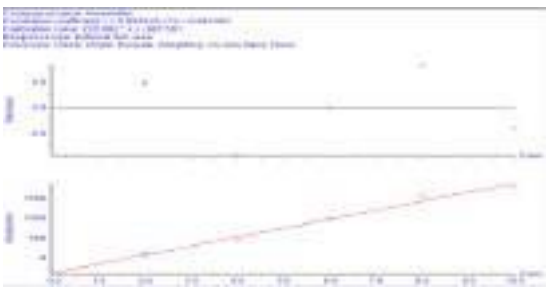

Fig 2. Calibration curve of amoxicillin standard

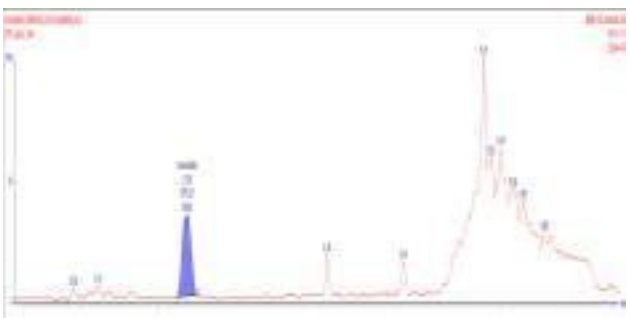

Fig 3. Chromatograph of antibiotic residue detection

The method for the determination of the residue of amoxicillin antibiotic in milk has been developed using LCMS-MS. The LCMS-MS was calibrated for amoxicillin by the standard concentration at 2 ppb, 4 ppb, 6 ppb, 8 ppb, and 10 ppb, respectively and the correlation coefficient of the calibration curve was 0.987 (Fig. 2). A total of 20 milk samples from the amoxicillin-treated cows were analyzed, but the residue of amoxicillin was not found. On the contrary, milk samples were spiked at three concentrations (5 ppb, 10 ppb, and 20 ppb) with commercial amoxicillin antibiotic, analyzed following the same method, and the recovery of amoxicillin antibiotic was 97.5%.

The present results determined the concentrations of the selected heavy metals in milk, concentrate feed, fodder, water, and soil samples from six different locations and revealed that the concentrations of Pb and Cd in milk were within the maximum limit. However, the concentration of Cr in milk exceeded the maximum limit in all six locations. The study also found that the concentrations of Cr in concentrate feed and fodder were higher in Cumilla, Sirajganj, Jessore, and Rangpur than in Savar and Chittagong. This study also developed a method for the detection of the residue of the amoxicillin antibiotic in milk. Further studies are necessary to develop methods for gentamicin, oxytetracycline, and ceftriaxone antibiotics to determine their residues in milk.

Existing Buffalo Farm Waste Management Practices in Selected Areas of Bangladesh

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Executive summary

Buffalo farming is a significant component of livestock in Bangladesh. The government has emphasized buffalo farming in the country. Therefore, several programs have been implemented throughout the country by different stakeholders to increase the productivity of buffalo. Profitable buffalo farming is associated with minimizing production costs through nutritional and other management, including buffalo farm waste recycling. Considering these facts, the current study was conducted to introduce existing buffalo waste management practices in Selected Areas of Bangladesh. To achieve the above-mentioned objective, a purposive survey on existing waste management practices was conducted in the five upazilas under five districts namely; Companiganj, Noakhali; Bauphal, Patuakhali; Ishwardi, Pabna; Godagari, Rajshahi; and Chorfession, Bhola district. Survey data were collected from 200 buffalo-rearing farms. Results showed that the average herd size of buffaloes was 16.1±8.2, 31.7±23.7, 15.5±7.1, 11.3±5.6 and 17.8±17.3 in the Godagari, Companiganj, Bauphal, Ishwardi, and Chorfession upazilla, respectively. Among these five upazila, farmer practices the rearing systems of buffaloes were intensive (2%), semi-intensive (32%), and extensive (66%) farming system. The overall buffalo-rearing experiences of the studied farmers were 19.1±8.4 years. About 98.5±2.23% of farmers had no farm drainage systems. Farmer process their buffalo dung through Solid storage (22.8%), Burned for fuel (29.9), Pasture (35.78%), Liquid/slurry (8.5%), and lagoon (3.02%).

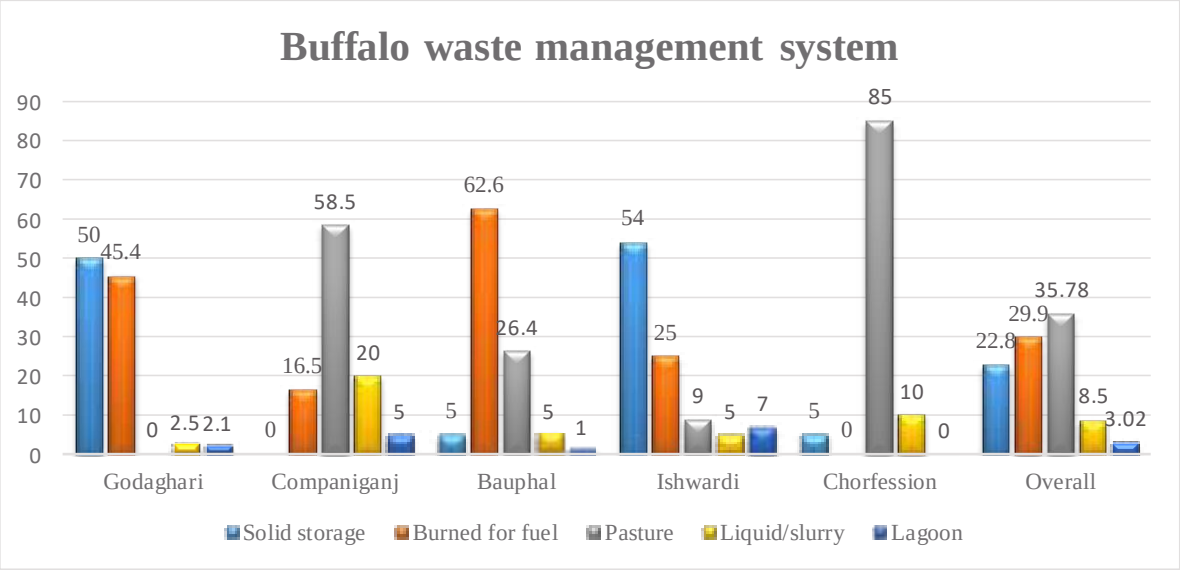

Figure 1. Buffalo Dung Disposal system (%)

The average distance of buffalo shed from their residential area was 91.04±72.16 feet among the study areas. About 54% of farmers daily spread their cropland from solid storage. Farmers cleaned their buffalo sheds once a day (52.5%), twice a day (46.5%), and three times a day (1.0%).

Table 1. Herd size, rearing system, rearing experience, and sanitary management of buffalo farm

Parameter	Herd size (%)	Farming System (%)			Rearing experience (Avg) years	Drainage system (%)	
		Intensive	Semi-intensive	Extensive		Yes	No
Godagari	16.1±8.2	0	27.5	72.5	11±7.4	0	100
Companiganj	31.7±23.7	2.5	25	72.5	15±7	2.5	97.5
Bauphal	15.5±7.1	0	87.5	12.5	25.4±11	0	100
Ishwardi	11.3±5.6	5	5	90	21.6±8.5	5	95
Chorfession	17.8±17.3	2.5	15	82.5	16.6±8.4	0	100
Overall	18.5±12.4	2	32	66	19.1±8.4	1.5	98.5±2.23

The practical problems associated with farm waste management by farmers were lack of manpower (31.2%), lack of adequate space (16.5%), lack of relevant equipment/machinery (8.5%), and lack of willingness (43.8%).

Table 2. Shed cleaning frequency and waste management problems

Parameter	Shed Cleaning			Distance between human residence & and buffalo shed(feet)	Waste management problems			
	One	Two	Three		Lack of manpower	lack of place	lack of machinery	lack of Desire
Godagari	5	92.5	2.5	34.1±10.1	5	80	5	10
Companiganj	97.5	0	2.5	191±132.1	27.5	2.5	2.5	67.5
Bauphal	87.5	12.5	0	124.3±172	36	0	15	49
Ishwardi	0	100	0	33.5±13.4	65	0	10	25
Chorfession	72.5	27.5	0	72.3±33.2	22.5	0	1	67.5
Overall	52.5	46.5	1	91.04±72.16	31.2	16.5	8.5	43.8

It may be concluded that knowledge developed during this study will help future planning for the country's buffalo farm waste management practices.

In vitro embryo production of buffalo

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Executive summary

Reproduction is the backbone of the livestock production sector. In spite of socioeconomic importance, female buffalo have poor reproductive efficiency in terms of delayed puberty, few number of follicles, high rate of follicular atresia, higher age at calving, long postpartum anestrus period, long calving interval, lack of overt sign of heat and low conception rate. *In vitro* embryo production (IVEP) is one of the reproductive approaches that minimize these problems and thus increase reproduction efficiency. IVEP with ovum pick-up technology (OPU) has enabled the repeated production of a large number of embryos from donors containing high genetic merits. In *in vitro* embryo production OPU has been used as crucial reproductive technology. However, the efficiency of OPU can be affected by breed, age, season, and hormone stimulation. Considering these facts, the present research study was designed to improve the efficiency of IVEP with OPU technology for the collection of oocytes from superior donor buffalo cows and transfer these embryos into recipient buffalo cows. To achieve these 10 buffalo cows were selected from BLRI Buffalo farm for OPU technology. Adaptation of OPU technology is going on. Therefore, to improve the efficiency of OPU pregnant mare serum having gonadotropin (PMSG) was administrated into buffalo. They were divided into 2 groups A) control (4) without administration of gonadotropin and B) PMSG (6) stimulated: animals with PMSG administration. The follicles were divided according to size <3mm as small, 3-7 mm as medium and >7 mm as large. On the day of 14 (day 0=estrus), PMSG was administrated. To detect ovarian follicular dynamics and trans-vaginal ultrasonography was carried out using a real time B mode ultrasound scanner (HS-2200V Honda Electronics Co., LTD) equipped with a 7.5 MHz probe. An 18-gauge disposable hypodermic needle was connected to a 50 mL falcon tube and used for follicular puncture. Oocytes were collected in Tyrode's lactate (TL)-HEPES medium.

From the study, it was revealed that the size of the left ovary ranged from 20.4±0.6 to 21.5±2.6 mm and that of the right ovary was 20.15±1.9 to 22.3±3.4 mm. Before PMSG administration there was no significant (P>0.05) difference in follicle size or follicle number at day 0 and at day 14 both for control and PMSG treated buffalo cows. At day 0, the diameter of large follicles was found 8.9±0.73 vs 9.2±0.69 mm and at day 14 that was 7.94 vs 7.49 mm, respectively for control and PMSG treated buffalo cows. But the significant difference was found for large follicle diameter after 40 hour of PMSG administration at day 14 which were 11.83±0.8 mm whereas 7.28±2.2mm for the control group (Fig. 2). Again, at the same time the diameter of the largest follicle was found about 11.6 mm and after PMSG treatment size increased to 13.5 mm. Also, the number of follicles was higher for the PMSG stimulated group than control that was 11 vs 7 considering both ovaries. 5 oocytes were aspirated by OPU from 2 PMSG treated buffalo and 2 oocytes were aspirated out of 3 control animals (Figure 1).

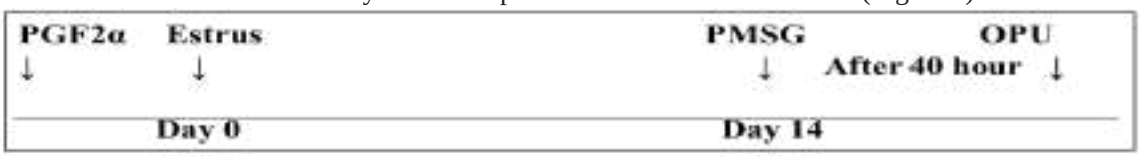

Figure 1. PMSG Hormone treatment protocol

In this study, it was also found that the right ovary was more active. This might be for its larger size than the left ovary. However, from the slaughter house ovary about 1401 COCs (cumulus oocyte complexes) were aspirated. After grading COCs by using a stereomicroscope, a total of 1274 graded

COCs with an even cytoplasm and covered with a minimum of 3 layers of compact cumulus cells were incubated for IVM (*in vitro* maturation). Around 1041 (82%) of COCs were expanded with cumulus cells. About 606 graded matured COCs were fertilized with capacitated cryopreserved bovine semen. The cleavage rate was 452 (75%). After IVF (*in vitro* fertilization), the assumed zygotes were cultured in an *in vitro* culture-I (IVC-I) medium for 3 days. After 3 days, 8 to 32 cells of the embryo were transferred into IVC-II medium and cultured for 8 days to reach to the blastocyst stage. It was found that about 362 (60%) were developed to 2 cells, 268 (44%) were to 4 cells, 159 (26%) were to 8-16 cells and 49 (8%) were to morula and 4 (1%) were developed to blastocyst (Table. 1).

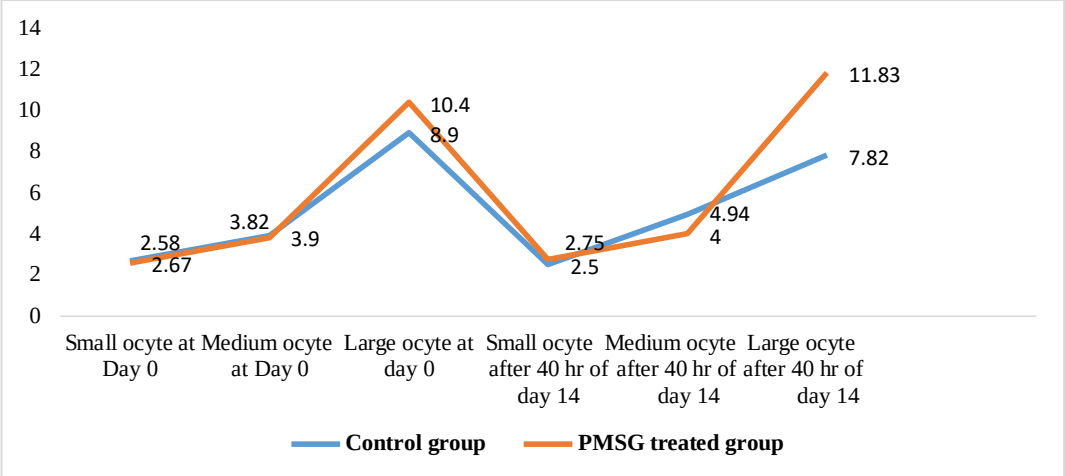

Figure 2. Follicular diameter of buffalo cows with PMSG treatment

Total COCs aspirated	Total COCs for IVM	COCs with cumulus expansion (%)	No. of matured oocyte for IVF	Cleavage (%)	*In vitro* culture				
					2 cells (%)	4 cells (%)	8-16 cell (%)	Morula	Blastocyst
1401	1274	1041 (82%)	606	452 (75%)	362 (60%)	268 (44%)	159 (26%)	49 (8%)	4 (1%)

Table 1. *Invitro* production of embryo

It may be concluded that after PMSG treatment follicular number and size both were increased. It is a new project and the study is going on for further more investigation.

Increasing the efficiency of artificial insemination for improving conception rates in river buffalo

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Executive Summary

Poor reproductive performance is a major constraint for increased production of buffaloes all around the world. It indicates that the profitability of buffalo farming is more or less directly related to the reproductive performance of the animals. To have a breakthrough in changing the present scenario, improved reproductive management practices are necessary for developing buffalo production at a satisfactory level. This study was evaluated to find out the problems that affect the artificial insemination (AI) on conception rate in river buffalo and how to improve the conception rate using nutritional supplements at coastal areas. The study was conducted in the Bauphal upazila of Patuakhali and the Charfassion upazila of Bhola district. Data on buffalo breeds, health management, reproductive parameters, and management practices were collected by personal interviewing of 200 farmers (100 of each upazila) using pre-tested questionnaires. The results showed that 100% of farmers rearing buffaloes to generate income by selling milk and meat without supplementing any nutritious feed and feed supplements. For breeding purposes, they bred their buffalo cows through natural mating. Taking into account this survey, initially, we selected thirty (30) non-pregnant buffalo cows over 2 years of age from two upazilas. After selection, all the experimental buffaloes were marked by tagging. Nutritional variation might be a good factor in increasing the efficiency of AI. For the trial, selected buffaloes were vaccinated and dewormed and divided into four (04) treatment groups as T_0= control; T_1= supplemented with urea molasses straw; T_2= supplemented with DCP and administrated AD3E; and T_3= supplemented with T_1 and T_2. For the availability of green grass, 3 acres of land were cultivated for high yielding fodder production. Twenty-one (21) heated buffaloes were inseminated. Among them, 12 buffalo cows were assumed to have been conceived (not shown heat last 3 months). It may be concluded that the reproductive performance of dairy buffaloes was relatively poor. The overall scenario about the existing breeding management practices followed by the buffalo farmers was not satisfactory and this situation might definitely influence adversely on the productive and reproductive performance of animals. In this research, supplementing with various feeds and nutrition is an alternative to enhance the efficiency of AI as well as pregnancy establishment and overall reproductive performance of buffalo cows.

