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FOREWORD

Bangladesh Agricultural University Research System (BAURES) is coordinating, organizing and monitoring all non-degree oriented research programmes undertaken by the teachers of this university. At present 463 projects are being carried out by the teachers and researchers in different disciplines of agricultural sciences. The annual review workshop is a regular process to present, discuss and evaluate the progress of researches carried out in the preceding year. I am very happy to know that the publication of the 32 volume of the Bangladesh Agricultural University Research Progress in the form of proceedings of the workshop held on 28, 29 & 30 January 2022 (Published on May 2023). This volume contains 420 abstracts of on-going/completed research projects conducted in the fiscal year 2020–2021. I am confident that the research findings documented in this report would be much helpful to the researchers working in the field of agricultural sciences.

I am taking the opportunity to congratulate the Principal Investigators/Project Directors and all other investigators/researchers of different research projects for presenting their research findings to make the workshop a success. My heartfelt thanks are due to the Associate Director, BAURES, Dr. Paresh Kumar Sharma and Mr. Abul Hashem, Deputy Director, BAURES.

Special appreciation and thanks are expressed to the national and international donor agencies for funding and implementing the research projects under BAURES. Finally, the encouragement and supports extended by the honorable Vice-Chancellor of BAU are gratefully acknowledged.

Professor Dr. Md. Zainul Abedin
Chief Editor
&
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EDITORIAL NOTE

Bangladesh Agricultural University Research System (BAURES) is responsible for providing necessary supports of overall administration, monitoring and implementation of research projects conducted by the teachers and researchers of different faculties of Bangladesh Agricultural University (BAU), Mymensingh. BAU itself provides grants for the research projects which have been increased by volume and number in the recent years. Through administrative and legal supports, BAURES has attracted many national and international donor agencies to provide research grants to the reseachers of BAU which is being steadily incleasing. The findings of these research projects are presented in the annual workshop which is held every year, and the progress of the projects are evaluated as part of the monitoring and evaluation process of BAURES. This Volume of the proceeding includes abstracts of 463 research projects presented in the workshop held on 28, 29 & 30 January 2022, where 143 projects were funded by BAURES, and the the remaining were funded by the domestic and and international donor agencies.

The aim of publishing this proceeding is to provide information generated through the project based research by the teachers, researchers and extension workers engaged in agricultural reseach and development. This proceeding is edited by an editorial board consisting of intellectual expert members from six different faculties of BAU. We have tried our best for quality publication of the proceeding however, suggestions are always highly appreciated by BAURES regarding improvement of the publication in the coming days and our best effort will be continued for improving the standard of future proceedings.

I would like to extend my sincere thanks and appreciation to the contributors and to the learned members of the editorial board for their sincere cooperation and help in preparing, improving and proof reading of the abstracts. I would also like to acknowledge and appreciate the valuable inputs of Prof. Dr. Md.Zainul Abedin, Director; Prof. Dr. Md. Abu Hadi Noor Ali Khan, Immediate past Director; Dr. Paresh Kumar Sarma, Senior Scientific Officer (SG); Mr. Md. Abul Hashem, Deputy Director and Mr. Md. Nazrul Islam, Computer Operator; BAURES in publishing this proceeding.

I wish you all the successes of respeted reseachers of BAU as a whole.

Professor Dr. A K M Mominul Islam
Executive Editor
&
Associate Director
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Efficacy of Alcohol-based Fixative as a Potential Substitute to Formalin for Preservation of Tissues in Bangladesh

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Abstract

Formalin has been used as the "gold standard" fixative for study and researches. But the students, academicians, researchers and employees in these settings may be at risk for high levels of exposure to formalin. To date, no ideal fixative has been found, *i.e.,* a safe fixative that perfectly preserves cellular morphology and yet does not modify the specimen composition so as not to change the reactivity of the chemical moieties therein for subsequent detection. Fast fixation, optimal preservation of specimens and a safer workplace environment, are some of the advantages of alcoholic fixation over formalin fixation. To examine the efficacy of presumably less toxic alcohol-based fixative, EMA (a combination of ethanol, methanol and acetic acid) as an alternative to formalin, a study was conducted in the Department of Anatomy and Histology, Faculty of Veterinary Science, Bangladesh Agricultural University, Mymensingh, during the period from January to December, 2019. Following fixation by EMA and 10% formalin, tissue morphology and cellular details of the liver, spleen and brain were analysed. Our gross study showed that EMA was faster in penetration of tissues than formalin, fixed tissues ideally as early as 8 hours of fixation whereas improper fixation was evident for formalin. In Hematoxylin and Eosin (H & E) staining and immunohistochemistry (IHC), better cellular details with stronger affinity for staining were evident for EMA than the formalin. The nucleic acid (DNA and RNA) analysis revealed that total genomic DNA and RNA yield of the EMA fixed tissues were significantly higher ($p < 0.05$) with superior quality than formalin fixed tissues. Our results suggest that EMA could be a potential alternative to formalin for fixation and preservation of tissues for morphologic and molecular analysis. These data provide new insights into an option for safer workplace environment to support study and research in Bangladesh.

Dietary Chitosan Oligosaccharides Improves Health Status in Broilers for Safe Poultry Meat Production

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Abstract

Feed additives are routinely used for improving poultry health and production worldwide. Chitosan oligosaccharides (COS) is a relatively new feed additive which is a derivative of chitosan, non-toxic linear polysaccharide with many biological functions. To investigate the efficacy of COS on gut morphology and serum biochemical profile (lipid, protein, glucose, creatinine and enzymes), a total of 180 day-old broiler chicks (n = 45) were allocated into 1 of 4 groups (control: T0 and treatment groups: T1, T2 and T3) fed basal diet supplemented with increasing amounts of COS for 35 days. Our findings showed that dietary COS supplementation increased the villus height and width, ratio of villus height and crypts depth, and tunica mucosa thickness of duodenum ($p > 0.05$) in the T1 and T2 groups whereas crypts depth of duodenum and cecum were decreased in the T1 and T2 groups compared to the control, T0; T3, however, was almost similar to T0. In case of cecum, tunica mucosa thickness, length and width of mucosal folds showed similar results as duodenum. The population and size of

intestinal glands and lymphocytic infiltration in the mucosa were increased considerably in the T1 and T2 than T0. Total serum cholesterol, triglyceride, LDL and VLDL cholesterol levels were significantly lowered in the T2 than T0 or other COS treated groups ($p < 0.05$), although HDL cholesterol levels were significantly ($p < 0.05$) higher in all of the treatment groups, but substantially higher in the group T1 and T3 compared to T0. Total serum protein, albumin, and globulin were gradually increased in all of the treatment groups along with the increasing dose rates. The liver and kidney functions (ALT, AST and creatinine) were not significantly ($p > 0.05$) affected due to COS supplementation. These results suggest that COS has dose dependent response to improve gut morphology and health physiology in broilers; low to medium doses more favorable for safe poultry production. Thus, COS could be a potential feed additive to support the poultry industry for supplying safe meat in the human food chain.

The Hazardous Effects of Formalin and Alcoholic Fixatives in Mice: A Public Health Perspective Study

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Abstract

Formalin is used for different purposes due to its preservation capability. But continuous exposure to formalin may result various health related issues leading to cancer and death. A new alcohol-based fixative, EMA (ethanol, methanol and acetic acid = 3: 1: 1) could be a safer option in this regard. To compare the health hazards of formalin and EMA, a total 15 adult male mice were randomly distributed into three groups- exposure groups (formalin and EMA) and control group. The mice were subjected to natural inhalation exposure of the fixatives followed by behavioral depression test (forced swimming test), histopathology and serum biochemical tests. Our results showed that the hazardous effects of formalin were remarkably higher than that of EMA. Formalin exposed group showed severe depression ($P < 0.001$) in the forced swimming test compared to EMA and control groups. Histopathologically, diffuse lymphocytic infiltrations around the lung alveoli and bronchioles and severe inflammation with accumulation of reactive cells in the cerebral cortex were detected in the formalin exposed group. However, little or no inflammation with fibrinous exudates in the bronchioles was reported in the EMA group. But no inflammatory cells were detected in the cerebral tissues. The serum biochemical analysis of the inflammatory mediators (Interleukin-6 and C-reactive protein) revealed that both significantly ($P < 0.001$) increased in the formalin exposed group compared to EMA and control groups. These results confer that EMA could be a safer option to reduce health hazards of formalin in the workplace environment.

Identification of a Safe Alternative to Formalin for Study and Research in Bangladesh

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Abstract

The search for formalin substitute has been evolved by two fundamental developments- it is hazardous and the fact that formalin does not assure a complete RNA recovery, essential to molecular biology

now. Under these circumstances, the alternative may be alcohol-based fixatives. Fast fixation, optimal preservation of specimens and a safer workplace environment, are some of the advantages of alcoholic fixation over formalin fixation. Therefore, our present study was designed to examine the efficacy of presumably less toxic alcoholic fixative (modified EthMeth) as an alternative to formalin. Our gross study showed that it was faster in penetration of tissues than formalin, fixed tissues ideally as early as 8 hours of fixation whereas improper fixation was evident for formalin at that time. In hematoxylin and eosin (H & E) staining, cellular disintegration and weak affinity for staining were evident for formalin. But alcoholic fixatives preserved tissue architectures better than formalin. Our nucleic acid (DNA and RNA) analysis revealed that total genomic DNA and RNA yield and quality of the modified EthMeth fixed tissues were significantly higher ($P < 0.05$) than formalin fixed tissues (poor preserver). These results suggest that alcoholic fixative could be a safe alternative to formalin for morphologic and molecular analysis of tissues.

Pernicious Impacts of Electromagnetic Field Radiation from 4G Mobile Phone on Behaviour and Hippocampal Neurons in Mammalian Brain

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Abstract

Electromagnetic field exposure to the nervous system can cause neurological changes. The effects of extremely low-frequency electromagnetic fields, such as second-generation and third-generation radiation, have been studied in most studies. The current study aimed to explore fourth-generation cellular phone radiation on hippocampal morphology and behavior in mice. Swiss albino male mice (n=30) were randomly categorized into 3 groups; control, 40 minutes, and 60 minutes exposure to 2400 MHz radiofrequency electromagnetic radiation daily for 60 days. The control mice were housed in the same environments but were not exposed to anything. Anxiety-like behaviors were tested using the elevated plus-maze. For histological and stereological examination, the brain was dissected from the cranial cavity. On Cresyl violet stained brain slices, the number of pyramidal neurons in the cornu ammonis of the hippocampus were counted. In exposed mice compared to control mice, a significant increase in anxiety-like behavior has been observed. Histological observations have shown many black and dark blue cytoplastic cells with shrunken morphology degenerative alterations in the neuronal hippocampus in the radiation exposed mice. In the RF-EMR mouse hippocampus, stereological analyses revealed a significant decrease in pyramidal and granule neurons compared to controls. Our findings suggest that 2400-MHz RF-EMR cell phone radiation affects the structural integrity of the hippocampus, which would lead to behavioral changes such as anxiety. However, it alerts us to the possible long-term detrimental effects of exposure to RF-EMR.

Introduction and Adaptation of Innovative Techniques for Taxidermy in Veterinary Education

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Abstract

Taxidermy is an important tool for anatomy study, awareness and conservation. This process is gaining popularity for its benefits as a teaching and research tool in anatomy. The present novel technique

might be many advantages over other methods. It is simple, cost effective and gives all the details of anatomy. This adds educational craft and museum use where life like appearance is desired. The applications and advantages of the taxidermy technique have been widely reported in the fields of training, research, and education. The importance of the plastination technique has been well described in anatomical education, being reported as a basic method of anatomical investigation. Taxidermy facilitates contact by anatomy students, and also reduces exposure to irritants, such as formalin, through inhalation during practical classes. The global anthropogenic pressure has been quite detrimental to animal populations and with global warming, climate change and environmental pollution several endangered species are on the verge of extinction. In this context, the role of several conservation approaches, like establishment of parks or gardens as well as taxidermy or stuffing of birds and animals, have significant roles in both entertaining and educating the public about avian life, conservation and avian biodiversity could not be overlooked. In our taxidermy techniques we keeping the appearance of an animal intact using cotton, iron rod, wire and some chemicals after removing and processing the skin of a dead animals. In the meantime, a good number of skeletons (Giraffe, Goyal, Common Eland, Horse, Monkey, Cow, Goat, Dog, Cat, Chicken, Turkey etc.), stuffed birds/animals (Rabbit, Cock, Pigeon. Duck, Lizard etc.), and organs of animals (Liver, Kidney, Spleen, Stomach, Heart) were preserved. Implementation of this technique for animal structure are teaching based on inquiry-discovery learning shown that students have good process skill. In conclusion the taxidermy samples will certainly have a more holistic approach to anatomy study and will be more educative and scientific.

Development of the Anatomy Museum for Enhancing Quality Veterinary Education and Research in the Department of Anatomy and Histology, Bangladesh Agricultural University

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Abstract

The museum is a centre for learning new information or knowledge through visual observation. Anatomy museum explores the knowledge based on the shape and structure of living beings as a whole or part. This research study was aimed to enrich veterinary anatomy museum collecting samples and preparing the skeletons, preserve, interpret, and display items of artistic, cultural, or scientific significance for the education of the educators and public. In this research project, we also described a simple techniques for the preparing of skeleton, stuffing for the teaching of animal structures, organs or animal as a whole. For preservation of the skeletons, the animals were sedated, skinned then internal organs removed. The sample was boiled with lemon extract combined with baking soda and kept in bleaching agent. The bones were washed out with clean water and sun-dried. The bones were arranged and connected with glue and wire. Finally, the skeleton was fixed on a wooden stand to be stored easily the animal structure for teaching purposes. The stuffing process involves keeping the appearance of an animal intact using cotton, iron rod, wire and some chemicals after removing and processing the skin of a dead animals. In the mean time a good number of skeletons (Giraffe, Goyal, Common Eland, Horse, Monkey, Cow, Goat, Dog, Cat, Chicken, Turkey etc.), stuffed birds/animals (Rabbit, Cock, Pigeon. Duck, Lizard etc.), and organs of animals (Liver, Kidney, Spleen, Stomach, Heart) were preserved. Implementation of this technique for animal structure are teaching based on inquiry-discovery learning shown that students have good process skill (cognitive process, knowledge, creativity and innovation). The anatomy museum offered great promise to cope with anatomy practice

in veterinary education and another science subjects as well. In conclusion such a museum will certainly have a more holistic approach to anatomy study and will be more educative and scientific.

Evaluation of Residual Effects of Agricultural Pesticides on the Male Reproductive Organs of Rabbits: A Public Health Perspective Study

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Abstract
Pesticide is considered as one of the top ten chemicals having significant public health concerns. The residue of pesticide in food and food materials continue to pose a global health challenge including in Bangladesh. Here, the present study is to investigate the residual effects of imidacloprid (IMD) on the histoarchitecture of testes, epididymis, and ductus deferens of adult male rabbits. The pesticide exposure rabbits (n=8) received IMD (Bildor® 0.5 ml (100 mg)/L water)-contaminated green grass for every alternative day in the morning up to three months. Control rabbits (n=4) received a standard diet. After exposure, animals were lost their weight, and nodules appeared in the skin. Histopathological observation of control testes, showing normal uniform in size and shape of seminiferous tubules containing an organized layer of different stages of spermatogenic cells. The Leydig cells are located in the interstitial connective tissue. Testes of IMD-exposed rabbits show seminiferous tubules having increased size of lumen diameter with derangement and reduced number of spermatogenic cells and presence of congested blood vessels adjacent to the Leydig cells. The number of spermatogenic cells significantly decreased within the seminiferous tubules compared to that of the control rabbit. A significant level of abnormal morphology of spermatozoa in testes and epididymis was seen in IMD-exposed rabbits. Granulomatous lesions are seen associated with or in the tunica adventitia of the spermatic artery and the spermatic vein is congested. The present findings revealed that IMD was found to cause degeneration of spermatogenic cells, separation of primary spermatocyte from spermatogonia, and irregular arrangement of spermatogenic cells in the seminiferous tubules, these histological changes indicated that IMD, has detrimental effects on the testes of adult rabbits and it might affect the reproduction of mammals. Therefore, it is very alarming, if the human being is exposed to toxic IMD food contaminants, it may cause reproductive failure.

Effects of Acute and Chronic Exposure of Low Dose of Pesticide on the Liver of Adult Rabbits (*Oryctalagus Cuniculus*)

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Abstract
The toxicity of pesticides for non-target organisms is of worldwide concern. Due to the indiscriminate use of pesticides in agriculture, it has become a part of our food chain and has an adverse residual effect on the vital organs of mammals. Here, to investigate the toxicity of low doses of top used pesticide, imidacloprid on the liver of adult rabbits (n=12). The pesticide exposed-rabbits (n=8) received imidacloprid (Bildor® 0.5 ml (100 mg)/L water)-contaminated green grass for every alternative day in the morning up to two weeks (acute exposure) or up to three months (chronic exposure). Control rabbits (n=4) received a standard diet. After exposure, no sign appeared in the acute

case, interestingly, in chronic case, animals were lost their weight, and nodules appeared in the skin. In blood biochemistry, serum hepatic enzymes aspartate aminotransferase (AST) and alanine aminotransferase (ALT) were significantly increased in imidacloprid exposed rabbits, indicating liver injury. Imidacloprid exposure produced coagulation necrosis in the periportal area of the liver with severe infiltration of the inflammatory cells in acute case. In chronic case, imidacloprid exposure produced fibrosis and bile duct epithelium hyperplasia. The findings of the present study suggested that pesticide use at the field level may affect the body homeostasis of animals as well as humans and the individual may suffer from liver dysfunctions, which lead to biliary cancer.

Protective Effects of Antioxidant Against Pesticide (Imidacloprid)-Induced Toxicity in Adult Rabbits (*Oryctalagus Cuniculus*)

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Abstract

Toxic chemicals especially agricultural pesticide residues will be a potential threat to the livestock and public health in Bangladesh. Imidacloprid (IMD) is a potent and most widely used insecticide and their use lead to widespread concern because of their potential adverse effect on environment, animal and human health. Here to investigate the protective effect of dietary vitamin E, C and/or Se supplementation on IMD induced toxicity in rabbits (n=12). Control rabbits (n=3) fed with fresh green grass and wheat bran with supplied tube well water ad libitum. Pesticide exposed (n=3) rabbits received IMD (Bildor® 0.5 ml (100 mg)/L water)-contaminated green grass every alternative day once daily up to 15 days. The pesticide exposed with supplemented antioxidants rabbits (n=6) fed with green grass contaminated by IMD, simultaneously different antioxidants like vit E+Se (vit E @75mg/L drinking water & Se @0.25mg/L drinking water) (n=3) and vit C (100mg/L drinking water) (n=3) were supplied with drinking water. The values of hepatic serum enzyme aspartate amino transferase (AST) was significantly increased in IMD exposed rabbit as compared to control rabbit. AST level were not change in IMD exposed Vit. E-Se, C or Vit. E-S+ C supplemented rabbits in comparison with control rabbit. Microscopically, no lesion were seen control liver and IMD treated rabbit's liver revealed severe histopathological alterations including features of periportal coagulative necrosis, dilation of intrahepatic veins, infiltrations of inflammatory cells and congestion of blood vessels. Interestingly, liver of Vit. E-Se, C or Vit. E-S+ C supplemented IMD-exposed rabbits showed no liver lesions. indicating that anti-oxidant property of Vit. E-Se, C have protective role against IMD induced liver toxicity. The present findings indicating that anti-oxidant property of Vit. E-Se, C have protective role against IMD induced liver toxicity. These result helpful to develop antioxidants based antidote against pesticide induced liver toxicity and would have the potential to combat pesticides toxicity.

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Preservation of Musculoskeletal Specimens of Animals by Improved Method of Plastination.

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Abstract
In nature, decaying is an unavoidable phenomenon. Fresh biological specimens lose their form due to putrefaction, which is a hindrance to morphological studies, teaching, and research. In order to address these challenges, morphologists have always been looking for a modern method to preserve biological specimens retaining their original features, and which can be stored without any special care and the ill-effects of formalin preservation. In the course of this, Dr. Gunther von Hagens introduced a new technique of tissue preservation called plastination. Since then, different modified or new plastination methods have been developed. But the requirement of specialized laboratory facilities and expensive chemicals make it difficult to apply these methods widely. The aim of our study was to establish a more simplified and economical method to replace the use of animals sacrificed for teaching fundamental anatomy, and to support training students in clinical skills. In the current study, we collected fresh musculoskeletal specimens (parts of forelimb) from goat, degreased and fixed the muscle and bones in a very low concentration of formalin, dehydrated the specimens in pure acetone, followed by immersion in glycerin. Finally, the specimens were desiccated using cornstarch. The preserved specimens did not lose any aspects of their physical appearance, such as color, following the plastination process. They retained their original shape without any shrinkage and revealed detailed anatomical structures. They were dry, clean, realistic and durable without any special storage care. The preserved specimens were clean and free from any offensive odor. However, the approximate cost for preserving musculoskeletal specimens in this method was 51$ (per kg specimen) which indicates the cost-effectiveness of the current method. The current method will help to overcome the challenge of deterioration of specimens and will be a highly useful tool for economical and healthful preservation of specimens, especially in tropical climates.

Effects of High Doses of Glucocorticoid, Dexamethasone on the Lipid Metabolism Within the Liver of Broiler Chicken

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Abstract
Liver is largely known for its detoxifying role in the body and drugs are mostly responsible for liver damage determined by dose and duration of administration. The current study aims to explore the impact of dexamethasone (DEX) on the serum glucose profile, gross and histological attributes as well as the localization and expression pattern of glucocorticoid receptor (GR) in the liver of broilers. To conduct this study, four homogenous groups of day-old chicks (DOCs) were used (a total of 106 DOCs); one control group (C), and three experiment groups (E1, E2, and E3). All the groups were maintained on a commercial feed where 3, 5, and 7 mg DEX (per kg feed) was supplied to the E1, E2, and E3 groups respectively. On days 7, 14, 21, and 28 of the experiment, blood and liver samples were collected. The serum glucose profile was analyzed by spectrophotometry. After investigating the gross morphometric parameters (color, weight, length, and width of the liver), the tissue samples were processed and stained with routine hematoxylin and eosin stain for histological investigation.

Immunohistochemical staining was performed to evaluate the expression pattern of GR in the hepatocytes. Thin-layer chromatography (TLC) was performed to detect DEX residue in the liver tissue. Increased serum glucose level was detected in the DEX groups. The liver samples of DEX groups were appeared dark and congested. Weight, length and width of liver were also decreased significantly. Congestion of the central veins, sinusoids, and accumulation of lipid droplets were also observed in the DEX groups. On day 28, expression of GR was seen in the central vein and cytoplasm of the hepatocytes which were largely dose-dependent. DEX residue was detected in the liver tissues of E2 and E3 groups. These findings indicated that DEX alters the gross and histological attributes of broiler liver.

Postnatal Growth and Development of Major Lymphatic Organs and Tissues with T-Cell Subpopulations in The Quail of Bangladesh: An Immunological Perspective Study.

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Abstract

Introduction: In Bangladesh, the urban and sub-urban peoples interestingly rear Japanese quails (*Coturnix coturnix japonica*) which are very easy to rear with a high return in a short time (Rahman, 2000) but they are susceptibility to common diseases and hampering quail farming in Bangladesh. In quails the Harderian gland, spleen, thymus, bursa of Fabricius, and all mucosa-associated lymphoid tissues performing central and peripheral immunity (Getty, 1975; Bach, 1978). The available literature report regarding this work is lacking. Therefore the present work has been undertaken.

Results: 50 quails used in the present study. The thymus, cecal tonsil, spleen, and bursa of Fabricius, from D1, D15, D35, D45, D105 was collected from the farms. Their length, breadth, thickness, and weight were measured using scale and balance. The thymus was located on both sides of the neck in chain form. Their color was light pinkish and shiny. At day old they were very small. Their size was found statistically higher at D35 and after that their growth was slower and decreased statistically at D105. There was no significant difference in growth and development between the right and left thymus. The cecal tonsil of the quail was oval-shaped and located at the proximal end of the cecal tonsil. Their higher growth was found from D15-D105, and statistically more growth was found at D35. There was no significant variation in growth between the right and left cecal tonsils.

The spleens of the quails were spherical in shape, deeply reddish in color, and located at the angle formed by the proventriculus, ventricle, and liver. The spleen at D1 was very small and its growth was increased with age from D15- D105, and found to be significantly higher at D45. The bursa of Fabricius was globular in shape and located dorsal to the caudal end of the colorectum. They are pale-yellowish in color and their growth was found from D15-D45 being statistically higher at D35. At D 105 the bursa was atrophied.

Molecular Characterization of Virulence Factor Genes and Antibiogram Study of *Salmonella* sp. in Avian Salmonellosis in Bangladesh

Najmun Nahar Popy, Md. Bahanur Rahman, Marzia Rahman, Md. Rashedul Islam and Mohammad Ferdousur Rahman Khan*

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Abstract

A total of 70 samples were collected from suspected avian Salmonellosis cases from 4 layer farms of different districts of Bangladesh. The samples were subjected to a series of conventional bacteriological examination, biochemical properties study and molecular characterization of isolated bacteria. Out of 70, 13(18%) samples were found positive for *Salmonella* sp. Farm wise occurrence of *Salmonella* sp. was 20%(n=4/20), 25%(n=5/20), 10%(2/20), 20%(2/10) at Farm 1 & 2 in Mymensingh district and Farm 3&4 in Kishoreganj district respectively. All the isolates (13) were confirmed by PCR as *Salmonella* sp. as well as virulence. Amplified virulence *Inv*A gene (796 bp) and *Inv*E gene (511 bp) of all isolates (13) were sent for sequencing which will be used to homology study. Antibiogram profiles indicate that 92.30%, 84.61%, 15.38%, 30.76%, 30.76% and 15.38% isolates were resistant to Amoxicillin, Ampicillin, Cefotaxime, Cefuroxime, Cephalexin and Cefoxitin respectively and susceptibility analysis showed that 7.69%, 15.38%, 84.61%, 69.23%, 69.24% and 84.61% *Salmonella* spp. isolates were sensitive to Amoxicillin, Ampicillin, Cefotaxime, Cefuroxime, Cephalexin and Cefoxitin respectively. PCR was also performed for amplification of Amoxicillin resistant bla_{TEM} (793bp) and Cephalosporin bla_{CMY} (562 bp) genes respectively. Among the isolates 92.30% (12) *Salmonella* sp. isolates were bla_{TEM} gene positive and 84.61% (11) were bla_{CMY} gene positive respectively. The study revealed that multidrug resistant *Salmonella* sp. are prevailing in poultry population which is very alarming. Cephalexin and Cefoxitin may the right choice antibiotics for therapeutic purpose.

Tracking Antimicrobial Resistance in the Migratory Birds, Aquatic Environment and Captive Wildlife and their Public Health Impact.

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Abstract

Role of migratory birds in the dissemination of these resistant pathogens are neglected in Bangladesh. The present study was therefore carried out to detect multidrug resistant *E. coli*. In addition, these isolates were also screened for the presence of avian pathogenic *E. coli* (APEC)-associated virulence genes. A total of 66 fecal matter samples of migratory birds were screened. *E. coli* were isolated and identified by culturing and biochemical tests followed by polymerase chain reaction (PCR). APEC-associated virulence genes were detected by PCR. Disk diffusion assays were employed to investigate antibiogram profiles. Bivariate analysis was performed to assess correlations in resistance patterns between antimicrobials and to assess associations between virulence genes of *E. coli*. Among the 66 samples assessed by PCR, 55 (83.33%) were found positive for *E. coli.* Of these 55 isolates, the APEC-associated virulence gene *fimC* was detected in 67.27% of the isolates, which was significantly higher than in the cases of *iucD* (29.09%) and *papC* (5.45%) genes. In addition, three isolates were

found positive for all three virulence genes, while 23 and 12 isolates were positive for one and two virulence genes respectively. In the bivariate analysis, significant associations were detected between *fimC* and *iucD* virulence genes. All *E. coli* isolates were multidrug resistant (MDR). The isolates exhibited 100% resistance against ampicillin and erythromycin in addition to varying percentages of resistance against streptomycin, tetracycline, ciprofloxacin, and chloramphenicol. Highly positive correlations between tetracycline and ciprofloxacin, chloramphenicol and ciprofloxacin, chloramphenicol and tetracycline were observed by bivariate analysis. To the best of our knowledge, this is the first study that reports APEC-associated virulence genes of MDR *E. coli* from migratory birds in Bangladesh. Results indicate that migratory birds are reservoirs of MDR *E. coli* isolates carrying APEC-associated virulence genes, which can seriously contribute to the development of human and animal diseases.

Antibiotic Resistance Pattern of Bacteria Isolated from Lumpy Skin Disease Associated Secondary Wound Infection

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Abstract

Lumpy Skin Disease (LSD) is a viral disease of cattle results in nodules formation in various parts of the body. As the disease progress, in many cases these nodules ruptured followed by bacterial contamination. In this study a total of ten samples were collected for bacteriological analysis. *Staphylococcus, Bacillus* and *E. coli* were the most dominant bacterial species. Among the total 13 isolates 54% isolates were *Staphylococcus,* 31% were *Bacillus* and 15% were *E. coli.*Isolated organism were subjected to antibiotic Isolated bacterial species showed variable sensitivity pattern against the antibiotics used. In general tested *Staphylococcus*were sensitive against antibiotics except oxacillin. In case of *E. coli* resistance was observed against gentamicin, amoxicillin and streptomycin.

Detection of blaTEM, blaCTX-M, blaCMY, and blaSHV Genes Among Extended-Spectrum Beta-Lactamase-Producing Escherichia coli Isolated from Migratory Birds Travelling to Bangladesh

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Abstract

Extended-spectrum beta-lactamase (ESBL)-producing Escherichia coli cause severe health hazards. Migratory birds are reservoirs and transmitters of many pathogens including ESBL-producing E. coli. To examine migratory birds as potential carriers of ESBL-producing E. coli and E. coli-carrying antibiotic resistance genes, 55 PCR-positive E. coli isolates were screened using the disk diffusion method, double-disk synergy test, and further polymerase chain reaction (PCR) tests. Genes encoding resistance to tetracycline [tetA, 100% (35/35); tetB, 31.43% (11/35)], fluoroquinolone [qnrA, 35.71% (10/28); qnrB, 25% (7/28)], and streptomycin [aadA1, 90.24% (37/41)] were detected in the isolated E. coli. Of the 55 E. coli isolates, 21 (38.18%) were ESBL producers, and all of them were multidrug

resistant. All the ESBL-producing E. coli isolates harbored at least two or more beta-lactamase genes, of which blaTEM, blaCMY, blaCTX-M, and blaSHV were detected in 95.24%, 90.48%, 85.71%, and 42.86% of isolates, respectively. All the beta-lactamase genes were present in four of the ESBL-producing E. coli isolates. Furthermore, 95.24% of ESBL-producing E. coli isolates were positive for one or more antibiotic resistance genes. To the best of our knowledge, this is the first study to detect E. coli-carrying antibiotic resistance genes including beta-lactamase blaCMY and blaSHV originating from migratory birds in Bangladesh. These results suggest that migratory birds are potential carriers of ESBL-producing E. coli along with other clinically important antibiotic resistance genes which may have detrimental impacts on human health.

Migratory Birds Travelling to Bangladesh are Potential Carriers of Multi-drug Resistant Enterococcus spp., Salmonella spp., and Vibrio spp.

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Abstract

Migratory birds could be a potential source for antibiotic resistant (ABR) bacteria. In this study, a total of 66 freshly dropped fecal materials of migratory birds were analyzed. Bacterial isolation and identification were based on cultural properties, biochemical tests, and polymerase chain reaction (PCR). The disk diffusion method was employed to evaluate antibiogram profiles. By PCR, out of 66 samples, the detection rate of *Enterococcus* spp. (60.61%; 95% confidence interval: 48.55–71.50%) was found significantly higher than *Salmonella* spp. (21.21%; 95% CI: 13.08–32.51%) and *Vibrio* spp. (39.40%; 95% CI: 28.50–51.45%). *Enterococcus* isolates were frequently found resistant (100–40%) to ampicillin, streptomycin, meropenem, erythromycin, and gentamicin; *Salmonella* isolates were frequently resistant (72–43%) to chloramphenicol, tetracycline, ampicillin, streptomycin, and erythromycin; and *Vibrio* spp. isolates were frequently resistant (77–31%) to vancomycin, ampicillin, erythromycin, tetracycline, and streptomycin. In addition, 60% (95% CI: 44.60–73.65%) *Enterococcus* spp., 85.71% (95% CI: 60.06–97.46%) *Salmonella* spp., and 76.92% (95% CI: 57.95–88.97%) *Vibrio* spp. isolates were multi-drug resistant (MDR) in nature. Three isolates (one from each bacterium) were found resistant against six classes of antibiotics. The bivariate analysis revealed strong associations (both positive and negative) between several antibiotic pairs which were resistant to isolated organisms. To the best of our knowledge, this is the first study in detecting MDR *Enterococcus* spp., *Salmonella* spp., and *Vibrio* spp. from migratory birds travelling to Bangladesh. Frequent detection of MDR bacteria from migratory birds travelling to Bangladesh suggests that these birds have the potential to carry and spread ABR bacteria and could implicate potential risks to public health. We recommend that these birds should be kept under an AMR surveillance program to minimize the potential risk of contamination of the environment with ABR as well as to reduce their hazardous impacts on health.

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Epidemiological Investigation on Zoonotic Tuberculosis and Campylobacteriosis Associated with Dairy Farming Practices in the Selected Districts of Bangladesh

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Abstract
The study targeted to estimate prevalence, risk factors for the occurrence of bovine campylobacteriosis and bovine tuberculosis (bTB) in source animal in Dhaka and Mymensingh districts of Bangladesh. Additionally, the study characterized molecularly of the isolated organism from animal-human interface and estimated financial loss associated with the both pathogens in source-animals. Besides, the study explored cattle handlers' knowledge and practices for bTB transmission through the food-chains. The study confirmed herd level prevalence of *Campylobacter* was 53.3%. The feces sample was found to be a high level of contamination of 30.9% followed by the manure swab (pooled) at 15.6%. *Campylobacter jejuni* was documented as an abundant species (12.6%), followed by *Campylobacter coli* (5.1%), and *Campylobacter fetus* (0.3%). Sampling from human diarrheal patients' estimated an overall prevalence of *Campylobacter* spp. was 31.5% (104/330) that comprised the prevalence of *C. jejuni*, 21.8%, and *C. coli*, 9.6%. Among the human isolates, 27.3% of *C. jejuni* and 31.2% of *C. coli* demonstrated as multidrug-resistant (MDR) to three or more antimicrobial agents. Together with survey in breeding bull farms, 75% (3/4) were confirmed as positive to have bulls infected with *Campylobacter fetus*. However, animal level occurrence of *C. fetus* was estimated to be 8.7%. Using data from secondary sources combined with the primary data on different financial parameters of livestock goods and associated loss parameters collected through stakeholder interviews were utilized in economic impact assessment for bovine campylobacteriosis for a year in two cattle-dominant districts of Bangladesh. The study confirmed an annual estimated economic loss of this disease in farmed cattle within the studied districts was BDT 1,282.26 million. In bTB component, the single intradermal comparative tuberculin test (SICTT) was used to estimate the prevalence of bTB. The risk factors were identified using mixed-effect multiple logistic regression analyses. The overall herd and animal level prevalences of bTB were estimated to be 45.6% and 11.3%, respectively. The true animal level prevalence of bTB was estimated to be 11.8%. In bTB knowledge and practice assessment, almost all (99%) recognized the important public health burden of tuberculosis in Bangladesh, however, most (58%) had inadequate knowledge about zTB transmission to humans. The study confirmed an annual estimated economic loss of bTB in farming cattle was BDT 1347.72 million. These findings emphasize that zoonotic TB control strategy must pay attention not only on *M. bovis,* but on all organisms under *M. tuberculosis* complex like *M. orygis* under a One Health(OH) approach is very much demanding.