Recycling of poultry wastes for environment friendly low cost poultry production

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Executive summary

The commercial poultry industry is growing rapidly. Wastes from poultry farms, processing and hatchery industry is an unavoidable by products. Wastes of a poultry farm includes litters from broiler and layer, hatchery debris, dead birds and other debris. On the other hand, the poultry industry mainly the hatchery unit produces large amount of hatchery wastes. Poultry waste can have serious impacts on the environment like odor and nuisance issues, infestation of insects and pests, groundwater pollution, surface water spillover etc. The actual database regarding the amount of processing and hatchery wastes produced in the country is almost absent. Poultry wastes is becoming a great concern for the growing industry. On the other hand, the efficient utilization of any by-products has direct impact on the economy and environmental pollution. Therefore, there is urgent need to give high attention by the scientists to develop scientific way of disposal of major poultry wastes like droppings, offal's and hatchery wastes. Taking those facts into accounts, the present study was focused with the hatchery wastes processing and poultry droppings utilization techniques. The aim of the study was to estimate the amount of poultry dressing and hatchery wastes produced in Bangladesh and at Poultry Research Centre (PRC), BLRI, and assessing their nutritional value; to process the hatchery wastes mechanically, an initiative was undertaken to develop a low cost local made hatchery waste processing device for drying and grinding the hatchery wastes, and to know the efficiency of bio-gas production using poultry droppings in the biogas plant established at PRC. To get the estimated hatchery and processing wastes production, the backward and forward calculation was done from the day-old chicks production of commercial broiler, layer, Sonali and colour broiler in Bangladesh. It was considered the generally accepted level of fertility and hatchability, mortality, dressing percentage and other parameters for the calculation of the wastes produced each year in the country. The information was collected from the authority of Bangladesh Poultry Industries Association. To get the estimated wastes produced at PRC, BLRI direct weight measurement was done keeping a register. The fresh offal's collected from the processing plant of PRC, washed with clean water and prepared for proximate analysis. To process the hatchery wastes in a smarter and convenient way and to make the wastes as feed supplement, a prototype processing device for research purpose was designed using locally available materials and techniques. The device run on trial basis and found suitable to get processed hatchery waste meal. The meal also underwent for proximate, microbial and heavy metal tests. The heavy metals (As, Pd, Cr, Cd and Hg) and spoilage microorganism (*Salmonella spp., Coliform and E. coli)*) were tested from the Quality Control Laboratory, Savar, Dhaka. The proximate analysis was done at PRC, BLRI. It was estimated that approximately 6 lakh MT poultry processing and 40,000 MT hatchery wastes produced at the against of 123,76,00000 DOC produced yearly in Bangladesh. On the other hand, the estimated poultry processing and hatchery wastes at PRC, BLRI produced to be 2.7 and 1.5 MT, respectively.

Table 1 Salient feature of the processing device

Feature	Description
Size (Length x Width x Height)	4ft x 3ft x 4.5ft
Weight	120 kg Approx.
Power Supply	220 Volt
Electric Motor	2.0 HP
Processing capacity	25-30 Kg/batch
Grinding and drying capacity	6-8 hours

Hatchery waste Processor

Processed wastes

Table 2 represents the moisture, dry matter, crude protein, crude fiber, ether extract and ash content of hatch out waste meal, candling eggs waste meal and offals meal. However, irrespective of the categories of the samples the dry matter, crude protein, crude fiber, ether extract and ash content ranged between 87.48-98.3, 17.05 – 62.67, 3.0-15.20, 2.8-17.0 and 8.46-50.85, respectively.

Table 2 Proximate (%) component of hatchery waste meal produced by the BLRI developed processing device

Sample	Moisture	DM	CP	CF	EE	Ash
Hatch out waste-1	2.37	97.63	24.94	3.0	2.8	50.85
Hatch out waste-2	2.77	97.23	18.42	10.35	3.8	26.1
Hatch out waste-3	8.75	91.25	23.91	11.45	9.4	33.55
Fresh candling eggs	1.7	98.3	17.05	10.25	5.6	33.25
Boiled candling eggs-1	2.52	97.48	19.08	13.90	11.6	34.95
Boiled Candling eggs-2	3.52	96.48	20.47	15.20	17.0	23.27
Poultry Offals	12.52	87.48	62.67	0.90	7.04	8.46

DM= Dry matter; CP= Crude protein; EE=Ether extract; CF= Crude fiber

Table 3 Heavy metals contents in hatchery waste, offal meal and infertile eggs

Samples	Heavy metals (mg/kg)				
	As	Pd	Cr	Cd	Hg
Hatch out wastes	ND	1.24	Trace	ND	ND
Candling/ Infertile eggs	ND	1.23	Trace	0.08	ND
Offal's meal	ND	Trace	ND	ND	ND

ND- Not detectable; Permissible limit of "Pd" and "Cd" in poultry feed by WHO/FAO/EU is "1-5" and "0.08"mg/kg respectively (Adekanmi, 2021).

Table 3 shows the results of heavy metal tests. Most of the samples were not detected the heavy metals or found trace amount except for "Pd" and "Cd" and it was found as permissible limit as mentioned in the above. Table 4 represents the results of microbial tests. All tested samples were found negative for *Salmonella Spp***.** But**,** there was found *E. coli* and coliform with varying quantity from 750 -1480 CFU/ml. However, references related to the standard bacterial count for such type of samples was not found.

Table 4: Microbial tests results

Name of sample	Salmonella *Spp.*	E. coli	TVC (CFU/ml)
Hatchery waste-1	(-)ve	(+)ve	1480
Hatchery waste-2	(-)ve	(+)ve	1300
Infertile eggs	(-)ve	(+)ve	750
Offal's meal	(-)ve	(+)ve	970
Hatchery waste-1	(-)ve	(+)ve **(**2.1 MPN/g)	Coliform (110 MPN/g)

In conclusion, a major "breakthrough" was achieved by developing newly designed local made low cost hatchery waste processing device that will directly help to recycle the hatchery waste into poultry and /or livestock and fish feed thus help to reduce the feed cost and increase the farm profitability and reduce the environment hazards as well. Therefore, further study is suggested specially, with the proper treatment to remove the *E. coli* content.

Development of Feeds and Fodder Data Base for Efficient Feeding System for Livestock Production

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Executive Summary

Feed is the fundamental and cost-involved item of efficient livestock farming. It relates directly to the farm economy. Feed costs are the single largest expense on most dairy farms. It is very important to prepare area wise local feed inventory determine their nutrient composition to reduce the feed costs of small, medium and large dairy farms. An Inventory of regionally available feed resources and their nutrient value will help to develop an economic strategy for livestock feeding management and national feeding standards as well. In this circumstance, the present research was designed with two different objectives to establish a national feed inventory for the development of a feed resources database for livestock production and to develop an online-based animal feed resources knowledge hub (data bank). To fulfill the first objective of this study, a baseline survey was conducted following a constructive questionnaire that was filled out through personal interviews with farmers. Data enumerators randomly visited respondents' houses from door to door for direct interviewing of the structured questionnaires and the number of respondents was 30 in each location. A total ten (10) Upazilas's from six different divisions (Manikgonj and Munshigonj of Dhaka division; Jeshore Sadar and Jhikorgacha of Khulna division, Patiya and Naikhongchori of Chattogram division; Charfashion of Barishal Division; Madarganj of Mymensingh Division, Godagari and Ishwardi of Rajshahi Division) the survey was completed. Local and commercial feeds and fodder samples were collected and analysis was completed. This year Patuakhali Sadar and Kalapara upazila from the Barishal division, Nachol and Sirajganj upazila from the Rajshahi division and Bhanga and Saltha upazila from the Dhaka division, the survey and sample collection is completed and the analysis of sample is also ongoing. Different types of local grass have been collected like bottle grass, paccha, chauchra, unknown hydrid, hechi grass, Rana, Jangra, Kolmi etc is remarkable in Patuakhali district. And Maskalai, Shama, Motha, Durba, Bashpata,Uri dhal grass, Fuler grass and Binnah local gras from Nachol Upazila. Chronologically, all upazila's from all the divisions of Bangladesh will be included in this study. After checking and cross-examination, all data were imputed in an MS Excel worksheet and analyzed. Locally available feeds and fodder samples both roughage and concentrate collected from each survey area were analyzed at the Animal Nutrition Laboratory of BLRI for proximate composition (DM, Ash, CP, EE, NFE, CF, ADF, NDF, lignin), energy (GE, ME) and mineral component's (Ca, P) from the Quality Control Laboratory of DLS and the Soil Resource Development Institute (SRDI). All data were cross checked by experts of animal nutritionist in Bangladesh. After cross checking all data, the data was inputted in online web portal. To achieve the second objective, an ICT company named Softcell System was hired to design a website for livestock feed inventory namely BLRI Feeds and Fodder Data Bank. All the feed ingredients found in each region, either locally or commercially was collected, analysis and data were checked by the expert's animal nutritionist of Bangladesh and then documented on a webpage. The website was divided for three different sections, like feed classification, region-based feedstuffs and overall feed composition of Bangladesh. All collected data was documented and will be presented in the website. A demo version of online portal has been developed to conserve all the collected data regarding feed resources, their composition and regions where available as well. A total of 6 (six) upazila's (Manikgonj, Munshigonj, Jeshore sadar, Jhikorgacha, Patiya and Naikhongchori) have already been surveyed and the data was cross-checked by animal nutritionists and has been uploaded to the website. Locally and commercially available feeds and fodder samples from the remaining 10 (ten) upazila have been collected and analysis is ongoing. At the end of this project, an interactive and user-friendly online feed database for all stakeholders along with a least-cost ration formulation facility for farmers will be developed. A comprehensive database of all kinds of feed resources, along with their nutrient composition and nutritive value for academia, scientists, businessmen, and farmers, (especially educated farmers) will be developed.

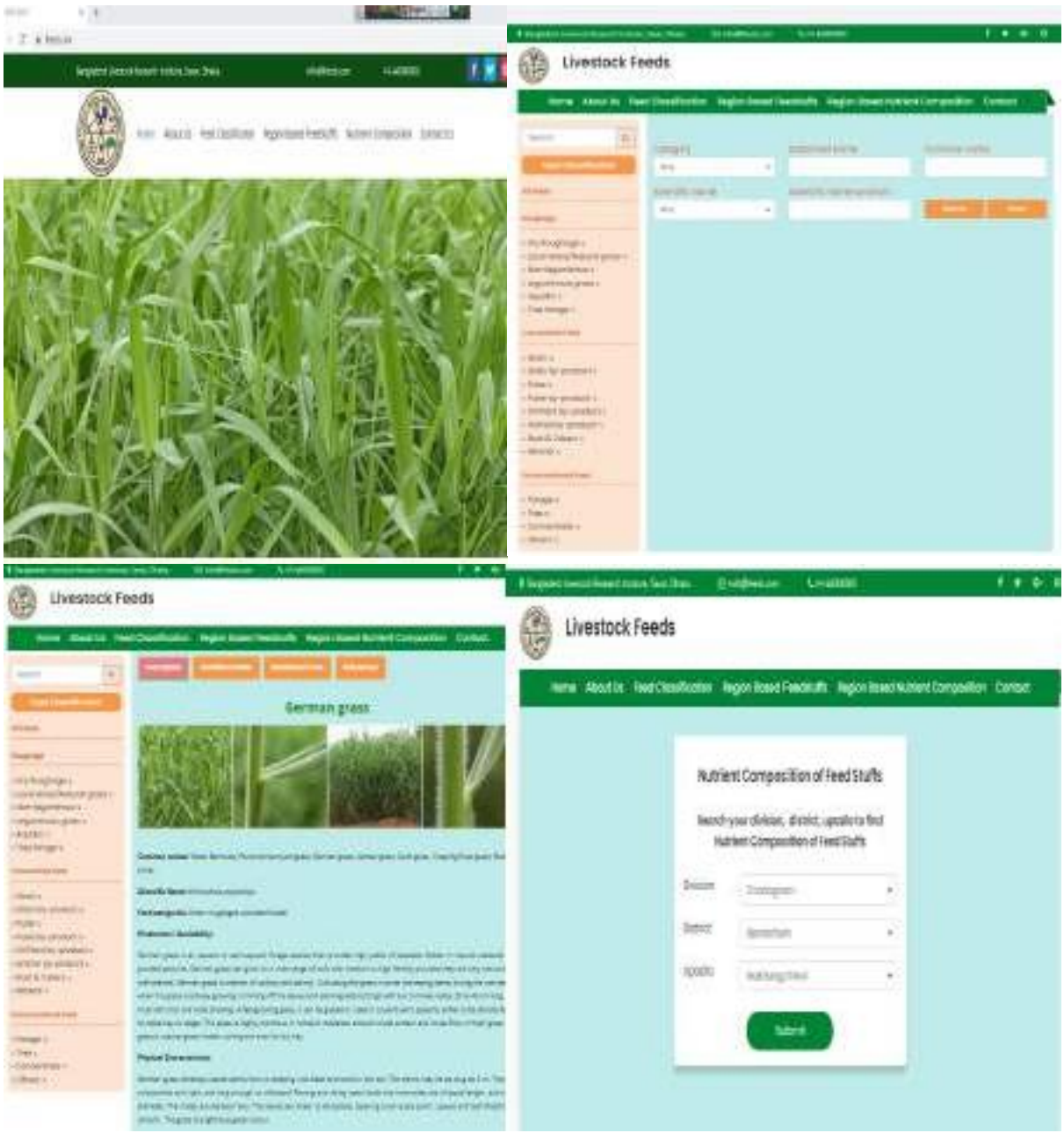

Fig. Demo version of online based web portal

Study on feeding management guideline and nutrient requirement of BLRI improved native chicken and mitigation of noxious gases from poultry litter
Component B: On-farm measurement of noxious greenhouse gases from poultry litter and their possible utilization

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Executive Summary

The present experiment was conducted to know the performance, blood properties and gas emissions of BLRI Layer chicken-2 (Shorna). Therefore, a low-protein diet with a particular amino acid (glutamine) was supplied. At 36 weeks of age, a total of 120 laying hens were randomly assigned to a 3×2 factorial arrangement of treatments (4 replicates/treatment, 5 birds/replication) consisting of three levels of glutamine (Glu: 0, 0.15, and 0.25 %) and two levels of dietary crude protein (CP:17 and 15%) in the diet. Replicates were equally distributed between the upper and lower tiers to minimize the cage-level effect. The diets were formulated (isocaloric and iso-nitrogenous) to meet the National Research Council (NRC, 1994) nutrient requirements for laying hens. A total of 110g of feed per bird was provided twice a day, and the rest of the feed was recorded the following morning. Egg production (EP) and feed intake (FI) in each treatment were recorded daily, and body weight (BW) and egg weight (EW) were weighed once a week. The FI and feed conversion ratio (FCR) were determined weekly. In each 5-week interval, 10 eggs were randomly picked up per replicate cage to assess egg quality parameters. In egg qualities, albumen height and width and yolk height and width were measured. At the end of the experiment, 10 blood samples from each treatment were obtained by wing vein puncture, and the sera were separated and stored at -20^{0}C until analysis. Serum triglycerides (TG), total cholesterol (TCL), high-density lipoprotein (HDL), calcium (Ca), and phosphorus (P) content were measured using an Erba blood chemistry analyzer. At the end of the feeding trial, 10 birds from each treatment were selected and allotted to individual cages and excreta samples (1000 g) were stored in a 10L plastic bucket and the gases (NH_3, CO_2, O_2, H_2S, CH_4, NO_2, CH_4S) forming were determined using a Geotech 500 and Portable Multi Gas Detector (BH-4S) from approximately 5 cm above the excreta samples. All the data were arranged by a 2-way ANOVA mixed model (PROC MIXED, SAS Institute, Cary, NC, USA) procedure of SAS, and differences among treatment means were separated using Duncan's new multiple-range test and the level of significant was considered at $p<0.05$.

The present results showed that no significant differences were found among the treatments. But a numerically higher egg production percentage was found in T_1 (17% CP x 0% Glu) and T_6 (15% CP x 0.25% Glu) treatments than that of other treatments. Egg weight was not influenced by the dietary interaction of CP and Glu in the diet. On the other hand, feed intake was higher in the T_3 treatment and lower in the T_4 treatment, but FCR was better in the T_1 and T_6 treatments. In egg quality parameters, albumen height was higher in the T_3 and T_6 treatments, and yolk weight was higher in the T_6 treatment. On the other hand, there was no dietary interaction between CP and Glu on the albumin index, yolk index, or Haugh unit, respectively. In serum properties, triglycerides and total cholesterol levels were significantly higher in T_1 and T_2 treatments than T_5 and T_6. In contrast, serum levels of glucose, uric acid, Ca, and P were not influenced by the interaction of dietary CP and Glu levels in the diet.

Table 1: Effects of dietary low protein with supplemented glutamine on the performance of laying hens from 36 to 60 weeks of age

Parameters	Dietary Treatments						SEM	P value (CP×Glu)
	T_1 (17×0)	T_2 (17×0.15)	T_3 (17×0.25)	T_4 (15×0)	T_5 (15×0.15)	T_6 (15×0.25)		
BW (g)	1890.65	1934.32	1946.87	1859.78	1887.26	1924.81	23.21	0.435
EP (%)	73.38	72.81	72.14	69.38	68.52	73.12	0.62	0.106
EW (g)	60.29^{ab}	59.63^{ab}	61.82^{a}	58.15^{b}	59.01^{ab}	60.27^{ab}	0.47	0.039
EM (g)	44.24^{a}	43.42^{ab}	44.59^{a}	40.34^{b}	40.49^{b}	44.07^{a}	0.38	0.038
FI (g)	103.85	104.57	105.01	104.24	102.05	103.56	4.74	0.693
FCR	2.346	2.406	2.355	2.584	2.520	2.349	0.21	0.102

SEM: Standard error of mean, two level of dietary crude protein (15 and 17%) and three glutamine (Glu) levels (0, 0.15 and 0.25%), BW: Body weight, EP: Egg production, EW: Egg weight, EM: Egg mass, FI: Feed intake, FCR: Feed conversion ratio, Pro=Protein, Glu=Glutamin, ^{a,b,c}Mean values within a column followed by the same letter are not significantly different (p>0.05)

Table 2: Effects of low protein diet with glutamine on blood composition in laying hens

Parameters	Dietary Treatments						SEM	P value (CP×Glu)
	T_1 (17×0)	T_2 (17×0.15)	T_3 (17×0.25)	T_4 (15×0)	T_5 (15×0.15)	T_6 (15×0.25)		
GLU (mmol/l)	12.22	11.495	13.034	11.374	11.08	12.83	0.912	0.561
UA (mg/dl)	18.69	19.953	24.252	28.674	21.098	26.61	2.145	0.753
TG (mg/dl)	1160.4^{a}	1105.64^{a}	980.37^{bc}	1040.3^{ab}	890.58^{c}	970.65^{bc}	198.32	0.034
TC (mg/dl)	227.55^{a}	203.20^{a}	141.83^{b}	140.64^{b}	159.58^{ab}	97.95^{c}	28.57	0.004
Ca (mg/dl)	9.64	10.39	12.46	13.68	11.53	12.14	0.241	0.362
P (mg/dl)	8.15	9.27	10.14	11.43	9.39	12.08	0.392	0.207

SEM: Standard error of mean, GLU, glucose; UA, Uric acid; TG, triglycerides; TC, Total cholesterol; Ca, Calcium; P, Phosphorus; ^{a,b,c} Mean values within a column followed by the same letter are not significantly different (p>0.05),

Table 3: Gas measurement from poultry litter of BLRI layer chicken 2 (Shorna)

Parameters	Dietary Treatments						SEM	P value (CP×Glu)
	T_1 (17×0)	T_2 (17×0.15)	T_3 (17×0.25)	T_4 (15×0)	T_5 (15×0.15)	T_6 (15×0.25)		
CH_4(%)	11.99	11.85	12.37	12.41	12.64	10.38	1.89	0.519
CO_2 (%)	6.48^{b}	9.88^{ab}	9.80^{ab}	12.95^{a}	11.61^{a}	6.42^{b}	1.76	0.025
O_2 (%)	20.15	20.13	20.17	20.14	20.12	20.11	0.52	0.624
NH_3 (ppm)	197.87^{a}	127.07^{ab}	108.93^{ab}	175.90^{a}	118.37^{ab}	88.37^{b}	11.34	0.034
H_2S (ppm)	42.82^{a}	37.22^{a}	26.16^{ab}	27.35^{ab}	22.11^{ab}	15.17^{b}	2.96	0.021
CH_4S (ppm)	84.67^{a}	81.07^{a}	58.33^{ab}	75.53^{a}	84.07^{a}	55.57^{b}	5.19	0.018
SO_2 (ppm)	12.57	14.52	9.73	13.70	11.43	15.25	0.65	0.261

SEM: Standard error of mean, ^{a,b,c}Mean values within a column followed by the same letter are not significantly different (p>0.05; CH_4, methane; CO_2, carbon dioxide; O_2, oxygen; NH_3, ammonia; H_2S, hydrogen sulfide; CH_4S, methyl marcaptane; and SO_2, sulfur dioxide

In poultry litter, a significantly lower level of NH_3, H_2S, and CH_4S was found in the dietary treatment T_6 as compared to T_1 treatment, but CO_2% was higher in T_2 and T_3 treatments. Dietary interactions of CP and Glu in the diet did not affect the CH_4, O_2 and SO_2 contents of the litter. Thus, dietary crude protein 15% with supplementation of 0.25% Glu in the diet of BLRI layer chicken (Shorna) had numerically improved egg production and reduced gases of NH_3, H_2S and CH_4S from poultry litter.

Conservation and development of native geese production package by determining feed requirement with supplemental forages

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Executive Summary

The geese (*Anas cygnoides*) is a herbivorous waterfowl that is reared for its higher and nutritious meat for human consumption. Geese meat contains high-quality protein, low cholesterol, and high concentrations of polyunsaturated fatty acid. It possess significantly bigger and powerful gizzard, which is biologically suitable to breakdown high fiber roughages and thus able to consume large amounts of forages. Previous studies conducted on the use of water spinach and suggests the suitability of spinach as a basal diet for geese production. The fresh biomass production of water spinach also reported as high as 19.2 tonnes/ ha for first harvest. The dry matter, crude protein, ether extract and crude fiber of water spinach is 12.9, 25.9, 4.2, 7.3 respectively that is encouraging. Considering those fact, the present study was designed to assess the supplementation of water spinach on the performance of meat color traits of native geese. The dressing percentage, meat color, pH, drip loss, cooking loss, water holding capacity & meat nutrient composition were determined. A total of 36 adult native geese of white and grey varieties were reared in a semi-intensive production system in HQ. They were randomly divided into 4 groups with 3 replicates having 3 geese in each replication. Corn-soya based diet was considered as Basal diet (2700ME/Kcal, 16% CP) where T_1 & T_3 groups were supplied 180 g of BSL diets in white and grey respectively and other diets included T_2 (White variety)- 80 g of water spinach + 140 g of BSL diet, T_4 (Grey variety)- 80 g of water spinach + 140 g of BSL diet. At the age of 28 weeks all the birds were individually weighed. A calibrated waterproof pH meter equipped with a spear tip probe was used to measure the pH values of the breast meat 24 hours of slaughter, Drip loss and looking loss was determined according to Wang *et al*., (2017). Meat colour was determined in triplicate using a chromo meter (3nh, china). A total of 13 slaughter traits divided into 2 groups- measured and calculated traits were analysed. The data of the variables collected were analysed using the general linear model procedure of SPSS software (29 version) following a random arrangement. Treatments had a remarkable effect ($P < 0.05$) on redness value (a*). For measured and calculated slaughter traits, results suggested that beneficial traits were not significantly varied but tented to be higher in treatment group. pH value for T_3 group was higher than other groups. However treatment group showed highest drip loss and cooking loss and water holding capacity (WHC), but these parameters were not significantly affected by treatments.

Table 1: The meat colour parameter of native geese with regard to the variety and different proportions of water spinach.

Traits	Treatments				SEM	P-value
	T_1	T_2	T_3	T_4		
L*	42.73	37.73	42.88	38.46	2.62	0.110
a*	8.90^{c}	14.32^{a}	10.10^{b}	12.68^{ab}	0.934	0.003
b*	8.60	8.97	8.76	8.18	1.473	0.942
Hue angle	43.27	32.08	39.37	32.97	4.613	0.093
Saturation index	12.59	16.92	13.44	15.12	1.41	0.065

Values of different variables under different treatment indicate Mean; SEM= standard error of means; * significant ($p<.05$); NS, Non- significant ($p>.05$). T_1= Total concentrate given 180gfeed/geese/day, T_2= 80 g of water spinach+140 g feed/geese/day, T_3= Total concentrate given 180g feed/geese/day, T_4= 80 g of water spinach+140 gm feed/geese/day.

Colour is an important determining factor in sensory quality. Because consumers correlate meat colour with freshness. Breast meat colour of redness (a*) differ significantly among the treatments group ($p=.003$).

Table 2 showed that, most favourable dressing percentage was characterized by T_4, on an average it was 48.43%, another calculated trait was meatiness which showed more carcass muscle % & This parameter showed higher value for T_2 (on an average 44.96%). Both values were higher in treatment group but not significantly varied. The abdominal fat on an average 4.82% and 5.32% and the skin with subcutaneous fat is about 37.30% and 30.44 % in case of T_2 and T_4 group, which is desirable in treatment group. Other traits were not significantly varied.

Table 2. The measured and calculated traits of the native geese with regard to the variety and supplementation of different proportion of water spinach**.**

Traits	Treatments				SEM	P-value
	T_1	T_2	T_3	T_4		
Pre-slaughter weight (g)	4123.33	3997.33	3517.67	3304.00	122.20	0.200
Carcass weight (g)	1878.00	1866.67	1578.33	1600.33	48.15	0.915
Dressing%	45.53	46.73	45.19	48.43	1.83	0.260
Breast weight (g)	371.00	378.33	279.33	344.67	31.91	0.288
Thigh weight (g)	220.00	218.00	201.67	168.00	13.73	0.230
Drumstick weight (g)	229.33	242.67	212.00	191.33	12.179	0.771
Abdominal fat (g)	137.67	88.67	147.67	86.00	32.93	0.131
Skin with sub fat (g)	704.33	696.33	608.00	491.67	62.97	0.352
(Total muscles) (g)	820.33	839.00	693.00	704.00	39.22	0.715
Meatiness %	43.67	44.96	43.90	43.87	1.71	0.720
Abdominal fat%	7.32	4.82	9.42	5.32	2.07	0.151
Skin%	37.51	37.30	38.34	30.44	3.60	0.292

Total muscles= Breast+thigh+ drum

Table 3. The meat pH, drip loss, cooking loss of the native geese with regard to the variety and different supplementation of water spinach.

Traits	Treatments				SEM	P-value
	T_1	T_2	T_3	T_4		
pH	5.75	5.84	5.87	5.76	.074	0.913
Drip loss	10.91	12.94	10.56	10.11	1.28	0.553
Cooking loss	27.47	28.14	25.94	26.48	1.754	0.738
WHC	39.89	41.14	41.35	41.63	.473	0.142

WHC= water holding capacity

The results showed that pH was higher in T_3 group. Drip loss, cooking loss & WHC another indicator for meat quality traits, that did not differ significantly (p=.553, p=.738 & p=.142).

Table 4: Effects of water spinach on chemical analysis of geese meat at adult stage.

Traits	Treatments				SEM	P-value
	T_1	T_2	T_3	T_4		
DM	31.70	32.10	30.73	30.97	.618	0.622
CP	24.13	23.70	23.97	23.70	.253	0.204
EE	4.70	4.80	4.80	4.33	.159	0.282

In addition, we observed that T_2 and T_3 group exhibited higher fat content (4.80), whereas crude protein found to be higher in T_1 (24.13). DM content did not differ significantly (0.662) among different treatment groups. Differences were thought to be due to age, variety, sex and nutrition.

Notably, the treatment groups had exhibited the highest dressing percentage, desirable slaughter and carcass traits as well as favourable meat quality parameters.

Considering the above findings it may conclude that supplementation of geese with water spinach found to be beneficial for improving meat quality parameters. However, further study is suggested to know the appropriate level of supplementations.

Title: Development of multivalent (*Eimeria tenella, E. necatrix, E. brunetti, E. maxima*) coccidial vaccine for poultry.

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Executive Summary

Chicken coccidiosis is an economically significant protozoan-parasitic disease of the commercial poultry industry, accounting for losses of more than £10.4 billion globally in 2022. The infection has been reported in all types of commercial chickens (broiler, layer, and breeder) with a reported prevalence of 7–90% worldwide including Bangladesh. The disease can lead to morbidity, reflected in increased feed conversion ratios, reduced weight gains, drop in production, lower reproductive performance, continuous Eimeria oocyst shedding, increased susceptibility towards secondary bacterial infections and high morttality rate. It is essential to recognize at least 7 chicken Eimeria species (Eimeria (E.) praecox, E. acervulina, E. mitis, E. brunetti, E. tenella, E. maxima, and E. necatrix) that are responsible for intestinal disease. Among them, E. maxima, E. tenella, E. acervulina, and E. necatrix have been reported the highest clinical and sub-clinical disease burden of poultry. The use of anticoccidials, coccidiostats, anticoccidial vaccines, feed additives, extensive list of good farm hygiene and biosecurity practices, have been established for the prevention and control options of coccidiosis in chickens. However, examples of some commercial Eimeria vaccines for chicken include Endrex®, Hipracox®, CoxAbic®, Hatchpakcocci III® Coccivac ®, Livacox ®, Paracox ®, etc. The concern of resistance to major anticoccidials has provided a way forward for vaccine research and development. In addition, it is recommended to look up indigenous strains of Eimeria and prepare multivalent vaccines accordingly to manage the drawback of coccidiosis. Therefore, the current project focuses on the development of a multivalent coccidial vaccine tailored the objectives in the financial year 202-23 were the isolation, identification, and molecular characterization of different Eimeria spp. of chickens in Bangladesh and thus development of a multivalent coccidial vaccine candidate.

A total of 77 clinical samples suspected to coccidia were collected randomly from infected birds on a questionnaire basis from commercial poultry farms located in Dhaka (Savar, Ashulia), Rajshahi, Jessore, Faridpur (Bhanga). That included feces, intestinal tissue, or any other appropriate samples, depending on the stage of infection and season basis. However, after collection, the samples were shifted to the Parasitology Laboratory, AHRD, BLRI in an ice-cool container, and subsequently, oocyst of *Eimeria* spp. was isolated by the flotation technique and the McMaster method. The oocysts were proceeding for sporulation, and it was performed using 2.5% potassium dichromate at 22-28^{0}C within 48 hours and the sensitivity of the test and subsequently DNA was extracted from the collected samples. Afterward, the DNA was extracted from sporulated and unsporulated oocysts using the QIAamp DNA stool mini kit (Qiagen, Germany) according to the manufacturer's protocol. Later, the DNA concentration was measured using a Nano-drop spectrophotometer (Thermofisher Scientific) and stored at -20^{0}C until further use. The species-specific primer sequences (oligonucleotides) were used in PCR targeting the amplification of the ITS-1 sequences of genomic DNA was carried out in 25 µL reaction volumes containing 5 µL of DNA template ITS1 gene of *Eimeria* spp. and visualized in 1.5% agarose gel electrophoresis. The PCR reaction was standardized with pure DNA of all seven species of *Eimeria* targeting ITS-1 based primer sequence of *E. brunetti* (310 bp), *E. maxima* (205 bp), *E. mitis* (306 bp), *E. necatrix* (285 bp), *E. tenella* (271 bp). and E. acervulina (321 bp). However, the collected data were recorded and analyzed in a Microsoft Excel spreadsheet followed by a t-test with P-value <0.05 was considered significant.

It was found that, traditional measures included microscopy to count oocysts excreted per gram (OPG) of feces or persisting in litter, or total oocysts excreted per unit of time (500 oocyst/EPG) was considered for PCR quantification. In this study, it was found that 76.62% (n = 59/77) of the samples were positive for *Eimeria* spp. based on microscopic analysis. However, blood profiles and histopathology were done (Fig.01) on each infected and non-infected poultry birds for comparison and evaluation of poultry health. PCR results shown that *E. tenella* (23%, P<0.05), *E. brunetti* (24%, P<0.005), *E. necatrix* (27%. P<0.4), *E. mitis* (18%, P<0.06), *E. maxima* (19%, P<0.006), and *E. acervulina* (4%, P<0.002) were prevalent among seven species. A total of 5 isolates of *Eimeria spp*. (*E. tenella, E. necatrix, E. brunetti , E. maxima)* have been prepared and forwarded for attenuation in the CAM route of a 9-day-old Embryonated Chicken Egg (ECG) according to the protocol of Myung-Jo You, 2014. However, the average EPG is 2000-2500 oocyst/ml for egg innoculation and 0.25 ml antibiotic treated inoculum was recommending for serial egg passages. The findings also included that due to adding high level of coccidiostate in commercial poultry feed it is sometime difficult to collect typical outbreak samples of coccidiosis. Therefore availability of coccidiosis in poultry is less in summer season, even medium farm are more susceptible than large and small scale farm.

Fig: 1. Detection of *Eimeria spp*. from poultry intestinal content

Coccidiosis is one of the major economic issues in commercial poultry production in Bangladesh. Thus the multivalent coccidia vaccine has been designed to provide broad protection against E. tenella, E. necatrix, E. brunetti, and E. maxima that has been minimized the risk of outbreaks and helps to maintain flock health, improves economic viability. Furthermorer the development of a multivalent coccidial vaccine targeting *Eimeria tenella, E. necatrix, E. brunetti, and E. maxima* will represents a significant breakthrough in the poultry industry.

Development of *Salmonella* vaccines from circulating strains of poultry in Bangladesh

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Executive Summary

Non-typhoidal *Salmonella* are widely distributed throughout the world, especially in developing countries. *Salmonella enterica* are predominantly being abundant in Bangladesh. There have been reports of 2610 distinct *Salmonella* serovars causing the zoonotic bacterial illness salmonellosis worldwide in 2018. As a common cause of mortality and/or decreased productivity among poultry population, it necessitates in-depth investigation and prophylactic action against *Salmonella*. The costs or impracticality of improvements in hygiene and management together with the increasing problems of antibiotic resistance suggest that vaccination in poultry could combat *Salmonella* infection in poultry. Thus, the research was conducted to develop an inactivated *salmonella* vaccine from circulating *Salmonella* Enteritidis and *Salmonella* Typhimurium strains.

Salmonella spp suspected clinical samples (liver and intestine) were collected from different layer farms and private veterinary hospitals of Dhaka, Manikganj, Narsingdhi, Tangail, Gazipur, Chattogram and Bogura districts during July 2022 to June 2023. Samples were transferred to the Animal Health Research Division immediately after collection. Samples were processed for bacterial isolation, identification and molecular identification to confirm *Salmonella* at genus level and later on at species level. For the PCR, DNA was extracted from the isolated samples using boiling method. *Salmonella* spp., *S*. Typhimurium and *S*. Enteritidis was confirmed by targeting the *sdi*A, *Typh* and *sdf-1* gene, respectively.

Among the 350 samples, *Salmonella* spp was isolated and identified from 34 samples (34/350, 9.7%) and confirmed by PCR at genus level. After detection of *Salmonella* at genus level, PCR was carried out to confirm *S*. Enteritidis and *S*. Typhimurium of the 34 PCR positive samples. Out of 34 *Salmonella* isolates, 3 for *S*. Enteritidis and 10 for *S*. Typhimurium were confirmed by PCR with species specific primers (Figure 1).

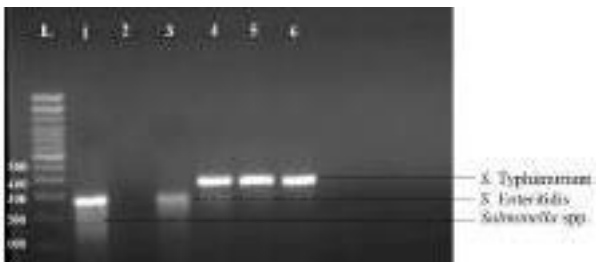

Figure 1. PCR result of representative *Salmonella* spp (284bp) *S*. Enteritidis (293bp) and *S*. Typhimurium (401bp) isolates

The isolated *S*. Enteritidis and *S*. Enteritidis were characterized by Whole genome sequencing (WGS). Now the isolates will be inactivated with Binary Ethylene Imine (BEI) and mixed with adjuvant in appropriate ratio. The efficacy and safety test of developed *Salmonella* vaccine will be performed. The prepared vaccine could therefore potentially be applied in the poultry industry to control and prevent *Salmonella* infection in poultry in Bangladesh.