Epidemiological Studies on Shiga Toxin-producing *Escherichia coli* O157:H7 and Cytolethal Distending Toxin-producing *Campylobacter jejuni* from Foods and Diarrhoeal Stools in Mymensingh

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Abstract
The 2nd year of this project was designed with a view to collect different food samples and human diarrhoeal stools, isolation and identification of *E. coli* O157:H7, *E. coli* non-O157:H7 and *C. jejuni* by

conventional and molecular methods, virulence characterization of the isolated bacterial strains. The above mentioned activities were performed successfully. In this study, out of 100 fresh vegetable (composite of tomato, carrot, cucumber, green chilli and coriander) samples, 12 samples were positive for *E. coli* O157:H7, 35 samples were positive for *E. coli* non-O157:H7 and 23 samples were positive for *C. jejuni*. On the other hand, out of 70 raw milk samples, 5 samples were positive for *E. coli* O157:H7, 18 samples were positive for *E. coli* non-O157:H7 and 12 samples were positive for *C. jejuni*. However, all pasteurized milk samples used in this study were negative for *E. coli* O157:H7, *E. coli* non-O157:H7 and *C. jejuni.* In case of poultry meat, out of 100 samples, 7 samples were positive for *E. coli* O157:H7, 42 samples were positive for *E. coli* non-O157:H7 and 65 samples were positive for *C. jejuni*. In case of sugar cane juice samples, out of 100 samples, 5 samples were positive for *E. coli* non-O157:H7. In case of betel leaves samples, out of 100 samples, 7 samples were positive for *E. coli* non-O157:H7. Interestingly, all sugar cane juice and betel leaves samples were negative for *E. coli* O157:H7 and *C. jejuni*. In case of diarrhoeal patients, out of 300 stool samples, 97 samples were positive for *E. coli* non-O157:H7 and 70 samples were positive for *C. jejuni*. However, all stool samples were negative for *E. coli* O157:H7. Different virulence genes were identified in *E. coli* O157:H7, *E. coli* non-O157:H7 and *C. jejuni* isolates obtained from foods and diarrhoeal patients in this study. The activities of the rest objectives are going on.

Clostridium Perfringens in Poultry Farms and Live Bird Markets in Mymensingh: Prevalence, Genotyping and Antimicrobial Resistance Patterns

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Abstract
Necrotic enteritis (NE) is one of the most prevalent diseases in broiler poultry caused by *Clostridium perfringens* connected with significant economic losses. A cross-sectional survey was conducted in Mymensingh district of Bangladesh to assess the prevalence of *Clostridium perfringens* through toxinotyping molecular assay, and to confirm the risk factors for NE including antimicrobial resistant (AMR) status of the isolates. We included 40 small scale commercial broiler farms randomly selected from two sub-districts of Mymensingh district of Bangladesh. As an individual sample, 240 cloacal swabs, and as a pooled sample, 40 drinking water, 40 workers' hand washing, 40 litter swab, and 40 feed samples were collected and evaluated by culture, biochemical, and molecular assays. A pretested semi-structured interview questionnaire was employed to capture flock-level data on risk factors from the farm owners. The flock-level data on risk factors were assessed via univariable and multivariable logistic regression analyses with a *p*-value of <0.05 was taken for statistically significant. Overall flock level prevalence of *Clostridium perfringens* was estimated to be 10.3% (95% confidence interval [CI] 7.5-13.6%). Litter swab (pooled) was found to be highly contaminated with *Clostridium perfringens* (25.0%, 95% CI: 12.7- 41.2%) followed by the cloacal swab (10.4%, 95% CI: 6.9-15.0%) and feed sample (5.0%, 95% CI: 0.6-16.9%). History of coccidia infection (AOR=33.01, 95% CI: 2.14- 507.59, *p*= 0.01) was significantly associated with flock level *C. perfringens* infection status. In this study, 78.1% isolates were found as multidrug resistant (MDR) as they demonstrated resistant to 3 to 5 antimicrobial agents. Evidence-based control options need to be taken through uses of prebiotic and probiotics, biosecurity and hygienic measurement including control of coccidia infection are needed to lessen the NE infection and antimicrobial resistant related to this pathogen in small-scale commercial broiler poultry.

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Development of BHK-21 Cell Based Chip for Electrochemical Detection of Foot and Mouth Disease (FMD) Virus Infection

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Abstract
Electrochemical detection of virus has recently been introduced as emerging tool in many fields of biomedical, biosensor, tissue engineering, therapeutics etc. for label free, fast and sensitive detection nature. The traditional virus detection methods employed isolation, propagation, serological and molecular detection which is time consuming, laborious and costly method requiring several days to week. Therefore, herein the cell chip based electrochemical methods were introduced as fast, sensitive, label-free method for detection of Food and Mouth (FMD) virus from clinical specimens. For this BHK-21 cell established on conductive ITO surface were employed for establishing infection with inoculum prepared from clinical sample. The virus propagated chip were subjected for electrochemical detection in comparison with healthy cell for confirming the infection specific electrochemical signal. The Cyclic Voltammetry (CV) of FMD infected was measured at applied potential windows of -0.6V to 0.6V with a scan rate of 0.5mV/s in compliance with the threshold of infected cell's potential using electrochemical workstation following standard three electrode setup. The current peak for infected cell and non-infected healthy cell were $3x10^{-5}$A, $2.2x10^{-7}$A, respectively at a potential of 0.24 mV, while no such peak was determined from the PBS. However, the significant decrease of peak current with the post infection periods showed excellent fits with the optical observation of the infectivity. Thus, the peak current at 0.24mV was considered as the parameter for electrochemical determination of virus infectivity. Thus, this research suggested that the electrochemical detection of virus could be an emerging alternative tool for label-free detection of any virus employing their susceptible cells.

Investigation and Characterization of Viral and Bacterial Diseases in Selected Fin Fishes and Shrimp in Bangladesh and Development of their Vaccines and Validation

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Abstract
The current trend in aquaculture is towards increased intensification and commercialization of aquatic production. However, Tilapia (*Oreochromis niloticus*), Koi (*Anabas testudineus*), Shing (*Heteropneustes fossilis*), Magur (*Clarias batrachus*) Pangas (*Pangasius hypophthalmus*) and Shrimp (*Penaeus monodon*) are been cultured in ponds and gher mostly as commercial basis by entrepreneurial farmers in Bangladesh. Although, Shing, Tilapia, Koi, Magur, Pangas and Shrimp culture has great potential in Bangladesh but recently unknown emerging diseases (Popped eye disease, Epizootic Ulcerative Syndrome (EUS), Early Mortality Syndrome (EMS), Acute Hepatopancreatic Necrosis Disease (AHPND) and Tilapia Lack Virus (TiLV)) are causing serious economic losses due to high mortality within 3 to 10 days under farming conditions. Four types (brain, liver, kidney, spleen and ulcerative skin tissue) of samples from each fish and total 1200 samples from 300 dead fishes of six species were collected from outbreak site of the selected areas (Mymensingh, Gazipur, Netrokona, Kishoreganj, Bagerhat, Khulna and Satkhira districts) in

Bangladesh for the isolation of bacterial and viral pathogens. Four different types of highly pathogenic bacterial species *(Streptococcus agalactiae, Aeromonas hydrophila, Aeromonas veronii and Vibrio parahaemolyticus*) have been isolated and identified from the above mentioned six different species of fishes. An inactivated whole cell bacterial vaccines (mono-, bi- and tri-valent) were developed using the field isolates of bacteria and the vaccines were injected through i/m route into the healthy male and female brood of Shing, Magur, Koi, Tilapia and Pangas fishes at a dose of 0.1, 0.3 and 0.5 ml/fish under aquarium condition. Fishes immunized with 0.3 and 0.5 ml/fish doses with the newly developed vaccines of each type were able to protect 90-100% in the vaccinated fishes whereas the non-vaccinated control showed 95-98% mortality in experimentally induced challenge infection (at a doses of 2.3 x10^6 cfu/ml) with homologous bacterial isolates after 3 weeks of post challenge. Findings of this study indicate that the mass mortality of highly consumed cultured fin-fishes from deadly bacterial infection could easily be controlled by vaccination. Tilapia lake virus (TiLV) has also been isolated from dead tilapia fishes of different outbreak, detail characterization and development of vaccine with the isolated virus is yet to be completed.

Isolation and Molecular Characterization of Bacteriophages and their Potentiality as Growth Promoter and Therapeutic Agent Against Colibacillosis *and* Salmonellosis in Poultry Alternative to Antibiotics

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Abstract

Now a day's emergence of antibiotic resistant bacteria is of great concern worldwide and thus use of new anti-bacterial agents as an alternative to antibiotics has drafted much attention. The use of bacteriophage, in this case, can be a potential solution. The proposed research proposal was designed with the objectives of isolation, characterization and application of bacteriophages as growth promoter and for the treatment of Salmonellosis and Colibacillosis in poultry as alternative to antibiotics. In the present study bacteriophages ECP-02 and SLP against *E. coli* 0157 and Salmonella were isolated by an enrichment method from sewage water sample. Further the bacteriophages were partially characterized by determination of host range, ability to produce number of plaque with different host bacteria, pH stability at different pH solution. A total of 4 bacteriophages were isolated. Of which one of each bacteria specific bacteriophages were characterized. Out of 14 isolates of *E coli,* ECP-02 able to lyse all bacteria and SLP also able to lyse all 23 isolates of Salmonella. In vitro antibacterial activity of the isolated bacteriophages were found highly effective to kill the pathogenic *E. coli* and *Salmonella spp.* The isolated bacteriophage might be a potential antibacterial agent that can be used as alternative to antibiotics.

Emergence of Multidrug Resistant *E. coli* in Food and Water Samples from Mymensingh City Corporation Areas

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Abstract
Multidrug-resistant *Escherichia coli* is one of the most important public health concern worldwide that can be transferred through the food of animal origin to human being causing serious infection. The present project was designed to isolate and identify *E. coli* in foods and water samples from Mymensingh City Corporation areas and to study their multidrug resistance pattern. To achieving the objectives a total of 80 food samples (milk-40, egg washing-20, chicken meat-20) and 30 water samples (Hotel water-15, Drainage water-15) was collected from various sources at Mymensingh City Corporation areas and transported to the laboratory of the Department of Microbiology and Hygiene for the isolation and identification of *E. coli*. Isolation of *E. coli* was performed by culturing samples in different cultural media and isolates of *E. coli* were confirmed by PCR. Isolated *E. coli* were then subjected to antibiotic sensitivity test using disk diffusion techniques using 10 commonly available antibiotics. Out of 80 food samples, 28 (8 for milk, 9 for eggs, 11 for chicken meat) were positive for *E. coli* by culture and PCR. Among 30 water samples, 20 (5 for hotel water, 15 for drainage water) were found to be positive for *E. coli.* Antibiotic sensitivity test of *E. coli* isolates from drainage water revealed 100% resistant to all tested antibiotics. However *E. coli* isolates from hotel water samples showed resistant to 8 antibiotics except colistin and Ceftriaxone. Antibiotic sensitivity pattern of *E. coli* from food samples and detection of their antibiotic resistant genes is on progress.

Phenotypic and Genotypic Characterization of Multidrug Resistant Salmonella Typhimurium DT104 from Selected Dairy Farms at Sadar Upazila of Mymensingh District

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Abstract
Salmonella typhimurium definite Type 104 emerges as a cause of human illness and has received increasing attention because of its multidrug resistance. *Salmonella Typhimurium* DT104 first demonstrated a typical pattern of penta- resistance to ampicillin, chloramphenicol, streptomycin, sulfonamide, and tetracycline (ACSSuT), but it has more recently displayed additional resistance to other antimicrobials. The present study was undertaken for the isolation and identification and antibiogram study of multi drug resistant Salmonella typhimurium DT104 from dairy farm environmental samples in selected areas of Mymensingh district. A total of 135 dairy farm samples comprising of faeces, soil, water, feed from different farms were subjected to isolation and identification of *Salmonella* spp. Out of the 135 dairy farm samples, 39 were positive to Salmonella by cultural examinations. Each isolates were tested by PCR using genus specific primer invA and species specific primer Salmonella typhimurium DT104. All the cultural positive isolates were confirmed genus specific by invA primer. While only 6 were confirmed by Salmonella typhimurium DT104 primer from collected samples. Phenotypic characterization of of each isolates was checked by antibiotic susceptibility testing using disc diffusion method. Among the isolates, 9(23.07%) were

found to be multidrug resistant showed resistant to more than 5 antibiotics. The multi-drug resistant isolates were observed among the isolated pathogenic strain which may be transferred to human from the domestic animals and birds or even from contaminated source of water.

Emergence of Multidrug Resistant *Salmonella Typhimurium* DT104 from Selected Poultry Farms at Mymensingh District

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Abstract

Salmonella infection in poultry industry has become an important issue throughout the world as well as in Bangladesh. It is one of the major barriers in poultry farming in Bangladesh. The zoonotic multidrug resistant bacteria possess a concern to human health when the drug resistant bacteria transmitted to human via food from animal sources or by environmental factor. The present research work was conducted for isolation, identification and antibiogram study of multidrug resistant *Salmonella typhimurium* DT104 from selected poultry farm environments in Mymensingh district. A total of 115 environmental samples (65 faeces samples, 10 soil samples, 20 water samples, 20 feed samples) from different poultry farms were collected and transported to the bacteriology laboratory of the Dept. of Microbiology and Hygiene for the isolation and identification of *Salmonella* spp. Among the collected samples 23 were shown to be *Salmonella* positive by cultural and PCR assay. Isolated Salmonella were then confirmed as *Salmonella typhimurium* DT104 using species specific primer. Out of 23 *Salmonella* spp. only 3 were confirmed as *Salmonella typhimurium* DT104. All isolates were exposed to antibiogram study revealed that isolates were 100% resistant to Erythromycin, Tetracycline, Colistin, Gentamycin, Ciprofloxacine, Streptomycin and Chlormphenicol followed by Ampicillin (83.33%), Enrofloxacine (66.66%) and Amikasin (16.66%). Results of our study concluded that the presence of *Salmonella typhimurium* DT104 in the poultry farm environment is of great threat to public health. Public awareness about proper hygiene, sanitation and multidrug resistance should be improved at farm level as well as national level to combat such threat.

Polyvalent Vaccine Development for Mastitis in Dairy Cow

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Abstract

Introduction: Mastitis is the most economically devastating dairy disease in Bangladesh like other countries of the world. This study was designed to develop a polyvalent mastitis vaccine to prevent mastitis in dairy cows.
Methodology: This study was designed to develop a polyvalent mastitis vaccine to prevent mastitis in dairy cows. To attain the objective, milk samples were collected from randomly selected 414 cows of 189 commercial and household farms from Chittagong, Mymensingh, Pabna, Shirajgonj and Sylhet districts of Bangladesh. On-farm California Mastitis Test (CMT) was performed for preliminary selection of mastitic cows. The tested milk samples were allowed to Somatic Cell Count (SSC) and subsequently, milk parameters (Fat, SNF, Protein, Lactose, Salts, Conductivity, Density and Total

solids) were analyzed using Lactoscan Combo (Milkotronic, Bulgeria). The milk samples were cultured on selective and differential media, incubated and purified; then molecular characterization and whole genome sequencing were done.
Findings: The SCC revealed that 21.98% (91/414) of tested cows were affected by clinical mastitis (500,000≤91,93000 cells/mL) and 22.46% (93/414) were affected by sub-clinical mastitis (201,000≤500,000 cells/mL), where 55.56% cows were healthy (0≤200,000 cells/mL). In milk parameters analysis, it was also observed that milk of clinical mastitis cows contained 1.38 times more fat and sub-clinical mastitis cows contained 1.14 times more compared to healthy cows; the protein percentage and conductivity in clinical mastitis cow were higher compared to subclinical and healthy cows. Where the SNF, lactose, salt and density were slightly high in healthy cow milk compared to mastitic cows. In cultural, morpho-physiological and molecular characterization, we found *Staphylococcus aureus*, *Streptococcus agalectiae, S, uberis, E. coli* and *Proteus sp.* pathogenicity of the isolates in mice and whole genome sequencing data analysis are being conducted to develop a polyvalent mastitis vaccine.
Conclusion: We found 44.44% of dairy cows are affected by mastitis, broad-spectrum antibiotics used to treat mastitis which leads to antimicrobial resistance, vaccination using local isolates will reduce the mastitis and enhance safe milk production.

Prevalence of Antimicrobial Resistant Bacteria Isolated from Selected Commercial and Backyard Poultry Farms in Mymensingh District

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Abstract

Antimicrobial resistant poultry pathogens may result in treatment failure, leading to economic losses, but also be a source of resistant bacteria/genes that may represent a risk to human health. The present study was undertaken to check the present situation about antibiotic use in the layer farms with the isolation of antibiotic resistant bacteria from commercial layer and backyard birds of selected poultry farms located at Mymensingh district over a period of time. Initially a questionnaire was prepared and survey was done to check the status of antibiotic use by the owners of the selected layer farms. Feces or cloacal swabs were collected from layer birds and surrounding backyard birds; and water sample was collected from the waterer for the isolation of *Escherichia coli*, *Salmonella* spp. and *Staphylococcus aureus*. Sampling was done once a month from each of seven selected farms up to six months followed by target species isolation, identification and antibiogram. It was found that most of the farmers used more than five different antibiotics (Amoxycillin, colistin sulphate, ciprofloxacin, oxytetracycline, neomycin, chlortetracycline, levofloxacin or enrofloxacin etc.) randomly in their farms. Among 245 samples, 231 were positive for *E. coli*, 12 were positive for *Salmonella* spp. and 58 were positive for *S. aureus*. The *E. coli* isolates showed high phenotypic resistance to erythromycin, ampicillin, amoxicillin, doxycycline, tetracycline, azithromycin, ciprofloxacin and nalidixic acid. 100% isolates of *Salmonella* spp. were resistant to erythromycin, ampicillin, tetracycline, doxycycline, amoxicillin and cefuroxime. The antibiotic susceptibility profile of *S. aureus* isolates showed highest resistance to amoxicillin, ampicillin, cephalexin, erythromycin, vancomycin, doxycycline and tetracycline. Most of the *E. coli* and *Salmonella* spp. contained *tet*A and bla_{TEM} genes and *10 isolates of S. aureus were positive for mec gene.* It can be concluded that multidrug resistant *E. coli*,

Salmonella spp. and *S. aureus* prevailing the selected layer farms might be a threat not only for human health but also for the poultry population.

Identification of an Alternative to Antibiotic Growth Promoter (AGP) for Safe Poultry Meat Production in Bangladesh

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Abstract
The widespread use of antibiotics as growth promoters (AGP) had adverse effects on poultry and on antibiotic resistance in microbes. Now a days, probiotics, prebiotics and enzymes are widely used as an alternative to potential AGP substitutes. Chitosan oligosaccharides (COS), a functional oligosaccharide, are a natural alkaline polymer of glucosamine and obtained by chemical and enzymatic hydrolysis of chitosan and considered as an antibiotic alternative in animal production. The effect of COS on the performance of broiler will be observed in the present study. As the budget was released at 3rd week of June 2021, the instruments, chemicals and appliances were purchased.

Molecular Detection and Prevalence of Multidrug Resistant Typhoidal and Non-typhoidal *Salmonella* Isolated from < 5-year-old Children in Mymensingh

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Abstract
Children are very sensitive to infection because their immunity is not strong enough like adult. Many children are dying every year for wrong antibiotic treatment, even after admission in hospital; the doctors could not save them. So, it is very important to check the present status of the antibiotic resistant *Salmonella* present in non-diarrheic children. The present study was conducted to detect the typhoidal and non-typhoidal MDR *Salmonella* from apparently healthy children with their antibiotic sensitivity pattern and resistant gene detection. A total of 60 rectal swabs were collected from apparently healthy children up to 5 years of age at different areas of Gouripur upazila in Mymensingh and only 16 isolates were confirmed as *Salmonella* by PCR with the isolation rate of 27%. None of the isolates was found positive as typhoidal *Salmonella*. All the non-typhoidal *Salmonella* isolates were found sensitive to trimethoprim and resistant to erythromycin and azithromycin. Gentamicin, florfenicol, trimethoprim and oxytetracycline were found effective against most of the non-typhoidal *Salmonella* isolates, whereas amoxycillin, cefixime, cefuroxime and ciprofloxacin were found less effective againt non-typhoidal *Salmonella* isolated from <5 yrs old children in Mymensingh. It can be concluded that antibiotic sensitivity test must be performed before prescribe any antibiotics to children.

Prevalence of Food Borne Bacteria in Animal Originated Foods and their Antibiotic Susceptibility Patterns

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Abstract
Introduction: *E. coli*, Salmonella spp. and *Staphylococcus aureus* are food borne bacteria. Emergence of antimicrobial resistance (AMR) in food borne bacteria is a growing public health concern. The present study was undertaken to isolate and identify food borne bacteria from animal originated foods and to determine their antimicrobial susceptibility patterns.
Methodology: Poultry meat (n=100), beef (n=100), milk (n=100) and egg (n=100) samples were collected. Food samples were inoculated onto Eosine methylene blue, Salmonella-Shigella and Mannitol salt agar for isolation of *E. coli*, *Salmonella* spp. and *Staphylococcus aureus*, respectively. Identification of these bacteria was performed by colony characteristics, gram's staining, sugar fermentation and biochemical tests. Molecular detection of *E. coli*, *Salmonella* spp. and *Staphylococcus aureus* were performed by amplification of 16*sRNA*, *inv* and *nuc* genes, respectively using PCR assays. The antibiotic susceptibility was performed by disc diffusion method.
Results: The prevalence of *E. coli*, *Salmonella* spp. and *Staphylococcus* spp. in chicken meat was 75%, 38% and 48% respectively. In beef prevalence of *E. coli*, *Salmonella* spp and *Staphylococcus* spp. in chicken meat was 55%, 25% and 28% respectively. In eggs prevalence of *E. coli*, *Salmonella* spp and *Staphylococcus* spp. was 60%, 15% and 36% respectively. In milk prevalence of *E. coli*, *Salmonella* spp and *Staphylococcus* spp. was 68%, 28% and 65% respectively. *E. coli* isolates (100%) were found to be resistant to Ceftazidime, Ampicillin and Mecillinam.. *E. coli* isolates (50.98%) were found to be multidrug resistant (MDR). *Salmonella* spp. showed highest resistant profile against tetracycline (96.67%) followed by azithromycin (90.70%), colistin (69.76%) and ciprofloxacin (60.47%). Twenty two of 43 (51.16%) Salmonella isolates exhibited MDR profiles. *Staphylococcus aureus* were found highly resistant to benzyl penicillin (66%) followed by amoxicillin (62%), ciprofloxacin (56%). Forty five of 50 *Staphylococcus aureus* isolates (90%) were found MDR since they were resistant two at least three different classes of antibiotics.
Conclusion: Data of this study indicate that animal originated foods were contaminated with MDR food borne bacteria which might affect public health.

Detection and Molecular Characterization of Colistin Resistant and Extended Spectrum Beta Lactamase (ESBL) Producing *E. coli* in Poultry Production Chain

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Abstract
Introduction: Increasing colistin resistance is a global concern because colistin is used as a last resort for the treatment of carbapenem-resistant Enterobacteriaceae infections. ESBL producing *E. coli* has been increasingly reported in livestock and poultry environment as well as foods of animal origin globally. The present study was carried out for isolation and molecular characterization of colistin resistant and ESBL producing *E. coli* from poultry production chain.

Methodology: A total of 197 samples comprised of cloacal swab (n=43), feed (n=41), water (n=41), litter (n=42) and hand washing (n=30) were collected from 40 poultry farms located at Mymensingh district. Isolation of *E. coli* was performed by streaking of samples onto MC agar and EMB agar and incubated at 37°C for 24 hrs. Identification of *E. coli* was done by Gram's staining, biochemical and sugar fermentation tests and PCR assays. Phenotypic detection of ESBL producing and colistin resistant *E. coli* by double-disc synergy test (DDST) and disc diffusion test .Detection of ESBLs producing genes (bla-TEM, bla-SHV, bla-CTX-1, bla-CTX-14 and bla-OXA) and colistin resistant gene (mcr-1, mcr-2 , mcr-3 and mcr-4) of *E. coli* by PCR assays.
Findings: Bright, pink-colored colonies of E. coli were seen on MC agar and metallic sheen colonies of E. coli were observed on EMB agar. Amplification of 704bp fragment of 16S rRNA by PCR confirmed the identity of E. coli. The prevalence colistin resistant *E. coli* was 5.45% (9 of 165) and ESBL producing E. coli was 30.91% (51 of 165). MDR profile of colistin resistant *E. coli* showed that 66.67% isolates were resistant against 3 classes of antibiotics, 55.56% were resistant to 4 classes of antibiotics and 22.22% were resistant against 5 classes of antibiotics. MDR profile of ESBL producing *E. coli* showed that 50.98% isolates were resistant against 3 classes of antibiotics, 27.45% were resistant to 4 classes of antibiotics and 7.84% were resistant against 5 classes of antibiotics. 100% ESBL producer E. coli harbor TEM gene, 25% harbor CTX-M-1 gene, 20% for OXA-1 gene and 5% harbor SHV gene of ESBL producing *E. coli*. One isolate harbour mcr1 (33.33%) gene and none of the colistin resistant isolates harbors *mcr-2*, *mcr-3* and *mcr-4* gene.
Conclusion: Data of this study indicated that MDR colistin and ESBL producing E. coli are prevalent in the poultry production chain which might cause public health hazard if these bacteria transmitted to the human though food chain.

Development of Inactivated Brucella Vaccine from Local Isolates

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Abstract

Bovine brucellosis is a bacterial zoonotic disease caused by *Brucella abortus*. It causes a huge economic loss in livestock enterprise mainly due to abortion and infertility and also responsible for undulant fever in humans. Vaccination of cattle against brucellosis is a suitable option to prevent this disease. Any vaccine prepared from local bacterial isolates is known to confer good protection. The present study was undertaken to prepare inactivated brucella vaccine using *Brucella abortus* biovar 3 isolated from cattle in Bangladesh. The laboratory stock culture of *Brucella abortus* biovar 3 was revived by streaking onto blood agar and incubated at 37°C for 5 days under 5% CO_2. The grown bacterial culture was confirmed by Gram's staining, biochemical test and PCR assays. The vaccine seed was prepared by culturing B. *abortus* biovar 3 onto *brucella* selective agar. The culture was harvested using normal saline (NS) and washed three times by centrifugation. The bacterial cell concentration was adjusted either 1.5×10^8 CFU/ml or 3×10^8 CFU/ml. Inactivation of bacterial cell was done by 1% formalin. 4% alum was added to the inactivated brucella antigen (1.5×10^8CFU/ml). The sterility brucella vaccine was tested by culturing on the blood agar plate. The BALB/c mouse (n = 20) of 6 to 8 weeks of age were taken and divided into groups A and B. Mice of group A (n=20) were vaccinated subcutaneously with 0.1 ml of alum precipitated brucella vaccine contained 1.5×10^8 CFU/ml, and Mice of group B (n=10) was kept as unvaccinated control. A 2nd dose of same vaccine was administered to mice of group A at 14 days after 1st dose of vaccination. Sera were collected from vaccinated mice at 7, 14, 21, 28 and 35 days of post vaccination. The sero-conversion rate of vaccinated mice was measured by rose Bengal plate test and ELISA. Challenge infection of vaccinated and control mice was given at 42 days after vaccination with the virulent strain of *B. abortus* biotype 3

by an intraperitoneal injection of 1.5×10^9 CFU in 0.1 mL of normal saline. Clinical signs, body temperature, food and water intake of vaccinated and control mice was observed. Mice in all groups were necropsied at 7 and 14 days after challenge infection and spleen were collected and its weight was measured. Spleen was macerated in glass grinder and colony forming unit (cfu) of bacteria per gram of spleen was determined. *B. abortus* recovered from spleen was confirmed by AMOS-ERY PCR assay. In blood agar, whitish-grey, shiny, circular, convex and non-hemolytic colonies of *B. abortus*. Gram-negative coccobacilli arranged in single or pair which were characteristics of the *Brucella abortus* . Enhanced AMOS-PCR assay for amplification of *B. abortus* biovar 3 (revived colonies from laboratory repository. Seroconvertion rate was 60% (6 of 10), 70% (7 of 10) and 80% (8 of 10) in mice at 2^{nd} , 4^{th} and 5^{th} week post vaccination, respectively. Following challenge infection unvaccinated control mouse showed the clinical signs: weakness, lethargy and anorexia and vaccinated mouse was found normal/healthy. The mean spleen weight of vaccinated and control mice were 0.063 ± 0.06 g and 0.372±0.07 g at 7 and 0.066 ± 0.08 g and 0.459 ± 0.08 g 14 day post infection, respectively which were statistically significant ($p < 0.001$). The bacterial load of spleen in vaccinated and control mice were at 10.91±0.79 Log_{10} CFU/g and 11.30 ± 0.34 Log_{10} CFU/g 7 and 8.81±0.83 Log_{10} CFU/g and 13.36±0.71 34 Log_{10} CFU/g, 14 day post infection, respectively which were statistically significant ($p < 0.001$). Data of this indicates that Brucella vaccine induces antibody response in vaccinated mice and protects the vaccinated mice from experimental infection

Molecular Diversity of *Streptococcus* spp. Isolated from Clinical Mastitis in Dairy Cattle of some Selected Dairy Farms of Bangladesh

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Abstract

Streptococcus are the predominantly associated with contagious and environmental bovine mastitis a major economically important disease in the dairy industries. The present study was aimed to the determination of molecular diversity of Streptococcus spp. occurring in clinical bovine mastitis in some selected areas of Bangladesh. A total of 105 milk samples were examined comprising 80 with clinical mastitis and 25 from apparently healthy cattle. Milk samples were collected directly from the udder aseptically and carried to the laboratory maintaining cold chain. Five hundred (500) microliter of the milk sample was enriched overnight in LB broth at 37oC with shaking. Enriched culture was streaked onto Modified Edward's medium (MEM) and Streptococcus resembling colonies were identified by Gram's staining followed by PCR and sequencing of 16SrRNA. Out of 80 clinical mastitis samples 18 samples were positive for Streptococcus spp. On the other hand none of the apparently cattle milk samples revealed Streptococcus like colonies onto MEM. Sequencing and phylogenetic analysis revealed 55.55%, 33.33%, 5.56% and 5.56% of the isolates as *Streptococcus uberis*, *Strep. agalactiae*, *Strep. urinalis* and *Strep. hyovaginalis*, respectively. Antibiotic sensitivity testing revealed 50% of the isolates as multidrug resistant with highest resistance to tetracycline (72.22%) followed by ciprofloxacin (66.67%) and penicillin G (50%). On the other hand, all the isolates were sensitive to chloramphenicol (100%), bacitracin (5.55%), ampicillin and amoxicillin (11.11%). From the findings it is evident that Streptococcus occurring in the clinical mastitis in the study area are genotypically diverse. In addition, multidrug resistance in the Streptococcus isolates threatens treatment failure in mastitis as well as transfer pathogenic strains to human through the consumption of contaminated milk or milk products.

E. albertii in Chicken Meat: A Probable Source of Human Infection in Bangladesh

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Abstract
E. albertii is a member of the genus Escherichia and an emerging enteropathogen. The bacterium was reported from human and animals from different part of the world and chicken meat is considered as a potential carrier of this bacterium to human. In this study we have aimed to the detection of *E. albertii* in chicken meat sold at the retail outlets for the first time in Bangladesh as well as determination of their molecular diversity and public health significance through genetic approaches. This study was planned to be completed by July, 2023. Till this day, we could analyze 28 broiler meat and giblet samples comprising seven (7) each of the thigh meat, breast meat, liver and stomach (proventriculus/gizzard). Twenty five (25) gm of each sample was homogenized with 225 ml buffered peptone water separately followed by incubation at 37oC overnight. DNA was extracted directly from the enrichment culture and screened by *E. albertii* specific *Eacdt* PCR. Sample with positive amplicon at *Eacdt* PCR was streaked onto XRM-MacConkey agar where *E. albertii* produces colorless/ transparent colonies. Characteristic colonies were purified by subsequent streaking onto XRM-MacConkey agar and confirmed by *Eacdt* PCR and sequencing. Eight (8) out of the 28 samples were found positive for *E. albertii* and homologous to *E. albertii* reported earlier in different counties on analysis of the partial *Eacdt* gene sequences. Findings of this study confirmed the presence of *E. albertii* in the chicken meat sold in the retail outlets in Bangladesh. However, further studies are ongoing which will reveal the diversity and public health significance of this bacterium at the end of this study.

Evaluation of Leukocyte Profile in Native and Exotic Chicken Breeds Under Stress by Adopting a New Technique

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Abstract
Blood leukocyte profile is a reliable health and stress indicator. Direct leukocyte count in birds is a complex and time-consuming procedure. It involves the preparation of the stain solution and is complicated by the need to differentiate lymphocytes from thrombocytes, and with the presence of stained erythrocytes in hemocytometer. Poultry is exposed to several concurrent stressors. The use of leukocyte profile could be a useful tool to measure the stresses of poultry birds. The study was designed to establish leukocyte profile by adopting a new method in both native and exotic chickens under normal and stress conditions. Blood samples from broilers of normal, stressed and crossbred Sonali chickens were collected; TLC and DLC were performed by the new technique. Preliminary data showed that heat stress, stocking density stress and transport stresses caused an increase in circulating heterophils and decreased lymphocytes count and resulted in an increase in H:L ratio. The values of

TLC were varied among the normal, stressed broilers and crossbred Sonali chickens. Mean values of serum total protein, ALT, AST and creatinine values were varied in heat stress, transport and density stressed broiler chickens. The exposure of heat stress significantly increased the value of ALT and creatinine and decreased AST and serum total protein. Transport stresses decreased triglycerides level significantly. LDL-c and total cholesterol levels were significantly increased where the level of HDL-C values was decreased in heat stress condition. Stocking density has no significant effects on lipid profiles Parameters of other native chickens are currently investigating. Overall, this work explores the effects of different stresses on blood leukocytes and biochemical parameters in broiler chickens. By successful completion of this project, the output would help to assess poultry health condition and stresses by leukocyte profile and documentation of leucocyte and blood biochemical profile of different breeds of chickens.

Effects of Water Acidification and Lysozyme Supplementation on Physiological Performances, Biochemical Profile and Immune Responses in Broilers Exposed to Heat Stress: A Poultry Welfare and Economic Perspective

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Abstract

The effect of heat-stress (HS) on growth performance, biochemical parameters and immune status of broilers fed acidifier and lysozyme were investigated. A total of 150, one-day-old "Lohman" broiler chicks were purchased and reared up to 40 days. On day 10, chicks were randomly divided into six groups: A, B, C, D, E and F (n=25). Group A, B and C were served as control, acidifiers and lysozyme supplemented groups in non-HS condition and similarly group D, E and F were designated as control, acidifiers and lysozymes groups under HS condition respectively. All birds were reared at room temperature of 26-30ºC whereas birds of group D, E and F were additionally exposed HS (35 ± 3ºC) for 6 hours daily. The results indicated that broilers supplemented with acidifiers and lysozymes had higher live body weight (BW). HS significantly reduced BW but both acidifiers and lysozyme significantly compensated the reduction of BW ($p<0.05$)). The highest FCR was recorded in groups D and A and lowest in groups B, C, E and F. Acidifiers and HS caused higher creatinine and uric acid levels, which may negatively affect kidney functions. Total cholesterol (TC), triglycerides (TG) and LDL-c values were lower in all HS group. Acidifier supplemented birds showed decreased levels of TG and LDL with higher HDL level. On the other hand, lysozyme supplementation increased TC but not significantly increased TG and LDL levels. The mean values of total protein and albumin did not differ among the groups. Serum glucose levels were found higher in HS control and acidifiers groups.
The antibody titers (log2) to sRBC were higher in supplemented groups of both heat-stress and non-HS conditions at different time points. The cutaneous basophilic hypersensitivity (CBH) response elicited by the PHA-P revealed significant skin increases in PHA-P treated right toe web compared to PBS treated left foot in a time-dependent manner. Supplementation of acidifiers and lysozyme in heat-stress birds achieved different degrees of CBH responses. It could be concluded that the use of acidifiers and lysozymes supplementation during HS may be useful to prevent or restore the altered functions. However, further concise studies need to be done to find out the molecular mechanism.