Classical, applied, and molecular epidemiological studies to develop disease risk management, treatment, and control model of FMD, Anthrax, and HS in Buffaloes

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Executive Summary

Despite being less susceptible to infectious diseases than cattle due to their hot and humid habitat, buffaloes are still vulnerable to various diseases, leading to production losses and mortality. Previous studies in Bangladesh have reported the prevalence of Foot and Mouth Disease (FMD), Anthrax, and Hemorrhagic Septicemia (HS) in buffalo populations. However, these studies lack credibility regarding statistical power and population representation. In response, our study aims to conduct classical, applied, and molecular epidemiological investigations. The objective is to generate real-world data on the transmission and dynamics of diseases, particularly FMD, Anthrax, and HS, in buffalo populations within specific study areas. Specific goals include describing outbreaks' magnitude and spatial distribution, quantifying transmissibility, studying the molecular nature and phylodynamics, investigating non-time varying modifiable determinants, and developing a farm-level treatment protocol for FMD, Anthrax, and HS occurrences in the study areas. Initially, we conducted a field survey to assess the frequency of diseases and farmers' perceptions of Foot and Mouth Disease (FMD), Anthrax, and Hemorrhagic Septicemia (HS) in buffaloes. To ensure adequate statistical power for analysis (targeting a prevalence of 50%, 95% confidence, and 5% absolute precision with cluster adjustment), we randomly selected a total of 600 buffalo farmers, 200 farmers from each of the three conveniently selected upazilas in Sylhet, Noakhali, and Rajshahi districts (specifically Fenchuganj, Companiganj, and Godagari). Farm and individual animal-level information was collected during enrollment through a pretested questionnaire. To reduce the cost of laboratory testing, we explored various pooling strategies by reviewing literature from diverse fields where pooling is commonly applied. Simulated samples helped us mapping out pooling schemes and assess as well as compare the performance of different strategies based on varying prevalence of diseases and pool sizes of samples. We conducted simulations to compare the in-silico performance of pooling schemes using different pool sizes and prevalence rates, evaluating their efficiency and considering different variants within the schemes. Additionally, a literature review was undertaken to understand and summarize the line of treatment applied for treating FMD, Anthax,and HS cases in various regions worldwide.

After this review, the clinical trial protocol for future intervention trials in this study was developed in consultation with field veterinarians.

Based on responses from farmers in our survey, the most prevalent diseases in the study area are Hemorrhagic Septicemia (HS), Lumpy Skin Disease (LSD), Foot and Mouth Disease (FMD), Anthrax, and nonspecific diarrhea. According to the survey results, 35% of farmers identified Hemorrhagic Septicemia (HS) as the primary buffalo disease, followed by 28% who expressed concern about LSD, 26% indicating FMD, 8% designating Anthrax, and 3% considered diarrhea as a significant health problem. The variation in farmers' concerns mirrors the diverse health challenges confronting the buffalo population, with Hemorrhagic Septicemia identified by the highest proportion (35%) of respondents as the primary buffalo disease. LSD and FMD require considerable attention from livestock officials responsible for disease control. This underscored the necessity for targeted interventions and intensified surveillance programs focused on Hemorrhagic Septicemia, LSD, and FMD in buffaloes. Concerning the significance of livestock disease categories, farmers prioritized the diseases in the following order: Infectious diseases, Internal Parasites, External Parasites, Nutrition, and Toxicity (encompassing poison,

toxic plants, and snake bites). This highlights the diverse nature of health concerns in buffalo, underscoring the necessity for a comprehensive approach that tackles infectious diseases, parasitic infestations, nutritional problems, and toxic exposures. Regarding constraints in disease control, farmers identified the following issues in order of importance: a lack of information for farmers, insufficient training for farmers, a shortage of expert assistance, and a deficiency in disease alert and vaccination services. Farmers' focus on disease control constraints highlights information gaps, inadequate training, limited expert assistance, and deficiencies in alert and vaccination services. Addressing knowledge gaps through enhanced education is crucial, emphasizing the need for accessible and timely expert support in disease control initiatives. Results of the simulation pooling strategies demonstrate that a larger pool size maximizes pooling efficiency at low prevalence, whereas a smaller pool size maximizes efficiency at higher prevalence. None of the pooling schemes can improve efficiency at prevalences above 30%. A pooling efficiency of 70% or higher was obtained by the intermediary pool sizes (8,10,12) at a prevalence level of 2%. The same level of efficiency was gained with a larger pool size (15,18,20) at a prevalence level of 1%. The simulation results elucidate the intricate relationship between pool size and pooling efficiency in various prevalence levels. Notably, a larger pool size emerges as optimal for maximizing efficiency at lower prevalence, underscoring its effectiveness in capturing positive cases when the overall occurrence of the condition is relatively sparse.

In the next phase of the project, a collaborative clinical trial will be conducted. The decision to use The Platform Trial for assessing various treatment approaches was made. This trial design enables the simultaneous evaluation of multiple interventions, optimizing efficiency and resource usage.

In conclusion, our study explains prevalent diseases, health concerns, and disease control constraints among buffalo farmers based on the opinions of 600 farmers surveyed in this study. The identified diseases, especially Hemorrhagic Septicemia, Lumpy Skin Disease, and Foot and Mouth Disease, demand targeted interventions and intensified surveillance. The prioritization of disease categories highlights the diverse health challenges in buffalo, emphasizing the necessity for a holistic approach. Our findings contribute to evidence-based disease management strategies and veterinary care improvement for buffalo diseases.

Exploring a model for the buffalo calf health management through improved therapeutics against pneumonia and diarrheal diseases in selected

Running Title: Characteristics and Performance of Micro-Enterprises in the Buffalo Production Sector: A Survey in Coastal Regions of Bangladesh

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Executive summary

The husbandry and production systems of buffaloes vary depending upon the topography and vegetation patterns of the country. Coastal Zone is the region where land, ocean and atmosphere interact with each other. Coastal zones of Bangladesh consist of 19 districts. It is dynamic and diverse in nature being continually attacked by cyclones, sea level rise, storm surge which have caused terrible impacts on buffalo health in low lying coastal area in the recent years. Buffaloes are raised under an extensive system in the coastal and hilly areas where large-scale pasture land and enough green forage are available. One of the most important characteristics of buffalo production in Bangladesh is that they are raised by medium or large farmers who are generally considered rich in the locality. Therefore, considering all the geo-climatic features and the new prospect of buffalo farming at the coastal region, the challenges of buffalo health management, farmers must need to play an integral role in minimizing disease threats and managing ongoing conditions on their farms. Perceiving climate variability and environmental hazards is the first step in the process of adaptation and mitigation in term of biological risk management. This study was conducted using a structured questionnaire in designated clusters located at in Bhola, Barishal, Patuakhali and Noakhali**.** The qualitative study, especially field interview method was followed to get the information from buffalo producers as micro-entrepreneurs (MEs) in study areas. A structured questionnaire was used to perform individual in-depth interview through focus group discussion. After preparation of the interview schedule for appropriate data collection, questionnaire comprised of eight sections focusing on specific activities of the survey with close and open questions. The survey was conducted from 8 August 2022 to 8 September 2023. When necessary, secondary and historical data and information were adopted for making logic of any statement or decision.

Characteristics of micro-entrepreneurs (MEs) included a total of 64% MEs were males and 36% were females. The average (mean±SEM) age of the respondent MEs was 45.75±1.01 years. Respondents were distributed into four aged groups as. MEs were found in all age groups, with the greatest concentration (38.83%) in the age group of 41-50 years. The educational qualification of owners indicates that the majority of MEs (50.49%) had completed primary school. Whereas, about 5.83% of MEs were illiterate. Only 4.85% of MEs were with higher secondary education. Various training courses were attended by MEs of this study. About 46.53% of MEs received training on livestock's health and vaccination, and 28.71% received technical training on entrepreneurship and business management. But 16.83% had not received any training before starting their business. We found significant ($P<0.05$) variation among MEs training groups. The average household of MEs was 5.84±0.17. MEs were divided into two groups as household size <5 and household size > five according to household size. We found 53.40% MEs had household <5 and 46.60% of MEs had household >5. The average income of MEs was BDT 22480.00±1350.00 with a range from BDT 1200.00 to 70000.00. The household's income table shows that one third (35.87%) had monthly income ranged within BDT 16000-25000. The motivation for starting a business originated for MEs from their need to support their families or to have their own business or good business opportunities or encouraged by friend and relatives. Most MEs (33.66%) were driven by sound business opportunities or the financial benefits they expected to generate. This motivation is reflected a degree in the reason given for their choice of own business (32.67%). Whereas,

27.72% of MEs cited the need to support their families in no job condition as a motivation for the start-up of micro-enterprises. As the state-of-the-art study on microentrepreneurial characteristics, the questionnaire was designed carefully to measure individual traits such as risk aversion and entrepreneurial self-efficacy as buffalo producers and to define the need for significant accomplishment, mastering of skills, and attaining challenging situations, overall, for achieving goals. The results highlights average 56.96% of MEs showed herd health management skill and 16.50% of MEs expressed knowledge on business management and marketing. A large percentage of MEs were able to recognize a healthy and a sick animal (97.09%), properly store vaccines and other medicines (73.79%, ($P<0.05$), to detect common buffalo diseases and udder problems (65.05%, ($P<0.05$)) and to detect heat (estrus) in buffalo cows and understand the basics of AI (63.11%). Screening MEs' skills on herd health management reveal that a few MEs could design, initiate and maintain a herd health program (25.24%) and set an effective culling standard (17.48%, ($P<0.05$). Whereas, only 20.39% of MEs reported their knowledge and ability in developing a ration for buffaloes depending on stages (pregnant, lactating, dry, heifer, growing calves, and breeding bulls) as feeding management skills. Regarding the business and marketing skills, it was observed that very few MEs were able to develop a marketing plan for buffalo products (17.48%), to keep effective financial records (16.50%), to analyze production records for making wise decisions (to analyze production records for making wise decisions%) and were familiar with sources of buffalo-related information (15.53%). Moreover, there were significant ($P<0.05$) differences among respondent groups according to primary (E2), secondary (E3) and higher secondary (E4) education levels.

Therefore, these results suggest that more training on-farm and enterprise's management in term of herd health, business, marketing and entrepreneurship, should be conducted to improve MEs knowledge. Efforts to bridge the ME's skills, experiences and business performances may prove very fruitful.

Community involving economic diseases control model for chicken

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Executive summary

Newcastle disease is a highly contagious and a fatal viral disease affecting the respiratory, nervous and digestive systems of birds and poultry including domestic poultry, found worldwide caused by a para-myxo virus. Birds affected by this disease are fowls, turkeys, geese, ducks, pheasants, partridges, guinea fowl, and other wild and captive birds, including ostrich.ND was considered the cause of the highest economic loss in village chickens in most developing countries including Bangladesh. ND had the highest proportional mortality rate and annual loss in Bangladesh is 288.49 million US dollars. ND has high morbidity and mortality rates up to 100%, resulting in severe economic losses. Backyard chickens play a vital role in our national economy, meeting protein demand, building rural economies and women empowerment. Therefore, the project was approved for two years to increase backyard poultry production and decrease mortality which will contribute to enhancing our GDP. Thus, the study was carried out in the first year (2022-2023) to unveil the status of economically important diseases (especially ND) in backyard chicken of a community and to determine the sero prevalence of ND in backyard chicken. The project site was selected at Nowapara village under Bhanga Upazilla, Faridpur. A baseline survey was completed over 100 backyard poultry households from door to door with the predesigned and pretested questionnaire. After completing the baseline survey, 50 beneficiaries were selected randomly from this village. The mass vaccination with BCRDV and RDV live attenuated vaccines manufactured by the Department of Livestock Services (DLS), deworming with Piperazine citrate as Peravet® in the dose of 1g/L drinking water, technical support, modern health care techniques with demonstration, and some inputs (anthelmintic, disinfectant, hand sprayers etc.) were provided to the selected farmers. Sero surveillance of ND before and after vaccination was done using Haemagglutination (HI) assay (β method).

The survey result showed that on average 25%, 17%, 33%, and 25% of farmers were illiterate, class one to four, class five to class nine, and SSC or above respectively. The distribution livestock population was 51%, 25.31%, 17%, 4.13%, 2.47% for indigenous chicken, duck, pigeon, cattle, and goat. Maximum farmers (Above 80%) were faced with different types of diseases in their birds especially ND, avian influenza, fowl pox, coccidiosis with high mortality rate, and low productivity of native birds. Only 6% of farmers use anthelmintic irregularly for their birds, 9% of farmers dispose of their dead birds in soil pits and others dispose of slaughtering waste and carcasses in environments. More than 80% of farmers don't practice vaccination schedules. Floors of the poultry houses were made of 5% concrete, 77% wooden, and 18% soil-made which were mostly found as very dirty and unhygienic. There are mass vaccination, deworming, technical support, modern health care techniques with demonstration, field disease diagnosis, and treatment. and some inputs (anthelmintic, disinfectant, hand sprayers), were provided to the selected farmers. Sero surveillance of ND before and after vaccination of a total 42 birds (16 serum samples for pre-vaccinated and 26 samples for post-vaccinated) were done using Haemagglutination (HI) assay (β method).

The results of Ab titer level of HI test showed <8 in 87.5% for pre-vaccinated birds whereas Ab titer level of HI test showed >16 in 78% for post vaccinated birds. Hence, vaccinated birds of 78% were in protective condition against ND.

Figure-1: Some pictorial views of the project's activities

Therefore, it needs to be continued ND vaccine at the age of 2 months for BCRDV and every 6 months interval for RDV respectively with sero-surveillance, disinfection, deworming, diagnosis, treatment, molecular detection, and characterization of NDV for developing the Nowapara village as a ND controlling model village.

Socioeconomic analysis of antibiotic use in poultry production in Bangladesh

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Executive Summary

A huge number of poultry farms are established across the country to respond to the increased demand for animal nutrition. To boost production and supply, farmers use various medications such as prebiotics, probiotics, growth promoters, steroids, etc. Besides, farmers use antibiotics to treat, prevent, and control poultry diseases immensely. This overuse of antibiotics in poultry can stimulate antimicrobial resistance to pathogens that can be a big threat to humans regarding sound health and well-being. Considering the facts, the study aims to identify the present scenario of antibiotic use in poultry production and the cost incurred for the purpose of antibiotic use. In addition, we also determine the factors that influence antibiotic use in poultry production. For this, a total of 243 poultry farmers' i. e. 90 broilers, 39 sonali, 34 layers, and 80 native chickens (scavenging) farmers were surveyed covering eight (8) divisions of the country. At first, from eight (8) divisions we selected eight districts namely Mymensingh, Narsingdi, Barguna, Jashore, Chattogram, Rajshahi, Moulavibazar, and Rangpur purposively based on poultry production and rearing density. Hereafter, we took at least two Upazilas from each district. The farm categories were small, medium, and large (Table 1). In the case of native chicken, there was no category. A simple random sampling technique was followed for collecting primary data from the respondents via face-to-face interviews with a structured questionnaire. Moreover, we conducted 30 Key Informant Interviews (KII) comprising Upazila Livestock Officers and Drug Sellers in the respective areas. Primary data collection and conduction of KII, these two activities were done from January to June in 2023. For analyzing data, we simply applied tabular analysis i. e. descriptive statistics, and statistical analysis i. e. multivariate regression analysis.

From the findings, we found that most of the poultry farmers were in middle age (36 to 50 years) and they were male in gender (96%) showing more than 5 years of experience, and poultry farming was their primary occupation (65%). Approximately 75 % of poultry farmers had secondary to higher secondary level of education which indicates they had a good understanding to perform farming activities wisely. On the contrary, only 3% of poultry farmers had institutional training on antibiotic use and the associates. In the study area, we found 55% broiler farms followed by 24% sonali and 21% layer farms. We got the highest farm size of 66% small, 82% medium, and 67% medium, respectively for broilers, layers, and sonali (Fig. 1). For native chickens, we found 16.89 birds per farm. In the case of antibiotic use, experts (key informants-Upazila livestock officer/ veterinary surgeon, and drug seller) came to a consensus that farmers used antibiotics for production purposes aligned with the treatment, control, and prevention of diseases where broiler farmers (37%) hold the top rank followed by sonali (27%) and layer farmers (26%). On the other hand, native chicken rearers (10%) were almost free from antibiotic usage. Moreover, we also calculated antibiotic cost per batch (1000 birds) was BDT 2,580, BDT 2,560, and BDT 23,300 for broiler, sonali, and layer, respectively considering rearing duration for broiler 25 to 30 days, for sonali 55 to 60 days and for layer 18 to 24 months. Besides, the antibiotic cost was half for broiler and one-third for sonali and layer in comparison with the total treatment cost (doctors' consultation fees, medicine costs, and vaccine costs) (Table 2). As small and medium farmers spend more on antibiotics than large farms, misuse of antibiotics is also high in them. From the regression analysis, we also found that the value of the coefficient of the variable "Advice" was negative and significant at a 1% level indicating farmers who had taken advice from the Upazila Veterinary Hospital or equivalent use fewer antibiotics. In addition, the sign of the coefficient of the variables "Knowledge", and "Training" was negative though insignificant indicating that farmers who had good knowledge and institutional training on antibiotics used less compared to others (Table 3).

In conclusion, we can say that almost 95% of poultry farmers belong to the small and medium category. Antibiotic consumption (as a proxy of antibiotic purchase cost) was the highest in broiler production. In contrast, native chickens are almost free from antibiotic use. Therefore, training on antibiotic use for poultry farmers and to make awareness about the negative effects of antibiotics may help regulating the unscrupulous use of antibiotics.

Table 1. Poultry farm category based on bird number

Poultry species	Small	Medium	Large
Broiler	<2000	2000-4000	> 4000
Layer	<1000	1000-2000	>2000
Sonali	<500	500-1000	>1000

Table 2. Treatment cost versus antibiotic cost calculation

Species	Batch duration (month)	BDT/batch (1000 birds)		
		Treatment	Antibiotics	Ratio (T:A)
Broiler	01	5220	2580	1:0.50
Sonali	02	6870	2560	1:0.37
Layer	24	67100	23300	1:0.35

Table 3. Determinants of antibiotic use

Explanatory var.	Coefficients	Std. error	Sig. level
Age	0.00	0.13	0.95
Occupation	-0.08	0.10	0.42
Education	0.04	0.03	0.17
Experience	0.02	0.03	0.61
Broiler	1.20***	0.28	0.00
Layer	-	-	-
Sonali	1.23***	0.29	0.00
Ln Bird No.	0.62***	0.18	0.00
Advice	-1.92***	0.22	0.00
Training	-0.47	0.33	0.15
Knowledge	-0.14	0.21	0.49
Constant	-1.83	1.42	0.19
R^2		0.59	
Adj. R^2		0.57	
F - value		0.00	

Note: ***p<0.01, **p<0.05, and *p<0.10 significant level.

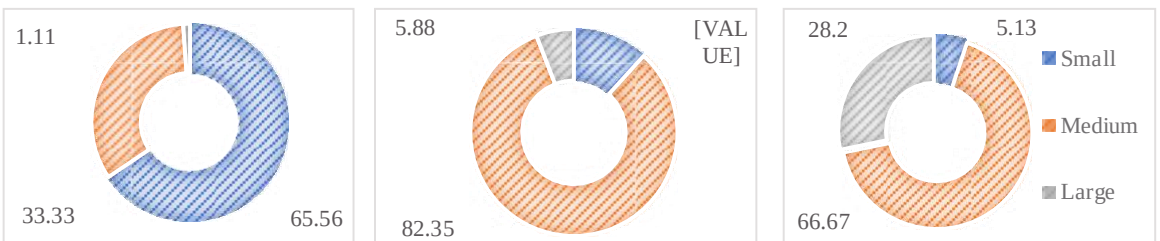

Fig. 1 Poultry farm scenario in the study areas

Impact of training given to farmers on BLRI technologies

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Executive summary

Bangladesh is primarily an agricultural nation, and about three-fourths of the population depends on agriculture, cattle, and related industries for living. The livestock sector makes an undeniable contribution to Bangladesh's economic growth, food and nutrition security, creation of self-employment creations importantly poverty alleviation. The contribution of livestock and poultry in country's Gross Domestic Product (GDP) accounts for 1.85% and 20% people are directly and 50% are partly depend on this sector (BER, 2023). Milk production in FY 2021-22 was 140.68 lakh MT, which increases 4.7 times as compared to FY 2010-11; hence per capita availability reached to 221.89 ml/day (DLS, 2023). Over the past few years, commercial cattle fattening has greatly expanded due to restriction of illegal cattle trade. As a result, Bangladesh has become self-sufficient in meat production. It is increased by 4.37 times in the last one decade and reached to 87.10 lakh MT in FY 2022-23 as well as per capita availability reached at 137.38g/day (DLS, 2023). The population of this country is increasing day by day, with the increasing population size and income the demand of meat, milk and egg also increasing. In order to meet the future challenges, awareness building among the farmers to adopt new technologies and to improve the production performance of livestock and poultry need to be emphasized. Therefore, the present study was designed to improve the knowledge and skill of farmers regarding livestock rearing and management through training. A total of 150 livestock farmers were randomly selected from Naikhongchhari, Jessore sadar, Vanga, Baghabari and Godagari Upazilas of Bandarban, Jessore, Sirajgonj, Faridpur and Rajshahi districts respectively and all of the farmers were imparted three days specialized training on BLRI developed technologies. Data was collected through pre-tested questionnaire and analyzed by the STATA computer software program.

Table 1: Demographic Characteristics of livestock farmers

Varibles	Baghabari, Sirajgonj	Vanga, Faridpur	Jessore Sadar, Jessore	Naikhongchori, Bandarban	Godagari, Rajshahi	All areas
Gender						
Male (%)	56.67 (17))	16.67 (5)	53.33 (16)	53.33 (16)	86.67 (26)	53.33 (80)
Female (%)	43.33 (13)	83.33 (25)	46.67 (14)	46.67 (14)	13.37 (4)	46.67 (70)
Age (Years) (Mean±SE)	39.55±2.10	36.63±2.14	32.5±2.05	39.2±2.09	40.27±2.24	37.63±1.42
Year of Schooling (Mean±SE)	6.61±0.65	5.77±0.90	9.2±0.93	5.16±0.88	5.3±0.87	6.41±0.74
Family member (Mean±SE)	4.67±0.31	5.17±0.37	4.8±0.28	4.93±0.38	5.03±0.33	4.92±0.09
Land Holding (D.C.) (Mean±SE)	148.48±14.26	65.74±13.96	68.01±8.97	123.27±22.96	61.78±15.25	93.45±17.8

The following Table 1 indicate the demographic data of Livestock farmers. The data represent that most of the respondents are male (53.33%). The average family member was 4.92±0.09. The highest number of family members per household was found in Vanga Upazila (5.17±0.37) and the lowest was in Baghabari Upazila (4.67±0.31). The average years of schooling were 6.41±0.74 years indicating that farmers were

moderately educated. The level of education was found slightly higher in Jessore Sadar Upazila (9.2±0.93 years) of Jessore district and the lowest was in Naikhongchari Upazila (5.16±0.88) of Bandarban district.

Table 2: Types of Livestock reared by farmers

Location	Cattle (Mean±SE)	Goat (Mean±SE)	Poultry (Mean±SE)
Naikhongchari, Bandarban	**2.** 2.1±0.30**1±0.30**	**2.97±0.54**	23.83±3.90
Baghabari, Sirajgonj	3.19±0.50	1.35±0.34	13.90±1.86
Vanga, Faridpur	1.43±0.49	0.93±0.38	**46.46±26.41**
Jessore Sadar, Jessore	3.73±0.34	2.1±0.32	30.13±17.99
Godagari, Rajshahi	**4.13±0.36**	1.6±0.47	13.8±2.67
All areas	2.92±0.50	1.79±0.35	25.62±6.06

The following Table 3 shows the types of livestock reared by livestock farmers at selected areas of Bangladesh. The table represents that the average number of cattle was highest in Godagari Upazila (4.13±0.36) and lowest in Vanga Upazila (1.43±0.49) compared to Naikhongchari Upazila (2.1±0.30), Jessore sadar Upazila (3.73±0.34) and Baghabari Upazila (3.19±0.50). In case of goats, the average number of goat was highest in Naikhongchari Upazila (2.97±0.54) and lowest in Vanga Upazila (0.93±0.38). However, the average number of poultry was found 25.62±6.06 and the highest was found in Vanga Upazila (46.46±26.41).

Table 3: Technology adoption by the livestock farmers at the selected areas

Location	Yes (%)	No (%)
Naikhongchari, Bandarban	86.67	13.33
Baghabari, Sirajgonj	70	30
Godagari, Rajshahi	0	100
Jessore Sadar, Jessore	16.67	83.33
Vanga, Faridpur	33.33	67.67
All areas	**41.33**	**58.67**

The following Table 3showed the technology adoption rate in the selected areas. The average technology adoption was 41.33% and non-adoption rate was 58.67%. The highest technology adoption rate was in Naikhongchari Upazila (86.67%) and lowest in Godagari Upazila (0%).

Table 4: Regularity of vaccination and deworming by the livestock farmers at the selected areas

Location	Vaccination (%)	Deworming (%)
Naikhongchari, Bandarban	76.67	66.67
Baghabari, Sirajgonj	100	100
Vanga, Faridpur	80	33.33
Jessore Sadar, Jessore	93.33	93.33
Godagari, Rajshahi	100	100
All areas	**90**	**78.67**

The Table 4 represents the regularity of vaccination and deworming. The average of regularity of vaccination and deworming in the selected areas was 90% and 78.67% respectively, which means almost all of the farmers practice regular vaccination and deworming. This result represents the livelihood scenario of farmers before training. From this result it was revealed that, most of the farmer's education level was slightly higher than primary level, their technology adoption rate was also low but they are willing to adopt new technologies after training. Although, most of the farmers perform regular vaccination and deworming but their knowledge regarding scientific rearing and management of livestock is poor. So the production performance of their livestock is not so good. After post training survey data analysis we could say that famer's knowledge, skill and technology adoption is significantly improved or not.

Research First

RESEARCH YET TO BE COMPLETED

ARRW-2023

Demonstration and validation of BLRI developed native duck through community based at Bhanga, Faridpur

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Executive Summary

Bangladesh boasts the largest delta environment globally, abundant in both natural and human resources. Duck is one of the major poultry species that raised in southern and harbor regions of Bangladesh. Bangladeshi rural farmers seem to find duck farming to be a lucrative venture. Duck rearing is one of the options of livelihood available to the landless, because of the fact that duck can utilize common feed resources from natural water bodies like wet and marshy lands, beels, haors, rivers, cannels etc. The environment and climate of Bangladesh are in favorable to duck settlement. Duck is more productive and resistant to the harsh climatic condition than chicken. Ducks are more resistant to common diseases compared to chickens. Duck also lay more eggs and produce more meat than indigenous chicken in the low laying of the country. Ducks are commonly maintained by rural woman and children that generate cash income as secondary business of the family. Duck rearing helps to supply necessary eggs and meat to family's diet which is the cheapest source of animal protein. Several studies found that indigenous ducks are well adapted to the management practices in rural areas of Bangladesh. Their meat has been reported to be excellent in quality. Improved feeding technique increases the egg production of ducks that is cost effective in comparison of feed cost. Productive and reproductive performances of duck depend specially on genetic makeup. Therefore, breed is one of the most important factors for successful duck rearing, particularly that for egg production. BLRI developed BLRI-1 and BLRI-2 ducks are suitable in Bangladeshi climatic condition. Numerous investigations were carried out to assess the productive, reproductive and phenotypic traits of BLRI-1 and BLRI-2 ducks.The present research was carried out to demonstrate BLRI native duck at community level in selected areas of Bhanga, Faridpur. The objectives was to establish BLRI improved native duck production farming community at BLRI regional station areas, Bhanga, Faridpur and to improve livelihood of community farmer through rearing BLRI improved native duck. For this research work we had visited the community village and conduct meeting with the native duck rearing farmer. We had also visited the farm of native duck farmer and provided advice on BLRI native duck farming. All the studies were conducted at farmer's level under semi intensive management system. Field trial was conducted to validate the production ability of BLRI-1 and BLRI-2 ducks and compared between them under farmer's condition. Eggs of BLRI-1 and BLRI-2 were distributed to the rural women from BLRI regional station duck shed. Eggs were hatched by the rural woman and BLRI native duck trial was conducted at community level at Bhanga, Faridpur. The farmer reared duck in their house in semi intensive farming system with local management practices. Their productive, reproductive and carcass data were then recorded. We found the hatchability of BLRI-1 duck was 70% whereas BLRI-2 was 68%. Egg production and Age at sexual maturity of BLRI-1 duck was 160 eggs & 180 days, therefore BLRI-2 was 150 eggs & 175 days. Dressing %, Dressing weight, duckling weight, Marketable weight & egg weight of BLRI-1 duck was 60%, 990gm, 50.07 gm, 1.65 kg & 66.70 gm in comparison with BLRI-2 duck.

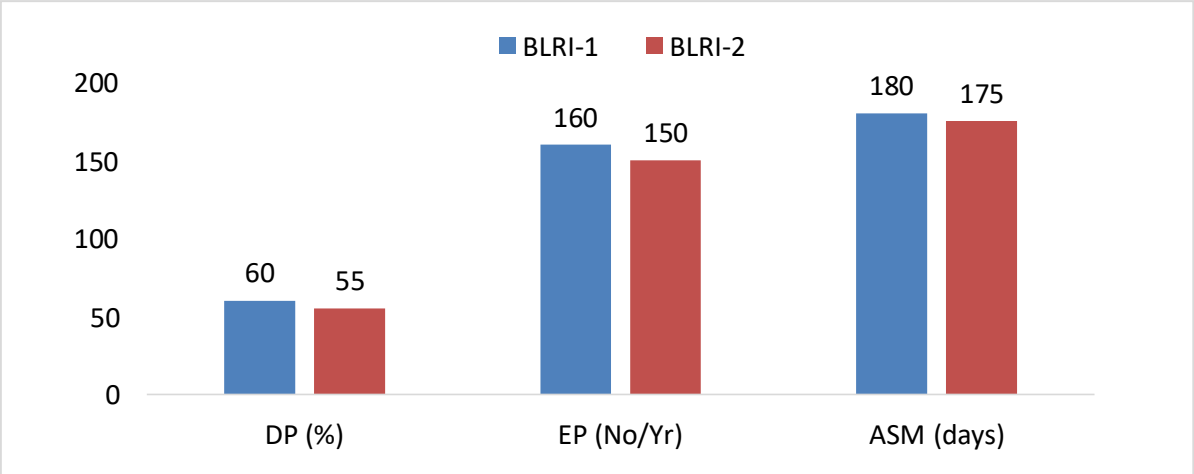

Figure 1: Comparative performance study between BLRI-1 & BLRI-2 (DP: Dressing Percentage, EP: Egg Production, ASM: Age at sexual maturity)

SL No.	Parameters	On farm level (In rural area of Bhanga, Faridpur)	
		BLRI-1	BLRI-2
1	Hatchability (%)	70	68
2	Duckling weight (gm)	50.07	47
3	Marketable weight (Kg)	1.65	1.50
4	Dressing weight(gm)	990	825
5	Egg weight (gm)	66.70	58

Table 1: Production Performance of BLRI Native duck at farmer's level

Table 1 shows that BLRI-1 duck had better marketable weight and egg weight than BLRI-2 duck. BLRI-1 had also high egg production in compared to BLRI-2 duck (Fig-1). There was some constraint in duck rearing. The mortality rate of duckling was 10% due to poor management, nutritional deficiency diseases (leg paralysis/curled toe) and attacked by predators. The average market price of BLRI native duck was high and was 550Tk. Most farmer sold their native duck from farm house and was 100%. The productive, reproductive and carcass performance of BLRI-1 duck was higher than BLRI-2 duck at community farm level. This study will motivate farmer to rear BLRI native duck for increasing profitability. There was high demand of BLRI native duck at community level and it had high market value. So extension of BLRI native duck at community level was expected by the farmers of Bhanga, Faridpur.

Productive and reproductive performances of ostrich in Bangladesh

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Executive summary

Consumption of animal-derived foods has increased significantly globally. In developing nations, it is anticipated that the per capita demand for Animal protein will rise even further. In order to meet the increasing demand for animal food products it is important to increase the productivity minimizing the input costs and production techniqes.It is necessary to investigate and assess variable choices in order to optimize food production and satisfy protein requirements in emerging nations. Ostrich farming might be alternative source of protein. it is Gaining popularity globally among the poultry species because of its numerous potentialities because to its potentiality. Ostrich meat is lean red meat with a good flavor, low cholesterol and high-quality protein which may be suitable for hypertensive as well as elderly people. Bangladesh is an over populated country with few lands, so considering huge meat production ostrich can play an important role. It produces 100-130 kg body weight within 10 to 14 months of age. Ostrich is more resistant than other poultry and reared in traditional farming systems, and integrated in rural development. Therefore, research is needed to resolve the outstanding husbandry, adaptability, sustainability and welfare issues. The objective was to study the physical and chemical quality of ostrich egg and the other objective was to observe dietary effect of different amino acids (Lys, Meth.) on growth performance of ostrich chicks. Twenty-four Ostrich chicks (*Struthio camelus*) aged one week were imported from South Africa to the Poultry Research Center, Bangladesh Livestock Research Institute (BLRI), Savar, Dhaka, Bangladesh and reared under semi intensive management system. The formulated ration was supplied along with *ad-libitum* roughages to the control group (T_0). While treatment groups T_1, T_2 and T_3 were added methionine 0.3, 0.4, 0.5 and lysine 0.8, 1.0, 1.2 percent in feed respectively. Fresh drinking water was supplied *ad-libitum* to the ostrich chicks.

Physical and chemical quality of ostrich egg found in the current study:

Under farming conditions no of egg laid = 12-22 eggs, weight of the egg (g) 1466.67±88.19, Ostrich egg = more oval, Shape Index= 81-85%, egg shell color = creamy and glossy, shell thickness= 1.45-2.0 mm, breaking strength= 55kg/cm^2, age of puberty (years)- 2.00± 0.25, age of sexual maturity (years)- 3.00±0.25, ratio of male: female= 1.75± 0.25. Major lab test findings of ostrich are as below-

(i) Glutamic acid and methionine were absent in albumen as well as cysteine absent in yolk.
(ii) Aspartic acid, Serine, Valine, Leucine, Tyrosine, Phenylalanine, Histidine remain higher in albumen and Threonine, Alanine, Lysine, Arginine, and Proline were found higher in yolk.
(iii) Glycine and Isoleucine were found more or less same amount in yolk and albumen.
(iv) Methyl Octanoate, Methyl Myristoleate, Methyl Pentadecantonate, Methyl Linolenate, Methyl Cis_11 Eicosenoate were found a trace amount in yolk fat.
(v) Cholesterol was less in ostrich egg which likely 492.41±30.89 (mg/100).

Growing ostrich

Adult ostrich

Hatching of ostrich egg

Table 1: Mean and standard error values for different growth performance and physical parameters of ostrich chicks (5-12 weeks).