Effect of Zink Oxide and Folic Acid on Reproductive Performance in Bisphenol-A (BPA) Treated Male Mice

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Abstract
Research background: Bisphenol A (BPA) becomes a great concern in recent years due to its toxic effects on health. The present study was designed to investigate the retrieval action of zinc (Zn) and folic acid (FA) supplementation against BPA-induced reproductive and hepatic toxicities in male albino mice. A total of 75 mice of 25-28 days old were divided into five equal groups (group A-E, 15 mice in each group). Mice were given normal ration (control, group A) or administered with daily doses of BPA at 50 mg/kg body weight (BW) (group B-E). Mice from group C, D and E were supplemented with Zn (10 mg/kg BW), FA (3 mg/kg BW) or both in feed, respectively daily for 12 weeks. Blood samples were collected and sera were separated for biochemical and hormonal analysis. The standard method was followed to test sperm motility and sperm count. Testis and liver samples were collected and processed for routine histopathological study using haematoxylin and eosin stain.Sperm counts and motility along with serum testosterone were significantly ($P \leq 0.001$) reduced in BPA-exposed mice but increased significantly ($P \leq 0.001$) upon Zn and FA supplementation. There was significant degeneration of seminiferous tubules and apoptosis of spermatogonial cells in the testes of BPA-exposed mice, which was recovered moderately by Zn and FA supplementation. The liver of BPA administered mice exhibited moderate degeneration and necrosis of hepatocytes but ameliorated by Zn and FA supplementation. The toxic effects of BPA on testis and liver could be restored by Zn and FA supplementation.

Evaluation of the Potency of Coral Fossil as a Toxin Binder in Blood Biochemistry and Different Organs in Heavy Metal Treated Broiler

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Abstract
Contaminated poultry feed can pose a risk to human health by biomagnifies and bioconcentrates toxic metals up the food chain, it may enter the poultry production system in a variety of ways. The experiment was carried out where in phase 1 105 broiler was divided into 07 groups randomly with 15 broilers in each group. Group A was served as vehicle control and received daily doses of the poultry feed. The mice in Group B was received daily doses of lead (10 mg /kg feed). Whereas The mice in Groups C was administered daily doses of chromium（5 in mg /kg feed) body weight. The mice in Group D was administered daily doses of chromium（10 in mg /kg feed) body weight. The birds in Group E was received daily doses of Cadmium（75 mg/kg feed) respectively. Whereas group E was supplemented with lead (10 mg /kg feed) ＋（1 gm ULKAL). Group F will chromium（10 in mg /kg feed) ＋（1 gm ULKAL). Group G will receive Cadmium（75 mg/kg feed) ＋（1 gm ULKAL). Both the heavy metals and coral fossil will be given with feed. The experiment will be carried out for a period of 30 days. Blood samples were collected and sera were separated for hematobiochemical analysis. Kidney, liver, heart, gizzard, proventriculus, brain samples were collected and processed for

routine histopathological study using haematoxylin and eosin stain. The results showed that there were variations in concentrations of liver and kidney enzymes as well as hematological parameters.

Assessment of Beneficial Effect of Vit-E on Histotexture of Testis, Testosterone Assay and Blood Biochemistry in Cadmium Treated Male Mice

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Abstract

Cadmium is an environmentally hazardous component that poses a variety of health risks to humans and animals alike. The research was designed to assess the salutary actions of Vit E on blood biochemistry and histotexture of selected organs in cadmium treated male mice. Out of 45, the mice were divided into 3 groups randomly with 15 mice in each group. Group A was the control group and received daily dosages of the normal mice ration for 60 days. The mice in Group B were treated with daily dosages of Cadmium (Cd) (3.5 mg/kg/day) for 60 days. The mice in Groups C were provided daily dosages of Cadmium (Cd) (3.5 mg/kg/day) and vitamin E (200 mg/kg) respectively, for 60 days. Both the Cadmium (Cd) and Vitamin E were administered with water. The level of testosterone and T4 was decreased significantly in cadmium treated mice compared to the control ones but raised in vit-E treatment group. The diameter of testis was reduced in cadmium exposed mice than the control group but enhanced after Vit-e supplementation. Testis weight was more or less equal following cadmium treatment but increased after Vit-E administration. Histology of testis showed minor degenerative changes. Our research determined that exposure to cadmium caused significant reduction in the TEC and Hb conc. but significantly raised in group C following vit-E treatment. An increase was detected in the levels of creatinine, AST, ALT and ALP in the serum of cadmium treated group B whereas reduced in group C after vit-E supplementation. We did not notice any changes in histotexture of liver in any of the treatment mice but kidney histology exhibited that there is tubular degeneration and cellular infiltration around the blood vessels and necrosis, dead cast on tubular epithelium.

Environmental Disaster Due to Lead Exposure in Magura Sadar: Exposure Evaluation and Rapid Disaster Mitigation

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Abstract

In December 2020, Print and news media bursted with the news of sudden accidental lead (Pb) exposure/toxicity in Barasia village and its surrounding area, Magura sadar, Maugura district causing the death of a number cattle and signs of respiratory illness among the inhabitants. This triggered havoc among the local residents and administration. Initial investigation revealed that a newly unplanned installed factory was extracting Pb from discarded automobile batteries and releasing toxic wastes in the surrounding environment ignorantly and without any care. As Pb is a very toxic to human, animal and environment as well as is a very persistent heavy metal with bioaccumulation activities, this project was therefore formulated to evaluated the extent of Pb contamination in human, livestock, fish, agriculture and environment in the study area, thereby to formulate a short and long

term mitigation approach to minimize the damage and spread of Pb contamination in the surrounding area. Initially, questionnaire survey was conducted using pre-tested standard questionnaires in the study area (n=50 families) where the epicenter was located to evaluate the knowledge about Pb poisoning and symptom assessment among the inhabitants representing different income, education, age and sex groups, through face to face interview. The blood samples were collected to assess the Blood Pb level in the local inhabitants and domestic animal focusing on different age and sex. The Pb in animal and human blood samples was determined using ICP-MS-2030 LF. The Pb contamination in the surrounding soil, vegetation (grass, small pants, paddy plants, wheat plants) and harvested crops (paddy, rice, straw), livestock, fishes and water from different sources were collected (n=366). Determination of Pb from all samples was done by using a Graphite Furnace AAS. Health risk and assessment of soil pollution were also evaluated. A strong cause and effect relationship was observed. Human and animal blood lead levels observed in the studied population were much higher than the standard set levels established by WHO. The contamination level both human and animal was much higher in population with lower income and/or educational levels. In addition, the Pb contamination status in the tested crops, other vegetation and animal organ samples collected from immediately, one and three months after the reported incidence were found beyond the MPL levels. However, food samples of animal sources (fish and poultry) were observed below the MPL level. Lead status in the areas surrounding the epicentre were much higher, which gradually decreases with distance. This data indicate that the principal source of Pb in the study area was from disposed acid batteries recycling factory. The anticipated data of the research project reveled that Pb extraction from disposed acid batteries recycling factory directly affect the environment including human and animal health through Pb contamination. The observed incidence is not an isolated event, rather, is happening throughout the country. Immediate steps are needed, both at policy as well as at management levels before the scenario turn out to be a greater disaster.

Determination of Antimicrobial Resistance and Residues in Livestock and Poultry Food Products and Feed in Bangladesh

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Abstract

Antimicrobial resistance is one of the biggest threats to global health, food security, and development today. Although antimicrobial resistance can occurs naturally, however, misuse of antimicrobials in humans and animals is accelerating the process. On the other hand, antimicrobial residues and it's metabolites found in any edible portion of the animal product after the administration. Considering the paramount impact of antimicrobial resistance and residue in food chain, the present study was undertaken to screening the antimicrobial resistance and residues in livestock and poultry food products and feed in Bangladesh. Samples were collected randomly from dairy, poultry and broiler farms and local markets of four upazillas of each district of Mymensingh division. A total of 410 different types of samples were collected, and survey was conducted among 150 farmers, 20 veterinarian & 20 informal prescribers. Assessment of the knowledge, attitude & practice regarding antimicrobial use and antimicrobial resistance among the livestock stakeholders were done by pretested questionnaires survey. Qualitative and quantitative determination of antimicrobial drugs residue in poultry feeds, meat, milk, egg & broiler were done by Thin Layer Chromatography (TLC) and High Performance Liquid Chromatography (HPLC), respectively. All the samples except feed were initially cultured in nutrient broth followed by streaking on selective bacteriological media for the growth of target bacteria. Chromosomal DNA was extracted from each isolate by simple boiling method and PCR was performed for the specific detection of each species using specific primers.

Antibiotic sensitivity pattern of each isolate was checked by disk diffusion test. In Mymensingh division poultry farmers are more educated compared to large animal farmers. About 2.8% large animal farmers follow good management practice (GMP) for large animal which were 5.6% for poultry farmers. About 66.6% poultry farmers and 77.2% large animal farmers follow the veterinarian guidelines. A large number of both poultry farmer and large animal farmer don't know about antibiotic residues in food of animal origin, withdrawal period after antibiotic use in food animal, antimicrobial resistance and their consequences. In poultry farming practice in Mymensingh division about 12% farmer use antibiotic as growth promoter where as in large animal farming practice the percentage is 0.2%. HPLC results showed that out of 40 poultry meat samples one sample (2.5%) found oxytetracycline residues above MRL level. On the other hand, none of the cattle, goat or buffalo meat found any residues above MRL levels. Out of 65 milk samples the residual levels in four samples found (6.1%) above MRL levels (oxytetracycline, amoxyciline, ampicilline, penecilline). Out of 30 poultry eggs sample the residual levels in one egg sample found (3.3%) above MRL level (oxytetracycline). In different types of broiler and layer non- brand/local made 60 feed samples, HPLC analysis showed 16 samples have high levels of drugs residue (oxytetracycline 11 samples, doxycycline 3 samples and ciprofloxacin 2 samples). Among 305 samples, 448 isolates were suspected as Escherichia coli, Salmonella spp., Staphylococcus aureus and Streptococcus spp. of which 192, 28, 125 and 22 isolates were confirmed as E. coli, Salmonella spp., Staphylococcus aureus and Streptococcus spp., respectively by PCR where positive band was appeared at 585 bp, 284 bp, 155 bp and 569 bp, respectively. Most of the isolates of livestock were found resistant against ampicillin, amoxicillin, cloxacillin and penicillin with variation in resistance pattern for other antibiotics. All the isolated E. coli and S. aureus from poultry meat showed about 100% resistance to 9 antibiotics which is alarming. Among the 50 isolates, most of them contained resistant genes of tetracycline and sulphonamide. Genes of erythromycin, streptomycin, gentamicin and beta lactam group of antibiotics were also detected in some of the isolates. Most of the isolates contained more than three resistant genes which is the indication of multidrug resistance.It may be concluded that rational use of antimicrobial as well as following the withdrawal period in the farming practices can reduce the emergence of resistance and transmission of residue in animal derived food products. In addition, awareness, motivation and knowledge among the producer, consumer, prescriber and policy maker would help in combating the resistance and residue in livestock and poultry food and feed in Bangladesh.

Antidiabetic and Reno-pancreas Protective Effects of *Spirulina platensis* in Streptozotocin Induced Diabetic Mice

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Abstract

Diabetes mellitus is one of the most common endocrine disorder characterized by hyperglycemia with hyperlipidemia, diabetic nephropathy, neuropathy and cardiovascular complications. Management of diabetes using currently available drugs is still a challenge as they possess various side effects. A large variety of herbals are employed in the treatment of diabetes for their better efficacy and safety compare to synthetic drugs. In this study Spirulina platensis were used to evaluate the antidiabetic potential on body weight, blood glucose, hemato-biochemical parameters, diabetic nephropathy and pancreatic injury protective effects in streptozotocin (STZ) induced diabetic mice. Male white mice having five weeks age matching were used for the experiment. Diabetes was induced by intraperitoneal injection

of STZ @ 65 mg/kg and experiment was carried out for a period of 6 weeks. The study was conducted by dividing the animal into five groups (n=7 mice in each group) indicated as with group-A, healthy normal mice supplied with pellet feed and water; group-B, STZ induced diabetic mice supplied with pellet feed and water; group-C, D and E, Diabetic mice treated with Spirulina platensis @ 300, 400 and 500 mg/kg, respectively. STZ induced diabetic mice shown hyperglycemia and body weight loss, which were significantly improved by Spirulina platensis @ 400, 500 mg/kg after 6 weeks of treatment. The histopathological alteration was observed in the kidney of diabetic mice which was characterized by glomerular hypertrophy, tubular necrosis and interstitial fibrosis. Partial improvement in the histopathological change were noticed in the kidney of diabetic mice treated with Spirulina platensis @ 400 mg/kg. Pancreatic injury was produced by STZ induction in mice characterized by destruction of the pancreatic β cells mostly in the central portion of the islets of langerhans and lymphocytic infiltrations, atrophy, and interstitial fibrosis, which were partially suppressed by Spirulina platensis @ 400 mg/kg. STZ induced diabetic mice showed increased plasma creatinine, lipid profiles (TC, TG, HDL, LDL) and ALT, AST levels, which were also suppressed by Spirulina platensis @ 400 mg/kg. In addition, STZ induced diabetic mice showed increased plasma lipid peroxidase level which was ameliorated by Spirulina platensis. Along with previously published reports the anticipated data may concluded that Spirulina platensis @ 400 mg/kg having antioxidant compounds could partially protect renal tissues damage, stimulate regeneration and reactivation of pancreatic β- cells in streptozotocin induced diabetic mice.

Risk Factor Analysis of Antibiotic Drug Residues in Poultry Food Products and Environment in Selective Area of Mymensingh District

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Abstract

Objective(s): Qualitative and Quantative detection of antibiotics residue in broilers and layers meat tissues, eggs and poultry faces and environmental samples by Thin Layer chromatography (TLC) and high performance liquid chromatography (HPLC). Risk factor analysis whether anticipated antibiotic residual levels in food are human health hazard or not.

Materials and methods: Samples were collected from 20 poultry and broiler farms from each Upazilla (Mymesingh and Trisal Upazilla). From each upazilla broilers (n=20) and layers meat (n=20), eggs (n=40) and poultry feces (n=40) as well as environmental (20 soil, 20 water) samples were collected. Qualitative and Quantative detection of antibiotics residue in collected samples were done by Thin Layer chromatography (TLC) and high performance liquid chromatography (HPLC), respectively. Risk factor analysis were done by comparing the anticipated antibiotic residual levels in food with MRL values.

Results: HPLC results showed that out of 80 poultry meat samples 7 (8.75%) samples found positive for antibiotics residue and one sample (1.25%) found oxytetracycline residues above MRL level. On the other hand, 4 (5%) egg samples found positive for antibiotics residue and none of the samples found residues above MRL levels. Out of 80 poultry feces samples 9 (11.25%) were found positive for antibiotic residues. Out of 80 environmental samples 5 (6.25%) soil samples were found positive for antibiotic residues.

Conclusion: Research project finding suggested that antibiotics residues are present in edible tissues of poultry and eggs and are risk free because the concentration of antibiotic residues are below the MRL values. In addition, antibiotics residues are also present in poultry feces and soil. Although the concentrations of antibiotic residues in edible tissues are bellow MRL values, however, along with

edible tissues, presence of antibiotic residues in feces and soil would lead to develop the antimicrobial resistance bacteria which are detrimental both for human and animals.

Detection and Mitigation of Antibiotic Residues in Poultry Products and Byproducts: a Need Based Research to Save the Human Health

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Abstract
In Bangladesh, recently more antibiotics are used in poultry farms. Majority of the people in Bangladesh are still not aware about the health hazards of antibiotic residues. Awareness is an important tool to control and combat the indiscriminate use of antibiotics in poultry farm and human health hazards. In this research, farmer's awareness has been investigated by a questionnaire in different poultry farms, retail sellers and poultry markets and spread out the knowledge of public health hazards of antibiotics residues. Poultry farmers were found well educated about health hazards of antibiotic residues and aware about the judicial use of antibiotics before selling the poultry for human consumptions. During this survey, sufficient samples (thigh muscle, breast muscle, liver etc., n=100) were collected from different poultry farms, retail sellers and poultry markets. Randomly 50 livers, 50 thigh muscle and 50 breast muscle samples respectively were evaluated by TLC analysis. Out of 50 samples for each 2 liver, 2 breast muscle and 2 thigh muscle samples were found positive for Amoxicillin antibiotic; 5 liver, 3 breast muscle and 3 thigh muscle samples were found positive for Ciprofloxacin; 3 liver, 3 breast muscle and 2 thigh muscle samples were found positive for Cefalexin; 2 liver, 2 breast muscle and 2 thigh muscle samples were found positive for Enrofloxacin; 4 liver, 2 breast muscle and 2 thigh muscle samples were found positive for Oxytetracycline. Gentamicin and Neomycin were found negative for any samples. Further investigation was done in indoor discriminate and indiscriminate use of antibiotics (Cefalexin) in broilers. Day old chicks (DOC) were collected and reared up to 30 days. On day 14^{th}, the chicks were randomly divided into three groups namely control group (n=10), discriminate antibiotic group (n=10) and indiscriminate antibiotic group (n=10). Control and discriminate antibiotics birds were found negative but ten liver samples, eight thigh muscles and eight breast muscles were found positive for Cefalexin in indiscriminate group. Therefore, poultry treated with antibiotics are required for specific withdrawal period until all residues are depleted to safe levels before human consumption.

Chronic Exposure of Drugs Residues To Human Health Through Meat, Milk, Egg and Poultry Products & Byproducts: A Long Term Exposure of Drugs Residues Study in Laboratory Animals to Establish the Legislation on Drug Residues to Save the Human Health

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Abstract
Antibiotic therapy has a great importance on the development of human and veterinary medicine. To ensure consumers protection, this work is designed to detect the presence of different antibiotic

residues in broiler chicken. In this study, five types of antibiotics namely amoxicillin, enrofloxacin, ciprofloxacin, colistin sulfate and cephalexin have been investigated on broiler birds. Each antibiotic group consists of three groups namely control group (Group A), discriminate antibiotic group (Group B) and indiscriminate antibiotic group (Group C) respectively. Each antibiotic group consists of 6 broiler birds for experiment. The broiler birds were reared up to 31 days. At the age of day 16, antibiotic treatment was started and continued in discriminate group for 7 days with proper maintain of withdrawal period and 15 days in indiscriminate group with no withdrawal period. The body weight gain was found higher in antibiotics groups in comparison with the control group. In case of indiscriminate group, amoxicillin intensity in liver, kidney, spleen, thigh muscle and breast muscle were positive by TLC as 57.82%, 52.30%, 51.48%, 45.18% and 49.96 % respectively, cephalexin intensity was 100%, 100%, 100%, 33.33% and 16.67% , colistin sulfate intensity was 100%, 100%, 100%, 83.33%, 66.67% respectively and enrofloxacin intensity was 100%, 100%, 100%, 83.33% and 100% respectively and in ciprofloxacin antibiotic group all the samples were positive. In amoxicillin antibiotic group, the haemoglobin (%) of control, discriminate, and indiscriminate groups were 7.07±0.099, 6.97±0.095, and 6.90±0.124, which in cephalexin antibiotic group were 8.17±0.097%, 7.25±0.10%, and 6.17±0.07%, in ciprofloxacin antibiotic group were 8.17±0.15%, 7.13± 0.39% and 6.5± 0.65%, in colistin sulfate antibiotic group were 8.34±0.15, 6.89±0.27, and 7.14±0.23 and in enrofloxacin antibiotic group were 8.17±0.07%, 7.37±0.09%, and 7.28±0.07%. Packed cell volume were (%) 19.83±1.302, 19.33±1.054 and 18.50±.044 million/mm^3 in amoxicillin antibiotic group, 24.17±0.48, 22.00±0.73 and 20.00±0.97 million/mm^3 in cephalexin group, 24.17± 1.07, 22± 1.83 and 20.5± 1.98 million/mm^3 in ciprofloxacin group, 24.17±0.48, 23.17±0.48, and 22.33±0.67 million/mm^3 in enrofloxacin group and 23.51±0.76, 21.17±0.94, and 22.83±1.19 million/mm^3 in colistin sulfate antibiotic group. Total erythrocyte count (TEC) were 2.55±0.044, 2.53±2.53±0.038 and 2.50±0.026 million/ mm^3 in case of amoxicillin group, 3.20±0.14, 2.63± 0.19 & 2.31± 0.28 million/mm3 in ciprofloxacin antibiotic group, 3.15±0.047, 2.66±0.091, and 2.90±0.11 million/mm^3 in enrofloxacin group, 3.20±0.06, 2.76±0.03 & 2.18±0.07 million/mm^3 in cephalexin group and 3.29±0.07, 2.63±0.09 & 2.21±0.06 million/mm^3 in colistin sulfate antibiotic group. There was no significant difference on blood parameter found between the antibiotic groups. Therefore, judicious use of antibiotics is safe for human consumption.

Anti-inflammatory, Wound Healing and Antidiabetic Effects of Pure Active Compounds Isolated from Turmeric (*Curcuma longa*).

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Abstract

We studied the anti-inflammatory, wound healing and anti-diabetic properties of pure compounds isolated from turmeric (*Curcuma longa*) namely; curcumin (**1**), demethoxycurcumin (**2**), bisdemethoxycurcumin (**3**), cyclobisdemethoxycurcumin (**4**), 3-hydroxy-1,7-bis(4-hydroxyphenyl)-6-hepten-1,5-dione (**5**), 4-methyllene-5-hydroxybisabola-2,10-diene-9-one (**6**), 5-hydroxy-1,7-bis(4-hydroxy-3-methoxyphenyl)-1-hepten-3-one (**7**), bisabolone-9-one (**8**), turmeronol A (**9**), turmeronol B (**10**). Anti-inflammatory study was performed in vivo in carrageenan-induced hind paw edema assay and paw tissue histopathology in rat. Wound healing properties were evaluated in a full thickness dermatic wound model mice by measuring the wound closing time. Intra-peritoneal injection of streptozotocin (65 mg/kg) was used to induce diabetes. Anti-diabetic effect was evaluated by measuring the blood glucose level and serum biochemical analysis. Among the 10 compounds, compound **1**, showed the highest anti-inflammatory activity (58.3501±3.9%) followed by compound 8 (51.43±4.3%) compound 6 (43.71±4.6%) and compound 2 (32.38±3.1%) compared to that of control. Histopathological examination of the paw tissue showed massive infiltration of inflammatory cell in

carrageenan injected paw which were significantly decrease by treating with compound 1, 8, 6 and 2 respectively. A similar trend of results were also observed in wound healing assay. Mean days to heal completely were 8 days for compound 1 and 8-10 days for others. The wound was not completely healed until the end of the experiment (day 14) in the control group. Streptozotocin injection significantly increased blood glucose, serum SGOT and SGPT which were significantly decrease by treating with compound 1, 8, 6 and 2 respectively. In conclusion, turmeric could be a useful cost-effective alternative for inflammation, wound management and diabetes.

Pattern of Antibiotics Use in Fish Farm and Screening of Antibiotics Residue in Farm and Wild Caught Fish-A Food Safety Concern

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Abstract
The present study was conducted to investigate the use of antibiotic in commercial aquaculture and to determine the persistence of antibiotics (doxycycline, oxytetracycline and ciprofloxacin) residue in different cultured and non-cultured fish (shorputi, puti, tengra, koi, shing, magur and taki) available in local fish farm and market in Mymensingh. To carry out this experiment, 10 cultured fish of each type were collected from local fish farm. Non-cultured fish samples of corresponding type of fish were randomly collected from local fish markets. To investigate the use of antibiotic use in commercial aquaculture, data collection was conducted through questionnaire interviews with owners of 50 fish farms. The samples were analyzed by using Thin Layer Chromatography (TLC) method to detect the presence of selected antibiotic residues. Sixty of the farm owner responded that they use antibiotics for fish health management or as growth promoter. All the antibiotic residues were present in all types of cultured fish. Among the non-culture fish about 20-30% samples were found positive for oxytetracycline and ciprofloxacin in case of koi, shingh and magur. However, most of the non-culture fish were found negative for antibiotic residue. The results indicated the persistence of antibiotic residue in aquaculture products and there is a general lack of knowledge about the purpose and proper usage of antibiotics by aquaculture producers. However, quantitative analysis of antibiotic residue is necessary to determine the detected residues these fish samples did not exceed the maximum residue limit (MRL)

Revealing the Use of Growth Hormone in Rui (*Labeo rohita*), Catla (*Catla catla*), Monosex Tilapia (*Oreochromis niloticus*) and their Harmful Effects on Public Health in Bangladesh

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Abstract
Fish is an excellent source of protein. The use of the hormone in fish production is becoming an alarming issue all over the world. So, it is necessary to know the hormonal contamination level as some hormones have human health hazards if they exceed acceptable dietary intake (ADI) for humans and animals. This study was designed to know the residual level of steroid hormones (Testosterone, Estrogen, and Progesterone) in fish flesh e.g. Rui (*Labeo rohita*), Catla (*Catla catla*), Monosex Tilapia

(*Oreochromis niloticus*). A standard questionnaire survey was conducted to know the attitude of the farmers towards the use of the hormone in fish farming. During the survey, the farmers denied using the hormone in fish farming (except Tilapia), but this study revealed hormonal residues in adult fish flesh. The High-Performance Liquid Chromatography (HPLC) was performed for the quantification of hormonal residue in 144 fish samples collected from different fish farms and markets of the Mymensingh district. The level of testosterone detected from this study range from 1.05 to 8.5 times higher than the ADI (ADI for the testosterone of 2 µg/kg BWT) in all three fish species. Progesterone the detected level in this study ranges from 1.05 to 24.4 times higher than ADI (ADI 30 µg/kg BWT) in all three species. Whereas, the level of Estrogen was higher than the ADI (ADI 0.05 µg/kg BWT) in Rui and Catla fish but there was no residue detected in Tilapia fish. There is no national monitoring system is established yet regarding the use of hormones in fish production in our country. This study reveals a new alarming fact to focus on and thus an effective monitoring system should be implemented as soon as possible for public health concerns.

Melamine in Milk: Exposing a Fact for Infant and Adult Humans

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Abstract
Milk is a naturally nutritious food for humans, especially children solely dependent on milk and can be supplied commercially. Non-protein nitrogenous substances can alter the percentage of protein content in commercial milk. Melamine, a nitrogenous substance, can be used as an adulterant in milk to show an increase in protein content. This study focused on detecting melamine levels in commercially available different types of milk, dairy products, and by-products to estimate the risk caused by it. The quantification was performed by The High-Performance Liquid Chromatography (HPLC). The presence of melamine was detected above TDI (Tolerable Daily Intake) among most of the categories. All eight brands of commercial powder baby milk contained melamine above TDI (1 ppm) that ranges 50-1100 times higher than the acceptable level. In adults brands, all eleven commercial milk samples (powder and liquid) showed the presence of melamine above TDI (0.2 ppm) that range from 8-1000 times higher than TDI. Detection of melamine in dairy products and dairy by-products are still going on. The amount of melamine detected so far in baby and adult milk raised serious concern about public health issues. A careful approach is needed to handle such a sensitive national issue.

Detection of House Index and Breteau Index of Dengue Vectors in Mymensingh City: the Most Important Early Warning Signal for Dengue Outbreak

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Abstract
Larval indices have been proved as the most valid tool of vector surveillance. Though dengue virus transmitted directly by the adult mosquitoes, since entomological surveillance has been based on different larval indices. The house index and the Breteau index have become the most widely used indices, these two larval indices proved as the important early warning signal for dengue outbreak in a

respective area. This project was planned to detect the House Index (HI) and Breteau Index (BI) of the dengue vectors *Aedes aegypti* and *Ae. Albopictus;* and to identify their most preferred breeding containers in Mymensingh city. A total of 1426 artificial wet containers and natural water lodged breeding sources have been identified in this study out of 405 houses/properties (with a mean of 3.5 containers per house) examined to find out the *Aedes* breeding places in Mymensingh city. This survey was carried out for the 8 months from January to August 2021. Among the 1426 identified wet containers and natural water lodged sources, 118 (8.3%) were found positive for *Aedes* immature stages (larvae and pupae). Artificial wet containers (94.6%) were the main breeding places for *Aedes* mosquitoes in Mymensingh city than that of natural water lodged breeding sources (5.4%). The overall combined container index (CCI) was 8.6. Among the 405 houses surveyed with 76 houses/properties found positive during this study, the overall CHI and CBI (Combined House Index and Combined Breteau Index) were 18.8 and 28.9, respectively. In this study, seventeen different varieties of wet containers were identified in Mymensingh city, in which 13 types of containers or water lodged places were found positive for *Aedes* larvae and pupae. Among the identified wet containers, coconut shells were the most prevalent container type (28.5%) followed by flower tubs (22.2%) and tires (14.6%). Out of all positive containers, coconut shells (12.0%) were revealed as the most productive container for the *Aedes* larval breeding, followed by discarded clay pots/yoghurt pots (10.7%), tires (8.7%), flower tubs (7.9%) and broken plastic buckets (6.3%). Among the 118 positive containers, 40.6% (n = 48) were infested with larvae and pupae of *Aedes aegypti* and 31.4% (n = 35) were *Aedes albopictus*. Moreover, *Ae. aegypti* co-existed with *Ae. albopictus* in 10.2% (n = 12) containers. Both the *Aedes* species have been found co-existed with *Culex quinquifasciatus* and *Armegeres subalbatus.* The result of this study would guide the responsible authorities to implement vector control programs well before the onset of any outbreak irrespective of the presence of dengue fever patients in Mymensingh city.

Molecular Detection of *Babesia* in Vector Ticks in Mymensingh, a Continued Threat in Cattle Farming

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Abstract

Babesiosis is an endemic and tick borne disease of cattle in Bangladesh. The disease is distributed globally and responsible for higher rate of morbidity and mortality. Babesiosis is caused by infection with intra-erythrocytic protozoan parasite. This parasite mainly transmitted by *Boophilus (Rhipicephalus) microplus* ticks, although other tick species can also transmit infection. With the changing climate, the epidemiology of tick infestations has changed in everywhere in the world. So, in this changing climate it is necessary to determine whether tick vectors other than *Boophilus (Rhipicephalus) microplus* is involved in transmission of babesiosis or not in Bangladesh. So far, little research has been done on to the detection of *Babesia* organism in tick vectors in Bangladesh. This study is designed to molecular detection of the *Babesia* species and screening of vectors ticks in Bangladesh. We have planned to collect ticks from the clinically suspected cattle for babesiosis from different farms of Mymensingh Sadar, Trishal, Fulbaria, Fulpur and Bhaluka. Unfortunately, we only could collect ticks from farms of Mymensingh sadar due to restricted movement for Covid-19. All collected ticks were studied under stereomicroscope and permanent slides of the ticks were prepared and examined under compound microscope to identify the tick species. A total of 28 fully engorged ticks were collected from the clinically suspected cattle for babesiosis from different farms of Mymensingh Sadar, among which *Rhipicephalus* (*Boophilus) microplus* was the predominant species (62.6%) followed by other *Rhipicephalus sp* (37.4%). DNAs were extracted from freshly collected ticks or from frozen tick specimens with commercial DNA extraction kit as instructed by

manufacturer. The extracted DNAs were preserved in -20°C temperature subjected to PCR using the set primers. The PCR will be performed by a Thermocycler machine following the standard protocol. As we could not collect the tick samples from all sites we have planned, we already applied for extension of the project time for 6 more months. After completion of the project, specific tick vectors will be identified and confirmed, which will help in designing sustainable methods for controlling the parasite in Bangladesh.

Impact of Climate Change on Tick Populations and Tick-borne Pathogen Transmission at Sal Forest Ecosystem of Gazipur, Bangladesh

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Abstract

Ticks and tick-borne diseases (TBDs) are ranking high in terms of their impact on animal and human health worldwide. They are efficient vectors of a variety of pathogenic protozoa, rickettsiae, spirochaetes and viruses, which are causing major diseases affecting livestock, humans and companion animals. Various nature of forests play distinct role in favouring the survival and growth of arthropods including ticks. The potential role of Sal forest ecosystem in tick and TBDs in Bangladesh was not investigated yet. Therefore, the present research work was undertaken with the objectives to identification of the existing parasitic tick diversity and intensity and TBDs at Sal Forest area in Gazipur district, Bangladesh. For this until now, 50 cattle and 20 goats have been examined and prevalence rate of ticks in cattle and goat were found 14% and 60%, respectively. Significant effect of farm management, age and sex was recorded. More ticks, soil samples, vegetation samples and climatic data will be collected. Molecular investigation of ticks for tick-borne pathogens will be performed. Finally association of epidemiological, molecular and ecological data will be checked through statistical analysis. Thus, this study will provide understanding of ticks and tick-borne pathogens through comprehensive examination and increasing knowledge of the complex associations among tick populations, habitat landscapes, climate, human demographics, economics and intrinsic pathogen factors.

PCR-Based Non-invasive Copro-Diagnosis: Qualitative Detection and Identification of Chicken Helminths

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Abstract

Diagnosing helminth infection in the field can be problematic, principally relying on collection and euthanasia or killing of hosts, followed by necropsy and morphological identification of parasites *in situ*. The proposed research work is designed with the aim to detect helminth infection using non-invasive PCR-based environmental DNA approach for sensitive detection and identification of endoparasitic DNA released in the faeces of infected chickens as egg or tissue fragments and aimed to

explore the possibilities for easier and confirmative diagnostic approach for peridomestic and wild animals as well. *Ascaridia galli* and *Heterakis gallinarum* from intestine (invasive sample) and faeces (non-invasive sample) from indigenous chicken was collected. DNA samples will be extracted from parasite and faeces. After PCR amplification with respective genus-specific primer, PCR products will be visualized using agarose gel. Sampling was interrupted by Covid-19 pandemic. Hence we could not manage enough positive sample for epidemiological and molecular study. This project is extended for a period of another six months. After completion of the project, the proportion of *Ascaridia galli* and *Heterakis gallinarum* circulating in indigenous chicken in Bangladesh will be identified and efficiency of non-invasive methods for helminth diagnosis will be validated. This method could be successfully replicated for zoo and wild birds and animals which are very valuable and difficult to restrain.

Molecular Epidemiological Study of Sand Fly Vectors from Kala-azar Endemic Areas of Bangladesh

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Abstract

Visceral leishmaniasis (VL), also known as kala-azar, is caused by the protozoan parasite, *Leishmania donovani* complex (*Leishmania infantum* and *L. donovani*). According to previous reports, the current prevalence in Bangladesh is estimated to be 40,000–45,000 cases per year. Female phlebotomine sand fly, *Phlebotomus argentipes*, is the only known vector for VL transmission on the Indian subcontinent. In Bangladesh, detailed molecular taxonomic knowledge of each species is poorly or not known. Correct sand fly species identification is very important to design strategies for surveillance and control of leishmaniasis in endemic areas. The present study was conducted to identify the field-captured sand fly species morphologically and for molecular detection and characterization of sand fly species in Bangladesh. Field surveys were conducted to collect phlebotomine sand flies from VL-endemic areas of Mymensingh, Jamalpur, Tangail and Gazipur districts. Mainly sticky trap and Shannon trap methods were used to collect the sand flies. Unfortunately no sand flies were trapped still from the sampling areas. The reason behind, since 2011, the National Kala-azar Elimination Programme in Bangladesh conducted indoor residual spray (IRS) for vector control in the affected communities. In addition to IRS, two commercially manufactured long lasting impregnated bed-nets (LLIN) were given to each patient treated in the government hospitals. The IRS and LLIN are associated to decrease the level of the *Phlebotomus argentipes* sand fly by 70±80% in Bangladesh. Due to these vigorous vector-control programs conducted by government of Bangladesh, there is a tremendous low vector density in all the VL-endemic areas which may be the most crucial reason of not finding any sand fly samples in the surveyed VL-endemic areas. Instead, we found different other species of insects which mostly include biting midges, non- biting midges, black flies and non-identified nematoceran flies. In future, we should try different sand fly sampling methods in other VL-endemics areas of Bangladesh.