Parameter	T_0	T_1	T_2	T_3
Initial Body weight(g/b)	6350±149	6320±134	6430±154	6480±151
Final Body weight (g)	25407.86±1411.64	26871.91±1698.61	27839.29±1847.22	28867.94±2021.58
Total Feed intake (g/b)	59846.96±2929	59579.55±1907	50988.75±1749	45896.84±1633
FCR	3.14±0.216	2.90±0.094	2.38±0.072	2.05±0.053
Water intake (ml/b)	104480±827	94270±591	96460±882	105190±1040
Shank diameter(cm)	13.60^{ab}±0.43	14.27^{ab}±0.31	14.83^{a}±0.56	15.91^{b}±0.75
Shank length(cm)	34.52±0.83	33.22±1.52	35.37±1.51	35.41±1.89
Neck diameter(cm)	15.93±0.43	15.76±0.33	15.53±0.48	15.37±0.58
Neck length(cm)	57.47^{ab}±1.89	63.33^{ab}±1.92	62.07^{a}±2.42	66.92^{b}±2.79
Wing Length(cm)	42.72±1.58	44.58±1.95	45.69±2.06	46.41±2.43
Body Length(cm)	69.10±2.56	72.77±2.58	74.33±2.84	76.86±2.99
Heart girth(cm)	74.92^{ab}±1.98	77.43^{ab}±2.08	78.74^{a}±2.28	83.50^{b}±2.44
Body height(cm)	85.48^{ab}±3.033	88.97^{ab}±2.95	91.28^{a}±3.43	96.27^{b}±3.41

Values are Mean ±Standard error (SE), Significant values are marked with superscripts (a,b).

Table 2: Correlation coefficient of body weight and body measurements of ostrich chicks.

Parameter	Body weight	Shank diameter	Neck length	Wing Length	Body Length	Heart girth	Body height
Body weight	1.000						
Shank diameter	0.949	1.000					
Neck length	0.971*	.996**	1.000				
Wing Length	0.974*	0.873	0.904	1.000			
Body Length	0.984*	0.926	0.946	.990*	1.000		
Heart girth	0.917	0.932	0.928	0.917	.960*	1.000	
Body height	0.940	0.923	0.928	.951*	.981*	.995**	1.000

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Under this research successfully hatched out 2 ostrich chicks through "Artificial incubator" at this breeding season, in 2023 at HSTU, Dinajpur. The data in table 1 stated that initial body weight (g), feed intake (g/day), water consumption (ml/bird) and feed conversion ratio (FCR) were found 6480±151, 47896.84±1633, 105190±1040 and 2.05±0.053, respectively. Mortality rate was 12% during first four months. The body measurements at different parameters of ostrich were highly significant ($P< 0.05$). High positive correlations between live weight and other parameters were measured (neck diameter and length, shank diameter and length, wing and body length, heart girth and bird height) in treatment group 3.

It can be concluded that the productive performance of ostriches under treatment group 3 was found better results in all parameters. Extra addition of 0.5% methionine and 1.2% lysine with the formulated concentrate feed has showed numerically higher growth compared to other levels.

Development of feeding strategy for different ages of Black Bengal goat

Sub Title: Replacement of Concentrate through Moringa foliage on the performance of yearling does

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Executive Summary

Black Bengal goat is famous for high fertility, prolificacy, and very good adaptability. Good balanced feeding practices during gestation is the keystone for healthy strong kid crop. Balanced feeding prolongs the productive life of the doe, increases milk yield by the doe resulting in healthier weanlings, lessens the incidence of kidding paralysis. But in Bangladesh low quality feeds are considered to be the major constraints hampering productivity of farm animals. In recent years, moringa leaf meal is used as a protein source and feed components in animal production especially in goats. In this context, moringa foliage has been evaluated to a limited degree in terms of as a supplementary feed to enhance production performances of goat. Considering the fact, the present study was designed to replace the concentrate mixture with dried moringa in the diet of yearling does up to kidding aiming to know their productive and reproductive performance. The study was conducted in Goat Research Farm of BLRI, Savar, Dhaka.A feeding trial was conducted with four dietary treatments having 8 yearling does in each treatment. The animals under the control group supplied with *ad libitum* green grass and a concentrate mixture at 1.5% live weight (T_0 – 100% concentrate). In other treatments, the concentrate portion was replaced with moringa foliage at different levels (T_1 – 80% concentrate+ 20% dried moringa foliage, T_2- 60% concentrate+ 40% dried moringa foliage and T_3 - 40% concentrate+ 60% dried moringa foliage). The experiment was conducted in Completely Randomized Design (CRD) and data were analyzed using Statistical Package for the Social Sciences (SPSS) version 23.0. Nutritional composition (%) of experimental diets were shown in table 1, which shows that CP content of T_O, T_1, T_2 & T_3 group was 23.19%, 21.68%, 17.46% & 14.47%, respectively. Effect of different diet on nutrition and growth rate of does was shown in table 2 which shows that the average dry matter intake of T_0, T_1, T_2 & T_3 treatments were 502.80, 506.58, 546.50 & 421.88 respectively. The average CP intake of T_0, T_1, T_2 &

Table-1: Nutritional Composition of Experimental Diet

Diet	Chemical Composition (% DM)				
	DM	Ash	CP	ADF	NDF
T_0 (Concentrate mixture)	89.73	5.5	23.19	60.85	28.06
T_1 (80% concentrate +20% moringa)	90.0	4.59	21.68	21.04	45.28
T_2 (60% concentrate +40% moringa)	89.90	4.55	17.46	24.24	49.01
T_3 (40% concentrate +60% moringa)	90.70	5.04	14.47	41.8	45.13

Table-2: Effect of different diet on nutrition and growth rate of does

Parameters	Diet (Mean)				SEM	P-value
	T_0	T_1	T_2	T_3		
Dry matter intake (gm)	502.80^{a}	506.58^{a}	546.50^{a}	421.88^{b}	12.2	0.003
CP intake (gm)	185.97^{a}	184.96^{a}	182.20^{a}	137.51^{b}	3.8	0.000
Initial live weight (kg)	11.76^{a}	11.26^{a}	11.52^{a}	11.51^{a}	0.35	0.972
Final live weight (kg)	18.05^{ab}	18.06^{ab}	19.32^{a}	17.20^{b}	0.34	0.174
Daily gain (gm)	28.09^{ab}	30.38^{ab}	34.80^{a}	25.39^{b}	1.35	0.081

^{abc} *different superscript in the same raw differ significantly*

T_3 treatments were 185.97, 184.96, 182.20 & 137.51 respectively. Highest growth rate (34.80 gm/day) was found in T_2 group compared to others group. Table 3 shows the effect of different diet on reproductive performance of does. Animal of T_1 and T_2 group shows first heat earlier than other two groups. The average postpartum heat period of T_0, T_1, T_2 & T_3 treatments was 38.0, 40.17, 42.12& 48.0 days respectively.

Table-3: Effect of different diet on reproductive performance of does

Parameters	Diet (Mean)					P-value
	T_0	T_1	T_2	T_3	SEM	
Age at first service (days)	286^{ab}	210^{b}	241.33^{b}	338.86^{a}	23.5	0.269
Placenta wt (gm)	247.92^{a}	197.29^{b}	188.08^{b}	169.0^{b}	8.1	0.001
Litter size	1.71^{a}	1.0^{b}	1.63^{a}	1.57^{a}	0.09	0.025
Postpartum heat period (days)	38.0^{b}	40.17^{ab}	42.12^{ab}	48.0^{a}	1.61	0.094
Kids birth wt (kg)	1.25^{a}	1.25^{a}	0.99^{b}	0.89^{b}	0.04	<0.001

^{ac} different superscript in the same raw differ significantly

Litter size comparatively higher as first parity goat for T_0, T_2 and T_3 groups reported by others. Lower litter size ($p<0.05$) observed in T_1 group may be due to the individual animal effects. In case of kids birth weight there is no differential effect on T_0, T_1 & T_2 diet. Table 4 shows the milk yield and composition of does fed with T_0, T_1, T_2 and T_3 diet. Does fed with T_2 diet had higher milk yield than the other treatment groups. Higher fat and protein contents were observed in the milk of does fed on T_2 diet than T_0, T_1 and T_3 diet. Higher lactose and solids not fat contents were observed in the milk of does fed on T_0 and T_3 diet than T_1 and T_2 diet. The results suggest that replacement of concentrate feed with 40% moringa foliage in the diet of does positively affected their milk yield and composition.

Table-4: Milk yield and composition of different diet group

Parametrs	Diet (Mean)					
	T_0	T_1	T_2	T_3	SEM	P-value
Milk yield (ml/day)	310.14^{ab}	312.14^{ab}	372.86^{a}	242.14^{c}	20.1	0.150
Milk composition (Mean)						
Fat%	2.74^{d}	3.3^{c}	4.69^{a}	3.94^{b}	0.22	.000
Protein%	3.5^{b}	3.4^{c}	3.83^{a}	3.5^{b}	0.05	.000
Lactose%	5.75^{a}	4.3^{c}	4.5^{c}	5.3^{b}	0.18	.000
Solids not fat%	10.22^{a}	8.4^{c}	8.6^{c}	9.5^{b}	0.23	.000
Salt%	0.87^{a}	$.67^{c}$	0.47^{d}	0.77^{b}	0.04	.000

It may be concluded that Moringa foliage had a greater effect on the growth performance and reproductive performance and milk yield of does. Finally, replacement of concentrate feed with 40% moringa foliage in the diet of does could be used as protein supplement for lactating goats at small holder farmers' level.

Study on feeding management guideline's & nutrient requirements of BLRI improved native chicken's and mitigation of greenhouse gas emission from poultry litter

Component A: Performance, carcass characteristics and meat chemical composition of BLRI improved non descriptive desi and naked neck chickens fed graded levels of dietary energy and protein concentration

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Executive Summary

Native or local chickens provide a valuable source of animal protein, both in the form of meat and eggs. In most developing countries, including Bangladesh, animal and poultry production must be improved to meet ongoing animal protein demands. A 3x3 factorial arrangement with three metabolizable energy (ME) levels (2800, 3000, 3200 kcal/kg) and three crude protein (CP) levels (18.0, 20.0 and 22.0%), respectively, was employed to investigate the influence of varying levels of dietary energy and protein on BLRI improved non-descript deshi chickens' performance and carcass quality. There were 351 uniform day=old native chicks were weighed and randomly divided into 9 treatments, each with three replicates. The diets were fed in meal form, and water and feed were available *ad libitum*. All performance parameters were monitored throughout the experiment, including body weight gain, feed intake and feed conversion ratio. In order to assess how the dietary treatments affected the physical attributes of the chickens, carcass characteristics such as dressing percentage, breast yield, and thigh yield were measured.

Table 1 shows the effects of energy and protein on BLRI-developed non-descript deshi chicken growth performance up to 56 days of age. Different ME and CP levels had significant effects on 8 weeks' body weight and daily gain. Chickens receiving diets with higher levels of ME (3200kcal/kg) and CP (22%) gained more weight and daily gain. The chickens fed diets containing high ME ($p<0.05$) and higher CP ($P<0.001$) had significantly better FCR than those who received lower dietary ME and CP diets during the experimental period. However, there is no significant interaction between dietary ME and CP concentrations with regard to body weight, feed conversion ratio, and feed intake, except for daily gain. The effects of energy and protein on carcass yield (%) of BLRI improved non-descript deshi at 8 weeks of age are shown in Table 2. Varying protein and energy levels did not affect ($P>0.05$) the carcass, breast and thigh muscle, wing, legs, and liver percentage of the non-descript deshi chicken. Table 3 shows the effect of ME or CP on meat quality of BLRI improved the non-descript deshi at 56 days of age. Both ME and CP levels did not differ ($P > 0.05$) in pH value, drip loss percentage, the performance of meat color grades.

Table 1: Effects of energy and protein on the performance of BLRI developed non-descript deshi chicken (1-56 days of age)

ME (Kcal/kg)	CP%	Final body weight (g)	Cumulative feed intake (g/b)	Daily weight gain (g/d/bird)	FCR Feed: gain
		Mean ± SE			
2800	18	602.16^{b}±23.60	1740.56±23.67	602.16^{b}±19.42	2.89±0.11
	20	583.84±22.67	1720.10±23.67	583.33^{a}±19.42	2.94±0.11
	22	599.97±13.26	1708.30±23.67	600.95±19.42	2.84^{a}±0.11
3000	18	561.65±17.04	1707.94±23.67	560.41^{ab}±19.42	3.04^{ab}±0.11
	20	543.36±17.42	1688.82±23.67	546.17±19.42	3.09^{b}±0.11
	22	613.41^{ab}±16.68	1746.05±23.67	613.25^{ab}±19.42	2.84^{ab}±0.11

3200	18	521.04±16.35	1737.17±23.67	521.98±19.42	3.32[b]±0.11
	20	521.87±14.23	1716.23±23.67	521.87±19.42	3.28[b]±0.11
	22	619.35[a]±13.09	1724.71±23.67	619.35[ab]±19.42	2.53[a]±0.11
P value					
ME		0.017	0.821	0.017	0.052
CP		0.000	0.531	0.000	0.008
ME*CP		0.023	0.561	0.024	0.285

Table 2: Effects of energy and protein on carcass yield of BLRI improved non-descript deshi at 8 weeks of age (%)

ME (Kcal/kg)	CP %	Carcass	Breast meat	Thai	Wing	Leg	Liver
		Mean ± SE					
2800	18	58.40±2.0	8.83±0.83	9.06±0.74	6.44±0.64	4.25±0.33	2.4±0.17
	20	58.37±2.0	9.14±0.83	9.08±0.74	8.44±0.60	4.30±0.36	2.35±0.17
	22	57.47±2.0	9.13±0.83	9.31±0.74	9.12±0.60	4.23±0.36	2.68±0.17
3000	18	59.25±1.41	9.26±0.83	9.60±0.52	8.54±0.42	4.53±0.25	2.31±0.12
	20	58.54±1.41	9.43±0.58	9.70±0.52	8.26±0.42	4.29±0.25	2.37±0.12
	22	58.80±1.41	8.98±0.58	9.14±0.52	8.75±0.42	4.56±0.25	2.21±0.12
3200	18	59.26±1.15	9.60±0.48	9.50±0.42	8.60±0.34	4.58±0.21	2.27±0.09
	20	60.0±1.15	9.57±0.48	9.40±0.42	7.8±0.34	4.53±0.21	2.18±0.09
	22	59.14±1.15	9.52±0.48	9.60±0.42	8.25±0.34	4.37±0.21	2.24±0.09
P value							
ME		0.570	0.608	0.768	0.457	0.628	0.117
CP		0.903	0.958	0.998	0.104	0.939	0.780
ME*CP		0.982	0.983	0.936	0.039	0.917	0.517

Table 3: The effect of ME and CP on meat quality of BLRI improved non descriptive deshi at 56 days of age

ME (Kcal/kg)	CP%	L*	a*	b*	pH	Drip loss%
2800	18	49.52	2.08	11.44	5.62	2.81
	20	51.57	1.99	10.86	5.65	3.05
	22	51.08	2.05	10.36	5.68	2.20
3000	18	49.05	2.00	9.54	5.62	2.69
	20	50.34	1.98	10.84	5.73	2.90
	22	51.44	2.10	10.60	5.62	3.10
3200	18	50.33	2.05	9.90	5.62	2.62
	20	51.21	2.00	10.44	5.69	2.66
	22	50.00	2.09	10.00	5.65	2.47
SEM		2.52	0.73	1.68	0.25	0.05
		P value				
ME		0.790	0.653	0.993	0.274	0.455
CP		0.705	0.828	0.810	0.994	0.281
ME*CP		0.857	0.910	0.975	0.742	0.240

The different energy and crude protein level's had significant effect on the body weight, body weight gain and FCR of non-descriptive deshi chickens. It can be recommended that a higher level of energy (3200 kcal/kg) and a higher protein (22%) combination diet could be fed to improve the performance of non-descriptive deshi chicken.

Quality and safety assessments of poultry meat products in Bangladesh

Sub-Title: Availability and consumption of chicken meat products in Chattogram town

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Executive Summary

Bangladesh's poultry industry is expected to grow by an average of 16 percent a year for the next five year, If this growth rate is raised to 18-20 percent, chicken meat will be the number one meat of choice by 2030. Dressed and processed poultry production is a growing food sector in Bangladesh. It is fuelled by consumer desire for food safety and a perception, particularly among city dwellers. Chattogram is the largest port city of Bangladesh. Chattogram town is oriented with the varieties of Super Shop, Franchise Outlet and Fast Food Shop where as chicken meat products are available. The aim of the study was to find out the available chicken meat products in Chattogram town and its consumption to the consumers level. According the first objectives of this study, to conduct the baseline survey about available poultry meat products in Bangladesh, we considered three different areas for data collection in Chattogram city. First one was Super Shop, second one was Franchise Outlet and the third one was Fast Food Shop. In super shop, frozen chicken meat products were available and ready to eat products were available in the franchise outlet and fast food shop. Into the super shop, it was selected The Basket, Khulsi Mart, Shwapno and Agora. The Basket is Chattogram's largest and most convenient superstore where 10 companies chicken meat products are available. The kazi farm kitchen was the best supplier company for chicken meat products in the Basket. Golden Harvest was the best supplier for Khulsi Mart and Shwapno. Essentials was the best supplier for Agora. The chicken meat products supplier companies of Chattogram are Kazi Foods, Golden Harvest, Country Natural, AG Food, Mafco, Roja, Here, the Basket, Essentials, Roja, Mafco was the Chattograms based company. Chicken Nugget, Chicken Sausage, Chicken Meatball, Chicken Spring Roll, Chicken Noddles, Chicken Hot Wings, Chicken Singara, Chicken Samosa, Chicken Burger Patty, Chicken Kebab and Chicken Lollipop were the available products in Super Shop.

Pictorial view of survey work

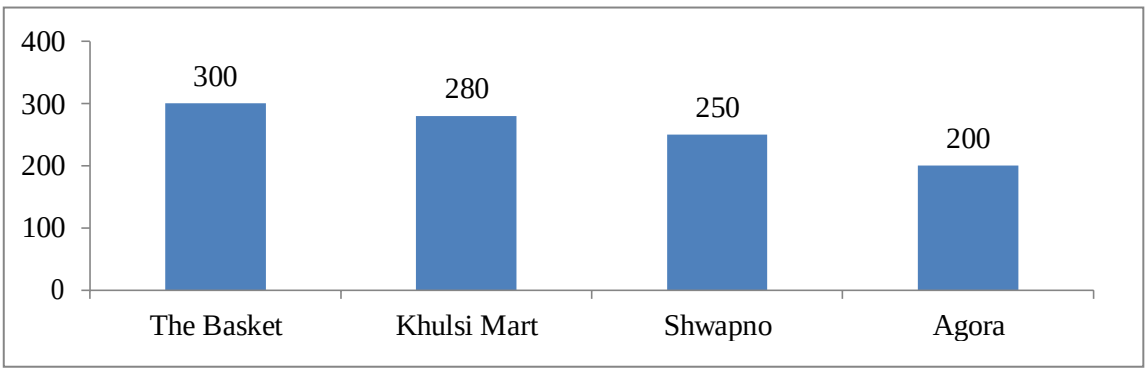

Fig. - Weekly sale in kg in different outlets

Weekly sale was 300 kg for Basket, 280 kg for Khulsi Mart, 250 kg for Shwapno and 200 kg for Agora.

Tab-01 Comparison of weekly sale for different chicken meat products.

Weekly Sale In Kg	Chicken Meat Products					Level of Sig.	P-Value
	Sausage	Nugget	Meatball	Fry	Noodles		
Super Shop	32.38 ± 3.83 [b]	33.67 ± 4.43 [b]	44.48 ±6.68 [a]	35.53 ± 5.43 [b]	15.00 ± 0.42 [c]	S	0.006
Franchise Outlet.	18.88 ± 3.43	21.22 ± 3.33	23.43 ± 2.21	22.45 ± 2.45	19.88 ± 3.11	NS	0.32
Fast Food Shop	13.32 ± 3.31	15.75 ± 2.76	14.43 ± 3.42	15.87 ± 2.90	12.43 ± 2.74	NS	0.43

*The data was analyzed through SPSS.16 version. Compare mean was estimated by one-way anova at 95% level of significance.

When, it was compared the data into these four super shop, it was showed highly significant difference ($p<0.001$) for weekly sale. The highest salable product was Chicken Meatball (44.48 ± 6.68) kg per week and the lowest salable product was Chicken Noodles (15.00 ± 0.42) kg per week. In case for Franchise Outlet: CP Five Star, Kazi Farm Kitchen, Golden Harvest, Basket and Essentials were selected. After analyzing the data, it was found no significant difference for weekly consumption. The Fast Food Shop was Ammazan Fast Food Shop, Eat Out, Street Café, Red Rose First Lady and Jhalmuri Fast Food Shop. Through comparing the data into these fast food shops, it was also found no significant difference for weekly consumption. Finally, it may be concluded that further study is needed to explore the chicken meat products market in Chattograms town.

Screening and utilization of edible insect as a protein source in poultry diet

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Executive Summary

In poultry production, feed cost is approximately 60 to 70% of the total cost. From last few years feed cost is increasing very rapidly for some reasons, outbreak of covid-19, Russia and Ukraine war and feed ingredients price hike especially animal protein sources. The price of poultry feed raises in order to the increasing world's population, other input cost, competition between humans and animals for the same food resources and the current trend for the use of cereals grains for biofuel production (Jozefak and Enbery, 2015; Khan, 2018; Cutrignelli et al., 2018;). Searching a new or alternative low cost but high quality protein feed source is demand for poultry feeding in our country. Researchers have been conducting a lot of experiments on the use of different valuable insects as high quality protein sources in Europe, Africa, Asia, and North America (Makkar et al., 2014; Sayed et al., 2019). These days, some farmers of our country are using black soldier fly (BSF) in poultry feed. This new research was launched at Bangladesh Livestock Research Institute (BLRI) with the objectives (a) to use insect as an alternate protein source in poultry diet. (b) to reduce feed cost by using high quality protein which are available in the nature and (c) to save the environment by using organic waste to produce insect meal in a large scale. There are different types of insects are also available in Bangladesh like silk worm, termites, black soldier fly (BSF), pupae larvae, housefly larvae, grasshopper etc. Based on literature we have initially screened out and collected black soldier fly larvae (BSFL), pupae and fly sample from different locations of Bangladesh and tested in our lab to find out the protein content. We have also collected pupae from Sky Agro Ltd. in Kushtia for production of larvae at BLRI. We have used different substrates like faeces, vegetables and faeces-vegetable mixed to study the proximate analysis of larvae. Broiler meat sample from field were collected after feeding BSFL larvae with commercial feed only to know the proximate composition of meat samples.

Table 1 showed that crude protein (CP) percentage is higher in fly stage (58.70%) than pupae (38.59%) and larvae (36.95%). Table 2 showed that highest CP percentage is found in feces and vegetable mixed substances (38.66%) than poultry feed (34.03%), feces (38.64%), vegetables (37.42%) and egg (38.56%). Table 3 reflected that CP, fat and ash were higher; 41.53%, 16.40% and 23.75% respectively in faeces and vegetables (75:25) mixed media compare to other mixed media but crude fibre (4.25%) is lower than others. In table 4, CP % was found higher in broiler meat using BSFL meal (22.98%) than ready feed (21.67%). However, this study focuses on the documentation of the proximate nutrient composition, impact on the animal feed industry, consumer acceptance, and safety of insect meal as animal feed.

Table 1: Crude protein percentage of Black soldier fly (BSF) at different stage

Stage of insect	T1 (Gaibandha)	(T2) Kushtia	(T3) BLRI	Average
Fly	58.67	59.04	58.38	58.70
Pupae	36.84	38.06	40.88	38.59
Larvae	35.62	36.09	39.15	36.95

Table 2: CP% of BSF larvae produced in different culture media.

Parameter	Larvae in feces	Larvae in feed	Larvae in egg	Larvae in mixed (veg+ feces)	Larvae in Vegetables
CP%	38.64	34.03	38.56	38.66	37.42

BSFL- Black soldier fly larvae

Table 3: Proximate analysis of BSFL with different media.

Treatment	Moisture (%)	DM%	CP %	CF %	EE %	Ash%
BSFL-Faeces:Veg (100:0)	9.10	90.90	37.44	7.56	6.80	19.40
BSFL-Faeces:Veg (75:25)	8.40	91.60	**41.53**	**4.25**	**16.40**	**23.75**
BSFL-Faeces:Veg (50:50)	10.60	89.40	40.31	9.65	13.40	18.05
BSFL-Faeces:Vegs (25:75)	8.30	91.70	37.74	7.30	12.80	21.00
BSFL-Faeces:Veg (0:100)	7.56	92.44	41.07	10.10	6.80	10.95

BSFL- Black soldier fly larvae, VEG- Vegetable waste

Table 4: CP % of broiler meat fed BSF larvae and ready feed at Saidpur.

Traits	Breast	Thigh	Drumstick	Average
Insect meal	25.29	22.32	21.33	22.98
Ready feed	22.70	20.45	21.85	21.67

Culture media for BSF

BSF Larvae

Black Soldier Fly

Lab test of BSF

In conclusion, among different levels of the substrate Faeces: Vegetable waste ratio (75:25) showed better in terms of crude protein content (CP), crude fiber (CF), ether extract (EE) and ash content. Moreover, BSF meal-fed broiler chicken showed better CP % compared to ready feed. The inclusion level of BSF meal need to be determined through further trial which will be carried out at on station in this financial year (2023-24).

Development of duck plague vaccine seed from circulating strain

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Executive Summary

Duck plague (DP) is an acute, highly contagious infection of ducks, geese, and swans caused by an alphaherpesvirus. This disease acts as a significant constraint on the development of the duck industry. This disease is a potential threat to all age groups of ducks and is characterized by high morbidity and mortality ranging from 5 to 100%. Migratory waterfowl act as asymptomatic carriers and play a vital role in spreading Duck Plague Virus (DPV). The spreading of DP among ducks occurs through direct contact with infected ducks and contaminated environments. In Bangladesh, the disease was first confirmed in 1980, and a significant number of ducks died each year because of this endemic disease; consequently, huge economic losses occurred. Higher flock density is usually the main contributing factor to the initiation of DP outbreaks. Livestock officials have expressed great concern over outbreaks of DP, especially in Haor areas in Bangladesh. Vaccination, along with lots of other actions, especially biosecurity, nutrition etc., is also equally important for the control of DP, but in Bangladesh, the vaccination program is not widely accessible because of the limited of vaccine. Additionally, very limited studies have been conducted in Bangladesh on the molecular detection, isolation, and adaptation of the DP virus for the development of a DP vaccine. To effectively combat this threat, there is a need for the development of an effective DP vaccine seed. Hence, the present study was carried out to isolate, identify and characterize the circulating DPV from suspected field samples and to adapt the virulent strain of DPV for the development of a live-attenuated vaccine seed.

A total of 90 samples (liver 30; intestine 30; and spleen 30) were collected from field samples suspected of DP within the study period of July 2022 to June 2023. Out of 90 samples, 30, 27, 12 and 21 were collected from four districts including Kishoreganj, Netrokona, Savar, and Sunamganj, respectively. All samples were collected aseptically in falcon tube containing virus transport medium and maintained at 4°C in an icebox during transport to the Animal Health Research Laboratory, BLRI. All the samples were processed according to the procedure described in the World Organization for Animal Health (WOAH). DNA was extracted from the processed samples using a commercial DNA extraction kit according to the manufacturer's protocol (Monarch®, UK). Conventional polymerase chain reaction (PCR) was performed for the amplification of the DNA polymerase and gC gene of DPV using published primers (WOAH, 2012). Inoculum were prepared from molecularly positive samples according to the method described in WOAH (2017). Afterward, 200 µl inoculum was inoculated into a 10-day-old embryonated chicken and duck egg (ECE/EDE) through the chorioallantoic membrane (CAM) route and observed regularly until 6 days of post-inoculation (dpi). Then, CAM and allantoic fluid (AF) were harvested; DPV was confirmed from the harvested samples by PCR and stored at -80˚C until further use. For the isolation and propagation of the DPV, three serial blind passages were continued on 10-day-old ECE and EDE, and AF and CAMs were harvested each time, re-confirmed by PCR, and stored at -80ºC.

Out of 90 samples, 25 (27.77%) were found to be positive for DPV, as confirmed by PCR targeting DNA polymerases and the gC gene of DPV. The expected PCR amplicon appeared at 446 bp and 78 bp in DNA polymerase and the gC gene, respectively (Figure 1). Organ-wise, recovery rate of DPV-positive sample was higher in the liver (36.66%), followed by the spleen (26.66%) and intestine (20%). Regarding locations, the highest DP cases were detected in Netrokona (37.04%), shown in Table 1. No positive samples were found in the samples of Savar. This year, a total of 25 PCR

positive samples were inoculated into ECE for the isolation of DPV but couldn't confirm any isolates from the harvested CAM and AF following inoculation. In addition, we have four DPV isolates that were isolated last year. Propagation and attenuation of these previous isolates are also going on in embryonated chicken and duck eggs.

Table 1. Molecular confirmation of DPV from DP suspected field samples by PCR.

Sampling locations	Type of samples	Detection of DPV by PCR		
		No. of sample	Positive sample	Recovery rate (%)
Kishoreganj	Liver	10	4	40.0
	Intestine	10	2	20.0
	Spleen	10	3	30.0
Netrokona	Liver	9	5	55.55
	Intestine	9	3	33.33
	Spleen	9	2	22.22
Savar	Liver	4	0	0.0
	Intestine	4	0	0.0
	Spleen	4	0	0.0
Sunamganj	Liver	7	2	28.57
	Intestine	7	1	14.28
	Spleen	7	3	42.85
Total	Liver	30	11	36.66
	Intestine	30	6	20.0
	Spleen	30	8	26.66

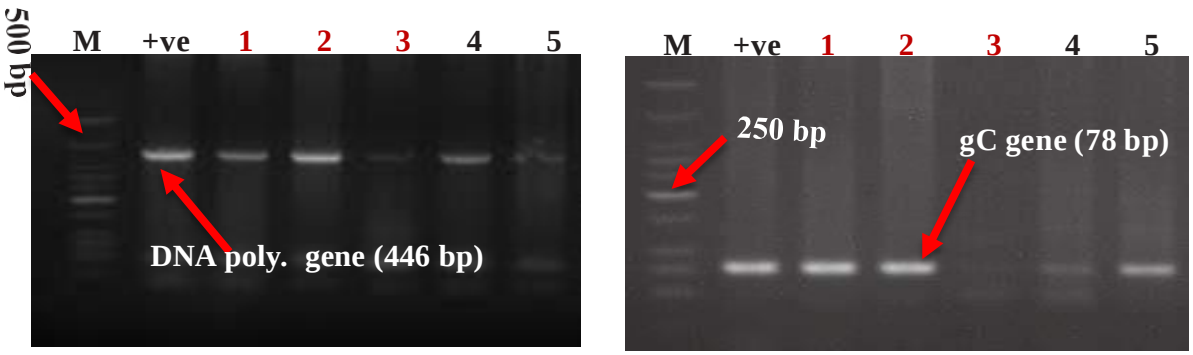

Figure 1. Amplification of the portion of DNA polymerase (left) and gC (right) gene from duck plague virus. Lane M: 50 bp ladder; Lane 1: positive control; Lane 2-6: field samples.

This study revealed that DPV is circulated among ducks in the Haor areas of Bangladesh. Among the three sample types collected, liver samples were highly susceptible compared to intestinal and spleen tissue samples for the detection of DPV by PCR.

Phenotypic and genotypic profiling of antimicrobial resistance (AMR) in enteric bacterial communities in finisher livestock and poultry in Bangladesh

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Executive Summary

The discovery of antibiotics has been a major breakthrough in human civilization. However, antimicrobial resistance (AMR) is a worldwide global health problem. AMR in Bangladesh's livestock and poultry food value chain is becoming a bigger worry. The indiscriminate use, low dosage, and overdose of antibiotics for the treatment of bacterial infections in domestic animals in Bangladesh are contributing to the developing resistance of microorganisms to various antimicrobial medications on a daily basis. Repeated exposure to the same medications through several routes causes bacteria to develop resistance to those particular drugs. The resistant genes will eventually find their way into the environment through farm waste, and they may even end up in humans due to close contact with animals, consumption of tainted food, and water. To the best of our knowledge there is no study to unveil the spatio-temporal patterns of AMR throughout the country. Therefore, this study was aimed to assess spatio-temporal variation of AMR in fecal commensal enteric bacteria like *E. coli* and *Salmonella* spp. in poultry farms and live bird markets (LBMs).

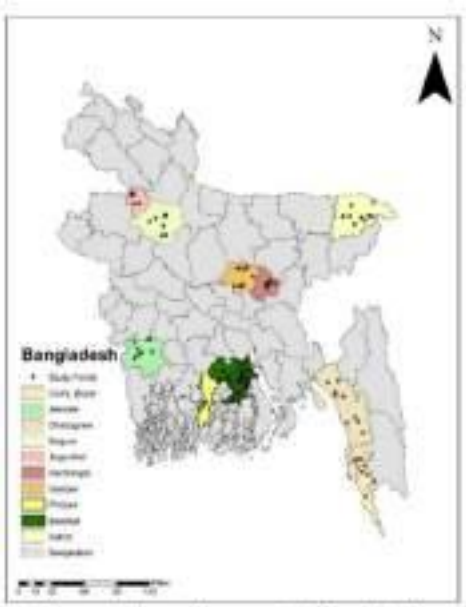

Figure 1. Sampling area in Bangladesh

A total of 567 samples including 243 cloacal swabs, 243 drinking waters from various poultry farms, and 81 caecal contents from LBMs were obtained from various locations of Gazipur, Narsinghdi, Bogura, Joypurhat, Barishal, Sylhet, Chattogram, Cox's Bazar, and Jessore (Figure 1). Samples were transferred to the Reference Laboratory for AMR (Research), BLRI immediately after collection, and all the samples were processed for isolation and identification of *E. coli* and *Salmonella* spp.

The overall recovery rate of *E. coli* and *Salmonella* spp was 75.8% (95% CI 72.15-79.18) and 9% (95% CI 6.9-11.6), respectively. At farm level, *E. coli* was 60.5% (95% CI 56.08-64.74) and *Salmonella* spp was 5% (95% CI 3.3-7.2). At market, *E. coli* was 91% (95% CI 83.2-95.8) and *Salmonella* was 9% (95% CI 4.3-16.8) (Figure 2). Antimicrobial susceptibility testing (AST) was done by disk diffusion method for all *E. coli* and *Salmonella* isolates. The results were interpreted by Clinical and Laboratory Standards Institute guidelines 2021. From the AST results, we found that tetracycline (89.3%), ampicillin (86.2%), ciprofloxacin (69.7%), nalidixic acid (72%), and sul-

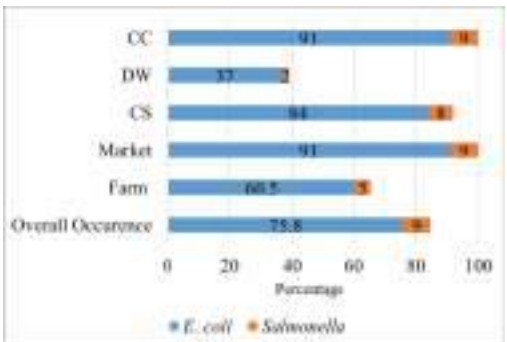

Figure 2. Recovery of *E. coli* and *Salmonella*

phamethoxazole (66.1%) were the most resistance antibiotics in *E. coli* whereas almost same resistance patterns were observed in *Salmonella* isolates. Ceftazidime, ceftriaxone, meropenem, amikacin and azithromycin showed the highest sensitivity against both *E. coli* and *Salmonella* isolates. For spatio-analysis of AMR in *E. coli* isolates, tetracycline shows the highest resistance in five sampling areas followed by ampicillin, nalidixic acid and ciprofloxacin (Figure 3). In case of *Salmonella*, ampicillin was revealed as the highest resistance antibiotic almost in all sampling area followed by tetracycline, nalidixic acid and ciprofloxacin (Figure-4).