Prevalence and Molecular Detection of *Balantidium coli* Infection in Cattle in Mymensingh District of Bangladesh

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Abstract

Balantidium coli is an important neglected tropical zoonotic protozoan parasite, which can infect a wide variety of hosts, including pigs, humans and non-human primates, rodents, ruminants, camels and

horses. *B. coli* fundamentally infects the colon and causes clinical manifestation from asymptomatic to serious dysenteric forms. The geo-climatic condition of Bangladesh is favourable for the development and survival of *B. coli* in cattle and buffaloes which play an important role in the national economy and trade of Bangladesh. Although there are reports on the prevalence of balantidiasis in reservoir pigs, buffaloes in Bangladesh, research on *B. coli* has been very sparse and no studies on molecular analysis of *B. coli* in animals have been reported in Bangladesh. In view of paucity of such information about balantidiasis, the present study was aimed to identify the *B. coli* infection using both morphological and molecular methods in cattle and buffaloes in Bangladesh. A total of 312 fecal samples of cattle were collected randomly from different areas of Mymensingh district irrespective of age, sex, health status, management system and seasons. Fecal samples were immediately processed and examined by Stoll's Ova counting technique. The total genomic DNA was extracted from the microscopically positive fecal samples for *B. coli*. Further, PCR will be performed to amplify the 18S rRNA gene and ITS gene with specific primers. In Stoll's Ova technique, a total of 105 cattle out of 312 (33.65%) were found to be infected with *B. coli*. Prevalence of *B. coli* infection in cattle was relatively higher in adult animals of > 5years (37.28%). The prevalence of *B. coli* was slightly higher in male (35.29%) than female (32.38%) cattle. From this study, it was observed that the occurrence of *B. coli* infection in cattle was higher in November (61.29%) than other months of the year. The observations from the present study revealed that cattle were highly susceptible to balantidiasis. The preliminary findings from this study are helpful to predict the potential risk and expansion of this disease. Further extensive work in this regard is needed to assess the impact of balantidiasis in animals, to study the zoonotic significance of the disease and to find out a proper control strategies against it in Bangladesh.

Echinostomiasis, a Zoonotic Trematode Infection, in Backyard Poultry in Bangladesh: Pathology and Risk Factors Analysis

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Abstract

Echinostomes are snail borne zoonotic, intestinal flukes, which infect a wide range of vertebrates including humans. Morbidity and mortality due to echinostomiasis are related to parasitic load. Heavy infections are associated with eosinophilia, profuse watery diarrhea, anemia, edema and anorexia. Here, we investigated some epidemiologic and pathologies of echinostomiasis in poultry. We collected and examined 116 chickens from different markets of Mymenshingh. Of the examined chickens, 17 (14.7%) chickens were infected with echinostomes. We recovered and identified *Echinostoma revolutum* (10.3%) and *Hypoderaeum conoideum* (6.0%) and each chicken were infected with 1-25 flukes. The infection was significantly ($p<0.5$) higher in male and no infection was detected below 6 months of age. The flukes were detected both in small and large intestine, however, they were most commonly found in caecum. Commonly, they induced enteritis characterized by the presence of excessive mucus. However, in some cases hemorrhagic spots were detected at the site of attachment of the flukes. In conclusion, echinostomiasis is still a big problem in indigenous chickens of poultry in Bangladesh and people, especially, villagers are at risk to the infection.

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Detection of Fish-borne Zoonotic Trematode, the Type- 1 Biocarcinogen from Marketed Fishes in Bangladesh

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Abstract

Fish-borne Zoonotic Trematodes (FZTs) are the major parasites that affect human and animal health globally, particularly in Asian countries. Of the FZTs, several species live in liver, therefore, they are termed as liver flukes (LFs). They can cause liver cirrhosis leading to colangio-carcinoma (CCA). A cross-sectional study was carried out to investigate the infection status of fishes with metacercariae (MC) of LFs and explore their genetic diversity. A total of 22 species of fishes, e. g., Punti (*Puntius ticto*), darkina (*Esomus danricus*), kholisa (*Colisa fasciata*), kakila (*Xenentodon cancila*), reba carp (*Cirrhinus reba*), rohu (*Labeo rohita*), mrigal carp (*Cirrhinus cirrhosus*), betta (*Paramugil parmatus*), grass carp (*Ctenopharyngodon idella*), kalibaus (*Labeo calbasu*), sarpunti (*Puntis sarana*), silver carp (*Hypophthalmichthys molitrix*), tilapia (*Oreochromis nibticus*), zebra fish (*Danio rerio*), nama chanda (*Chanda nama*), ranga chanda (*Parambassis ranga*), highfin glassy perchlet *(Parambasis lala),* kana pona (*Aplocheilus panchax*), bele (*Glossogobius giuris*), and gutum (*Lepidocephalichthys annandalei*), and kuncho river prawn (*Macrobrachium lamarrei*) were collected and digested with pepsin to recover MC. Out of 21 species of fishes, 17 species were infected with FZTs, except grass carp, kana pona, bele, and gutum, and kuncho river prawn. The overall prevalence of LFs infections was 26.4%, ranging from 11.1-100%. Both the prevalence and load of MC were significantly higher in wild fishes. By morphological and morphometrical analysis, we identified MC of *Clonorchis* spp., *Opisthorchis* spp., and *Metorchis* spp. By employing molecular tools, we confirmed the presence of MC of *Opisthorchis viverrini, O. felineus* and *Clonorchis sinensis*. Taken together, our results suggest the frequent occurence of MC of LFs in fish types, indicating both the wild and cultured fishes carry the infection and people of the country are at risk.

Opisthorchiasis, Fish-borne Zoonotic Helminths, in Snake-Head and Cat-Fishes in Bangladesh

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Abstract

Opisthorchid flukes are the major human liver flukes (mHLFs) that also affects animals globally, particularly in Asian countries. They can cause liver cirrhosis leading to colangio-carcinoma (CCA). A cross-sectional study was carried out to investigate the infection status in snake-head and cat fishes with the metacercariae (MC) of mHLF. A total of 130 snakehead and 192 cat fishes were collected and examined, of which 39.2% snakehead and 34.9% cat fishes were found to be infected with the MC of one or more species of mHLF. We examined *taki* (spotted snakehead, *Channa punctatus*), *shol* (striped snakehead, *Channa striatus*), *shingi* (stinging catfish, *Heteropneustes fossilis*), *magur* (waking catfish, *Clarias batrachus*) and *thai pangas* (pangas catfish, *Pangasianodon hypophthalmus*). During

examination, we recovered MC of fish-borne trematodes and on the basis of morphologic and morphometrical analysis, they were tentatively identified as the MC of *Opisthorchis* spp., *Clonorchis* spp., and *Metorchis* spp. Overall, 36.6% examined fishes were found to be infected with MC of one or more species of fish-borne trematodes. The highest infections were detected in taki (63.8%) and shingi (53.3%) and the lowest in pangas (13.5%). To estimate relative distribution of MC, we processed and examined head, body and scales of each fishes separately; and we found that MC were almost equally distributed in head and body, however, no MC were detected in scales. To validate tentative identifications, we extracted total genomic DNA and PCR was performed by employing specific primers. By PCR, presence of metacercariae of *Opisthorchis viverrini, O. felineus* and *Clonorchis sinensis* were confirmed. Taken together, our results suggest that both snakehead and cat fishes of Bangladesh carry MC of mHLF, the causal agent of colangiocarcinoma in humans.

Molecular Identification of Food-borne Parasite *Taenia saginata* Cysticercosis.

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Abstract

This study aimed to verify *Cysticercus bovis* occurrence in different anatomical sites, as head, heart, esophagus, diaphragm, tongue, liver and carcass, examined by federal inspection service. Diagnosis was performed by gross examination and PCR with boiling DNA extraction for metacestode identification. Of 220 slaughtered cattle, (3.23%) were infected. The heart was mostly affected with 1.90% followed by head, 1.11% esophagus, 0.08%), carcass, 0.07%, diaphragm, 0.03% liver, 0.02% and tongue, 0.01%). Of the cysts obtained, 58.35% were dead and 41.65% were alive. Of the live cysts subjected to PCR with boiling DNA extraction, 65% were positive. Fibrous nodules, rich in lymphoid or mixed infiltrates, were frequently seen. Of the live cysts subjected to PCR with boiling DNA extraction, 65% were positive for whose centers were characterized by caseous and / or calcareous material, multinucleate giant cells, histiocytes in palisade and infiltrate composed predominantly by lymphoid cells, wrapped up by fibrosis. Sometimes the lesions peripheries had granulation tissue and mineralized areas, like linear blade. The parasite debris were like a hyaline, non-cellular material with spherical and ovoid, basophilic, eosinophilic and colorless corpuscles. These corpuscles were seen rarely, sometimes, among inflammatory reaction. Fibrous nodules, rich in lymphoid or mixed infiltrates, were frequently seen. Of the live cysts subjected to PCR with boiling DNA extraction, 65% (13/20) were positive for Some times the lesions peripheries had granulation tissue and mineralized areas, like linear blade. The parasite debris were like a hyaline, non-cellular material with spherical and ovoid, basophilic, eosinophilic and colorless corpuscles. Due to PCR diagnosis of C. bovis, mainly in the liver and esophagus inspection should include these sites in the bovine routine inspection at the slaughterhouses of Bangladesh.

Characterization of Liver Fluke *Fasciola gigantica* Secreted Extracellular Vesicles and Identification of Immunogenic Proteins

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Abstract
Fasciola gigantica is the causative agent of liver fluke disease (fasciolosis) in domestic animals. Fasciola infects more than 300 million cattle and 250 million sheep worldwide resulting in losses of over $3 billion to global agriculture through lost productivity (Nyindo and Lukambagir, 2015). All host-parasite associations have been shaped over time by an evolutionary arms race. While hosts have restricted the pathogens' deleterious impact, the latter have managed to establish and reproduce in spite of host responses. Hence, the constant 'cross-talk' between hosts and parasites has led to the evolution of highly sophisticated relationships, characterized by complex molecular dialogues, where only precisely delimited conditions permit a successful infection. In recent years, extracellular vesicles (EVs) have been accepted as a new intercellular communication system that mediate the transfer of proteins, lipids, mRNA, microRNA and other non-coding RNA species. Our study collected samples from various districts of the study area as planned for the 1st year and 2nd year of the project and successfully performed the culture of *F gigantica* parasites in incubator maintaining optimum conditions and using specific culture media. Fluke spit has been collected for isolation and subsequent characterization of extracellular vesicles. We have processed the fluke spits in the from the culture media RPMI1640 and preserved in the freezer for column extraction and other analysis and characterization.

Gastrointestinal Helminth Parasites in Domestic Ducks in Dingaputha Haor Areas in Netrokona District: Epidemiology and Molecular Characterization

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Abstract
The ducks are second to the chickens in respect of population and meat and egg production in Bangladesh. Gastrointestinal parasitism is a major constraint of profitable duck rearing throughout the world including Bangladesh. This study was conducted to investigate the epidemiology of the gastrointestinal helminth parasites of ducks in the Dingaputha Haor areas of Mohongonj upazila of Netrokona district from July 2020 to June 2021. Molecular identification of the important duck intestinal trematode, *Echinostoma revolutum* was also performed. Post mortem examination revealed that 81.67% (98/120) domestic ducks were infected with one or more species of helminth parasites. Thirteen species of helminths including 8 species of trematodes namely, *Echinostoma revolutum*, *Hypodaerum conoideum, Psilochasmas oxyurus, Tracheophilus* (*Typhlocoelum*) *cymbius*, *Amphimerus anatis*, *A. lancea, A. ovalis* and *Metorchis orientalis*; 2 cestode species namely, *Hymenolepis lanceolata* and *Schillerius longiovum*; and 3 nematode species namely, *Capillaria contorta, Echinuria uncinata* and *Heterakis gallinarum* were detected in ducks. The highest prevalence of infection was with the cestode, *H. lanceolata* (35.0%) followed by the duck liver fluke,

A. anatis (29.17%) and the tracheal parasite *T. cymbius* (22.5%) and the nematode, *E. uncinata* (14.17%). Among the age groups, 46.67%, 87.50% and 98.0% infections were recorded in ducks of <6 months, 6 months to 1 year and > 1 year of age, respectively. The prevalence was higher in females (87.14%) than in male ducks (74.0%). The prevalence was the highest in the summer (92.0%) followed by the winter (85.0%) and the lowest in the monsoon (68.57%). Molecular detection of the 28S rDNA gene of *E. revolutum* confirmed the parasite species. This study suggests that the prevalence of gastrointestinal parasites is alarmingly high in domestics ducks in Dingalutha haor areas. Countrywide epidemiological study and immunogenic gene detection are needed to formulate effective control measures against the helminth parasites of ducks.

Exploring Anthelmintic Resistance and Molecular Analysis of Some Economically Important Gastrointestinal Nematode Parasites of Cattle in Bangladesh

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Abstract
Haemonchus contortus, the blood feeding nematode is the most prevalent and pathogenic gastrointestinal nematodes (GINs) in ruminants causing severe health hazards. To overcome this problem, there is an essential need to select an effective anthelmintic against *H. contortus* in livestock. For this, the present study was conducted to evaluate the efficacy of some anthelmintics such as albendazole, levamisole, ivermectin, closantel and rafoxanide by developing a standardized and reliable *in vitro* culture technique. To perform this, adult worms were collected from the abomasum of slaughtered animal, cultured into four basic media (MEM, DMEM, M199 and RPMI with or without 20%FBS) for 72 hours. In this assay, albendazole (ALB), levamisole (LEV), and ivermectin (IVR) were used at 2, 10 and 50 µg/ml concentrations and closantel (CLO) and rafoxanide (RAF) were used at 0.5, 1 and 2 µg/ml concentration in triplicates. Treated worms were examined at 3, 6, 12, 24, 36 and 48hrs after treatment and the mortality rate was calculated in all treatments under an inverted microscope. Among the four media with or without 20% FBS, DMEM supplemented with 20% FBS revealed as the best culture medium in which the survivability rate of parasites was significantly higher ($p \leq 0.001$) than others. The efficacy of CLO and RAF were significantly ($P<0.001$) higher than other drugs. The maximum effect i.e. 100% mortality was observed at 2 µg/ml of CLO and RAF after 12 hours of post exposure whereas, ALB, LEV and IVR showed significant effect at 50 µg/ml conc. after 48 hrs, 36 hrs and 24 hrs of post exposure. Taken together, CLO and RAF can be the promising drugs as a favor of prevention, control and treatment of *H. contortus* in ruminants.

Genetic Characterization of Blood Feeding Haemonchus Contortus Populations Isolated from Sheep and Goats Based on β-tubulin Gene Analysis

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Abstract
Haemonchus contortus is considered as the most endemic and injurious gastro-intestinal nematode (GIN) of small ruminants in tropical and subtropical regions. Anthelmintic resistance (AR) against

GINs especially *H. contortus* of sheep and goat is a global issue. To address the gravity and extension of AR in Bangladesh, genotyping of 160 adult *H. contortus* parasites were performed to confirm benzimidazole (BZ) resistance allele from different geographic zones of Bangladesh based on allele specific PCR (AS-PCR). The genotype frequencies were 9.4% for homozygous resistant (rr), 61.2% for heterozygous (rS) and 29.4% for homozygous susceptible (SS) among the selected areas. The allelic frequency of the mutation conferring resistance (r) ranged from 27.5% to 52.5% indicating substantial existence of BZ resistance in *H. contortus* in small ruminant nematodes. The genotype frequencies (rr, rS and SS) and allelic frequencies (r and S) varied significantly ($p<0.05$) in different geographical areas of Bangladesh. Thus, throughout the country, an extremely critical situation of BZ resistance was revealed by this present survey. Therefore, it can be concluded that genotyping the F200Y polymorphism can be used to monitor the resistance and thereby to enhance the control on the development of AR against *H. contortus* in small ruminant nematodes.

Exploring Genetic Diversity Patterns of *Haemonchus* Parasites Isolated from Cattle

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Abstract
Gastrointestinal nematode infections of livestock are ranked in the top twenty diseases affecting small-holder farmers' livestock. *Mecistocirrus digitatus* is one of the most prevalent parasitic nematode among the trichostrongylids causing severe health hazards leading to production losses in cattle worldwide. This study was conducted to explore the existence and genetic diversity of *M. digitatus* parasite populations from cattle characterizing second internal transcribed spacer (ITS-2) gene of nuclear ribosomal DNA (rDNA). A total of 23 adult *Mecistocirrus* parasites were collected from abomasa of slaughtered cattle from Mymensingh district of Bangladesh. After the extraction of DNA from adult parasites, ITS-2 of nuclear rDNA gene was amplified and sequenced. The edited and aligned sequences were employed for analysis to determine sequence variation and genetic diversity. All the sequences were found to have high identical ratio with *M. digitatus* of a published sequence and sequence identities ranged from 97.9% to 100%. Genetic analysis revealed 3 distinct ITS-2 genotypes among the *M. digitatus* isolates. The nucleotide and genotype diversities were 0.00089 and 0.170, respectively for ITS-2 sequences. Phylogenetic analysis (neighbour joining, maximum likelihood and maximum parsimony) of ITS-2 sequences indicated the existence of a single cluster within *M. digitatus* population in the study area. In conclusion, our study could confirm *M. digitatus* in the analyzed parasite isolates by amplifying and sequencing ITS-2 gene. Most of the isolates from our present study presented identical genotypes indicating that low genetically diversified parasites are circulating in Mymensingh region of Bangladesh. The findings of our study creates a basis for further molecular epidemiological surveys applying more *M. digitatus* parasite isolates from different regions of Bangladesh.

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Validation of Species of *Raillietina*, Most Common Cestode of Domestic Chickens in Bangladesh by Molecular Tools

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Abstract
Raillietina are the most prevalent and pathogenic cestode in domestic fowl, *Gallus domesticus* around the world. For this, the present study was carried out to investigate the present status of *Raillietina* spp. in domestic chickens in different areas of Mymensingh district and validate different species of *Raillietina* using molecular markers. To do this, a total of 211 domestic chickens were collected from farmer's household. Adult worms were isolated from intestine by postmortem examination and identify different species of *Raillietina* by microscopic examination. Furthermore, DNA was extracted from adult parasites, amplified ITS-2 gene by PCR and sequenced to validate microscopically identified species of *Raillietina*. Out of the 211 birds examined, 144 (68.2%; 95% CI: 62.0- 74.5%) were found harboring one or more species of *Raillietina.* The mean parasitic burden was 10.5±0.8. According to the morphological study, four species of *Raillietina* were identified including *R. tetragona* (50.7%, 95% CI: 44.0-57.5%), *R. echinobothrida* (38.9%, 95%CI: 32.3- 45.4%), R. cesticellus (19.9%, 95% CI: 13.9- 25.6%) and *Raillietina* sp. (9.4%, 95% CI: 4.7-15.2%). Prevalence was significantly higher in Gouripur upazila (76.6%) than Mymensingh sadar upazila (59.6%). The mean parasitic burden at Gouripur and Mymensingh sadar upazila were 11.26±1.1 and 9.45±1.1, respectively. According to univariate analysis, sex, age, farming nature, deworming and education level of farmers were not significantly ($p > 0.05$) associated with *Raillietina* infection but flock size and seasons of the year were significantly ($p < 0.05$) associated with *Raillietina* infection. For validation of *Raillietina*, ITS-2 gene was amplified and showed positive band on 944, 1,008, 813 and 588 bp conforming *R. echinobothrida, R. tetragona, R. cesticillus* and *Raillietina* sp., respectively. This epidemiological data along with molecular conformation will help to formulate an effective control strategy against this parasite in domestic chickens.

Prevalence and Molecular Characterization of Taeniid Metacestode, *Cysticercus tenuicollis* in Goats Slaughtered at Mymensingh Sadar

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Abstract
Taeniid metacestode, *Cysticercus tenuicollis* is the larval stage of the *Taenia hydatigena* resulting cysticercosis. It causes enormous economic loses especially in livestock production. The present study was carried out to determine the prevalence and explore genetic variation of small subunit ribosomal RNA (*rrnS*) and cytochrome oxidase subunit 1 (*cox1*) derived from *C. tenuicollis* in goats. To do these, samples were collected from different slaughter houses of municipal areas at Mymensingh sadar and examined under microscope for detailed morphological study. To study genetic variation, DNA was extracted from *C. tenuicollis*, amplified *rrnS* and *cox1* genes using specific primers and sequenced PCR products. Among 1372 examined animals, 177 (12.9%) were infected with *C. tenuicollis*. Cysts were isolated from peritoneum (7.9%), liver (4.4%) and urinary bladder (0.6%) of infected animals. Females (18.9%) and adults (20.7%) were significantly more susceptible than male (8.8%) and young (9.3%), respectively. Genetic analysis defined 8 distinct *rrnS* genotypes and 9 unique *cox1* haplotypes

among 20 *C. tenuicollis* isolates. The nucleotide diversities were 0.00283 and 0.00434 for *rrnS* and *cox1* gene, respectively. A neighbor joining (NJ) tree was constructed and the studied sequences were clustered with reference sequences of *T. hydatigena* with strong nodal support (100%). The NJ tree of *cox1* tree also supported the results of *rrnS* gene. To compare Bangladeshi isolates, a median joining network was constructed with the populations from other geographical regions and hosts and supported a clustering pattern but the clusters were not built with unique geographical regions or hosts. In conclusion, this is the first study that describes the genetic variation of *T. hydatigena* population and suggests the existence of host-specific variants. We recommend that future studies employ long mitochondrial DNA sequence to provide reliable data that would explain the extent of genetic variation in different hosts/locations and biological and epidemiological significance.

Control of Brucellosis, a Zoonotic Disease in Selected Dairy Farms

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Abstract
One health concept is progressing; as a result the control of zoonotic diseases is getting prime importance in Bangladesh. In the present investigation, the used methods were the application of bovine *Brucella* antibody rapid test strip, histopathology and direct immunohistochemistry (IHC). The used materials were sera from pregnant cows (n=30), aborted placenta (n=1) and aborted fetus (n=1). All 29 samples did not show *Brucella* antibody in the sera while 1 sample showed invalid result. A total of 20 mesenteric lymph nodes were collected from 20 slaughtered cows. A total of 8/20 (40%) lymph nodes showed normal histological features, 5/20 (25%) showed lymphoid depletion, 3/20 (15%) lymph nodes showed hemosiderosis, 2/20 (10%) lymph nodes revealed edema. Various tissues of an aborted fetus were studied for histopathology. The placenta showed mild placentitis and other tissues showed fibrinous pleuritis, hepatitis, fibrinous casulitis of kidney, pericarditis. The histopathological lesions described in placenta and in aborted fetal lung, liver, kidney and heart were not typical with *Brucella* lesions. A suspected granulomatous lesions 2/20 (10%) were reported in the present study. These 2 lymph nodes were confirmed by immunohistochemistry (IHC) to identify intra- or extra-cellular *Brucella abortus* organism. One (1) of 2 lymph nodes showed positive reaction by IHC within and outside the macrophages. *Brucella*-suspected other (n=1) aborted placental inoculums injected to guinea pigs and after 15 days the guinea pigs while only spleen showed suspicious positive reaction to *Brucella* antibody detected by IHC within and outside the macrophages. From this study, it is difficult to give opinion on the control of bovine brucellosis in Bangladesh. However, it is a common practice in developed countries that after definite diagnosis of *Brucella*-positive cases mainly by direct methods in a particular farm and the *Brucella*-positive animals are disposed to get rid of *Brucella* infection.

Identification and Characterization of Avian Corona Virus in Poultry in Bangladesh

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Abstract
Introduction: Infectious bronchitis (IB) is a highly contagious respiratory gamma corona virus infection and are circulating for many years in poultry in Bangladesh resulting significant economic

loss. In this study we not only focused on duck sample but also in chicken. The study was aimed to detect and molecularly characterize of the infectious bronchitis virus (IBV) from clinical outbreaks and surveillance samples. Methodology: Real time RT-PCR was used to detect IBV in pooled (lungs and tracheal) tissue samples (n=7), oropharyngeal swabs (n=19) and pooled fecal samples (n=6) from live bird markets. Conventional PCR was done for real-time positive samples. Further sequencing and phylogenetic analysis were done for few selected samples. Results: Both respiratory and nephropathogenic forms of IB were suspected at necropsy (n=7) from clinical outbreaks. Sequencing of hypervariable regions (HVR1-2 and HVR3) of S1 subunit of spike gene (S) of five isolates revealed circulation of Mass-like, QX-like, and 4/91-like genotypes of IBV in Bangladesh. Each genotype was extremely variable as confirmed by separate clustering of the viruses in the phylogeny and high nucleotide (nt) divergence (38.8-41.2% and 25.7-37.4% nt divergence based on HVR1-2 and HVR3 sequences, respectively). Three neutralizing epitope sites were predicted within the HVRs which significantly differed among three genotypes. In addition, one Bangladeshi isolate carried fixed mutations at 294F and 306Y similar to other pathogenic QX-like IBVs, which could affect the neutralization responsive epitopes and modulate antigenic escape, facilitating virus circulation among vaccinated flocks.

Respiratory Co-infections in Commercial Layer Chickens of Bangladesh and Genotyping of Avian Influenza and Newcastle Disease Virus

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Abstract

Respiratory infections are multifactorial and often involve the co-infection with several pathogens. The prevalence of six respiratory pathogens in small- and medium-scale commercial layer farms of Bangladesh were studied. Respiratory samples were collected from 84 layer flocks showing respiratory signs and tested by PCR. A total of 22 flocks showed of one or more of the respiratory pathogens tested for. Out of 42 (50%) positive flocks, 23 showed single respiratory infections whereas 19 flocks showed mixed respiratory infections containing 2 to 3 pathogens. Among various pathogens, *Mycoplasma gallisepticum* was detected in 28 flocks (66.7%) followed by avian influenza in 21 (50 %), infectious laryngotracheitis virus in 7 (16.7%), *Avibacterium paragallinarum* in 3 (7.1%) and Newcastle disease in 2 flocks. One case of infectious bronchitis was detected. Next we amplified and sequenced the complete genome of 9 HPAI viruses collected from Mymensingh (Bhaluka) and Tangail (Sakhipur), Sirajganj, Bhola and Dhaka districts during 2018 and 2020. Phylogenetic analysis based on full length gene sequences of HA, NA and M gene placed all nine viruses of the present study under clade 2.3.2.1a of H5N1 phylogeny. However these viruses together with H5N1 viruses reported from Bangladesh in 2015 and onward formed a separate cluster (new reassortant) under clade 2.3.2.1a. Analysis of other internal genes showed that the nine study isolates were segment reassortant containing PB2, PB1, PA, NP and NS genes from LPAI viruses of non-H9N2 subtypes. These gene segments were closely related to the viruses detected recently from live bird markets (LBM), aquatic birds and field outbreaks. Genotyping of four NDV isolates from broiler chickens isolated in 2020-21 revealed a novel genotype VII.2 circulating in poultry of Bangladesh. Pathogenicity testing showed the velogenic viscerotropic pathotype of the isolates. Three NDV isolates from pigeons were characterized as genotype XXI.1.2 and mesogenic pathotype.

Isolation and Molecular Characterization of Mycoplasma Gallisepticum from Poultry

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Abstract

Mycoplasmosis is a common respiratory disease in poultry. Successful isolation of the causative agent, *Mycoplasma gallisepticum* is essential for the development of an effective vaccine based on local isolate. We performed clinical and pathological investigation of suspected cases of mycoplasmosis in layer chickens and attempted isolation of the bacteria. A total of five outbreaks of suspected mycoplasmosis in layer flocks in Mymensingh district were investigated. The mycoplasmosis affected chickens showed tracheal rales, nasal discharges, coughing, decrease egg production, conjunctivitis, facial edema. On post-mortem examination, air sacculitis, air sacs filled with fibrinous exudates; fibrinous perihepatitis and adhesive pericarditis were found. *M. gallisepticum* was successfully isolated in modified Fery's broth supplemented with pig serum (FMS). Positive growth of *M. gallisepticum* showed orange coloration of the FMS broth and round, transparent colonies with raised centre (Fried egg appearance) in FMS agar. PCR targeting the IGSR gene of *M. gallisepticum* produced positive amplification in the culture. Phylogenetic analysis based on the partial *mgc2* gene sequences revealed that Bangladeshi *M. gallisepticum* isolates were closely related to vaccine strain ts-11-like *M. gallisepticum* isolates with nucleotide similarity ranging from 93.26 to 99.13%, although no flocks included in the current study were vaccinated against *M. gallisepticum*.

Residual Effect of Nonsteroidal Anti-inflammatory Drug (paracetamol) on the Immune System of Broiler Chicken

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Abstract

Nonsteroidal anti-inflammatory drugs (NSAIDs) are extensively used both in human and veterinary medicine. Paracetamol is one of the most used compounds worldwide in the aminophenol group of NSAIDs. The current study was evaluate the gross and histopathological changes of lymphoid tissues/ organs (spleen, thymus, cecal tonsil and Bursa of Fabricious) following acute dose of paracetamol in chicken. A total of 25 chickens were collected and randomly divided into control and paracetamol-treated chicken (a single dose orally @2mg/kg body weight) and observed on day 1 after exposue. The mean body weights of chickens were not change after paracetamol treatment. The values of serum alanine transaminase (ALT) was significantly increased paracetamol-treated chicken in compare with control chicken. Appearance of thymus, spleen and Bursa of Fabricious were found normal in control chicken and small spotted hemorrhages were seen in the surface of paracetamol-treated thymus. Histologically, Bursa of Fabricious showed loosely packed lymphocytes as outer cortex and inner medulla and interfollicular space is wide and filled with few connective tissue fibres, indicating reduction of lymphocytes and atrophy of bursal follicle size. Atrophy of thymic lobules was seen in paracetamol-treated chickens with decreased number of lymphocytes in the cortex and medulla with many degenerative areas of Hassel's corpusles. Thin fibro-muscular capsule surrounding the splenic

parenchyma and congested blood vessels was observed in paracetamol treated chicken. Interestingly, splenic parenchyma, red pulp and white pulp was comprised large number of lymphocytes, large size periarteial lymphatic sheath in paracetamol treated chicken. Paracetamol treated cecal tonsil also showed large number of lymphatic nodules and densely packed lymphocytic populations around the intestinal gland. The present findings revealed that paracetamol overdose have detrimental effects on lymphoid organs in chicken. Thus, the current research will explore the underling mechanisms of acute toxicity on the basis of immune systems in paracetamol-induced toxicity in chicken.

Experimental Pathogenesis Study of Low Pathogenic Avian Influenza (LPAI) H9N2 Infection in Sonali Chicken in Bangladesh

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Abstract
Low pathogenic avian influenza (LPAI) H9N2 virus is the predominant avian influenza virus in domestic land-based poultry in Bangladesh, followed by HPAI H5N1. The H9N2 viruses have been isolated frequently from commercial poultry flocks, live-bird markets as well as the environment. Although molecular characterization of a large number of Bangladeshi LPAI H9N2 viruses was conducted and several molecular determinants have been identified at present, there is meagre and insufficient data on the pathogenicity of H9N2 viruses in Bangladesh. With the ultimate goal of achieving improved therapeutic and preventive strategies, the project is designed to assess the detailed pathogenicity of Bangladeshi low pathogenic avian influenza (LPAI) H9N2 isolate in experimentally infected Sonali chicken. The LPAI H9N2 influenza virus was isolated from layer during 2021. Six weeks old Sonali chicken (n=20) was inoculated by dropping 0.2 ml of allantoic fluid of H9N2 isolate (104 EID50/ml) in both nostrils and eyes. Birds were monitored for clinical and pathological outcomes, and virus shedding for 21 days post-infection (DPI). No mortality and clinical signs were recorded in the infected and controlled Sonali chicken. Experimentally infected Sonali chickens with H9N2 displayed mild congestion and hemorrhage of the trachea and lungs, hemorrhage in small intestine and caecal tonsils throughout the experimental period. Histopathologically, mild to moderate tracheal hemorrhages and congestion in lungs were noticed in infected Sonali chickens. The LPAI H9N2 virus was detected in the trachea, lungs and cloacal swab of infected Sonali chicken by RT-qPCR during the experiment course. The viral shedding was detected up to 21 DPI in trachea, lung, and cloacal viral shedding was not observed after 10 DPI. This study demonstrated the pathogenic nature of the local LPAI H9N2 isolate in Bangladesh.

Clinico-Pathological Investigation of Lumpy Skin Disease of Naturally Infected Cattle in Mymensingh

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Abstract
Lumpy skin disease (LSD) is an economically important disease of cattle. The first outbreak of LSD was reported in 2019 in Bangladesh. Therefore, the present study to investigates the hematological and histopathological changes of the LSD virus-affected organs or tissues of cattle. Blood was collected

from the jugular vein of naturally infected LSD cattle and was used for routine hematological examination. Skin nodule samples were collected and fixed in 10% neutral buffered formalin for histopathology. The commonly observed clinical signs and lesions of LSD infected cattle include fever, skin lesion (nodular-laceration), enlarged lymph node, swelling of joints, and lameness. There was no significant difference found on the blood parameter between healthy non-infected cattle (considered as control) and LSD infected cattle. In comparison to control, the value of erythrocyte sedimentation (ESR) was increased in LSD infected cattle but not at a significant level. On the other hand, the value of Hb concentration, PCV, TEC, and TLC have a tendency to decrease in LSD infected cattle in comparison to the control. Histopathology of skin nodules in LSD infected cattle showed that most cutaneous lesions were extended throughout all layers of skin. Vesicle formation in the skin was characterized by sloughing of lining epithelium, infiltration of huge inflammatory cells mainly lymphocytes, eosinophils, and few macrophages among the layers of the dermis, deposition of excess melanin pigments in the basal layer of the epidermis. In conclusion, the present findings revealed that LSD has no significant effect on the blood parameter and this disease mainly affects the skin of cattle. Therefore, LSD needs to be considered important as skins are the most important items to generate foreign currency for developing countries.

Evaluate the Ameliorator Property of Antioxidants Against Acetaminophen-Induced Hepatotoxicity

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Abstract

Drug-induced liver injury is becoming a major concern in public health globally. Acetaminophen (paracetamol) is extensively used as a non-prescribed drug for antipyretic and analgesic drugs both in human and veterinary medicine. Acetaminophen overdose causes acute liver failure. However, very few researches have been undertaken to know to protective strategies of acetaminophen-induced hepatoxicity. Therefore, the present study to investigate the protective property of antioxidants against acetaminophen-induced hepatotoxicity in mice. A total of 20 mice were collected and randomly divided into four groups as control, the acetaminophen-treated group, the acetaminophen+Vit C group, and acetaminophen+Vit E & Se group. Vit C (100mg/L) and Vit E (@75mg/L +Se@0.25mg/L) were mixed in drinking water from day 1 to 4. Acetaminophen was given by a single intraperitoneal injection @50mg/kg body weight on day 4. All the mice were sacrificed at 24 hours of acetaminophen injection. There were no clinical signs developed after acetaminophen injection. At necropsy, no gross lesions were seen in the liver and other visceral organs in mice of any group. Interestingly, the level of serum hepatic enzymes such as aspartate transferase (AST) and alanine transaminase (ALT) was significantly increased in acetaminophen exposed mice as compared to treatment-free control mice and no significant difference were seen with APAP-exposed with Vit E-Se and Vit C supplemented mice. Microscopically normal histoarchitecture of the liver was seen in the control liver. Hepatic lesions characterized by coagulation necrosis along with marked infiltration of inflammatory cells and mild congestion were seen mainly in the centrilobular area of the liver in acetaminophen-treated mice. However, liver lesions become less or almost no in acetaminophen-exposed mice where supplemented Vit. C or Vit. E-+Se, indicating a protective property of Vit. E+Se and Vit C. In conclusion, acetaminophen may lead to acute liver dysfunction and Vit. E-Se and Vit C have a protective role against acetaminophen-induced liver toxicity.