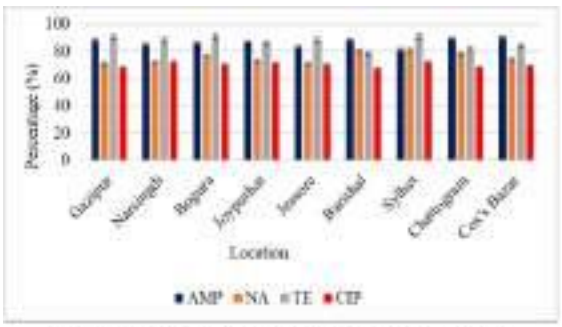

Figure 3. Patterns of top antibiotic resistance in different sampling area of *E. coli* isolates

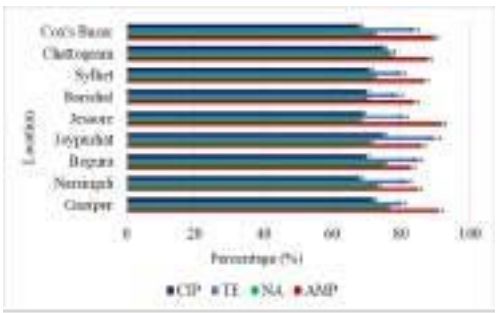

Figure 4. Top antibiotic resistance patterns in different sampling area of *Salmonella* isolates

A total of four ARGs were detected by PCR in both phenotypically resistant isolates. The *E. coli* isolates were positive with *bla*TEM (89%), *tet*A (91%), *sul*1 (96%) and *sul*2 (36%) isolates and *Salmonella* spp isolates were positive with *bla*TEM (82%), *tet*A (81%), *sul*1 (92%) and *sul*2 (31%).

The results of this study showed that resistant *Salmonella* and *E. coli* are circulating in live bird markets and poultry farms, which can quickly spread to farmers, vendors, customers, and eventually the food chain.

Recommendations
of
Annual Research Review Workshop-2022
Bangladesh Livestock Research Institute
Savar, Dhaka

SL No.	Recommendations	Progress
Technical session I: Animal and Poultry Breeding and Genetics		
1.	Initiative should be taken to prepare a development project for beef cattle production in Bangladesh.	A development project proposal has been prepared for research on beef cattle production in Bangladesh
2.	Collaborative research project with specific breeding plan and objective should be taken between BLRI and DLS for conservation and improvement of Munshiganj cattle (MC) and North Bengal Gray (NBG) cattle.	Development project proposals have been prepared for research on genetic improvement of important indigenous cattle breeds/varieties of Bangladesh
3.	More replica stock of indigenous chicken should be developed at different regional stations of BLRI.	BLRI has developed replica of improved indigenous chicken varieties at BLRI Regional Station Godagari, Rajshahi and Naikhonchori, Bandarban.
4.	Rate of inbreeding need to be reduced in the both indigenous and exotic stock of BLRI.	BLRI is flowing planned breeding for avoiding inbreeding. Moreover, new birds/animals are regularly introducing into the research flock/herd to manage inbreeding in the population.
5.	Research program should be taken by combining productive, reproductive and health traits with specific breeding goals.	On-going breeding programmes are already addressing this issue.
6.	Research should be taken for preparation, cryopreservation and conservation of poultry semen.	BLRI has already been taken this research activities
7.	Stakeholder consultation meeting should be organized before initiating any breeding project for long term in any specifies.	Stakeholder consultation is already adopted in BLRI research planning programme.
8.	A project should be taken for continuous production of pure breeding bulls of native cattle (RCC/MC/NBG/Pabna) through multi stakeholder participatory breeding approach.	This suggestion addressed in the proposed DPP on indigenous cattle.
Technical session II: Biotechnology, Environment and Climate Resilience		

SL No.	Recommendations	Progress
Technical session I: Animal and Poultry Breeding and Genetics		
1.	Different functional gene of Gayal relates with Cattle, Buffalo and other species should be identified and explored of GMO milk and meat product.	A Development Project Proposal (DPP) has been submitted in the ministry for research on Gayal.
2.	Validate the BLRI developed cryopreservation machine collaborating with DLS, BRAC and different private organization.	Validation activities are in field.
3.	Establishment of cryopreservation plant in BLRI with sufficient supply of liquid nitrogen	This activity implemented.
4.	Gene bank related developmental project should be taken.	Gene bank development activities are implementing through revenue budget. DPP may be prepared for large scale gene bank development in near future.
5.	Microbial load of different milk borne diseases would be noticed on research activities.	Initiative will be taken.
6.	Assessment of antibiotic and heavy metal and given emphasis on data analysis.	Initiative will be taken.
7.	From 5 color variety of goats at least 2 promising variety according to milk production and growth rate should be selected for future development.	BLRI is continuing research on conservation and genetic improvement of five color varieties of Black Bengal goat.
8.	Make a decision and take necessary steps to wrap up all the documents about Black Bengal Goat for declaration as a native breed in our country.	Initiated on wrapping up of all research documents on BBG have taken.
9.	Validate the BLRI produced zinc fortified meat through Human model or mouse model trial.	Initiative will be taken.
10.	Build awareness about the worse impact of tannery waste feeding to poultry through leaflet, folder and other possible ways.	Initiative has been taken.
11.	Attempt should be taken to develop well organized research teams with Senior Researcher for Biotechnological research work	Initiative has been taken.

SL No.	Recommendations	Progress
Technical session I: Animal and Poultry Breeding and Genetics		
Technical session III: Socioeconomic and Farming System Research		
1.	Research is needed to know the number of swamp type and river type buffaloes and different strategy needs to be adopted and impact study should be undertaken	DPP will be prepared for addressing these issues in future.
2.	Research is needed to increase the shelf life of cheese.	Adopted with ongoing research project.
3.	Socioeconomic research should be undertaken to figure out benefit cost ratio and difference analysis should be done to know the impact of Technology Village.	Analysis of impact of technology village is on-going.
4.	BLRI developed technology should be taken to the farmers in the form of products and undertaken as business model.	BLRI updated its technology development and validation policy to ensure transfer of matured technology..
5.	It is recommended to arrange research review workshop within August of every year.	This is administrative concern of the institute.
Technical session IV: Animal & Poultry Diseases and Health		
1.	The study on monitoring and evaluation of PPR virus isolates circulating in Bangladesh needs to be continued as it is a transboundary animal disease.	Routinely addressing.
2.	Proper surveillance in collaboration with DLS is needed to explore the vaccine efficacy, information about circulating virus in Bangladesh	Routinely addressing.
3.	To address the distribution of AMR in finisher livestock and poultry in Bangladesh, new antibiotic can be considered for doing resistant study because most of the antibiotics used in this study that are very old classes.	Routinely addressing.
4.	Sonali and broiler chickens can be included for doing AMR surveillance and larger scale study is needed. How much antibiotic has been using in those species need to be explored.	Routinely addressing.
5.	For development of Lumpy skin disease (LSD) vaccine seed from	Vaccine on LSD has been developed and its efficacy evaluation by third party is ongoing.

SL No.	Recommendations	Progress
Technical session I: Animal and Poultry Breeding and Genetics		
	circulating strains in Bangladesh and its efficacy study, sampling area could be increased and genetic information should be explored to show their genetic variation.	
6.	In order to sample collection, population size should be considered that can represent the whole population in the selected areas.	Statistical formula for sampling will follow in future research.
7.	Appropriate treatment policy should be developed for controlling LSD in Bangladesh as this problem has increased the irrational use of antibiotics.	Initiative to be taken in coming years.
8.	LSD Vaccine should be handed over as soon as possible to DLS as it has tremendous economic importance livestock sector.	LSD vaccine wills handover to DLS after third party evaluation.
9.	DLS demanded a proper procedure before handing BLRI developed any technologies over to them.	BLRI adopted technology transfer policy.
10.	Science needs to be translated into policy level; therefore, a permanent coordination committee has to be developed for collaborating with BLRI, DLS and MOFL.	Informed to the administrative ministry.
11.	H9N2 is most economic disease and long-term problem in poultry sector in Bangladesh, so this vaccine should be handed over to DLS within very short time.	Vaccine has developed. Efficacy evaluation of developed vaccine at farmers' farm is ongoing.
12.	Prior development of goat pox vaccine seed, BLRI should identify the genetic variation between LRI vaccine seed and the proposed vaccine seed.	Initiative has been taken.
13.	In order to identify the major goat health problems, more area should be considered and the principal component analysis has to be included to explore the risk factors associated with the disease occurrence	Research project has revised to address these issues.
Technical session V: Feeds, Fodder & Nutrition		

SL No.	Recommendations	Progress
Technical session I: Animal and Poultry Breeding and Genetics		
1.	Different graded level of ingredients along with best management practice (BMP) Napier grass should be designed in next activity.	Initiative has been taken.
2.	Comparison between BMP Napier grass and traditional crop should be required in terms of production and cost benefit ratio.	Initiative has been taken.
3.	Nutrient uptake of buffalo at intensive, semi-intensive and traditional/existing system during field trial should be included.	Research has been taken at firm level.
4.	Collaboration research work between Mashroom Research Institute and BLRI can be considered for creep feeding experiment on Black Bengal goat.	Initiative has been taken.
5.	Cost benefit analysis of nutrient enriched designer eggs should be calculated and impact of this egg should be considered on human health	Research has taken to analyze cost benefit ratio of nutrient enriched designer eggs
Technical session VI: Poster		
1.	Title of poster should be focused based, not the entire project title.	Scientists were instructed to improve poster presentation quality
2.	Conservation of native germplasm in large population should be emphasized.	Initiative has taken to increase population size of conserved germplasm
3.	Experiment should be conducted with reasonable sample size and multiple trials (at least two) considering season, single trial should be avoided.	Will be considered in future research plan.
4.	Field trial is necessary for each experiment for making valid conclusion of animals' experiment.	Will be considered in future research plan.
5.	Quail and duck should be validated at field in large scale cooperating with DLS.	Will be considered in future research plan.
6.	Research on buffalo reproduction efficiency and feeding system should be focused.	Addressed with ongoing research projects.
7.	Research related with poultry waste management should be taken in cooperation with DLS.	Will be considered in future research plan.

Recommendations (2022-23)
of
Livestock Division
Bangladesh Agricultural Council
Dhaka

SL No.	Recommendations	Progress
Animal Production Research Division		
1.	All the ongoing research program under Animal Production Research Division should be continued and emphasis should be given on technology development.	Except "Feeding banana plant waste to livestock" all the research program were executed under Animal Production Research Division and a technology namely "BLRI grass-5 (salt tolerant)" was developed in 2022- 2023 fiscal year.
2.	Research Program on "Feeding banana plant waste to livestock" should be executed.	Research Program on "Feeding banana plant waste to livestock" was not executed due to fund availability.
3.	Research Program on "Isolation, Production and utilization of Gelatin from bovine hides" should be executed.	This research program is ongoing.
4.	BLRI should give emphasis to develop beef producing breed/cattle and also should give emphasis to conserve Munshiganj cattle for further breed development.	BLRI took initiative to develop beef producing breed/cattle and for this a project namely "Strategic development of beef breed (s) in Bangladesh" is ongoing. Munshiganj Cattle conservation and development activities are ongoing at field level.
5.	BLRI developed HYF variety should demonstrate and disseminate to the stakeholder through DLS.	This activity is ongoing.
6.	The cost benefit ratio analysis should be incorporated with research program	The cost benefit ratio analysis is already incorporated with research program
Goat Production Research Division		
1.	All the ongoing research program under Goat Production Research Division should be continued	According to recommendation, 9 research projects were executed in the fiscal year 2022-23 under „Black Bengal Goat Conservation and Development research project"
2.	Research program should be taken on Artificial Insemination in Goat, prolificacy and milk production and more emphasis should be given on goat research in hilly areas	Research has been taken on artificial insemination, prolificacy, milk production in BBG.

Sheep Production Research Division		
1.	All the Ongoing research program under Sheep Production Research Division should be continued	Three on-going research programs are continued
2.	Research Program on "Copra meal (*Cocos nucifera*) in lamb production and its impact on enteric gas emission" should be avoided.	The research program has been avoided.
Poultry Production Research Division		
1.	All the Ongoing research program under Poultry Production Research Division should be continued and emphasis should be given on technology development	All the on-going research program under Poultry Production Research Division has been continued.
2.	Research on value added product develop from poultry should be emphasized considering quality.	"Strengthening Poultry Research and Development Project" has taken initiative to research on value added poultry product.
Animal Health Research Division		
1.	A Research project should be formulated including low path & high path Avian Influenza virus to check cross immunity, co-circulation (H_5N_1, H_9N_2) and to monitor the new Evaluation of Avian influenza virus	Two research projects have been conducted during 2023-24 FY 1. Surveillance and molecular evolution of avian influenza virus in Bangladesh 2. Development Avian Influenza H9N2 vaccine from circulating strain in Bangladesh.
2.	Project on epidemiology of LSD should be included in 2022-23 financial year and to develop a guideline of GLPs.	Development of Lumpy Skin Disease (LSD) vaccine seed from circulating virus has been taken.
3.	Both BLRI & DLS should work jointly specially Epi-unit, DLS for Disease outbreak investigation & sample collection.	BLRI has taken initiative to work with DLS for disease outbreak investigation and sample collection
4.	SAARC PPR Laboratory should link with PPR control program, DLS & continue sero-monitoring program after vaccination.	Monitoring and evaluation of Peste des Petis Ruminants virus isolates circulating in Bangladesh and development of vaccine seed
5.	SAARC PPR Laboratory should be taken an action to developed PPR Rapid Diagnostic Kit.	-
6.	SAARC PPR Laboratory, BLRI need to collect BAU developed PPR vaccine seed (PBRG project, ID-139) & should continue to develop vaccine.	Under NATP-2 project, BLRI has implemented a PBRG sub-project- "Preparedness for the control of PPR in Bangladesh"

7.	Financial analysis of disease outbreak should be included in every disease related research project.	Research program has been taken in the 2023-24 fiscal year under revenue budget.
8.	Semen born disease should be included in research project.	Research program on surveillance of extremely zoonotic pathogen (*Brucella* species) at different areas of Bangladesh has been taken in the 2023-24 fiscal year under revenue budget.
9.	AMR and related research work would be continued	Two AMR related projects have been implemented in 2022-23 FY 1. Genomic Mapping and Elucidating the Antimicrobial Resistance Pathogens Evolution in Companion and Farm Animals 2. Phenotypic and genotype profiting of anti-microbial resistance (AMR) in enteric bacterial communities in finisher livestock and poultry in Bangladesh
Biotechnology Division		
1.	All the ongoing research program under Biotechnology Division should be continued and emphasis should be given on technology development	All the on-going research program under Biotechnology Division has been continued and a technology "¯^í Li‡P mn‡RB wngwqZ wm‡gb Drcv`b cÖhyw³" has been developed.
2.	Semen borne disease should be checked during semen preservation for artificial insemination, like brucellosis, campylobacter, tuberculosis etc.	Adopted with semen cryopreservation technology at BLRI.
3.	BLRI should be taken research program on commercial preparation of silage inoculum for silage making	This project has been completed.
4.	BLRI should take research on what gene are causing the oxalate in Napier grass	Research has been taken on "Determination of Oxalate content in Napier varieties and Identification of gene responsible for oxalate content in Napier".
Socio-Economic Research Division		
1.	All the ongoing research under Socio-Economic Research Division should be continued	All the ongoing research program under Socio economic Research Division are continued
2.	Research programme should be taken on economic losses due to economic disease specially FMD, PPR, AIV	Socioeconomic analysis of antibiotic use in poultry production in Bangladesh
3.	Research programme on economic benefit of beef fattening technology should be done	Assessing livestock rearing knowledge, attitude and practice in the coastal belt of Bangladesh

4.	Research programme as feed cost, production cost and consumable price should be analyzed	A research program has been taken linked with this recommendation for the financial year 2023-2024. (Availability and Price Volatility of Poultry Meat and Egg in Bangladesh: An Inter-Institutional Study in 2024)
Farming System Research Division		
1.	All the ongoing research program under Farming System Research Division should be continued	All the ongoing research program under Farming System Research Division are continued
2.	A complete book incorporating detailed activities should be prepared on "Technology village"	Responsible Scientists of Farming System Research Division are working on incorporating and preparing of a complete book on BLRI Technology Village"

General Recommendation

SL no.	General recommendation	Progress
1.	It is important to establish "Fodder Seed Certification Board" and "Vaccine Seed Certification Board" as like as seed Certification Board of DAE for livestock development. BLRI or DLS can take necessary initiative to open both these board.	No initiative has been taken yet to establish "Fodder Seed Certification Board" and "Vaccine Seed Certification Board"
2.	BLRI should give emphasis on 4IR, Precision/IoT based animal husbandry, climate smart livestock research, OMICS research during design of new research.	BLRI has already taken steps to implement 4IR/IoT based smart livestock research
3.	BLRI should give emphasis on partnership research with national and international collaboration and also avoid duplication of the research.	Joint research programs are ongoing with CIMMYT, PKSF, MHPL, ACDI/VOCA, CVASU, GT-MORINGA, IFPRI and other national/internatuional organizations.
4.	BLRI should be taken an initiative to conserve BLRI developed all vaccines (master seed) properly.	For this project office, "Zoonoses and Transboundary Animal Diseases Prevention and Control Research Project" has taken an initiative and incorporate the estimated budget to establish a pathogen repository in the proposed revised DPP
5.	Technology validation program should be done collaboratively with BARC, BLRI, DLS and farmers.	Will follow in future.
6.	Black Bengal Goat is our intellectual property. BLRI should take initiative for its intellectual property right (IPR).	Initiative has taken.

7.	Multi-Color Table Chicken (MCTC) should handover to DLS and should make available throughout the Bangladesh collaboratively BARC, BLRI, DLS and Stakeholders.	Multi-Color Table Chicken (MCTC) has already been handed over to DLS at "BLRI research review workshop and Technology transfer program 2022"
8.	It was recommended that a microbe"s repository should be established in BLRI.	For the establishment of microbes repository, Project office, "Zoonoses and Transboundary Animal Diseases Prevention and Control Research Project" has taken an initiative and incorporate the estimated budget to establish a pathogen repository in the proposed revised DPP