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Irradiation of Transboundary Animal Disease (TAD) Pathogens as Vaccines and Immune Inducers

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Abstract
Mycoplasmosis is a major threat in achieving sustainable animal and poultry development in Bangladesh. Caprine mycoplasmosis is caused by a variety of pathogens under the *Mycoplasma mycoides* cluster. Isolation of Mycoplasma in the laboratory is a big challenge. Previous studies under this project have isolated and identified the etiology of caprine mycoplasmosis using culture, staining and PCR method from 18 goats. In culture, large colonies of cream yellowish color, a characteristic of M. mycoides subsp. capri (Mmc), were detected in 13 samples. Whereas, small colonies of cream color, which is a characteristic of *M. mycoides* subsp. *mycoides* SC (MmmSC) were detected in 8 samples. Three samples showed both type of colonies. Recently we started working on avian mycoplasmosis. Isolation of *Mycoplasma gallisepticum* (MG) has been established using a positive isolate from a collaborating institute. MG produced orange color in Modified Ferry's broth within 24 hours after inoculation. On Modified Ferry's agar, MG produced round, transparent colonies with raised center within 5-7 days post-inoculation. PCR method using IGSR gene specific primers amplified 812 bp product of the MG isolate. Mass culture and irradiation of the MG isolate to produce vaccine are in progress.

Improving the Animal Health and Productivity through Mobile Veterinary Services

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Abstract
In Bangladesh, state veterinary service is limited and available only at upazila center where most of the livestock populations are reared in the periphery. Mobile veterinary services with a view of improving animal health and productivity funded by Krishi Gobeshona Foundation (KGF) was being implemented in Fulbaria Upazila of Mymensingh and Nakla Upazila of Sherpur district. A mobile veterinary clinic has been established at Bangladesh Agricultural University and in two sub-centers in two research areas. Initially a total of 500 beneficiaries, 250 from each area, were selected; questionnaire developed, pretested and distributed to research areas to find out the risk factors that directly or indirectly influence the livestock morbidity and mortality. The farmers in each area are being visited regularly by two research assistants and monitored by projects vets. A total of 500 farmers (Fulbaria-250 and Nakla-250) were trained on better cow and calf health management that included biosecurity, housing, feeding, care and other management activities. In Fulbaria upazila 1435 cattle, 324 goats and 2728 poultry were treated, 1665 cattle and 663 goats were dewormed, 1700 cattle and 2705 birds were vaccinated. 89 new farmers cultivated different types of fodder at their homestead / fallow land. In Nakla upazila a total of 904 cattle, 345 goats and 502 poultry treated, 1945 cattle and 1076 goats were dewormed, 2602 cattle and 685 goats and 1579 birds were vaccinated. 127 farmers

cultivated fodder in their homestead. A total of 283 and 284 artificial insemination (AI) have been performed in Fulbaria and Nakla upazila, respectively. 265 calves in Fulbaria (including 32 Brahma calves) and 201 calves in Nakla were born during this period. In brief doorstep veterinary services can play very important role in improving livestock health and productivity and thus improves socioeconomic status of the marginal farmers.

Analysis of the Antibacterial and Antiviral Efficacy of Ash Filtrates

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Abstract
Sanitizer plays an important role in reducing the risk of infection in man and animals which are aqueous or alcohol based chemical agents mostly. Due to inconsistent uses microorganisms often get resistance to common sanitizers, particularly occurs in animal farms. Organic antimicrobials can be an alternative. We prepared an organic sanitizer from household ashes and tested its efficacy against *Salmonella* sp. and Newcastle disease viruses. Household ashes derived from different sources were collected and obtained filtrates in water by layering charcoal, stone, sand, cotton, or gauze in a handmade filtration system. *Salmonella* from table eggs was isolated and incubated 10 µl ($2.58*10^8$ CFU/ml) culture either with different dilutions of ash filtrate or with 100% washing soda or with distilled water only. Afterwards inoculated in BG agar plates. The number of colonies was counted and statistically compared. 100µl Newcastle disease virus viruses ($2.5\ X10^6\ EID_{50}$) on Petri dishes were sprayed with 250µl of different dilutions of ash filtrate and incubated for 30 minutes at room temperature. Swabs from the respective treated petri dishes were inoculated in 1 ml MEM. For each dilution of ash filtrate, 200µl was inoculated into embryonated eggs. After 4 days of infection, allantoic fluid (AF) was harvested and the hemagglutination test was performed and titre was calculated. Using our handmade filtration system, we obtained a clear ash filtrate with pH ranging from 8.5 to 10.5. Ash filtrates showed pH dependent antibacterial activity against a pure culture of *Salmonella* sp. Spraying ash filtrate on infected eggs or dipping infected eggs in ash filtrates reduced bacterial loads significantly. Works on virus is in progress. In conclusion, since ash filtrates showed antimicrobial efficacy, can be used as organic sanitizer to reduce infection risk in man and animals.

Prevalence of Antimicrobial Resistance of Oral and Periodontal Disease Pathogens in Pediatric Patient

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Abstract
The present research work was undertaken to investigate the prevalence of oral and periodontal disease pathogens (*Staphylococcus aureus*, *Lactobacillus spp* and *Streptococcus sp.*) in pediatric patient and to determine their antimicrobial resistance pattern in Bangladesh. A total 131 oral swab samples were collected from Outdoor Dental Unit, Mymensingh Medical College Hospital and Vhani Dental Care during October 2019 to September 2020. The samples were cultured onto Mannitol Salt Agar (MSA), De Man Rogosa Sharpe (MRS) and Mittis Salivarius Agar. The isolation and identification of the oral

and periodontal diseases pathogens were performed based on morphology, staining, biochemical and molecular properties. The isolates were subjected to antimicrobial susceptibility test using 12 commonly used antibiotics by disk diffusion method. Among the 131 oral swab samples, 64 (48.9%) were found to be positive for *Staphylococcus aureus*, 18 (13.7%) were *Lactobacillus spp* and 84 (64.1%) were *Streptococcus sp.* Antibiotic sensitivity test showed that 100% of *Staphylococcus aureus* were resistant to metronidazole, 95.3% were found resistant to cephradine and 90.6% were resistant to amoxicillin. For *Lactobacillus spp.* 100% were resistant to amoxicillin, 94.4% were resistant to metronidazole and 88.9% were resistant to cephradine. For *Streptococcus sp.* 98.8% were resistant to metronidazole, 97.6% were resistant to cephradine and 96.6% were resistant to amoxicillin. However, none of the isolates were 100%sensitive to any antibiotics tested. Overall, 100% of *Lactobacillus spp,* 95.2% of *Streptococcus sp.* and 92.2% of *Staphylococcus aureus* were multidrug resistant. The antibiogram profile of the isolates will be very helpful in judicious use of antimicrobials for treatment of clinical cases of children in Bangladesh.

Evaluation of Genetic Diversities and Risk of Re-Emerging Highly Pathogenic Avian Influenza Viruses from Infected Chickens, Turkey, Crow, Ducks, Quails and Other Infected Birds of Bangladesh

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Abstract

Introduction: Disease are major hurdle of successful domestic bird rearing. The main hindrance of domestic and semi domestic birds rearing is the outbreaks of avian influenza (AI). Crows, sparrows, pigeons, herons living around the farm or along with home ground may often provide a bridge to transmit AI in man and other birds.

Methodology: This study was designed to identify type of avian influenza viruses circulated in domestic birds. A total of five crows, three sparrow, seven quails, four pigeons, and six turkeys were investigated. The birds submitted to necropsy at central disease investigation laboratory (CDIL), 48 Kazi Alauddin road, Dhaka constitute the study materials. A systemic investigation and reverse transcriptase polymerase chain reaction (RT-PCR) techniques and sequencing of the cDNAs were carried out to identify the specific types of avian influenza.

Findings: At necropsy the birds showed wide spread congestion and hemorrhages in trachea and lungs, hair follicles, pancreas and visceral organs. Histopathological examination of the visceral organs showed massive and widespread congestion and hemorrhages. Viral RNA extracted from the trachea of suspected birds and used in RT-PCR found to amplify matrix protein gene specific fragments (430bp) in three crows, two sparrows, five quails, two pigeons and four turkeys. The viral RNA was used in RT-PCR amplification of hemagglutinin (HA) and neuraminidase (NA) genes using published primers. Results of RT-PCR generated 1475bp and 1089bp amplicons specific to HA and NA genes of AI viruses in three crows, two sparrow, five quails, two pigeons, and five turkeys. The cDNAs of HA and NA genes were prepared for sequencing.

Conclusions: Domestic and wild birds found to infect with avian influenza viruses. The sequence data will be studied and phylogenical analysis will be carried out to note for the presence of specific types of AI viruses and possible emergence of pandemic viruses.

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Molecular Identification and Isolation of PPR Virus in Vero Cell for the Development of PPR Viral Vaccine

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Abstract

Introduction: Peste des petits ruminants (PPR) is an acute and rapidly propagating viral disease of goats leading to morbidity and mortality. To protect infectivity, it needs routine immunization. The vaccine currently used in Bangladesh is derived from African isolate, need native vaccine viral isolate.

Methodology: This study isolated PPR virus from field cases. Twenty clinically infected goats were examined from Mymensingh and Chuadanga districts, Bangladesh. Molecular identification of PPR virus was done by RT-PCR and known positive PPR virus was grown in Vero cells. Confluent monolayers of Vero cells were prepared in 25cm^2 flasks using Minimum Essential Medium (MEM) enriched with 5-10% fetal calf serum. The cells were examined daily for cytopathic effects (CPE) and the cell culture supernatant was tested by RT-PCR for the detection of growing PPR virus. The isolated virus may be used as viral antigen for vaccine formulation.

Results: PPR infected goats showed high fever, occulonasal discharges, profuse diarrhea, soiled anal region and stomatitis. Out of 20 samples tested in RT-PCR, PPR positive amplicon (402bp) was detected in 16 cases. The partial N gene of four isolates was sequenced and submitted in GenBank (MW444788, MW525117, MW525118 MW525119). A distinctive close relationship between Bangladesh isolates and isolate of China, India, Nepal, Bhutan and Middle-eastern isolates were found. Two field strain PPRV (MW525118, MW525119) was adapted in Vero cells. After inoculation of PPRV in Vero cells, the minimum cytopathic effect has started to develop following day 2 of inoculation and maximum CPE was seen in day 7 post inoculation. The infected Vero cells showed cell fusion, extensive cell vacuolation, cytoplasmic extension, and syncytia formation. Acidophilic intracytoplasmic and intranuclear inclusions were also seen. Up to 20th passages of PPRV in Vero cell line was achieved.

Identifying Infectious Causes of Caprine Abortion from the Aborted Foetus and Slaughtered Goats

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Abstract

Introduction: Abortion in small ruminant is caused by infectious and non-infectious agents. The infectious causative agent of caprine abortion have public health implication. Bangladesh having agro ecology, with a goat population of more than 26.26 million heads. The goat's productivity is frequently affected by toxoplasma, leptospira, listeria, brucella, Q fever, chlamydial abortion, babesia, neospora and PPR virus, the pathogens of caprine abortion.

Methodology: A total of 32 aborted fetus and 50 slaughtered goats were examined and liver, spleen, kidney, stomach, placenta from the aborted fetus and liver, spleen and kidney from the slaughtered goats were collected. The organs were fixed in formalin, processed for H&E staining, Gram staining and PAS staining and examined under microscope to visualize specific lesions. Parts of the organs

were used for DNA and RNA extraction and PCR and RT-PCR detection of specific pathogens of caprine abortion.
Findings: Results of PCR with fetal DNA (N=32) showed *Toxoplasma gondi* (B1 gene, 512bp) in five cases (15.62%). DNA extracted from the liver of slaughtered goats showed *Toxoplasma gondi* in a case. Histopathological changes of tissues were also observed and banana shaped tachyzoite of Toxoplasma was seen in five fetus and a slaughtered goat. The PCR amplified *Listeria monocytogenes* (517bp), *Chlamydophila abortus (*315bp) and *Leptospira interrogans* (323bp) species specific amplicons in three (9.4%), one (3.12%) and three (9.4%) aborted fetus respectively. DNA extracted from the slaughtered goats showed *Leptospira interrogans* in five cases (10%) and *Listeria monocytogenes* in a case. The causes of abortions due to brucellosis, babesiosis, neosporosis, Q fever and PPR viruses was not identified in this study.
Conclusions: The infectious agents of caprine abortion like toxoplasma, listeria, and leptospira having public health importance. It needs extensive study to detect causal agent of caprine abortion and designing future preventive and control strategies for better production and management.

A Study to Design Protocols for the Detection and Management of Multi Drug and Extensively Drug Resistance Tuberculosis (Tb) in the Dairy, Slaughtered and Zoo Animals of Bangladesh

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Abstract

Introduction: Bangladesh is a top ten tuberculosis (TB) burden country in the world and the National Tuberculosis Control Program (NTP) is trying to reduce TB burden. The difficulties may be due to unidentified corner of TB in a number of sources including wild life. This study was designed to detect specific cause of tuberculosis in wild animals.
Methodology: Twelve animals of nine different species investigated were spotted deer, gayal, giraffe, bhutanese cow, white lion, impala, wildebeest, kangaroo and rabbit. The dead animals were examined in situ, necropsy and gross pathological examination were carried out. Impression smears onto the slides were examined following Ziehl Neelsen staining. Portion of the visceral organs were used in genomic DNA extraction for the multiplex and uniplex PCR detection of specific species of TB. The uniplex PCR targeted Rv3479HP gene of *Mycobacterium tuberculosis* (667bp) and MPB83 gene (600bp) of *Mycobacterium bovis*. Portion of organs was preserved in 10% neutral buffered formalin, processed, sectioned and stained with H&E and Ziehl Neelsen staining.
Findings: Lungs was the predominant site for tuberculous infection. Creamy to yellowish caseous mass and granulomas in the lungs consisting of peripheral cuff of lymphocytes, epitheloid cells, Langhan's type multinucleated giant cells and calcification. Pink color bacilli under microscope were detected in six animal's tissues. PCR confirmed *Mycobacterial* infectivity (1030bp) and infectivity due to *Mycobacterium tuberculosis* complex (372bp) in seven cases. Uniplex PCR showed three animals (two spotted deer and a gayal) were infected with *M. tuberculosis* and four animals (Bhutanese cow, giraffe, white lion and impala) with *M. bovis*.

Conclusion: *M. tuberculosis* and *M. bovis* are extremely zoonotic pathogen and found to infect captive wildlife; may be a silent corner of TB. It requires massive surveillance of zoo animals to detect TB at regular intervals and enabling country NTP to curtail its burden.

Improving Veterinary Services Through Digitalization of Animal Health and Disease Information System at Veterinary Teaching Hospital of Bangladesh Agricultural University

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Abstract

Veterinary Services preserve and develop animal resources, reducing poverty and hunger worldwide through improving rural livelihoods and feeding the world. The delivery of veterinary services to livestock populations in Bangladesh has never been easy. Over the last couple of years the veterinary services are getting momentum, and animal owners/farmers are now more aware of their animal health, production and disease. Veterinary Teaching Hospital (VTH) of the Faculty of Veterinary Science, BAU has been playing an important role to produce and foster skilled veterinarians since its establishment. Besides, VTH provides animal health and disease management services to animal populations of greater Mymensingh, and of other divisions to some extent. To date around 4000 farmers/animal owners are getting veterinary services through VTH. However, the service delivery system including diagnostic approaches, and record keeping system at VTH remain backdated. At the present time, timely and good-quality information about health and disease events are needed in order to understand the disease situation, support decision-making, prevent potential disease incursion and respond quickly in an emergency situation. The present government under the dynamic leadership of Prime Minister Sheikh Hasina has transformed the country into a Digital Bangladesh by making information technology accessible to all, including the marginal people, through efficient, service-oriented and ICT-friendly services. Therefore, the study is intended to improve veterinary services at VTH through digitalization of animal health and disease management system with a follow up efficiency study of the system in terms of client's satisfaction, and performance of the VTH personnel. Though the revised budget is approved the project's main activities are not started as because the fund is not released yet.

Prevalence of Clinical Mastitis Pathogens in Dairy Cows and Their Antimicrobial Resistance Pattern

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Abstract

Clinical mastitis is the most prevalent and significant disease of dairy cows, which causes huge economic losses to the dairy industry worldwide including Bangladesh. The present study was conducted to identify the bacteria causing clinical mastitis from recent cases in dairy cows along with their antibiogram studies. Data and milk samples were collected from 150 lactating cows from seven

upazilas of two districts in Bangladesh. Six types of bacteria were isolated by using selective media, and identified by Gram-staining, biochemical characteristics, and PCR. Among 150 samples, the frequency of *E. coli*, *S. aureus*, *S. hemolyticus*, *S. sciuri*, *Str. dysagalactiae*, *Enterococcus* spp. was 40.0%, 43.3%, 23.3%, 6.7%, 6.7%, and 20.0%, respectively. Antibiogram studies revealed that all the isolates of *S. aureus*, *S. hemolyticus* and *S. sciuri* were resistant to penicillin G, ampicillin and amoxicillin. In contrast, 100% *S. sciuri* was sensitive to amoxicillin-clavulanic acid, gentamicin, streptomycin, ciprofloxacin, oxytetracycline and cotrimoxazole. In case of *E. coli*, highest resistance (66.7%) was observed against ampicillin, amoxicillin and erythromycin. Moreover, all the isolates of *Enterococcus* spp. were resistant to amoxycillin, amoxycillin-clavulanic acid, and cotrimoxazole. Resistance levels among the *Str. dysagalactiae* isolates were high, and it was revealed that 100% isolates were resistant to 6 antimicrobials (penicillin G, ampicillin, amoxycillin, amoxycillin-clavulanic acid, oxytetracycline, and cotrimoxazole). Most importantly, all the isolates of *S. aureus*, *S. hemolyticus*, *Str. dysagalactiae*, and *Enterococcus* spp. were multidrug-resistant (MDR) while 83.3% *E. coli* showed MDR. However, none of the isolates of *S. sciuri* was MDR. We observed strong correlation between antimicrobial use and antimicrobial resistance and antimicrobial resistance gene. The high resistance percentage against different antimicrobials in mastitis pathogens is alarming, which may limit the therapeutic possibilities of clinical mastitis in dairy cows. Therefore, it needs regular monitoring of antimicrobial resistance of mastitis pathogens, and antimicrobial stewardship should be conceived and implemented. In addition, udder health and hygiene should be emphasized to ensure IPC (Infection prevention and control).

Welfare Assessment of Dairy Cattle in Baghabarighat Milk Shed Areas of Bangladesh

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Abstract

The aim of the present study was to evaluate the welfare status of dairy cows and the prevalence of subclinical mastitis (SCM). Data collection was performed by a face-to-face interview with farmers using a structured questionnaire, followed by an inspection of animals and on-farm direct observation. A cross-sectional study was conducted during the period from May 2019 to September 2020 in Sirajgonj and Pabna districts. A total of 348 cross-bred lactating cows from 136 farms in the dry season and 337 lactating cows from 134 farms in the wet season were included from 270 dairy units. The overall prevalence of SCM was 32.35 % (n=685) at cow level using the California mastitis test kit. The prevalence of SCM was higher ($P<0.05$) in the wet compared to the dry season. The prevalence of SCM was not significantly different among the different types of floor ($P>0.05$). The prevalence of skin lesions in different body parts was higher in brick-made (62%) and concrete floor sheds (88%) compared to soil bedded (31%) floors. Hair loss in the concrete and brick-made floor was significantly higher ($P\leq0.01$) in comparison with the soil floor. About 14.0 % of cows had various forms of lameness. The highest percentage (64.52%) of the cow had BCS 2 and found the highest milk yield (12.65 l/d/cow). Among studied animals, hock injury (78.6%), knee injury (48.8%), and a pronounced state of poor cleanliness on dirty udder (65.58%), flank (54.74%), and hind limbs (86.4%) were observed. Many farmers did not follow routine vaccination and deworming schedules. Farmers had no idea about animal welfare. About 100% and 93% of farmers believed that good attitudes increases and negative handling decreases milk production, respectively. Farm animal welfare is still in its early stage of development and more efforts are needed to improve the farmers' perception of animal welfare.

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Exploring Co-Regulatory Transcriptional Networks of Bovine Mammary Epithelial Cells in Response to Mastitis Causing Bacterial Infection

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Abstract
Bovine mastitis is defined as the inflammation of mammary gland and is the costliest disease of dairy cattle worldwide. Mammary epithelial cells stand at the frontline resisting bacterial infections in mammary glands, and therefore, severity of mastitis largely depends on the patterns of interactions between invading pathogens and the bovine mammary epithelial (BME) cells. This study was aimed at exploring the mechanisms and identifying the key candidate genes associated with S. aureus and E. coli mastitis. A public microarray dataset GSE24560 was downloaded. Differentially expressed genes (DEGs) were screened in E. coli- and S. aureus-infected BME cells. A functional enrichment analysis was performed, and construction of a gene co-expression network was performed based on genes that showed consistent changes over time, which were identified using time series expression analysis. Then, a miRNA/TF regulatory network was constructed based on the genes in the co-expression network. The genes in the miRNA/TF regulatory network were screened for involvement in related diseases. In total, 92 and 81 DEGs showed continuous differential expression over time in the *E. coli*- and *S. aureus*-inoculated groups. DEGs in the *E. coli*-inoculated group were associated with the NOD-like receptor signaling pathway, and those in the *S. aureus*-inoculated group were associated with the lysosome pathway.

Knowledge, Attitude and Practices of Veterinarians Regarding Lumpy Skin Disease Outbreak in Cattle in Bangladesh

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Abstract
The Lumpy skin disease (LSD) is a highly contagious, transboundary, and notifiable emerging viral disease of cattle worldwide including Bangladesh. The LSD has economic impact causing decreased milk yield, abortion and infertility in cows and the reduced growth rate in beef cattle. Since an emerging disease, the veterinarians working in the field have come across the LSD as new cases, and front liners to provide service related to treatment and management of clinical cases. Therefore, a country-wide, cross-sectional questionnaire survey was conducted among the Government, non-government, and private veterinary practitioners to gather existing field-side knowledge, attitude and practice associated with LSD outbreak. A total 398 practicing veterinarians participated in this study, among them 283 (71.11%) were male and 115 (28.89%) were female. The responders were aged between 22 to 30 years old and many of them (83.67%) were experienced with the field case of LSD. Round circumscribed nodule, skin eruption, and edema in the brisket regions were reported as the major clinical signs. Among the responders, 76.18% think that field sided diagnosis is confirmatory, remained think that laboratory test is required for confirm the LSD diagnosis. Many of them thought that there is no significant association of age, sex and breed of the host with the occurrence of LSD but

hot humid weather may influence the LSD outbreak. Mechanical vector and direct contact are the major mode of viral transmission. From the total participants, about 45.80% of them think antibiotics are rationally used, 39.05% participants think antibiotics are irrationally used and 15.15% of participants had no idea about rationality of antibiotic therapy in the treatment of LSD. Majority of the participants about 66.55% mentioned LSD outbreak has negative impact on antimicrobial resistance. In conclusion, this proposed survey would contribute to a better understanding of veterinary clinical aspects of the LSD outbreak, and thereby to design effective strategies for the preparedness and control of LSD outbreaks at the regional and the national level.

Bulk Milk- and Individual Cow Level Somatic Cell Count Cut-off for the Diagnosis of Subclinical Mastitis in Dairy Cattle

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Abstract
Our aims for this study were to determine the optimal cut-off values of somatic cell counts at bulk milk and individual cow milk level for the herd and cow level diagnosis of subclinical mastitis. Based on the selected cut-off values we estimated the herd and cow-level subclinical mastitis prevalence and identified the herd and cow level risk factors. A cross-sectional study was undertaken between 01-10-2019 and 01-10-2021 in the Baghabarighat milk shed area. Bulk milk and individual cow milk were collected aseptically from 342 and 965 randomly selected herds and cows, respectively. The herd- and cow-level risk factor data were recorded using a pretested questionnaire. Somatic cells per milliliter of bulk- and cow-level milk was counted using a somatic cell counter [Ekomilk Scan]. The herd- and cow-level somatic cell cut-off values for the diagnosis of subclinical mastitis (SCM) were determined using ROC curves in the "OptimalCutpoints" R package. The cow- and herd-level prevalence of SCM were estimated using a Bayesian hierarchical model. The herd-and cow-level risk factors for SCM were identified using Bayesian mixed-effect logistic regression models. The herd- and cow-level somatic cell cut-off values were determined as 205,000 and 97,000 cell/ml milk, respectively. About 62% (57.0; 67.0) of the herds were SCM positive. The overall cow-level SCM prevalence was 69.1% (59.1; 79.1). Cleanliness of the floor and herd size were identified as the risk factors for herd-level SCM. On the other hand, lactation stage and history of clinical mastitis were identified as cow-level risk factors for SCM. The herd-and cow-level cut-off we determined should be used for the diagnosis of the herd and cow-level diagnosis of subclinical mastitis. The herd and cow-level SC is very high in the study area. Floor cleanliness will help reduce the prevalence of herd-level SCM. Cows in the lactation stage of >5 months and having a history of previous clinical mastitis especially in herds with >7-11 cattle should be targeted for future surveillance control programs.

Livestock and Human Brucellosis: Molecular Diagnosis, Treatment and Control 4. Development of Treatment Strategy for Human and Animals Infected with Brucellosis

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Abstract
Brucellosis is a 'multiple burdens' disease with economic impacts attributable to human, livestock and wildlife disease. The importance of brucellosis is not known precisely, but it can have considerable

impact on socioeconomic development and continue to be a major public and animal health problem in many regions of the world especially in countries like Bangladesh where rural income relies largely on livestock breeding and dairy products. In animals, brucellosis mainly affects reproduction and fertility, with abortion and reduced milk yield. In man, the clinical picture resembles many other febrile diseases, but sacroiliitis and hepato-splenomegaly are the most prominent. Brucellosis is endemic both for human and animal in Bangladesh. *Brucella* positive cows, of which four had history of abortion were selected for therapeutic trials with combined long acting oxytetracycline @ 25 mg/kg BW 16 doses at 72 hours intervals and streptomycin @ 25 mg / kg BW 10 doses at 24 hours interval injections. Blood samples of all the *Brucella* negative control and pre- and post-treatment stages of all the *Brucella*-infected cows were tested for haemato-biochemical changes and *Brucella* antibody responses by using ELISA and PCR. The haemato-biochemical values between *Brucella*-negative and positive cows and antibiotic pre-treated and post-treated values of *Brucella*-infected cows were compared and discussed. The antibody titer decreased with antibiotic treatment and increased on with-drawl of the antibiotic at 180 days which indicates that antibiotics only effective against bacteremia form not intracellular stage that caused to relapse. Treated cows became pregnant on artificial insemination with normal reproductive cycle and gave birth. Comparative study on haematological and biochemical changes between healthy and brucellosis infected humans were performed. A multi-locus analysis of concatenated data sets of 9 genes gap, aroA, dnaK, gyrB, trpE, dnak, glk, omp and int-hyp inferred the phylogenetic position of the Bangladeshi 4 (four) isolates of *B. abortus* clade were recorded with well supported value.

Molecular Diagnosis and Risk Factors of Q Fever in Human, Cattle & Goat

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Abstract

Q fever is a zoonotic disease caused by *Coxiella burnetii*. Cattle, sheep, goat act as a primary reservoir host of this disease. Coxiellosis occurs during late pregnancy (about 15 days before term) and leads to abortion and stillbirth in goats and sheep, infertility, mastitis and endometritis in cattle. In humans, it affects respiratory system, musculoskeletal system, digestive system, nervous system and cardiovascular system. Usually, the disease has non-specific clinical manifestation, with an onset as a flu-like febrile infection accompanied by severe headache. Q fever has been spread worldwide with the exeption of New Zealand and the infection is habitually asymptomatic both in humans and in animals. The present study was conducted for molecular diagnosis and treatment of Q fever in human, cattle & goat in Kurigram sadar, Kurigram, Shahjadpur, Sirajgonj, Pabna sadar, Pabna and Mymensingh sadar, Mymensingh. Questionnaires containing information of animal's age, breed, and history of anoestrus, retention of placenta, repeat breeding and abortion were prepared and filled out during collection of sample. A total of 162 cattle, 172 goat and 159 human serum samples, 119 cattle milk samples, 6 aborted materials of goat and 126 tick samples were collected for this study. Cattle and goats with the history of reproductive disorders (retained fetal membrane, abortion, anestrous, repeat breeding) and human patients with PUO (pyrexia of unknown origin) with body temperatures higher than 38°C and lasting over a period of three weeks and who were in close contact with animals, came for treatment at Mymensingh Medical College Hospital, Mymensingh, Bangladesh were selected for sampling. Milk and sera samples has already examined by for antibodies against *C. burnetii* using the commercial CHEKIT® Q fever antibody ELISA Test Kit (IDEXX, Liebefeld-Bern, Switzerland). ELISA plates are coated with *C. burnetii* inactivated phase 1 and phase 2 antigens. DNA from seropositive samples of *C. burnetii* are now extracting using the High Pure PCR Template Preparation Kit™ (Roche Diagnostics,

Mannheim, Germany) for PCR. The total DNA from ticks will also be extracted using Nucleo Spin Tissue kit (Macherey-Nagel GmbH, Duren, Germany) for PCR and the study is still in progress.

Molecular Epidemiology of *Mycobacterium bovis* Infection in Animals and Man in Bangladesh

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Abstract
The present study was designed to determine the prevalence of tuberculosis (*Mycobacterium species*) in human and animals by conventional and molecular techniques. Data were collected by history taking from the TB suspects and from the findings of laboratory investigations of relevant specimens especially sputum from human and milk, blood, lymph node aspirate and tissue from animals. A total of 262 TB suspects were interviewed. Sputum from 262 patients were examined under LED microscope after auramine staining and 28 were found positive for tubercle bacilli. GeneXpert/RIF was done with 65 samples of sputum and 26 were found MTB positive and RIF sensitive while 2 were found MTB positive but RIF resistant. Uniplex PCR showed 21 positive cases for genus *Mycobacterium*. Multiplex PCR and gel electrophoresis were done and 21 were found positive for species *Mycobacterium tuberculosis*. These Multiplex PCR products were sent for DNA Sequencing. Results of DNA sequencing was submitted to GeneBank and got the accession number. Strains of *M. tuberculosis* isolated by us showed similarity with the strains related to other parts of the world. Overall detection rate of TB in TB suspects by LED microscopy was found 10.69%. A total of 560 BTB suspected animals were CFT (Caudal Fold Tuberculin) tested with bPPD (Bovine purified protein derivatives) where 35 (6.30%) were shown sensitive. On the other hand, a total of 410 BTB suspected animals were tested with bovine antibody rapid test kit where 1.00% found positives for *Mycobacterium bovis*. Fifty five samples (Milk, blood and tissue) were tested by Zeihl Neelsen staining and light and inverted microscopy where 3 (5.50%) were positive. Uniplex PCR was done for 181 samples (Milk, blood and tissue) and 21 (11.60%) found positive for genus *Mycobacterium*. Multiplex PCR and gel electrophoresis were done and 5 (2.76%) were found positive for species *Mycobacterium bovis*.

Role of Heat Shock Proteins (HSPs) in Immunomodulation, Adaptation and Productivity of Indigenous Goats Under Heat Stress Condition

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Abstract
Heat stress induced by long periods of high ambient temperature decreases animal productivity, leading to heavy economic losses. This devastating situation for livestock production is even becoming worse under the present climate change scenario. The cellular and molecular responses in heat stress in livestock are very crucial as it may lead to identification of confirmatory biomarker for this stress in livestock. The heat shock protein (HSP) acts as molecular chaperon to survive cell under heat stress condition. The research was, thus, conducted to assess the role of HSP on resilience of indigenous

goats under high ambient temperature. To perform the research, two indigenous breeds of goats [(Black Bengal (BB), and Jamunapari (JP)] are utilizing. Physiological parameters like rectal temperature (RT), heart rate (HR)and respiratory rate (RR) are being recorded at 15 days interval in summer (April-July) and winter (November-February) in the morning and afternoon. Peripheral blood has been collected similarly at 15 days interval in both the seasons. From the whole blood, serum and peripheral blood mononuclear cells (PBMC) have been prepared for biochemical analysis and immune study (cytokine and HSPs mRNA expression) respectively. In this study so far, there were no significant difference in RT, HR and RR between the BB and JP goats but these parameters were significantly (P<0.05) higher in the afternoon than those of morning. There was no significant variation in hematological profile among the breeds. In terms of serum biochemistry, except Aspertate Transaminase (AST) there was no significant changes in total protein, albumin, glucose, ALT, creatinine, urea, calcium, phosphorus, and magnesium among the breeds. The value of AST was significantly (P < .05) lower in Jamunapari goats as compared to local goats. The data so far are very promising and after successful completion of the project, it may be possible to explore the prominent biomarker acting as heat stress protecting molecule in our indigenous goats.

Effects of Increased Drinking Water Salinity on the Haemato-Biochemical Parameters of Black Bengal Goats

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Abstract

Global climatic changes are contaminating ground and surface water sources around the world, resulting in increased salinity. Knowing the animals' typical physiological capability for salinity tolerance without compromising their health is a necessity. The research was undertaken to determine the impacts of long-term drinking water salinity on hemato-biochemical parameters of Black Bengal goats. A total of 40 Black Bengal goats (20 male and 20 female), weighing an average of 18 kg and age ranging from 1 to 5 years, were randomly selected from two Upazilas in the coastal belt (Koyra, Khulna) and riverine areas (Sharisabari, Jamalpur) of Bangladesh. In order to account age effects, all goats were categorized as young (less than 2 years) and adults (older than 2 years). The goats were again subdivided into 2 groups based on the geographical locations. The animals of group 1 received higher saline water (12 ppt) and those in group 2 received lower saline water (1 ppt) as regular drinking water. Blood parameters of all selected goats were measured. Serum creatinine, uric acid, urea, potassium, sodium, and chloride were significantly higher (P<0.05) in the animals of group 1 compared with group 2, although serum phosphorous was significantly lower (P<0.05) in group 1 compared with group 2. There were no significant differences in serum aspartate aminotransferase (AST), alanine aminotransferase (ALT), glucose, magnesium, and calcium between the animals of group 1 and 2. AST and magnesium differed significantly (P<0.05) between young and adult goats in group 1. Glucose and urea levels were slightly higher (P<0.05) in young goats. In both groups, male goats had significantly higher (P<0.05) serum potassium and urea levels than female goats. The results suggest that Black Bengal goats of the coastal areas have different salt tolerance capacities based on their age and sex, and adapt to higher salinity by changing kidney functions.

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Midline and Flank Approaches for Spaying: A Comparative Study in Cats

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Abstract
The study was conducted to compare midline and flank approaches for spaying in cats. Ten queen cats age between 8 months to 2.5 years and body weight between 1.5 to 3 kg were randomly selected at Veterinary Teaching Hospital, Bangladesh Agricultural University. Cats were divided into two groups based on surgical approaches for spaying, Group-A (Flank approach) and Group- B (Midline approach). In order to evaluate the best approach for spaying, various parameters such as length of surgical incision, extent of haemorrhage, ease of location and exteriorization of ovaries and uterus, duration of surgery, post-operative complications, and time required for complete wound healing were recorded. In addition, the heart rate, respiration rate and temperature were recorded at different days of experiment. The heart rate, respiration rate and temperature were significantly ($P<0.05$) differ between two groups. The heart rate was higher in group B whereas the respiration rate and temperature were more in group A. In both groups, the average length of skin incision was 2.8 cm. The average time of exteriorization of ovaries and uterus was 23.50±6.56 minute in ventral midline approach which was higher than flank approach (19.25±6.40). The average time for duration of surgery was 54.25±7.23 and 55±10.80 minute in group A and B, respectively. The average wound healing days was also more in group B (29.75±1.26) comparing to group A (23.75±7.85). During Spaying in cats, extent of haemorrhage was mild to moderate in flank approach, whereas it was moderate to severe in ventral midline approach. The post-operative complications were less in flank methods than ventral midline approaches. It is concluded that spaying through flank approach is superior to the midline approach due to convenience, faster healing, less bleeding, rapid recovery, and less postoperative complications.

Physiological Adaptation of Indigenous Sheep to Increased Water Salinity at the Coastal Areas of Bangladesh

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Abstract
Water and soil salinization is becoming more common as a result of global climate change, posing significant hazards to farm animal productivity. In these salinity-affected areas, adequate adaptation mechanisms for farming methods are critical. As a result, the study investigated the adaption mechanisms or methods for preserving salt-water balance in sheep when drinking saline water for an extended period of time in Bangladesh's coastal districts. A total of 30 indigenous sheep (15 male and 15 female) with ages ranging from 1.5 to 6 years will be chosen at random from various Upazilas in Bangladesh's coastal areas. To account for age effects, all sheep will be divided into two groups: young (under 2 years) and adults (over 2 years). The sheep will be again sorted into three groups depending on their geographic areas. In group 1, sheep were picked from the coastal area where higher water salinity was recorded (Noakhali), and sheep were selected from the river basin or island around the coastal belt where moderately water salinity was recorded (Khulna). Sheep were chosen as the control group from a location where there was little or no evidence of water salinity (Mymensingh) (group 3). During the first year of the study, animals from the respective research areas were selected, and blood

samples from sheep from group 3 (Mymensingh district) were collected, processed, and laboratory analysis of serum has been carried out to measure alanine aminotransferase (ALT), aspartate aminotransferase (AST), creatinine, urea, uric acid, antidiuretic hormone, aldosterone, cortisol, glomerular filtration rate (GFR), relative medullary thickness (RMT) and osmolality. A detailed questionnaire has been prepared for collection of data related to farming practices, diseases, and different performance of animals in the selected research areas. Blood electrolytes of sheep in group 3 remained within the reference range. No significant difference was observed in serum sodium, potassium and chloride between the young and adult sheep.

Ultrasonographic and Histopathological Examination of Liver and Kidney in Black Bengal Goats While Drinking Saline Water

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Abstract
The objective of this study was to see how different levels of water salinity affected the appearance of the liver and kidneys ultrasonographically and histopathologically, as well as blood enzymes related to liver and kidney function in Black Bengal goats. Twelve goats, ranging in age from 1 to 1.5 years, were divided into three groups (starting weight: 10.91 ± 1.71 kg). For 8 weeks, all goats in group 1 were given to drink tap water as a control, group 2 was provided tap water with 0.5% salt, and group 3 was supplied tap water with 1.0% salt and allowed to drink spontaneously. Blood samples were collected weekly from all animals. At the beginning and end of the trial, ultrasonography was conducted. At the completion of the study, one goat from each group was slaughtered and liver, spleen, lung, kidneys and genital tract were collected for histopathological examination. Body weight did not differ considerably between the groups. Serum alanine aminotransferase (ALT), aspartate aminotransferase (AST), urea, and creatinine are now being measured in the laboratory. In group 3, an ultrasonographic examination of the liver revealed a hyperechogenic appearance. During an ultrasonographic examination of the kidneys, no changes were identified in the left or right kidneys. In comparison to group 1, gross examination of the samples revealed pale and fibrosed liver in groups 2 and 3. The liver, spleen, lung, and kidneys are all being examined histopathologically. Water salinity is thought to alter the activities of the liver and kidneys, as well as their appearance in Black Bengal goats, and thus goat production.

Blood and Plasma Transfusion for the Clinical Management of Critically Ill Sheep (Ovis aries)

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Abstract
This study investigated the hematobiochemical and clinical responses of blood and plasma transfusion in critically ill sheep. Ten unhealthy ill sheep of both sexes were divided into two groups. The group A (n=5) received blood and group B (n+5) received plasma transfusion. Blood was transfused to the recipients (group A) afresh immediately after collection or serum was separated and transfused to the recipients (group B). Blood samples were collected from the experimental animals before and after transfusion (day-1, 7, 14, 21 and 28) and subjected to complete blood count (CBC): total erythrocyte

count (TEC), total leukocyte count (TLC), haemoglobin (Hb), packed cell volume (PCV), differential leukocyte count (DLC) and biochemical assay: total protein (TP), ALT, AST and Creatinine. The TEC, PCV, Hb and TP were increased significantly in both the blood and plasma transfused sheep but the parameters were found superior in blood transfused animals. There were minor elevation in the level of ALT, AST and creatinine but remained in normal range. The findings of this study suggest that the blood transfusion is superior in upgrading hematological (TEC, Hb, PCV) and Biochemical (TP) parameters in sheep in comparison to that of the plasma transfusion. Transfusion of blood and plasma do not adversely affect kidney functions (no significant change in creatinine level) and also do not cause any hepatic injury (no significant change in ALT and AST level). The blood and plasma transfusion can be a successful tool for the treatment and clinical management of severe anemia and critically ill sheep.

Blood and Plasma Transfusion for the Treatment of Critically Ill Goats

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Abstract

Now-a-days transfusion of blood and plasma become a very essential and life-saving tool in veterinary critical care and emergency medicine throughout the world. This study investigated the clinical and hematobiochemical responses of blood and plasma transfusion in severe anemic goats. From January 2020 to December 2021, a total of 13 anemic goats were admitted in the Veterinary Teaching Hospital (VTH), Bangladesh Agricultural University (BAU), Mymensingh. Among them, 7 clinical anemic goats (group A) received fresh whole blood transfusion and 6 (group B) received plasma transfusion. The recipients were selected depending on the clinical and hematological parameters and containing less than 18% PCV with clinical sign of weakness and pale or whitish mucous membrane (anemic). Five healthy goats were used as donors. Desired amount of CPDA-1 (1 ml/7 ml blood) was taken into a 50 ml disposable syringe and blood was collected from the donor through jugular venipuncture. The blood was then transfused @10-12 ml/kg body weight afresh to the recipient or centrifuged for separation of plasma for transfusion. Clinical (heart rate, respiratory rate and rectal temperature), Hematological (TEC, TLC, HB, PCV, Neutrophil, Eosinophil, Lymphocyte, Monocyte), Electrolytes (Na^+, K^+, Cl^-) and Biochemical (ALT, AST, Creatinine, TP) parameters were evaluated before and after at 1st, 7th, 14th, 21th, 28th days post-transfusion. In both the group, total erythrocyte counts (TEC), packed cell volume (PCV), hemoglobin (Hb) and total protein (TP) were increased significantly ($p<0.05$) at 1st, 7th, 14th, 21th, 28th days of post-transfusion in comparison to pre-transfusion values. However, the hematological parameters were found superior in the animals received blood transfusion. All the animals recovered successfully except one received blood transfusion that was critically ill, emaciated, lateral recumbent and cannot stand, eat or drink. The blood and plasma transfusion was found to upgrade the hematological and biochemical parameters in anemic goats. The transfusion of blood and plasma can be an effective tool for the clinical management of anemic goats.

Application of Genomic Tools for Genetic Improvement of Crossbred Friesian Cattle in Bangladesh

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Abstract
Productive and reproductive performance of dairy cows are governed by genetics. The objectives of the investigation were to identify the best crossbred Friesian dam and sire using genomic tools for future selection to be used for AI in Bangladesh. A total of 1000 phenotypically looked crossbred Friesian cows from 60 private and 2 public dairy farms from 4 divisions (Dhaka, Chattogram, Mymensingh and Rajshahi) were randomly selected and tagged. Phenotypic data from selected cows were collected 1-2 months interval using questionnaire and farm records. One blood sample (~10 ml) was collected from each animal and genomic DNA was extracted following standard procedure using commercial kit. The quality and concentration of extracted DNA were checked by Nanodrop machine. The DNA was analyzed for genomic admixture by using Axiom bovine (BOVMDv3) 60K SNP array following standard protocol in Animal Production and Health Laboratory (APHL), Seibersdorf, Vienna, Austria. On the basis of presence of Taurine genetics, animals were classified into <25.0%, 25.0 to <50.0%, 50.0 to <62.5%, 62.5 to <75.0%, 75.0 to <87.5%, and ≥87.5% Tarine cows. Among 944 genotyped cows, the highest proportion of cows (n=301; 31.9%) had 50.0 to <62.5% and the 2nd highest proportion (n=277; 29.3%) had 62.5 to <75.0% Taurine blood in 4 divisions. The mean lactation yield in 1st, 2nd, 3rd, 4th, 5th and 6th lactation were 2856.8±3.4, 3164.7±2.6, 3347.7±6.2, 2756.7±4.3, 2157.8±5.2 and 1858.7±3.2 L, respectively in cows with 62.5 to <75.0% Taurine genetics. The age at first service was 517.5±5.2 days, calving to 1st service interval was 151.3±1.0 days, calving to conception interval was 169.3±2.0 days, calving interval was 483.7±2.0 days, 1st service conception rate was 46.01% and service per conception was 1.89 in studied cows. This study will lead to select desired sire and dam by the AI programmes and farmers in Bangladesh.

Efficacy of Platelet Rich Plasma on Clinical Management of Arthritis in Calves

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Abstract
Arthritis is inflammation in joint. Analysis of synovial fluid for detection of arthritis. Physical, chemical, clinical and cultural parameters. Pain response, enlargement of joint, lameness, transparency and viscosity of synovial fluid. Chronic arthritis showed pain response, enlargement of joint and hairless skin. Moreover, acute joints infection appeared more firmer, warmer and painful. Synovial fluid of inflamed joints exhibited significantly (0.42±0.123 ml, p>0.012) higher volume than the control (0.143±0.013 ml). Mucin clot test revealed poor or no clot in infected calves, strong bands were found in healthy calves. The cellular infiltration and densities of leukocytes were noticed. The highest leutocytes (75,400/ml) were found in one calf (#12). In this study, total leukocytes were ranged from 21 to 34 cells/ml of synovial fluid of healthy calves. Synovial fluid exhibited 80%, 55%, and 57% of neutrophils in calves No. 12, 13 and 18, respectively. The status of monocytes is highest in calve No. 3 and 7, (75% and 78%) respectively. The highest number of cell types are monocytes (56.33±6.179) followed by lymphocytes (40.2±5.525), neutrophils (1%), basophils (1-4%) and

eosinophils (1-3%) in healthy calves. Bacteria and fungi were isolated from 4 joint, but neither the bacteria nor the fungus were found in joint. This study suggest that 25% of calves might have been affected by arthritis. The cytology of synovial fluid and cultural isolation technique used in this study can be used to detect specific cause of arthritis at sub-clinical or clinical stage. Early detection of specific cause of arthritis in calve may help accurate therapeutic intervention, alleviate pain and finally enabling higher production of milk, meat or offspring.

Comparison of Suture Materials and Closure Techniques of Subcutaneous Tissue and Skin During Experimental Laparotomy in Goats.

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Abstract
Studies on different types of suture materials and closure techniques are very scared in veterinary practice. This study was designed for observing the comparison and outcome of wounds closed with two suturing patterns using four suture materials to compare healing effects of these suture techniques. Simple interrupted and cross mattress suture patterns were used with catgut, vicryl, dexon used in muscle and silk to close loose skin. A good number of surgical wounds were made in 12 goats . The effect of wound healing was measured by morphological, histological and biochemical methods.There is no difference was demonstrated upto 28 days postoperatively. After 70 days, wound sutured with non-absorbable sutures were weaker than those of absorbable suture. Catgut (chromic) produced only mild cellular reactions at 21 days. Polyglactin 910 a synthetic absorbable suture, produced a moderate tissue reaction and uniformly disappear at 28 days . Silk showed the highest rate of wound infection. This study could help to choose appropriate suture materials and suture technique for subcutaneous tissue and skin closure of a particular region in terms of aesthetic view with minimum complication.

Scaling up Assisted Reproductive Technologies (AI and MOET) and Nucleus Flock Development in Local Sheep through Public Private Partnership.

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Abstract
The work was conducted in the Department of Surgery and Obstetrics, Sheep farm, Government Bogra and Rajshahi and NGO (Friendship) Gaibandha district. The objectives were for i) *scaling up of ram semen and developed Artificial insemination (AI) technology in field sheep through public private partnership and ii) buildup and sustainability of nucleus flock in research station with prolific, AI and MOET produced lambs.* ***In research station,*** 30 ewes and 14 ram lambs of 10-12 months were purchased. Following preliminary acclimatization, deworming and vaccination the rams under went for selection of best rams by measuring the reproductive performances and semen evaluation. Blood was collected (5ml) from jugular and stored at -20°c temperature until used for the detection of FcB gene. **In the field** following consultative with local livestock administrator and farmers, training was given to selected farmers using produced manual from the project. The nominated persons (# 6) from each station were given AI technician training in ewes for a period of 7days. For AI, the ewes in all

stations, induced for oestrus by i.m. injection of Cloprostenol, 175µg (Ovuprost^{R,} Bayer, Newzealand). The reproductive performances of Garole rams were higher than local rams (P<0.05). The motility of semen on 2h, 12h, 24h, 48h and 72 hour of production was 72%, 64%, and 54%, 48% and 40%, respectively**.** The body condition score of the ewes was 2.5-3.5 and duration of oestrus was 24.45 ± 0.15 hours. Ewes (# 29) were mated with fertile rams on an average of 13.43±0.17 hours of onset of oestrus. The pregnancy and lambing rates were 89.65% and 1.75%, respectively. The lamb survival rate was 95%. In Bogra, Rajshahi and Gaibandha , the mean time of onset of oestrus was 34±0.72, 34.14±1.16 and 36±0.86, respectively. The prenancy and lambing rates were 81.6% and 1.63% respectively, body weight of lambs were 1±0.09kg, (0.5-2kg). Works are going on to sustain the ram semen production, AI and MOET for quality lamb production through public private partnership.

Factors Affecting the Increased Pregnancy Rates Following Laparoscopic Artificial Insemination (lap-ai) in Local Ewes.

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Abstract

The main objectives of this study were to increase pregnancy rates by LAP-AI in ewes using frozen semen and to determine factors affecting the success of LAP-AI. A total of twenty four ewes and four rams were selected for the study. Six ejaculates were collected from each ram by AV method and evaluated for macroscopic and microscopic characteristics. Frozen semen was produced in the same laboratory by considering the semen concentration of 100×10^6 spermatozoa/ml and volume of 0.25 ml. The selected ewes were synchronized for estrus using two doses of PGF2α (Cloprostenol or Dinoprost) @ 175µg (0.8 ml) i.m injection per ewe at 9 days interval. The factors considered for the observations were age, bodyweight and BCS of ewes, type of synchronizing agents, insemination time, angle of placement of ewes on laparoscopic cradle, and the puncture sites. Pregnancy was confirmed by ultrasonographic scanning on days 45-50 following insemination. The pregnancy rate of ewes having BCS >3 was significantly higher (p<0.05) (78.57% vs. 30%) than BCS 2-2.5. The 20-24 hours insemination time from the onset of estrus using frozen semen yielded a significantly higher (p<0.05) (75% vs. 25%) pregnancy rate than 12-16 hours. The pregnancy rate was higher (66.67% vs. 50%) at 45° angle than 30° angle of placement of ewes on the laparoscopic cradle. However, there was no significant difference (p>0.05). The puncture point, 4-5 cm away from the udder resulted in a significantly higher pregnancy rate (p<0.05) (83.33% vs. 33.33%) than 7-10 cm. The present study indicates that the pregnancy rate with LAP-AI, using frozen semen could be increased if the significant factors are considered during insemination. The ease performance and increase pregnancy rate may ensure the acceptability of LAP-AI by the sheep farmers to speed up the quality production within a shorter time.

Breeding Season and Treatment Manipulation with Zinc and Selenium on Reproductive Efficiency of Rams

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Abstract

Study was carried out to observe the seasonal effects on local rams reproduction and treatment manipulation to increase their reproductive efficiency. Four indigenous and 4 Garole rams were used in both breeding (September-February**)** and non-breeding season (March-August). Morphometric measurement and ultrasonography examination of genitalia and semen evaluation were done for each

ram 1 week before and after treatment within each season. Rams were injected with 160 mg vitamin E and selenium (E-vet plus®) and 0.2 mg vitamin B_{12} (Cynomin®) intramuscularly twice per week for a month. Season effect: Testes length and scrotal circumference were tended to be higher during breeding season compared to non-breeding within each breed. Echo-texture of testes, epididymis, mediastinum thickness, echogenicity and dimension of pampini-form plexus and seminal vesicles were well defined in breeding season compared to non-breeding season. Sperm volume and concentration were significantly higher ($P<0.05$) in Garole rams (0.8±0.01 vs. 0.75±0.04 and 3662.7±82 vs. 3428.5±49) during breeding season compared with non-breeding season. Although some of the individual ram semen had significantly higher ($P<0.05$) motility and percentages of normal spermatozoa however, cumulative significant values ($P<0.05$) were only existed in indigenous rams (87.2±1.12 vs. 82.9±1.12). Treatment effect in non-breeding season: Increased testis length and scrotal circumference were obtained in both indigenous and Garole ram following treatment manipulation compared to without treatment. The echotexture of testis, epididymis, pampiniform plexus and seminal vesicle, thickness of mediastinum were well defined following treatment compared to without treatment. Less Fibrosis was observed in testicular parenchyma following treatment with vitamin and mineral compared to without treatment. Semen volume (0.77±0.03 vs. 0.73±1.12 ml), concentration (3471.2±56 vs. 3059.2±67.4 million/ml) and motility percentage (81.3±0.01 vs. 78.5±0.03) of spermatozoa were significantly higher ($p<0.05$) following treatment compared to without treatment in indigenous rams. There is a tendency of presence of seasonality in both indigenous and Garole rams. Increased reproductive efficiency was observed with treatment. Works is going on to observe the effect with treatment during breeding season.

Ram, Ewe and Lamb Factors Affecting the Pregnancy and Lamb Survival Rate Under Field Condition

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Abstract

Sheep production has been shown to compromise the lamb survivability in field condition. The aim of present study was to evaluate reproductive performances, ram and ewe factors affecting pregnancy, lambing and lamb survival rate. A total of 60 ewes and 6 rams were randomly used for giving natural service in Trisal and Mymensingh Sadar (n=30 and 3 within each area). Presence of infection in semen was confirmed through microbiological examination. Lambs were assessed up to weaning to observe the factors inducing lamb mortality. Higher pregnancy and lambing rate were observed in rams of both areas having no infection in semen sample. Significant difference ($P<0.05$) in pregnancy rate (100 vs. 60%) was observed between two rams (R5 vs. R0) between two different areas. Abortion occurred in rams where both *E. coli* and *Staphylococcus spp.* were found in semen. Pregnancy and lambing rate varied from 70-100% and 86-100% in Trisal. The rates varied from 60-90% and 83-100% in Mymensing sadar. Regarding ewe factors, higher pregnancy and lambing rate were observed at age between 2-3 years (81-100 and 94-100%), body weight >15kg (92-100 and 100%), BCS 2.5-3.5 (96 and 100%), parity 2^{nd} - 3^{rd} (87-100 and 90-100%). Lamb survivability from collected data varied from 65-70%, while that of selected ram and ewes was 79.7%. Higher lamb survival (80-90%) rate was observed ≥ 3 years. Significantly higher ($p<0.05$) lamb survivability (91.3 vs. 73.1 %) was observed in ewes with BCS≥3 compared to BCS 2-2.5. The ewes producing good amount of milk and having good maternal behavior resulted in higher lamb survivability (85 and 83%). Higher lamb survivability (90.0 vs. 69.6%) was obtained in ewes with placental weight >170 gm compared to <l20 gm. Significantly higher ($P<0.05$) lamb survivability (89.5 vs. 65.3%) and (96.4 vs. 66.7%) was observed when birth weight ≥ 1 kg and single born compared to twin born type. Lamb survival rate in field condition could be increased through intervention for ram, ewe and lamb rearing.

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Physiological and Proteomic Analysis of High Temperature Tolerance During Grain Filling Period in Rice

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Abstract
Addressing the physiological and molecular mechanisms conferring tolerance to high temperature during grain filling period will help to develop rice germplasm capable of adapting to changing climate. Therefore, the objectives of the study was to elucidate the physiological and molecular mechanisms and identify traits conferring to high temperature tolerance in rice varieties. Three differentially identified heat responsive rice varieties were sown on three different dates (10 December, 30 December and 10 January) to identify physiological traits conferring to high temperature tolerance in rice varieties. Data on yield and yield attributes and heat susceptibility indices were collected and different traits responded differently based on the genotypic ability against heat stress. Again to see the expression of high-temperature-responsive proteins during grain filling period in rice four temperature levels were imposed in this rice varieties with control and 6 hours for days heat stress imposition during anthesis stage. Proteins from the developing grains(caryopsis) of three different varieties collected under control and heat-stressed conditions. Analysis of the differential expression of Hsp genes under heat shock the results appeared that, up-regulated and stable expression were observed in *OsHsp16, OsHsp16.9, OsHsp17,7 and OsHsp18* after 37·c and it continued up-to 48·c in BRRI dhan86. It showed no significant change in the level of expression between control and heat shocked tissues. On the other hand, slight to strong up regulation and un-stable down-regulated expression were detected in Tej Gold in most of cases. We also found, totally un-stable and down-regulated expression were investigated in BRRI dhan58 in all imposed temperature level. The findings of our study provides basis to undertake experiments across rice genotypes belonging to different genetic backgrounds to search for newer sources of tolerance as episodes of high temperature are expected to occur more frequently in future climates.

Improving Crop Productivity Through Adoption of Climate Resilient Cropping Systems in the Selected Charland of Bangladesh

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Abstract
For improvement of crop productivity of char land people, firstly a survey on crops and cropping along with farmers existing practices should be undertaken. The project is aiming at providing crop specific intervention with the selection of climate resilient cropping systems along with the management practices with a view to increasing cropping diversity and intensity in this vulnerable ecosystems. In this connection, several crop specific field experiments along with improved production technologies will be carried out in all the three crop seasons of the year so that farmers' easily can link them to formulate an alternate profitable cropping pattern. Therefore, the study was designed 1) to delineate the existing crops and cropping practices in the selected charland of Bangladesh, 2) To adopt climate resilient cropping systems including climate smart production packages in the selected charland of Bangladesh, and 3) to depict the most suitable and economically profitable cropping systems to scale up in the charland of Bangladesh. Two sites were selected in Dakshin Char Kalibari under

Mymensingh Sadar Upazila and another one in Ujan Kashiar Char under Gouripur Upazila. A baseline survey was done in the selected research sites to analyze the existing cropping practices and socio-economic conditions of the farmers. Fifty farmers were interviewed with a semi-structured questionnaire. Farmers were selected randomly from each of the farmers' group: large, medium, small, marginal and landless. Data on their socio economic conditions, crops and cropping practices were taken. A number of crops were inserted in the existing cropping pattern. During T.aman season an experiment was undertaken to study the effect of age of seedlings on the performance of modern transplanted Aman rice cultivars under Charland ecosystem. It is found from the study that BRRI dhan66 and 35-day old seedling produced the highest grain yield which may be recommended for better rice production during T.Aman season.

Genotype x Environment Interaction (GEI) and Stability Analysis for Seed Yield and Oil Content in Short Duration Rapeseed (*Brassica rapa*)

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Abstract
Identification of highly performing short durated rapeseed cultivars under environment of Bangladesh is crucial to sustain rapeseed production. Genotype-environment interaction and stability performance on the seed yield and oil content of five rapeseed cultivars (*Brassica rapa*) were investigated across five different locations of Bangladesh viz. BAU, Mymensingh, Jamalpur, Pabna, Rangpur, Cumilla during Rabi season of 2019. The significant GxE interaction caused difficulty in identifying superior yielding cultivars. Therefore, stability parameters in addition to mean seed yield over environments were calculated. The analysis of variance indicated that heterogeneity of regressions was highly significant ($P<0.01$). The overall yield performance of the BARI Sarisha-14 and BARI Sarisha-9 was superior. These cultivars had b-values superiors than the others and low deviations from regression indicating relatively stable performance over environments. The lowest b-value of Tori-7 indicated that it performed relatively better in low yielding environments and less well adapted to favorable environments. The result of this investigation demonstrated that production response index (regression coefficient) and other stability parameters are suitable means of selecting cultivars that are stable, high yielding and responsive. It is further illustrated that the regression coefficient is the most useful stability statistics, which can be applied for the selection of brassica cultivars adapted to wide range of environments or adapted to restricted environments.

Influence of Zinc and Boron Micronutrients on the Performance of Faba Bean (*Vicia Faba* L.)

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Abstract
The experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University (BAU), Mymensingh to study the effect of zinc and boron on growth and yield of faba bean (*Vicia faba* L.). The experiment consisted with three levels of zinc viz. 0, 1 and 2 kg Zn ha^{-1} and four levels of boron viz. 0, 1.0 kg B ha^{-1}, 0.5 kg B ha^{-1} (basal application) + 0.5 kg B ha^{-1} (foliar application at pre-

flowering stage) and 0.5 kg B ha^{-1} (foliar application at 30 days after sowing) + 0.5 kg B ha^{-1} (foliar application at pre-flowering stage). The experiment was laid out in randomized complete block design with three replications. In case of zinc, the highest plant height (67.9 cm), pods $plant^{-1}$ (33.3), seed yield (2.24 t ha^{-1}) and stover yield (2.55 t ha^{-1}) of faba bean was observed when fertilized with 1 kg Zn ha^{-1}whereas corresponding lowest values were recorded from control treatment. In case of boron, the highest number of branches $plant^{-1}$ (6.51), pods $plant^{-1}$ (39.1), seed yield (2.14 t ha^{-1}) and stover yield (2.42 t ha^{-1}) were obtained from application of 0.5 kg B ha^{-1} (basal application) + 0.5 kg B ha^{-1} (foliar application at pre-flowering stage). In interaction, the highest number of branches $plant^{-1}$ (7.22), pods $plant^{-1}$ (41.93), seed yield (2.46 t ha^{-1}) and stover yield (3.05 t ha^{-1}) were recorded from application of 1 kg Zn ha^{-1} with 0.5 kg B ha^{-1} (basal application) + 0.5 kg B ha^{-1} (foliar application at pre-flowering stage) whereas the lowest seed and stover yields were recorded from control treatment. Based on the present study it can be concluded that application of 1 kg Zn ha^{-1} coupled with 0.5 kg B ha^{-1} (basal application) + 0.5 kg B ha^{-1} (foliar application at pre-flowering stage) appears as the promising combination in respect of seed yield of faba bean.

Influence of Zinc and Boron on the Yield and Quality of Tropical Sugar Beet

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Abstract

The experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University (BAU), Mymensingh to study the influence of zinc and boron on the yield and quality of tropical sugar beet, The experiment comprised three varieties viz. HI-0473, KWS Danicia, KWS Serenada and nine combinations of zinc and boron viz. Zn_0B_0, Zn_0B_1, Zn_0B_2, Zn_1B_0, Zn_1B_1, Zn_1B_2, Zn_2B_0 , Zn_2B_1 and Zn_2B_2, Where, Zn_0 = without Zn application, Zn_1 = Zinc @ 2.0 kg ha^{-1} applied as 50% basal + 50 % foliar application of (two equal installments at 50 and 70 DAS), Zn_2 = Zinc @ 2.0 kg ha^{-1} applied as 25 % basal + 75% foliar application of (three equal installments at 50, 70 and 90 DAS), B_0 = without B application, B_1 = Boron @ 1.5 kg ha^{-1} applied as 50% basal + 50 % foliar application of (two equal installments at 50 and 70 DAS), B_2 = Boron @ 1.5 kg ha^{-1} applied as 25 % basal + 75% foliar application (three equal installments at 50, 70 and 90 DAS). KWS Danicia produced the highest beet yield (105.20 t ha^{-1}) compared to HI-0473 and KWS Serenada. Irrespective of varieties, Zn @ 2.0 kg ha^{-1} and B @ 1.5 kg ha^{-1} applied as 50% basal + 50 % foliar application of (two equal installments at 50 and 70 DAS) produced the highest beet yield (119.40 t ha^{-1}). The highest beet yield (138. t ha^{-1}) and brix (19%) were recorded in KWS Danicia fertilized with Zn @ 2.0 kg ha^{-1} and B @ 1.5 kg ha^{-1} applied as 50% basal + 50 % foliar application of (two equal installments at 50 and 70 DAS). Therefore, Zn @ 2.0 kg ha^{-1} and B @ 1.5 kg ha^{-1} applied as 50% basal + 50 % foliar application of (two equal installments at 50 and 70 DAS) appeared as the promising technique for higher yield and quality of tropical sugar beet.

Effect of Basal and Foliar Application of Zinc And Boron on Yield and Quality of Sugarbeet

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Abstract
Two experiments were conducted during July 2019 to June 2020 at the Agronomy Field Laboratory, BAU to assess the effect of Zn and Boron as well as their application method on the yield and quality of sugarbeet. Sugarbeet variety Cauvery, HI-0473, and KWS Danicia were fertilized with Zinc whereas HI-0473, KWS Danicia and KWS Serenada were fertilized with Boron. At the rate of 2.0 kg ha^{-1} Zinc and 1.5 kg ha^{-1} Boron doses were applied in both basal and foliar methods of application to assess their response to the variety where the application of doses were used in five ways, viz. 100% basal, 75 % basal + 25% foliar application at beet formation stage (70 DAS), 50% basal + 50 % foliar application (two equal installments at 50 and 70 DAS), 25 % basal + 75% foliar application (three equal installments at 50, 70 and 90 DAS), 100% foliar application (four equal installments at 50, 70, 90 DAS and 110 DAS). Irrespective of variety, Zinc increased beet yield when applied in 50% basal + 50 % foliar (two equal installments at 50 and 70 DAS). The highest beet yield (95 t ha^{-1}) was recorded in HI-0473 which was fertilized with 50% basal + 50 % foliar application while the lowest beet yield (73.75 t ha^{-1}) was recorded in KWS Danicia with 100% foliar application. In the case of Boron, the highest beet yield (117 t ha^{-1}) was produced in KWS Serenada with 50% basal + 50 % foliar application method which was at par in KWS Danicia with 50% basal + 50 % foliar application while the lowest beet yield (81 t ha^{-1}) was found in HI-0473 with 100% foliar application. The highest Brix (19.06%) and pol (14.5%) were found in HI-0473 with 50% basal + 50 % foliar application of Boron. Therefore, in both cases, 50% basal + 50 % foliar application method appears as the best method.

Evaluation of Nitrogen Use Efficiency in Modern Wheat Cultivars

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Abstract
The nitrogen (N) requirement of wheat varieties may vary due to the differences in the duration of crop growth and dynamics of soil N. Variability in utilization, content and uptake of N affects physiological aspects and grain yield. To investigate these, pot experiments were carried out during two consecutive wheat-growing periods in 2018 and 2019 at the Department of Agronomy, Bangladesh Agricultural University, Mymensingh to evaluate yield, nitrogen use efficiency and genetic divergence in modern wheat varieties. Ten wheat varieties viz., BARI Gom 24 (V_1), BARI Gom 25 (V_2), BARI Gom 26 (V_3), BARI Gom 27 (V_4), BARI Gom 28 (V_5), BARI Gom 29 (V_6), BARI Gom 30 (V_7), BARI Gom 31 (V_8), BARI Gom 32 (V_9), BARI Gom 33 (V_{10}) were used and four levels of nitrogen viz. 0 nitrogen (N_1), 45 kg N ha^{-1} (N_2), 90 kg N ha^{-1} (N_3), and 135 kg N ha^{-1} (N_4) were applied. The experiment was laid out in a completely randomized design (CRD) with three replications. With nitrogen levels, up to 90 kg N ha^{-1}, wheat yield and yield contributing factors improved. Leaf area index, spike length, 1000 grain weight, grain yield, and nitrogen use efficiency were all affected by the interaction between variety and nitrogen levels. The result illustrated that the variety BARI Gom 32 had the maximum grain production and nitrogen use efficiency with a 90 kg N ha^{-1} application. Dendrogram prepared based on

the resemblance by Euclidean distance among the wheat varieties showed that varieties assigned in clusters II were more diverse. The result revealed significant genetic variation in wheat varieties that can potentially be used for the wheat breeding program.

Improvement of Nitrogen Management of Rice Field Using Chlorophyll Meter (Spad)

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Abstract
Balanced fertilization is a pre-requisite for better rice production and it is necessary to determine optimum combination of fertilizer dose and varieties. The field experiment was carried out during the period from November 2020 to May 2021 at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh to study the SPAD value and yield performance of *boro* rice varieties at different nitrogen levels. The experiment comprised of four *boro* rice varieties viz., BRRI dhan28 (V_1), BRRI dhan58 (V_2), BRRI dhan74 (V_3), and BRRI dhan81 (V_4) and four treatments of nitrogen fertilizers viz., N_1 (50 kg N ha^{-1}), N_2 (100 kg N ha^{-1}), N_3 (150 kg N ha^{-1}) and N_4 (200kg N ha^{-1}). The two factorial experiments were laid out in a randomized complete block design (RCBD) with three replications. SPAD value ranged from 34.01 to 42.12 for variety and 37.81 to 42.15 for N application, while leaf nitrogen ranged from 2.98 to 3.67 % for variety and 2.94 to 3.48%. The highest grain yield (6.13 t ha^{-1}) was found in V_2 (BRRI dhan58). In terms of fertilizer management, the highest grain yield (5.35 t ha^{-1}) was obtained due to the application of 150 kg N ha^{-1} and the lowest grain yield (4.72 t ha^{-1}) was recorded due to control (50 kg N ha^{-1}) in respect of other levels of N fertilizer application. The interactive effect of variety and fertilizer application exerted that the performance of the combination $V_2 \times N_3$ (BRRI dhan58 with 150 kgN ha^{-1}) was the highest (6.59 tha^{-1}) and the lowest performance (3.42 tha^{-1}) in grain yield was found in $V_1 \times N_1$ (BRRI dhan28 with 50 kg N ha^{-1}). Thus the variety BRRI dhan58 with 150 kg N ha^{-1} was superior for attaining the highest yield.

Field Assessment of *Echinochloa crusgalli* (L.) Residues for Allelopathic Effects on Both Crops and Weeds

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Abstract
Allelopathic residues release some chemicals after its application to the field which has the suppressing ability to weeds. An experiment was conducted at the Agronomy Field Laboratory, BAU to assess the allelopathic effects of the *Echinochloa crusgalli* residues on both rice yields and weeds therein. The experiment consisted five treatments of *E. crusgalli* residues *viz*. no residues, residues @ 0.7 t ha^{-1}, residues @ 1.4 t ha^{-1}, residues @ 2.1 t ha^{-1}, and farmers practice (two hand weeding @ 15 and 30 days after transplanting); and three treatments of time residues application *viz*. one week before transplanting, at the time of transplanting and one week after transplanting. Five weeds belonging to the five families were identified in the field such as *E. crusgalli*, *Marsilea quadriflia, Monochori vaginalis, Paspalum scrobiculatum* and *Fimbristylis miliacea*. The highest grain yield (5.13 t ha^{-1}), straw yield (6.19 t ha^{-1}) biological yield (11.32 t ha^{-1}) and harvest index (45.18%) were recorded when residues applied @ 2.1 t ha^{-1}. In case of time of application of the residues, the highest grain yield

(3.84 t ha^{-1}) and straw yield (5.21 t ha^{-1}) were found when the residues applied one week before transplanting. In case interaction between doses and time of application of the residues of *E. crusgalli* the highest the grain yield (5.98 tha^{-1}), straw yield (6.67 t ha^{-1}) and biological yield (11.32 t ha^{-1}) were found when residues applied @ 2.1 tha^{-1} at one week before transplanting. *E. crusgalli* residues could be applied to the rice field before one week of transplanting of seedlings to control weed growth and to get higher rice production.

Effect of Plant Establishment Method on the Performance of Hilly Black Rice Cultivars in Plain Land Ecosystem

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Abstract

Black rice contains many vitamins and minerals, including iron, vitamin A and vitamin B, which are beneficial for overall health and the prevention of heart disease and cancer. Black rice is a type of the rice species *Oryza sativa* L. which is glutinous, packed with high level of nutrients and mainly cultivated in Asia. In Bangladesh, the black rice is being cultivating in the remote hilly areas including Bandarban district as shifting cultivation without any agronomic management practices and hence giving very low yield. However, the overall cultivation procedure of this black rice under plain land condition is still unknown in Bangladesh. Therefore, this study intends to develop an agronomic package for few hilly black rice cultivars in plain land environment of Bangladesh. The first step to develop the package was to find out the establishment method of black rice cultivation in plain land condition and in this connection one experiment was conducted comprising four black rice cultivars (Kongnam ene, Gelong ni, Gelong se and Indonesian cultivar Ketan hitam) with three establishment method namely direct sowing, puddled transplanting and un-puddled transplanting following randomized complete block design with three replication. It has been found that among the four black rice cultivars, Indonesian black rice (Ketan hitam) produced better yield (5.2 t/ha) than that of Bangladeshi black rice cultivars. Out of three establishment methods puddled transplanting method was found more suitable than that of wet direct seeding and un-puddled transplanting method. In addition to that it was also revealed that un-puddled transplanting method took the longer period to harvest the crop.

Site-Specific Nutrient Requirements of Baby Corn-Legume Intercrops by Omission Plot Technique in a Charland of Sherpur District

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Abstract

The main advantage of intercropping is the more efficient utilization of the available resources and the increased productivity compared with each sole crop of the mixture. Charland areas are sometimes deficit of different plant nutrients and legume cultivation as intercrop is an important aspect of maintaining the nutrient status of soil. The initial nutrient requirement for crops varies from location to location. Therefore, the current experiment was set to find out the amount of nutrients to be required by baby corn legume intercropping system in charland area of Bangladesh following an omission plot

technique. The experiment comprises two factors viz. intercropping system (baby corn with chick pea in 2:1 ratio, baby corn with pea in 2:1 ratio, baby corn with chick pea in 2:3 ratio and baby corn with lentil in a 2:3 ratio) and nutrient management (N_0PKS, NP_0KS, NPK_0S, $NPKS_0$ and NPKS). The experiment was laid out in a split-plot design with three replications where intercropping was allocated in the main plot and fertilizer management was distributed in the sub plots. The recommended dose of N, P, K, S, and Zn were used as 119.6 kg, 27.24 kg, 45 kg, 19.2 kg, and 2.88 kg per hectare in the form of Urea, Triple Super Phosphate (TSP), Muriate of Potash (MoP), Gypsum and Zinc Sulfate as 260kg, 130kg, 90kg, 120kg and 8 kg per hectare, respectively.

The results indicated that to cultivate baby corn with legumes as intercrop in the charland area of Bangladesh excess amount of N, P and S is required. It has been found that 171.06 kg/ha N, 37.03 kg/ha P and 38.5 kg/ha S is required to get the maximum return from the intercropping. However, K requirement is low (20.99 kg/ha) than that of the recommended dose (45.0 kg/ha).

Field Performance and Economic Profitability of Baby Corn-Legumes Intercropping System in a Charland Ecosystem of Sherpur District

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Abstract

An experiment was set to find out the feasibility of cultivating baby corn intercropped with legumes in charland of Sherpur district. The experiment was conducted at a char area of Sherpur district. The experimental treatments were 1) sole baby corn, 2) sole chickpea, 3) Sole garden pea, 4) sole groundnut, 5) sole Lentil, 6) two rows baby corn + one row chickpea, 7) two rows baby corn + one row pea, 8) two rows of baby corn + one row groundnut, 9) two rows baby corn + one row lentil, 10) two rows baby corn + two rows chickpea, 11) two rows baby corn + two rows pea, 12) two rows baby corn + two rows groundnut, 13) two rows baby corn + two rows lentil, 14) two rows baby corn + three rows chickpea, 15) two rows baby corn + three rows pea, 16) two rows baby corn + three rows groundnut and 17) two rows baby corn + three rows lentil. The experiment was laid out in a randomized complete block design (RCBD) with three replications. Each plot size was 15 m^2 (5m × 3m). The unit plots were uniformly fertilized with, urea, triple super phosphate, muriate of potash and gypsum according to the recommended dose of BARI. All intercultural operations were done as and when necessary.

From the results it was found that the highest net return (277,461.00 Tk) was obtained from the treatment T6 i. e. when two rows of baby corn was sown with one row of chick pea. Again, considering benefit cost ratio, highest (2.92) was found in the treatment T14 i.e. when two rows of baby corn was cultivated with three rows of chick pea. In conclusion it can be said that intercropping of baby corn with chick pea would be a best combination among the legumes that will bring better economic output rather than sole baby corn or legumes. This could improve the socioeconomic status of char people of Sherpur district and hence the Bangladesh.

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Performance of Black Rice Cultivars as Affected by Planting Season and Establishment Method in Charland of Bangladesh

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Abstract
Black rice, is a type of rice that belongs to the *Oryza sativa* L. species. In ancient China, it's said that black rice was considered so unique and nutritious that it was forbidden for all but royal family. In Bangladesh, the black rice is being cultivating in the remote hilly areas including Bandarban district as jhum cultivation crop without any agronomic management practices and hence giving very low yield. Two experiments were conducted where first experiment composed of three black rice cultivars planted in aus, aman and boro season. The experiment two consisted of four black rice cultivars (Kongnam ene, Gelong se, Gelong ni and an Indonesian cultivar Ketan hitam) and three plant establishment method (Wet seeding, Puddled transplanting and Un-puddled transplanting). In the first experiment it has been found that the cultivar Kongnam ene requires only 80 days to harvest after transplanting. But, considering the grain yield performance, Gelong ni is the best as it produced highest grain yield (4.0 t/ha) among the three varieties. All the three varieties can be cultivated in aus, aman and boro season. But maximum yield can be obtained when these varieties are transplanted in boro season. In the second experiment, it can be said that all the four varieties namely Kongnam ene, Gelong ni, Gelong se and Indonesian black rice cultivar Ketan hitam can be cultivated following all the three plant establishment methods. However, to get maximum yield (5.2 t/ha) it is better to follow the puddled transplanting method with the variety Ketan hitam. However, it needs further experimentation to other location for drawing more precise conclusion.

Effects of Arbuscular Mycorrhizal Fungi and Zinc Fertilizer on Yield and Nutritional Quality of Maize

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Abstract
An experiment was conducted at the Agronomy Field Laboratory in Bangladesh Agricultural University to evaluate the effect of AMF inoculation and Zn fertilizer management on growth, yield and nutritional status of hybrid maize Kohinoor 1820. The experiment consisted two levels of AMF inoculation (AMF-inoculated and non-inoculated) and five levels of Zn fertilizer management. The Zn management regimes were NoZinc = no Zn fertilizer (control); Basal100 = 100% recommended dose of Zn fertilizer added during final land preparation; Foliar100@EV = 100% recommended dose of Zn fertilizer was applied as foliar spray (0.1% ZnSO4) during early vegetative (EV) stage; Folar100@Rp = 100% recommended dose of Zn fertilizer was applied as foliar spray (0.1% ZnSO4) during early reproductive (Rp) stage; Foliar@50EV+50Rp = 100% recommended dose of Zn fertilizer was applied as foliar spray (0.1% ZnSO4) by equal split during EV and Rp stages. The experiment was laid out a factorial randomized complete block design (RCBD) with 3 replications. 'Serakinkon', a commercially available AMF inoculum was collected from Japan and used in the experiment. The inoculum mainly consisted of *Gigaspora margarita* species of AMF. It was found that both AMF inoculation and Zn fertilizer management significantly affected leaf greenness (SPAD value), number of cobs plant□ 1, number of seeds cob□ 1, weight of 1000 grains, and grain yield (all $p<0.05$). The highest maize grain

yield was obtained from the AMF inoculated plots when Zn was foliar applied during both early vegetative and reproductive stages (50%EV + 50% Rp) or foliar applied (100% RD) during reproductive stage. It appeared that only AMF inoculation boosted 15% maize yield in comparison to non-inoculated crops. Zn fertilizer management increased 16% grain yield over control (no Zn applied). Further research should be conducted on the screening of naturally occurring AMF species suitable for maize crop.

Effects of Arbuscular Mycorrhizal Fungi on the Performance of Maize Under Rainfed Condition

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Abstract

Arbuscular mycorrhizal fungi (AMF) can create a symbiotic association with plant roots forming a hyphal network which enables the plant harvest soil moisture and nutrient from a larger rhizosphere. As a result, an AMF symbiotic plant suffers less stress than a non-symbiotic plant growing in the same stressful condition. AMF has been used in many crops in to cope with drought, salinity and heavy metal stress as well as to cut the fertilizer use in nutrient-deficit soils. An experiment was conducted at the Agronomy Field Laboratory of Bangladesh Agricultural university to evaluate the inoculation potential of AMF with maize varieties, to judge the potential of AMF symbiosis on reducing soil moisture stress in maize, and to estimate the phosphorus use efficiency of maize as affected by AMF symbiosis in rainfed condition. The experiment was comprised of three factors, viz., irrigation (irrigated and non-irrigated), AMF inoculation (inoculation and non-inoculation) and levels of phosphorus (P) (no P, 50% recommended dose (RD) of P, and 100% RD of P). A split-plot design with three replications was followed with irrigation in the main plots and combination of AMF and P levels in the sub-plots. The inoculation potential of maize variety (Kohinoor) was confirmed through microscopic evaluation of dissected roots. The values of SPAD, and ROS and anti-oxidant parameters of maize leaves suggested that AMF inoculated reduced moisture stress in maize under non-irrigated condition. AMF inoculation increased grain yield of maize under rainfed condition and no or low P fertilizer treatments. It appeared that irrigated maize (3 times) performed better in terms of growth grain yield than AMF inoculated plants. Therefore, arbuscular mycorrhizal fungi can be used for maize cultivation in drought-prone area of Bangladesh.

Comparative Efficacy and Economics of Different Zinc Application Approaches in Rice

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Abstract

Zinc deficiency is now very common in Bangladesh causing significant yield losses of different crops including rice. Therefore, in many cases farmers are applying zinc fertilizers indiscriminately without considering the efficacy and economic output. Keeping those in mind the proposed study bears huge importance to elucidate and enrich the present state of knowledge on zinc fertilization in rice for ensuring food and nutritional security of Bangladesh. An experiment was therefore conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh (24.75^0 N latitude and

90.50^0 E longitude at an altitude of 18 m) during the period from December 2020 to May 2021 aimed to investigate into the effects of different methods of Zn applied through soil, root soaking and foliar on rice growth and yield and their economics in *Boro* seasons following a randomized complete block design with three replications. Two boro rice varieties (BRRI dhan58 and Hera Dhan-1) and seven different zinc application approaches (including soil application, root deeping and foliar spray of zinc with different dose/concentration). Hybrid variety Hera Dhan-1 performed better than BRRI dhan58. Application of zinc resulted in better crop growth and higher yield. Soil application appeared as the most efficient approach. Grain yield increased over control due to zinc application raged from 5.1 to 14.7%. Present study confirms the necessity of zinc fertilizer application for increasing boro rice yield. Among the different application approaches, soil application was found most effective and foliar spray was least effective. Although soil application of $ZnSO_4$ @ 10 kg/ha produced the highest yield, application of $ZnSO_4$ @ 5 kg/ha was the most economic one. Hybrid rice Hera Dhan-1 out yielded high yielding inbred variety BRRI dhan58. Therefore, it is recommended to cultivate hybrid rice in boro season with soil application of $ZnSO_4$ @ 5 kg/ha for higher yield.

Optimizing Application Rate of Selected Herbicides for Better Weed Control in Three Different Boro Rice Production Systems

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Abstract

Despite some undesirable side-effects no viable alternative is presently available to shift the chemical dependence for weed management in rice. Efficacy, cost-effectiveness, application time and doses are very important to determine the suitability of an herbicide. But the problem is, safest application time may not always coincide with the optimum time for maximum efficacy. In this context, three experiments were carried out at the Agronomy Field Laboratory of Bangladesh Agricultural University to find out the effective doses of herbicides for weed management and their phytotoxicity to crops under three boro rice production systems *viz.*, puddled transplanted rice (PTR), no till non-puddled transplanted rice (NT NPTR) and dry direct seeded rice (DDSR). The experiment comprised eight herbicides with three different doses (recommended dose, 25% higher and lower than the recommended dose) along with season long weedy and weed free conditions. These herbicides were selected based on the results of first year experiments. The experiments were conducted under randomized complete block design with three replications. The results showed that the herbicidal performance in terms of dose variation for weed suppression varied significantly depending on the type of herbicide and rice cultivation. More interestingly the herbicide performance varied depending on the manufacturer and/or marketing company rather their chemical groups. Similar types of observation was also found in first year experiments. For puddled transplanted rice (PTR), post-emergence herbicide Porishkar 10WP (Pyrazosulfuran ethyl) at recommended dose (RD) @125 g ha^{-1} or 25% more than RD performed as the best in terms of weed control and yield performance. However, in no till non-puddled transplanted rice (NT NPTR), pre-emergence herbicide Council prime 20 SC (Trayafemon) at RD @150 mL ha^{-1} or 25% more than RD performed the best, while in dry direct seeded rice (DDSR), pre-emergence herbicide Clean master 18WP (14% acetachlor +4% bensulfuran methyl) at RD @500 g ha^{-1} or 25% more than RD performed the best in terms of weed control and yield performance. Although the findings obtained so far are interesting, the final conclusion and recommendation will be made after the completion of this project.

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Reduction of Dose of Herficides by Combining Allelopathic Potential Aqueous Extract for Weed Management in Wheat

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Abstract
Nowadays, the increasing costs in the agricultural sector, increasing public concern about the widespread use of herbicides and the development of the most important things that need to import non-chemical methods of weed control programs are alerting management. Two experiments were conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh to evaluate the effect of aqueous extract of grass pea and lentil crop residues on weed management and crop performance of wheat. These experiments consisted of three varieties of wheat viz., BARI Gom 30, BARI Gom 31, BARI Gom32 and six different levels of treatments such as no weeding (T_1), recommended dose of herbicide (T_2), aqueous extraction of grass pea (T_3), 90% recommended dose +aqueous extraction of grass pea (T_4),80% recommended dose +aqueous extraction of grass pea (T_5), 70% recommended dose +aqueous extraction of grass pea (T_6), 60% recommended dose +aqueous extraction of grass pea (T_7) and in the second experiment the varieties and treatments were the same but lentil was used instead of grass pea. The grain yield as well as the other yield contributing characters produced by BARI Gom 31 was the highest among the studied varieties. The highest numbers of tillers hill^{-1}, numbers of grains spike^{-1}, 1000 grain weight, grain yield, straw yield were observed where recommended dose of herbicide was used followed by the application of 90% recommended dose +aqueous extraction of grass pea and lentil. BARI Gom 31 along with 90% recommended dose +aqueous extraction of grass pea and lentil produced the highest grain and straw yield among the treatment combination. Finally 90% recommended dose +aqueous extract of grass pea and lentil crop residues showed potential activity to suppress weed growth and it has significant effect on the yield of wheat.

Rooting Ability of Rice Under Diverse Ecosystems and Its Impact on Grain Yield

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Abstract
Rice root development, which is essential for growth and yield, is different under different varietal characteristics. To evaluate this, pot experiments were conducted in the net house of Department of agronomy, Bangladesh Agricultural University for screening of best rice cultivars to have the maximum rooting ability for higher yield. Thirteen (13) cultivars of *boro* rice named BRRI dhan29, BRRI dhan58, BRRI dhan67, BRRI dhan74, BRRI dhan81, Binadhan-8, Binadhan-10, Hira -2, Tej gold, SL8H, Jagli boro, Rata boro and Lakhai are used for the experiment. The experiment was laid out following completely randomized design (CRD) with three replications. The selected 13 cultivars were screened for total root number (TRN), total root length (TRL), root volume (RV), root porosity (RP) and yield. The observation pertaining to root growth were recorded at 20, 40, 60, 80 DAT and at harvest stage. Results showed that with the increase of age of plant, all root parameters also increased

simultaneously irrespective of all cultivars. But, rate of increase up to 80 DAT very fast, then rate of increase is slow. At harvest stage, the value of root parameters very closer to at 80 DAT. Binadhan-10 had highest value of all root parameters followed by Hira-2 and BRRI dhan29. The grain yield, straw yield and harvest index also followed the similar trend. The total number of root hill^{-1}, root length hill^{-1}, root volume hill^{-1} and root porosity had very strong and positive correlation with grain yield. Out of 13 cultivars Binadhan-10 performed best according to root traits and yield performance and then Hira-2 and BRRI dhan29 respectively.

Survey, Identification, Characterization, Mechanism of Herbicide Resistant Weeds and Diverse Approaches for Their Management in Bangladesh

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Abstract
Herbicides are a primary tool for the control of weeds in modern agricultural production, providing a means to achieve optimum crop yields and enabling the adoption of environmentally friendly practices such as conservation tillage. In most of the world's major crop production areas the evolution of weed populations with resistance to one or more herbicides is a serious concern. In this respect, one survey and one experiment were conducted at Agronomy Field Laboratory, BAU, Mymensingh to monitor and collection of suspected herbicide resistant weeds/ weed seeds from major rice growing areas of Bangladesh and to identify herbicide resistant weeds in rice field in Bangladesh. The weeds were collected from six locations viz. Agronomy Field Laboratory, BAU Farm Management section, BADC Netrakona, BADC Madhupur, BADC Meherpur and BADC Muktagacha. The experiment consists of six herbicides viz. Contra 50 EC(H_1), Bicofit 50 EC (H_2), Agritop 18 WP (H_3), Nikash 10 WP (H_4), Commit 50 EC (H_5), Alfit (H_6) and herbicide dose viz. no herbicide (control) (D_1), half of recommended dose (D_2), recommended dose (D_3), double of recommended dose (D_4). The experiment was laid out in a randomized complete block design with 3 replications. The size of the unit plot was 10.0 m^2 (4 m × 2.5 m). The distance between two blocks was 1.0 m. The distances between two adjacent plots were 0.5 m and plant to plant distances was 0.25 m. The total number of plots was 72 (6 × 4 × 3) where each replication was divided into 24 unit plots. The treatment combinations were allocated randomly in each replication. The treatments significantly differ with weed number, weed dry weight, grain and straw yield. Double of recommended dose was effective to control weed but in some cases shama was not controlled.

Designing and Developing Climate Change Resilient Cropping Systems for the *Haor* Area of Bangladesh

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Abstract
The *haor* region has long been lagging behind mainstream national development although the economic development of Bangladesh is moving steadily at a moderate pace. The future challenges in the context of climate change are also a major concern for the sustainable development of the region. Based on these issues, a number of studies were undertaken in the haor region of Bangladesh to create

an inventory of existing cropping systems and to design, test and formulate the performance of climate resilient and nutrition sensitive cropping systems. First of all, the scenarios of existing cropping systems in the study area were evaluated through focus group discussion (FGDs) and in depth farmers' interview with questionnaire. The strengths points of the study area are fertile soil, surplus rice production, more per capita land, possibility of crop diversification with high value crop and struggling effort with adversity. Besides the weak points are water logging, mono-cropping, malnutrition, fallow land, poor communication system, absentee farmers, food insecurity and technologically poor. After that study the feasibility of crop diversification and intensification of Fallow-*Boro* rice was evaluated in the selected farmers' field with different vegetables and oilseeds but not neglecting *Boro* rice. The treatments were T_1-Fallow-Boro (Control), T_2-Potato-Boro, T_3-Red amaranth- *Boro*, T_4-Carrot-Boro, T_5-Spinach-*Boro*, T_6-Radish-*Boro*, T_7-Mustard-*Boro*, T_8.Chinashak-*Boro*, T_9-Sweetgourd-*Boro*, T_{10}-Tomato-*Boro*, T_{11}-Cabbage-*Boro* and T_{12}-Cauliflower-*Boro*. The comparatively higher yields were obtained from T_2-Potato-*Boro* (8.17 and 5.20 t ha^{-1}), T_{11}-Cabbage-*Boro* (39.52 and 4.80 t ha^{-1}), T_{10}-Tomato-*Boro* (21.74 and 5.01 t ha^{-1}), T_{12}-Cauliflower-*Boro* (30.87 and 4.85 t ha^{-1}), T_4-Carrot-*Boro* (14.82 and 4.90 t ha^{-1}) and T_5-Spinach-*Boro* (11.11 and 4.90 t ha^{-1}). Based on yield and economics the best responsive six cropping patterns were T_2-Potato-Boro, T_{11}-Cabbage-*Boro*, T_{10}-Tomato-*Boro*, T_{12}-Cauliflower-*Boro*, T_4-Carrot-*Boro* and T_5-Spinach-*Boro*.

Response of Dry Direct Seeded Boro Rice to Water Stress at Different Growth Stages

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Abstract
Rice cultivation using dry direct seeding method requires 50-60% less irrigation than the conventional puddle transplanted system. The present study was undertaken with a view to develop an irrigation schedule for dry direct seeded boro rice grown under T. aman rice – mustard – boro rice system. Two experiments were conducted under the study: (1) Effect of water stress applied at different growth stages on the yield performance of dry direct boro seeded rice (var. BRRI dhan58) and (2) Response of selected rice varieties to water stress at tillering stage under dry direct seeded system in boro season. Experiment1 used two sowing dates (22 February and 13 March 2021) and six irrigation levels (irrigation at 25% field capacity (4 irrigation), 1 week 25% FC (3 irrigation), 2 week 25% FC (2 irrigation), 3 week 25% FC (1 irrigation), one irrigation at 25% FC, and no irrigation). Experiment 2 comprised three irrigation levels viz., only one irrigation at 25% FC (I_1), only one irrigation at 3 weeks after 25% FC (I_2) and no irrigation (I_3) and five rice varieties (BRRI dhan48 (V_1), BRRI dhan50 (V_2), BRRI dhan63 (V_3), BRRI dhan67 (V_4) and BRRI dhan88 (V_5). Both the experiments used split-plot design with three replications assigning the irrigation as main plot. Data on different growth and yield parameters of rice were recorded and analysis was done by Statistics 10 software. The result of experiment 1 showed that sowing dates had no effect on grain yield and two irrigation gave similar yield to that of four irrigation. Experiment 2 revealed that rice yield was the highest when one irrigation was given at 25% Field capacity. On an average, among five rice varieties BRRI dhan 48 gave the highest yield. However, the interaction effect showed that variety BRRI dhan88 gave the highest yield for one irrigation at 25% FC soil moisture. The present study concludes that reasonable yield of dry direct seeded boro rice can be obtained from sowing during 22 February to 13 with 2 to 3 irrigations.

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Effect of Methods of Crop Establishment and Weeding on the Performance of *Boro* rice

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Abstract
The experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during December 2019 through June 2020 to find out the effect of crop establishment methods and weeding on weed growth and yield of *boro* rice. The experiment comprised of two factors; factor A: Methods of crop establishment viz. DDSR, Unpuddle transplanting, Puddle transplanting and AWD and; Factor B: Weed management practices viz., No weeding (control), Two hand weedings at 20 and 35 DATs, Pre-emergence herbicide Superhit followed by one HW at 35 DAT, Early post emergence herbicide Paddy plus followed by one HW at 35 DAT & Pre-emergence herbi;cide Superhit followed by early post emergence herbicide Paddy plus. Among the crop establishment methods DDSR produced the highest weed density and dry weight. Out of five weeding methods no weeding had the highest weed density & dry weight. Pre emergence herbicide followed by Early post emergence herbicide had the lowest weed density. The highest grain yield was recorded from Puddle transplanting which was statistically identical to AWD & Unpuddle transplanting, and the lowest grain yield was recorded in DDSR. Early post emergence herbicide followed by one HW at 35 DAT produced the highest grain yield which was statistically identical to Pre-emergence herbicide followed by Early post emergence herbicide. AWD with Early post emergence herbicide followed by one HW at 35 DAT produced the highest grain yield which was statistically at par with Puddle transplanting along with Pre-emergence herbicide followed by Early post emergence herbicide and the lowest grain yield was recorded in DDSR with no weeding treatment. From the results of the study it may be concluded that that AWD with Early post emergence herbicide followed by one hand weeding might be used for controlling weed effectively as well as obtaining highest grain yield and highest economic return.

Effect of Nitrogen Fertilization on Weed Infestation and the Yield Performance of Rice

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Abstract
Both weed and rice plants compete for nitrogen and in a weed infested field weeds uptake N more rapidly than rice plant, particularly at high nitrogen levels. Growth and seed production of *Echinochloa. crussgalli* increase with increased in nitrogen rate resulting lesser nitrogen availability to the rice plants. The study was, therefore, conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during December 2020 to May 2021 to find out effect of nitrogen fertilization on weed infestation and the yield performance of *boro* rice. The experiment comprised of two factors; Factor A consisted five nitrogen management treatments and Factor B consisted six weed management practices. The experiment was laid out in a randomized complete block design with three replications. Among the nitrogen fertilizer management practices, The highest weed density was observed in application of 50% nitrogen from poultry manure + 50% nitrogen from prilled urea which was

statistically identical to application of 100% nitrogen from urea and application of 100% nitrogen from poultry manure and no weeding treatment. The lowest weed density was observed from application of 100% nitrogen from USG. Out of six weeding methods no weeding treatment had the highest weed density and dry weight at 20 and 40 DATs and the lowest weed density and dry weight was observed in weed free condition which was followed by Application of early post emergence herbicide followed by one hand weeding at 40 DAT. The highest grain yield was recorded from the application of 100% nitrogen from USG. Weed free condition throughout the growing period produced the highest grain yield which was statistically similar to application of early post emergence herbicide followed by one hand weeding at 40 DAT, application Application of early post emergence herbicide followed by one hand weeding at 40 DAT, application of pre emergence herbicide followed by one hand weeding at 40 DAT and application of pre emergence herbicide. In interaction, the highest grain yield was recorded from the treatment combination of 100% nitrogen from prilled urea × Weed free throughout the growing period which was statistically similar with the treatment combination of 100% nitrogen from USG × Application of early post emergence herbicide followed by one hand weeding at 40 DAT. From the results of the present research work it could be concluded that Application of 100% nitrogen from USG with Application of early post emergence herbicide followed by one hand weeding at 40 DAT might be used for controlling weeds effectively as well as obtaining highest grain yield.

Isolation and Molecular Identification of Native Beauveria and Metarhizium Strains from Bangladesh and Their Bio-efficacy Against Aphid

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Abstract

The *Beauveria bassiana*, *Metarhizium anisopliae* are considered very promising biological control agents to develop fungal biopesticides. We have isolated a total of eighty-six (86) Entomopathogenic fungi from different locations in Bangladesh. By molecular methods, we confirmed the identity of 17 B. bassiana and two Metarhizium sp. fungal species. Finally, the efficacy was tested by bioassay to bean aphid. We have found that the native B. bassiana and Metarhizium strains exhibited a variable degree of efficacy to aphid comparing to the B. bassiana GHA strain from a commercial source. It was found that application of 1 x 108 spore/ml of Beauveria bassiana (GHA) strain caused about 90% mortality after to aphids after 120 hours of treatment (HAT). The B. bassiana Panchagarh 4 (Pnc-4), B. bassiana Khulna 4-2 (Kh-4-2), B. bassiana Mymensingh 4 (M-4), B. bassiana Chuadanga 3 (C-3) were also exhibited similar efficacy comparable to commercial strain (70-88% mortality) suggesting they are highly effective. The other strains caused low to moderate mortality (36 to 70%) suggesting having lower virulence. The M. anisopliae Khagrachari 3-2 (K-3-2) and M. robertsii Kurigram 2 (Kr-2) strains showed 53.33% and 40.00% mortality, respectively to aphids indicating they are also less virulent to bean aphid. The LC_{50} (conidia/ml) and LT_{50} (days) were also calculated by probit analysis. The LC_{50} of B. bassiana Dinajpur 4 (D4), B. bassiana Dinajpur 5 (D5), B. bassiana Panchagarh 4 (Pnc4) and B. bassiana Khulna 4-2 (Kh-4-2) are 4.97 x 106, 2.51 x 106, 7.71 x 105 and1.02 x 106 conidia/ml, respectively. It is thus found that the B. bassiana Panchagarh 4 (Pnc4) isolate is the most virulent against bean aphid. The LT_{50} also showed similar trends. The Metarhizium isolates are relatively slower than Bassiana against bean aphid. Thus, our native strains possess a high potential for developing fungal biopesticides.

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Bio-efficacy of Native *Beauveria* and *Metarhizium* Strains from Bangladesh and Against Aphid Under Lab Conditions

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Abstract
Biopesticides based on *Beauveria bassiana*, *Metarhizium anisopliae* are widely used throughout the world. There are no previous reports of native strains of *Beauveria* and *Metarhizium* from Bangladesh. We had isolated of seventeen samples as *Beauveria bassiana*, one sample as *Metarhizium anisopliae*, one sample as *M. robertsii* from Bangladesh. The efficacy was tested by bioassay to bean aphid as a model organism. We have found that the native *B. bassiana* and *Metarhizium* strains exhibited a variable degree of efficacy to aphid comparing to the *B. bassiana* GHA strain from a commercial source. The lethal concentrations (LC_{50} and LC_{90}) (conidia/ml) and the lethal times (LT_{50}, days) was calculated for 4, 5 and 6 days after treatment by probit analysis. In general, the lethality of all the strains is increased with the increase of time. However, their individual virulence was varied among them. It is found that the *B. bassiana* Panchagarh 4 (Pnc4) isolate is the most virulent against bean aphid while the *B. bassiana* Dinajpur 4 (D4),*B. bassiana* Dinajpur 5 (D5), and *B. bassiana* Khulna 4-2 (Kh-4-2) are about 7, 3 and 8 times lower virulent comparing with the *B. bassiana* Panchagarh 4 (Pnc4). The LC_{90} values also showed similar trends. The lethal period ($LT_{50,}$ days) for different strains required different level of periods for causing 50% mortality to bean aphid, *Aphis craccivora*. The *B. bassiana* Dinajpur 5 (D5) required 2.73 days followed by *B. bassiana* Khulna 4-2 (Kh-4-2) (LT_{50}, 3.67 days) and *B. bassiana* Dinajpur 4 (D4) (LT_{50}, 3.75 days). On the other hand, comparing with the *B. bassiana* strains, the *Metarhizium* species strains was found to be low virulent against bean aphid, *Aphis craccivora*. Thus, our native *B. bassiana* and *Metarhizium* strains possess high potential for developing fungal biopesticide. Further studies and Industry-Academia co-operations are required to develop fungal biopesticides.

Isolation Native Mosquitocidal *Bacillus Thuringiensis* Strains from Bangladesh

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Abstract
Dengue, Zika, chikungunya, yellow fever, filariasis, and malaria are all spread by mosquitos, particularly the Aedes, Culex, and Anopheles mosquito vectors. Vector control is the most effective method for avoiding and controlling the spread of these diseases. Chemcial insecticides are mostly used in Bangladesh for vector control. However, using chemical pesticides to manage vectors causes a slew of issues, including resistance, resurgence, secondary pest outbreaks, residual effects, and so on. As a result, environmentally friendly and long-term vector management solutions are in high demand. Mosquito bioinsecticides based on Bacillus thuringiensis (Bt) are the most frequently utilized around the world. Bt is a spore-forming bacteria that produces an insecticidal protein that kills dipteran and other insect groups. *Bacillus thuringiensis* subsp. *israelensis* (Bti) is a mosquito-control strain that is utilized all over the world. The mosquitocidal Bt strains, on the other hand, have yet to be isolated and characterized for their toxicities against Bangladeshi mosquitos. As a result, this initiative was started.

After approval of this work during June 2020, initiatives were taken to collect soil samples from different locations of Bangladesh which will be used to isolated Bacillus thuringiensis (Bt) strains. We gathered 60 (sixty) soil samples from 12 (twelve) different districts across Bangladesh, which will be utilized to isolate local *Bacillus thuringiensis* strains. We have analyzed five samples for isolation of Bt and so far, eight Bt samples were isolated and stored. Detail characterization of the isolated strains are on-going.

Development of a Molecular Identification System of Fall Armyworm, *Spopdotera Frugiperda* (Jesmith) (Lepidoptera, Noctuidae), an Invasive Insect Pest in Bangladesh

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Abstract
Native to the tropical areas, the fall armyworm (FAW, *Spodoptera frugiperda*) (J. E. Smith) (Lepidoptera: Noctuidae) is now an invasive pest threatening food security in Bangladesh. The larval stage of FAW infests maize, rice, sorghum, soybean, millets and vegetables, and many staple crops. The existence of two host strains (corn 'C' and rice 'R') that differ in host preference complicated the situation and can only be distinguished based on genetic markers. Morphological identification of larvae of *Spodoptera frugiperda* requires lots of experience and time. Correct identification is the prime requirement to develop appropriate and effective management techniques. Use of DNA technique could be used as a powerful tool to identify these strains of fall armyworm. In this connection, a total of ninety-seven larval and three adult samples of the fall armyworm (FAW) were collected from maize infested field of Bogura, Chuadanga, Dinajpur, Gaibandha, Jenaidah, Manikganj and Thakurgaon districts of Bangladesh. The genomic DNA was extracted using GeneJET Genomic DNA Purification Kit (Thermo Fisher Scientific, USA) and the mitochondrial Cytochrome Oxidase I (COI) gene marker was amplified by PCR technique. The DNA sequencing of the amplified PCR fragments and Genbank database search confirmed the identity of all the collected samples as fall armyworm, Spodoptera frugiperda. Analysis of the presence or absence of MspI restriction site in the obtained DNA sequences also identified the Corn (C) and Rice (R) strain of FAW samples collected from Bangladesh. Among the ninety-three molecularly identified fall armyworm samples, thirteen (13) samples were identified as 'C' strain (13.98%) and the rest eighty (80) samples were identified as 'R' strain (86.02%). PCR-RFLP of PCR DNA fragments by MspI enzyme also confirmed the presence of both strains. Thus, both the strains of fall armyworm have prevailed in Bangladesh however, the 'R' strain was the most abundant one.

Eco-Friendly and Sustainable Management of Major Insect Pests of Cucurbitaceous Vegetables Through Holistic Approach With Special Emphasis on Non-Chemical Methods and Biorational Pesticides

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Abstract
In the present study, the efficacy of some integrated or holistic approches was evaluated against bitter gourd-infesting cucurbit fruit fly (CFF). Experiment was conducted at the Entomology Field

Laboratory, Bangladesh Agricultural University during the period of 2020-2021. A total of five approaches was evaluated against CFF and these are (1) Field sanitation + hand picking + Pheromone trap (2) Hand picking + Fruit bagging + Bait trap + Pyrifen 10.8 EC @ 1.0 ml/L (3) Pheromone+ Hand picking + Fruit bagging + Bait trap + Ravjum 14.5 SC @ 1.5 ml/L (4) Field sanitation + Hand picking + Pheromone + Pyrifen 10.8EC @ 1.0 ml/L (5) Field sanitation + Hand picking + Pheromone + Ravjum 14.5 SC @ 1.5 ml/L. All the approaches significantly reduced fruit infestation than that of control. But the lowest infestation, maximum protection over control and the highest yield was found when bitter gourds plants were treated with approaches 3 & 5. On thy other hand, approach 1, 2 and 4 were found moderately effective in reducing CFF as well as increasing yield. Specifically, approximately 8% fruits were found to be infested when plants were treated with approach 3 and 5 with the protection of 78 & 75% respectively. On the other hand, 45, 67 and 68% fruits were protected over control when plants were treated with approach 1, 2 and 4 respectively. Moreover, the highest yield was found from approach 3 (17.0 t/ha) and 5 (17.6 t/ha). The highest infestation (55.50%) and the lowest yield was found from control plots (4.6 t/ha). The highest BCR (2.56) was found form the approach 5 that was followed by approach 3 (2.50) and other approaches.

Management of Jassid and White Fly on Okra through Coloured Sticky Traps and Biorationals-based Integrated Management Approach

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Abstract
Okra, (*Abelmoschus esculentus*) is an important vegetable crop under the family Malvaceae and is widely grown in tropics and subtropics for its tender green fruits. This popular vegetable is severely attacked by various insect pests but sucking insects like jassids and whiteflies are most important cultprits to reduce okra production. Unfortunately, we are spraying different toxic and conventional insecticides on okra which causes different negative impacts on environment. Therefore, time came to use alternative molecules to control insect pests on okra instead of conventional insecticides. In this study, some treatments including sticky traps and biorationals were evaluated against jassids and whiteflies on okra. Data clearly showed that all the selected treatments had significant effect on the reduction of abundances of sucking insects, increases yield and conserved bio-contol agents in treated plots as like as control plots. Our present result showed that all the treatments were found to be very effective against jassids and whiteflies although yellow sticky trap + Fytoclean was found most superior than that of others because insects populations were reduced effectively and yield was increased when plants were treated with YST+Fytoclean. All the treatments were found safe for arthropods predators like ladybird beetles as numbers were not changed significantly in comparison with untreated control. Therefore, it may be recommended for the okra growers to use YST + Fytoclean for effective management of sucking insect pests like jassids and whiteflies in field condition.

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Invasion of Exotic Rugose Spiraling Whitefly in Bangladesh: A Baseline Survey Study on Its Geographical Distribution, Host Plants Dynamics and Infestation Severity

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Abstract
The rugose spiraling whitefly (RSW), *Aleurodicus rugioperculatus* (Aleurodidae: Hemiptera) was first identified in Florida (Central America) in 2009, in India 2016 and in Bangladesh in 2019. This study was conducted to fulfill few objectives *viz.* (i) to know the biological parameters of RSW under room temperature as well as different controlled temperature condition, (ii) to identify different host plants and (iii) to identify RSW-infesting geographical locations in Bangladesh as well as to assess the damage severity. Biology of RSW was studied under laboratory condition on native and dwarf coconut saplings as well as on guava. The biology was also studied on guava saplings under five constant temperature regimes *viz.* 20, 25, 30, 35 and 40°C. Data showed that a total of 35.00 ± 0.36, 35.95 ± 0.55 and 36.00 ± 0.53 days were taken to complete the life cycle of RSW on native coconut, siam green and siam blue respectively but slightly higher duration (37.50 ± 0.60 days) was taken to complete the life cycle on guava. Thus, it indicates that RSW prefers coconut plants than that of guava for its oviposition, growth & development and survival. Among five constant temperatures, more or less 30°C was the most suitable temperature for the growth and development of RSW that was followed by 25°C. Low temperature (20°C) prolonged the development period (45 days) while high temperature (35 and above) showed lethality for the egg survival. Taxonomical study confirmed that the collected RSW specimens were *A. rugioperculatus* although molecular study is needed to confirm the taxonomic findings. Based on our survey, we report that RSW has invaded all over Bangladesh with low to very severe infestation level. The highest infestation was noticed in west and south-western regions while comparatively lower was found in south-eastern and central part of the country. It was evident from this study that both border and non-border districts were affected almost equally by this insect pest. Moreover, 61 host plants were identified till now where approximately half of them were fruit plant species that was followed by ornamentals, crops, forests and others respectively. Among the host plants, coconut (native and dwarf) was affected severely by RSW that was followed by banana and guava respectively. To control this insect pest, coconut growers applied at least 29 insecticides from different toxicity groups and among them 15% were WHO toxicity class Ib followed by class II (66%) and class III (19%) respectively. It was also found that about 30-35% coconut yield was reduced once RSW has been invaded in Bangladesh. Thus, it is concluded that the existing quarantine rules should be followed strictly to restrict the invasion of any exotic insect pest through the plants or plant parts.

Bio-intensive Management of Caterpillar-Complex of Major Cruciferous Vegetables Through Ecological, Non-chemical and Biorational-based Holistic Approach.

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Abstract
The cruciferous vegetables are severely infested by a wide range of insect pests throughout the cultivation period and among them diamondback moth (*Plutella xylostella*), cabbage butterfly (*Pieris*

brassicae) and leafworm (*Spodoptera litura*) are the most devastating and severe species. As they stay combindly on the same leaf/plant and develop similar type of damage symptoms and hence this condition is known as "caterpillar complex". In this study, some ecological and non-chemical approaches were evaluated against caterpillar complex on cabbage. Approaches were- only push plant, only pull plant, push + pull plant, bait trap, yellow sticky trap, blue sticky trap and integrated approach. Data were collected on percent head infestation as well as yield (t/ha) of cabbage head. Results showed that 25.09, 22.81, 29.84, 15.64, 15.75, 17.77 and 32.04% head infestations were reduced over control when cabbage plants were inter-cropped with only push plant, only pull plant, push + pull plant, installation of blue sticky trap, yellow sticky trap, bait trap and combined approach respectively. On the other hand, 17.48, 18.93, 25.58, 14.22, 15.05, 16.58 and 38.33% yield was increased over control when cabbage plants were inter-cropped with only push plant, only pull plant, push + pull plant, installation of blue sticky trap, yellow sticky trap, bait trap and combined approach respectively. Economic analysis showed that the highest BCR was achieved from integrated approach (1.53) that was followed by push + pull technology (1.20).

Role of Abiotic Factors on the Incidence of Brinjal Shoot and Fruit Borer, *Leucinodes orbonalis* Guenee

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Abstract
Brinjal or eggplant (*Solanummelongena*L.) is one of the most popular vegetables grown in many regions of the world viz., Central, South and South East Asia, some parts of Africa and Central America. Several biotic and abiotic stresses directly and indirectly influence the plant growth and the population of insect pests harbouring on the plant and contribute in lowering the yield of brinjal. The most important insect pest is brinjal shoot and fruit borer (BSFB) which alone causes yield loss from 20-90 per cent in various parts of Bangladesh. An experiment was conducted during Rabi season in 2020 to find out the effect of abiotic factors viz. temperature, relative humidity and rainfall on the infestation of brinjal shoot and fruit borer in the field. The data on the abiotic factors were taken from the weather yard of BAU during experiment time. Shoot and fruit infestation data were collected from the field weekly basis. Finally the data were analyzed using "R'' statistics program and correlation between abiotic factors and BSFB infestation were determined. The results revealed that the incidence of shoot and fruit borer and severe shoot infestation started from third week of January whereas, fruit infestation started from third week of January with a minimum percentage. The highest per cent shoot infestation was recorded in first week of March and the highest per cent fruit infestation of shoot and fruit borer was recorded on second week of February. Abiotic factors like temperature played significantly positive correlation with shoot and fruit infestation whereas, relative humidity imparted negative correlation with shoot and fruit infestation by *L. orbonalis* during the study. But the correlation between rainfall and BSFB infestation was observed non-significant.

Biorational Insecticide based IPM Modules: for Managing Whitefly, *Bemisia tabaci* Gennadius on Brinjal

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Abstract
A field experiment was conducted in the field laboratory, Department of Entomology, Bangladesh Agricultural University, Mymensingh during July 2018 to June 2019, to determine the efficacy of

different biorational insecticide based IPM modules against the infestation of whitefly. Five treatments namely T_1- Abamectin + Buprofezin @ 1mL+1mL; T_2- Emamectin benzoate +Buprofezin @ 1g+1mL; T_3- Abamectin +Emamectin benzoate @1mL+1g; T_4-Spinosad +Lufenuron @1mL+1mL; T_0-Untreated control were selected. The experiments were laid out in RCBD with 3 replications. A total of three sprays were applied and data were collected on 3, 5 and 7 days after spray. The effect of individual treatment was evaluated on different parameters viz. no. of whitefly plant^{-1}, no. of adults on twig plant^{-1}, no. of adult leaf^{-1}, no. of curl leaf plant^{-1}, plant height and yield. The mean percentage of reduction of whitefly population was significantly different among the treatments after spraying on whitefly infested brinjal plants compared to control plants. The overall efficacy of the selected treatments at 3, 5 and 7 days interval against whitefly revealed that the treatments of Abamectin + Buprofezin proved the most effective treatment followed by Emamectin benzoate + Buprofezin. Abamectin + Emamectin benzoate existed in middle order of effectiveness. Spinosad + Lufenuron proved the least effectiveness in managing whitefly population. In case of percentage of reduction of whitefly on plant, a remarkable reduction 48.21%, 72.99%, 52.59% was observed on the plants treated with Abamectin + Buprofezin from 3DAS, 5DAS and 7DAS respectively. In case of percentage of reduction adult whitefly on twig over control was found 69.325, 77.57%, 97.82% in Abamectin + Buprofezin treated plants after 3DAS, 5DAS and 7DAS respectively. In case of the leaf infestation with whitefly on brinjal plants, the highest mean percentage of reduction of infested leaf over control was detected from Abamectin + Buprofezin and Abamectin + Emamectin benzoate. The highest reduction was observed in Abamectin + Buprofezin treated plots followed by Abamectin + Emamectin benzoate. The mean percent reduction of leaf infestation was 60.49%, 69.16%, 58.86% after 3DAS, 5DAS, and 7DAS respectively in Abamectin + Buprofezin treated plants. In case of Abamectin + Emamectin benzoate treated plots, the mean percent reduction of leaf infestation was 58.40%, 64.00%, 59.59% after 3DAS, 5DAS and 7DAS respectively. In case of percentage of reduction of curl leaf in plants over control was found 21.32%, 17.04%, 21.61% in Abamectin + Emamectin benzoate treated plants and 17.28%, 22.35%, 20.03% in Abamectin + Buprofezin treated plants after 3DAS, 5DAS and 7DAS, respectively. The highest mean percentage of increase of plant height over control was observed in Abamectin + Buprofezin treated plants. The increase percentage 20.23%, 19.18%, 18.47% was found after 3DAS, 5DAS and 7DAS, respectively. The highest mean percentage of increase of yield over control was observed in Abamectin + Buprofezin treated plants. So, Abamectin + Buprofezin can be used as the best management practices for brinjal cultivation. Therefore, Abamectin + Buprofezin could be recommended to the brinjal growers for effective management of whitefly followed by Emamectin benzoate + Buprofezin and Abamectin + Emamectin benzoate.

Integrated Management of Guava Spiraling Whitefly, *Aleurodicus dispersus* Russel

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Abstract

Guava spiraling whitefly is an emerging and destructive pest of guava in Bangladesh. The efficacy of some IPM packages consisting of T_1= Detergent (2g/l) + Chili dust (1 g/l), T_2= Detergent (2g/l) + Neem oil (2 ml/l), T_3= Detergent (2g/l) + Mahogany oil (2ml/l), T_4= Detergent (2g/l) + Emamectin benzoate (1 g/l), T_5= Detergent (2g/l) + Abamectin (1ml/l) was evaluated against the infestation of this pest in the Horticulture Field Laboratory, Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh during July 2020 to March 2021. An untreated control was also maintained. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. Data were collected on the mean number of nymph and adult whiteflies per twig and per five leaves

and mean number of curl leaf per plant. All the IPM packages were significantly effective in managing whitely in comparison to control. But among the IPM packages Detergent (2g/l) + Chili dust (1 g/l) showed the best efficacy against whitefly proving the lowest mean number of nymph and adult whitefly per twig and per five leaves and curl leaf per plant. The similar efficacy was also showed by the Detergent (2g/l) + Chlorpyriphos (2 ml/l) and Detergent (2g/l) + Abamectin (1ml/l). But considering the bad impact of the chemical insecticide Detergent (2g/l) + Chili dust (1 g/l) and Detergent (2g/l) + Abamectin (1ml/l) might be suggested to the farmers for the eco-friendly and sustainable management guava whiteflies in the field orchard.

Bio-Rational Management of Marigold Leaf Mite, Tetranychus Urticae Koch a Pest of Marigold

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Abstract
The marigold leaf mite commonly known as two-spotted spider mite Tetranychus urticae Koch (Acari: Tetranychidae) is a ubiquitous pest species having large number of host plants and immense damage potential. It is a serious pest that infests different agricultural crops in Bangladesh and cause significant yield losses. However, T. urticae pest management is becoming increasingly difficult because of it's terrific ability of pesticide resistance. Biorational management is an economically and ecologically sound alternative of T. urticae pest control. A set of research experiments were conducted at the laboratory of Applied Entomology and Acarology, Department of Entomology, Bangladesh Agricultural University, Mymensingh during the period of July 2019 to June 2020 to evaluate the effectiveness of certain botanicals viz. Neem oil, Mahogoni oil, Garlic clove extract, Lemon extract; microbial derivatives viz. Spinosad, Emamectin benzoate, Imidacloprid, Abamectin and growth regulators including entomopathogenic fungus Beauveria bassiana, entomopathogenic bacteria Bacillus thuriengiensis, Buprofezin and Lufenuron against Tetranychus urticae Koch based on percent mortality of adult mites. The findinds of these in-vitro study is, the effect of all tratments were clearly time and dose dependent. The experimental results revealed that abamectin (1.0ml/L) was most effective in controlling spider mites having 86.06% mean mortality which was highest in all microbial derivatives as well as all treatments used in the study; after abmectin imidacloprid (0.5ml/L) also gave well check of T. urticae population showing 78.49% mean mortality. Among all the botanical extracts evaluated against T. urticae in the study neem oil @ 8 percent was found effective against adult Tetranychus urticae (56.52% mean mortality). In case of growth regulators, buprofezin 0.75ml/L scored well than the other growth regulators. From the experimental findings, it could be concluded that abamectin, imidacloprid, neem oil and buprofezin will be promising and eco-friendly alternatives of conventional pesticides for successful biorational management of Tetranychus urticae.

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Evaluation of Botanical, Chemicals Pesticides and Entomopathogenic Fungus in Managing Spider Mites

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Abstract
Several spider mites cause serious damages to many crops in Bangladesh. Many insecticides and acaricides have been recommended to farmers to control spider mites. We used different chemicals, neem oil and *Beauveria bassiana* in laboratory and in field for the development of improved management of spider mites. The adult females of *T. urticae* was highly susceptible to the most acaricides except etoxazole. The LC_{50} and LC_{90} values of etoxazole were 27.85 and 2368.06 mg/l in adult of *T. urticae*, which higher than the recommended concentrations. The tested neem oil showed acaricidal effect against adults and eggs of *T. urticae*. Neem oil showed the toxicity (LC_{50} and LC_{90} values were 1.26 and 9.25% respectively) with moderate efficacy against adults. The LC_{50} and LC_{90} values of *B. bassiana* against *T. urticae* were found to be 2.25×10^6 and 1.35×10^7 spore/ml, respectively. It was found that the acaricidal activity of *B. bassiana* against eggs and adults of *T. urticae* was concentration dependent. The mixture of bifenazate + neem oil, etoxazole + neem oil and neem oil + entomopathogen showed additive effect, while the bifenazate + etoxazole, bifenazate + entomopathogen, etoxazole + entomopathogen showed synergistic effect. Application of different chemical pesticides i.e., Abamectin, Bifenthrin, Bifenazate, Etoxazole, Hexythiazox, and Spinosad; plant extract, i.e., Neem oil (5%); and Entomopathogen, i.e., *Beauveria bassiana* affect the spider mite population on bean plants affected significantly at different days after treatment. On the contrary, the spider mite population initially decreased but it was tended to be increased again in case of etoxazole and neem oil (2%). Based on the present results, the effective or recommended acaricides are Abamectin, Bifenthrin, Bifenazate, Hexythiazox, and Spinosad. In addition, neem oil and *B. bassiana* should be considered into integrated mite management programs could reduce the dependence on synthetic acaricides and increase the levels of control.

Perception of Farmers Toward Papaya Mealybug Outbreak and Evaluation of Different Bio-Pesticides Against This Invasive Polyphagous Pest

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Abstract
The papaya mealybug has been identified recently in Bangladesh and within the last few years this insect pest spread throughout the country very rapidly and has become major concern to papaya growers in Bangladesh. A survey was conducted to determine farmers perception on this pest. Further, experiments were conducted with selected bio-pesticides to determine their field efficacy against papaya mealybug. Farmers in the study area reported that they have papaya mealybug attack since the last 8 years. All farmers said that this insect caused severe economic damage. About 60% farmers reported that they faced problem to sale infested papaya in the market. 80% farmer reported that conventional insecticides do not work against this noxious sucking insect.Field experiment revealed that highest mortality of papaya mealybug was recorded in Tracer 45 SC (spinosad) treated plants.

Similarly, significantly highest yield of papaya was found in Tracer 45 SC treated plants. No significant differences in yield of papaya plants was found between Proclaim 5 SG and Vertimec 1.8 EC treated plants. Therefore, Tracer 45 SC can be used to control papaya mealybug in the fields.

Supplementation of Detergent Soap to Entomopathogenic Fungi Formulations (*Beauveria Bassiana* and *Metarhizium Anisopliae*) for Improving Efficacy Against Papaya Mealybug

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Abstract

Field efficacy of entomopathogenic fungi, *Beauveria bassiana* and *Metarhizium anisopliae* with suitable concentration of detergent soap (0.1% selected from lab trials) for the control of papaya mealybug was determined in the field laboratory of the Department of Entomology, Bangladesh Agricultural University, Mymensingh using RCBD with six replications for each treatment. In this experiment, papaya seedlings were planted individually in pits having 2m×2m spacing. When papaya plants were 2 months old, 100 mealybugs from the laboratory stocks were released to each plant with the help of camelhair brush. Selected entomopathogenic fungi with suitable concentration of detergent soap were sprayed separately to the experimental plants after 1 day of artificial mealybug inoculation. In control treatment, experimental plants were sprayed with water only. The number of death mealybug in the treated plants was counted after 6 and 12 days from the treatment imposition. The fruits of the treated papaya plants were harvested at maturity and finally yield of each papaya plants were recorded. Highest mortality of papaya mealybug was recorded in *B. bassiana* with 0.1% soap treated plants. Similarly, significantly highest yield of papaya was found in *B. bassiana* with 0.1% soap treated plants. In contrast, detergent soap decreased the efficacy of *M. anisopliae* and was not suitable to mix with its formulation. Therefore, soap supplementation only increased the efficacy of *B. bassiana* against papaya mealybug.

Development of Eco-Smart Management Tools of Fall Armyworm, Spodoptera Frugiperda in Bangladesh

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Abstract

Maize, the emerging cereal crop of Bangladesh and its production is being affected by the extensive attack of Fall armyworm (FAW), *Spodoptera frugiperda*, a polyphagous and migratory pest since its invasion in 2018. Efficacy of some Eco-smart tools viz., the microbial pesticide Nuclear Polyhedrosis Virus NPV with three doses viz., 0.1 g/L, 0.2g/L and 0.3g/L and reduced risk insecticides Spinetoram and Emamectin Benzoate with the doses 0.5ml/L, 1ml/L, 1.5ml/L against third and fourth instar larvae Fall armyworm in causing mortality was determined in the laboratory of Department of Entomology. Bangladesh Agricultural University. Higher doses of the biopesticides were found to be more effective to reduce the pest in shorter period of time. NPV doses of 0.2g/L NPV and 0.3g/L NPV were found effective against Fall armyworm. Emamectin benzoate was found more effective to cause larval mortality than Spinetoran. Therefore, the bio-pesticide emamectin benzoate @ 1.0 ml/L and NPV @ 0.3g/L /L could be recommended for their high efficacy to be used for the management of Fall

armyworm. Considering the efficacy and eco-friendly nature it would be selected as promising alternative to hazardous conventional insecticide for successful management of the devastating pest of Fall armyworm in Bangladesh.

Alleviation of Aluminium Toxicity of Acid Soils in Rice-Maize Cropping System by Application of Lime and Phosphate Fertilizer

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Abstract
Aluminium (Al) toxicity represents a serious limitation to crop production in acid soils in Bangladesh. The production of staple food crops, in particular grain crops, is negatively influenced by acid soils. To alleviate the crop production problems due to Al toxicity in acid soils, the experiments were conducted at the farmers' field of Fulbaria, Mymensingh considering rice-maize cropping system by using lime and phosphate fertilizer. The experiments were laid out in a randomized complete block design (RCBD) in a factorial arrangement with three replications. Three different rates of lime (0, 1 and 2 t/ha dololime) and four different rates of phosphate (P) fertilizer (0, 100, 150 and 200 % of recommended dose) were used for the experiments. There were twelve treatment combinations viz. T_1: $Lime_0P_0$, T_2: $Lime_0P_{100}$, T_3: $Lime_0P_{150}$, T_4: $Lime_0P_{200}$, T_5: $Lime_1P_0$, T_6: $Lime_1P_{100}$, T_7: $Lime_1P_{150}$, T_8: $Lime_1P_{200}$, T_9: $Lime_2P_0$, T_{10}: $Lime_2P_{100}$, T_{11}: $Lime_2P_{150}$, T_{12}: $Lime_2P_{200}$. The crop varieties were BINA Dhan-17 and BARI Hybrid Maize-9. The rice was grown first followed by maize. Lime and phosphate fertilizer had significant effect ($p>0.05$) on the yield and yield contributing characters of rice. In case of maize, significant differences ($p<0.05$) were also observed due to different rates of lime and phosphate fertilizer. In most cases, lime @ 2 t/ha and P @ 200% of the recommended dose produced significantly higher grain yield compared to other treatment combinations. Nutrient (NPKS) contents and uptake by both crops significantly increased due to application of lime and phosphate fertilizer. It is concluded that combination of lime and P fertilizer could effectively reduce Al toxicity in rice and maize and increase crop yield in acid soils.

Increasing Nutrient Use Efficiency of Rice-Rice Cropping System by Split Application of Phosphorus, Potassium and Sulphur Fertilizers

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Abstract
Nutrient management is one of the important aspects for better productivity in rice crop. But, more concern is given only N management as it plays vital role in growth and development of rice. However, it is equally important to manage other nutrients especially P, K and S for increased productivity of rice. This research project was undertaken to study the improvement of nutrient use efficiency by split application of P, K and S fertilizers in rice cultivation under existing cropping system. A field experiment was conducted at the Soil Science Field Laboratory, BAU, Mymensingh. There were six treatment combinations consisting of single and split application of PKS *viz.* T_0: Control (No PKS fertilizers), T_1: 100% PKS at transplanting, T_2: 100% PK at transplanting + 50% S at transplanting + 50% S at maximum tillering, T_3: 100% PS at transplanting + 50% K at transplanting + 50% K at maximum tillering, T_4: 100% KS at transplanting + 50% P at transplanting + 50% P at

maximum tillering, and T_5: 50% PKS at transplanting + 50% PKS at maximum tillering. Single application of PKS fertilizers significantly increased growth, yield components and grain and straw yields of rice over control. Split application of PKS fertilizers also significantly increased growth, yield components and grain and straw yields of rice over single application of PKS and control. Similarly, nutrient uptake by rice crop significantly increased due to application of split application of PKS fertilizers, thereby improving nutrient use efficiency. It was noted that no remarkable differences were observed in aspects of growth, yield and nutrient uptake among the split application of PKS fertilizer treatments. It is concluded that application of split application of PKS fertilizers could be profitable for rice cultivation under existing system.

Effects of Different Planting Methods and Fertilizer Management Practices on Methane Emission, and Yield of Rice

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Abstract

Despite knowing the importance of rice field as an anthropogenic source of methane (CH_4), little is known about CH_4 emissions during the rice-rice cropping pattern. Furthermore, information regarding the impact of management like fertilization and planting methods on CH_4 emissions from rice fields is scarce. Field experiments were established in Bangladesh Agricultural University to study CH_4 emissions in rice-rice pattern: T. Aman (BRRI dhan 71)-Boro (BRRI dhan81). For T. Aman rice, six fertilization regimes (T_1, T_2, T_3, T_4, T_5, T_6) were adapted to randomized block design in four replications. During Boro season, a split-plot design was employed with four planting methods [P_1-continuous flooded (CF), P_2-alternate wetting & drying (AWD), P_3-system rice intensification (SRI), and P_4-direct seeded rice (DSR)] as main plot and fertilizer management (F_1-no fertilizer, F_2-100% chemical fertilizer, and F_3-70% chemical fertilizer with poultry manure) in subplot. Each of the experiments was carried out for two consecutive years. Methane flux was measured during the entire rice-growing season to get the cumulative CH_4 emissions using static closed chamber method. The application of organic manures with chemical fertilizers (CF) increased rice yield by 30~38%; in contrast it stimulated the CH_4 emissions as additional organic carbon was supplied for CH_4 production. Rice straw (T_5) stimulated the CH_4 production rate most, followed by poultry manure (T_3), cowdung (T_4), 100% CF (T_6), 70% CF (T_2) and control (T_1). Yield scaled CH_4 emissions followed the pattern (T_5>T_3>T_4>T_6>T_1>T_2) from different fertilizer management. However, from Boro season, yield difference was not significant (p > 0.05) in CF and AWD methods of planting. AWD, SRI and DSR significantly reduced the total water use (by 17~33%) and increased water productivity (by 22~35 %) compared to CF. SRI system with poultry manure incorporation (P_3F_3) produced higher grain yield (7.44 t/ha) than AWD and DSR. Methane emission during boro season was the highest under CF method of planting followed by AWD and DSR methods. Combining evidence from both rice season results concluded that organic manure application could be potential trade-off between rice productivity and CH_4 emissions.

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Management of Acid Soils for Maize Productivity in Northern and Eastern Piedmont Plains

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Abstract
The acidic piedmont soil of Northern and Eastern Piedmont Plains is one of the problem soils of Bangladesh that limits crop production. An experiment was, therefore, conducted at farmer's field of Ramchandrakura Union in Nalitabari Upazila under AEZ 22 (Northern and Eastern Piedmont Plains) to evaluate the effect of lime and organic manure amendment on the productivity of maize (BARI hybrid maize9). The soil of the experimental field was sandy loam in texture having pH 4.12, organic carbon 0.502%, total N 0.056%, available P 6.93 ppm, available K 15.1 ppm and available S 22.7 ppm. There were nine treatments laid out in a RCBD design with three replications viz. $T_{1:}$ Control ; T_2: Lime-1, Dololime @ 1t/ha; T_3: Lime-2, Dololime @ 2 t/ha; T_4: OM-1, Cowdung @ 5 t/ha; T_5: OM-2, Poultry manure @ 3 t/ha; T_6: Lime-1 OM-1, Dololime @ 1 t/ha, Cowdung @ 5 t/ha; T_7: Lime-1 OM-2, Dololime @ 1 t/ha, Poultry manure @ 3 t/ha; T_8 : Lime-2 OM-1, Dololime @ 2 t/ha, Cowdung @ 5 t/ha; T_9: Lime-2 OM-2, Dololime @ 2 t/ha, Poultry manure @ 3 t/ha. All experimental plots received full dose of recommended fertilizers (N, P, K, S, Zn and B). Application of lime and/or manure along with chemical fertilizers demonstrated increased crop yields as compared to sole application of chemical fertilizers. The treatment T_9 (Lime2 OM2, Dololime @ 2 t/ha, Poultry manure @ 3 t/ha) ranked the first in producing grain and stover yield of maize which was statistically similar with T_7. The addition of dololime and poultry manure also showed beneficial effects on nutrient content and uptake by maize crop. Therefore, application of dololime @ 1 t/ha in combination poultry manure 3 @ t/ha can be recommended for enhancing crop productivity in acidic Piedmont soils of Nalitabari.

Acid Soil Management for Wheat and Mungbean Productivity in Northern and Eastern Piedmont Plains

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Abstract
An experiment was conducted at farmer's field of Nalitabari Upazila under AEZ 22 (Northern and Eastern Piedmont Plains) to evaluate the effect of lime and organic manure on wheat and mungbean productivity. The soil of the experimental field was sandy loam in texture and strongly acidic in nature having pH 4.66. The treatments include $T_{1:}$ Control; T_2: Lime-1, Dololime @ 1t/ha; T_3: Lime-2, Dololime @ 2 t/ha; T_4: OM-1, Cowdung @ 5 t/ha; T_5: OM-2, Poultry manure @ 3 t/ha; T_6: Lime-1 OM-1, Dololime @ 1 t/ha, Cowdung @ 5 t/ha; T_7: Lime-1 OM-2, Dololime @ 1 t/ha, Poultry manure @ 3 t/ha; T_8 : Lime-2 OM-1, Dololime @ 2 t/ha, Cowdung @ 5 t/ha; T_9: Lime-2 OM-2, Dololime @ 2 t/ha, Poultry manure @ 3 t/ha. The experiment was laid out in a RCBD design with three replications. All experimental plots received full dose of recommended fertilizers (N, P, K, S and B). Dololime, cowdung and poultry manure were applied to wheat as lime and organic manure amendment and their residual effects were evaluated on mungbean. Results demonstrate that dololime alone or in combination with cowdung or poultry increased the grain and straw yield of both wheat and mungbean in comparison with sole application of recommended chemical fertilizers. The increase in grain and straw yield of BARI Gom30 over control ranged from 10.14 to 54.38% and 9.65 to 54.02%,

respectively and that of BARI Mung6 grain varied from 40 to 161.67%. The N, P, K, and S content and uptake by grain and straw of wheat, and grain of mungbean were influenced significantly by the combined application of lime and organic manure. Therefore, application of lime in combination with manure can be practiced for uplifting the crop productivity in acidic Piedmont soils of northern and eastern Piedmont plains.

Determination of Critical Limit of Sulphur, Boron and Magnesium for some Selected Crops (Mustard and Wheat) in Piedmont and Non-Calcareous (AEZ 1, 3 and 9) Soils

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Abstract
The conception of critical limit (CL) of a nutrient element distinguishes its deficiency from sufficiency, which could advise fertilizer application. The state-of-the-art methodologies were followed to update the decade old critical limit values of some selected soils and crops in Bangladesh. In this connection, the benchmark survey was completed, and a total 180 soil samples were collected as per protocol. Results varied from very low to very high level among different soils and chemical properties under study. Bangladesh Agricultural University (BAU) was determine CL of S, Mg and B for 20 soils of which 12 soils were of low fertility level, 4 soils were of medium fertility level and the remaining 4 soils were of high fertility level of the particular nutrient and 2 crops (Wheat and Mustard) through vigorous pot trials and laboratory study. Seeds were sown in the pot and the crop was harvested at 8-10 weeks of plant growth. Dry matter (DM) yield was recorded and plant samples were analyzed for the particular nutrients under study. The CL of soil S for wheat was found to be 14 mg/kg and 11 mg/kg in graphical and statistical methods, and the CL of plant tissue concentration was recorded as 0.14%, in both methods. In case of mustard, the CL of soil S was estimated to be 14 mg/kg by graphical procedure and 11.45 mg/kg in statistical method while plant tissue concentration showed the CL of 0.35% in both methods, respectively. On the other hand, the CL of soil B for wheat was found to be 0.3mg/kg and 0.28 mg/kg in graphical and statistical methods, and the CL of plant tissue concentration was recorded as 13.0% and 13.39%, in graphical and statistical method, respectively. In case of mustard, the CL of soil B was estimated to be 0.25 mg/kg by graphical procedure and 0.12 mg/kg in statistical method while the CL of plant tissue concentration was recorded as 26.5% and 24.0%, in graphical and statistical method, respectively. Again, the CL of soil Mg for wheat was found to be 0.5 meq/100g soil and be 0.39 meq/100g soil in graphical and statistical methods. In case of mustard, the CL of soil Mg was estimated to be 0.55 meq/100g soil by graphical procedure and 0.31 meq/100g in statistical method, respectively. The results would be useful for predicting crop (wheat and mustard) response to S, Mg and B fertilizer and developing efficient S, Mg and B fertilizer management to promote sustainable crop production. The results were also validated through field experiment at farmers field level both Mymensingh and Panchagar District which were in line with the laboratory and pot experiments results.

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Improvement of Soil Health and Crop Productivity in Climate Vulnerable and Polluted Areas Through Organic Amendments

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Abstract
Improvement of soil quality is a prerequisite for sustainable crop production in nutrient poor soils of char land and acidic areas. Several organic fertilizers e.g., rice husk biochar, poultry manure biochar and vermicompost along with chemical (lime) amendments were applied to improve soil structural quality, microbial biomass, enzyme and elemental content and to increase cropping diversity and the system productivity. Crops were grown continuously for two years with Maize−Jute−T. Aman in char land and Mustard−Boro−T. Aman in acidic soils. In addition to field application, soils, mixed with the organic amendments, were incubated at two moisture regimes viz. field capacity and continuous standing water for 120 days for understanding and quantifying rate of organic matter mineralization and nutrient release. During the reporting period mustard, boro and T. Aman were grown in acid soils whilst maize, jute and T. Aman were grown in charland soils. In charland soils, higher system productivity was recorded from poultry manure biochar (2 ton ha^{-1}; IPNS basis) amended plots which was statistically similar to rice husk biochar and recommended fertilizer applied plots. However, soil structural quality and nutrient storage were higher in poultry manure biochar amended plots. In acid soils, liming (1 ton ha^{-1}) and poultry manure biochar (2 ton ha^{-1}) had higher crop yield than all other treatments which were similar to the recommended fertilizer treated plots. With regard to soil properties, poultry manure biochar has improved soil physico-chemical and microbial biomass and enzyme activities. The results indicate that poultry manure biochar increased H^+ adsorption on their exchange sites resulting in higher soil pH, thereby increased crop productivity. The effect of biochar in charland soil indicated that it can improve soil conditions like lower bulk density, higher nutrient and water holding capacity and root growth that all together enhance crop growth and yield. These results suggest that biochar can be a good organic source for soil conditioning and for improving soil health.

Nutrient Management in Diversified Cropping in Bangladesh

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Abstract
Nutrient management should ensure sustainably improved crop production that maintains current nutrient levels where they are adequate, while avoiding nutrient deficiencies and imbalance or overuse of fertilizers. The Nutrient management project (funded by ACIAR and KGF) aims to develop nutrient management packages for emerging cropping systems based on reduced tillage and residue retention with suitable crop rotations. Conservation agriculture (CA) practices (Tillage: strip-ST vs. conventional-CT; residue retention: 15 and 40% crop residue) with low to high nutrient application rate (100% recommended dose-RD, 75RD and 125RD) at five contrasting sites viz. BAU Farm, Ishwardi, Pabna, Godagari and Alipur are being carried out since January 2012 (except at BAU which started in 2018). From the two seasons crop rotations at all sites, it was observed that at the beginning of CA practices crop yields were higher in CT than in ST but after continuation for 6 or seven years rice yield turn the opposite. For example, rice yield at BAU Farm was significantly lower in CT than in ST, while higher at Alipur and Godagari sites. Conversely, wheat yield was higher in ST than in CT at all sites. Lentil yield significantly increased due to conversion of CT to ST at Alipur site but the result was

opposite at Ishwardi site. Soil organic carbon (SOC), total N (TN), total- and available P, K and S were higher in ST than in CT at all sites suggesting higher potential of ST for nutrient sequestration. On the contrary, mineral N content was found higher in CT than in ST indicating increased N mineralization rate in the CT. The ST appears to have removed plough pan in soil enhancing water percolation through the soil profile. With regards to crop residue retention, higher residue retention showed better soil quality resulting in higher crop yield. Considering nutrient application rate, at most of the sites for all crops, 125% of the RD significantly increased the crop yield.

Conservation Agriculture with Optimum Fertilizer Nitrogen Rate Reduces GWP for Rice Cultivation in Floodplain Soils

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Abstract

Wetland rice cultivation contributes significantly to global warming potential (GWP), an effect which is largely attributed to emissions of methane (CH_4). Emerging technologies for wetland rice production such as Conservation agriculture (CA) may mitigate greenhouse gas (GHG) emissions but the effects are not well defined. Investigations were carried out in an irrigated rice field in the fifth crop after conversion of conventional tillage (CT) to strip tillage (ST). Two crop residue levels (low vs high, LR vs HR) and three nitrogen (N) application rates (N1 = 108, N2 = 144 and N3 = 180 kg N ha^{-1}) were laid out in a split-plot experiment with three replicates. Yield-scaled GHG emissions and GWP were estimated to evaluate the impacts of CA on mitigating CH_4 and N_2O emissions in the rice paddy field. There was 55% higher N_2O emission in ST with HR coupled with N3 than that in CT with LR coupled with N1.The N_2O emission factors ranged from 0.43% to 0.75% in ST and 0.45% to 0.59% in CT, irrespective of residue level and N rate. By contrast, CH_4 emissions were significantly lower in CA than in the conventional practices (CT plus LR). The ST with LR in N2 reduced the GWP by 39% over the GWP in CT with HR in N1 and 16% over the conventional practices. Based on our investigation of the combination of tillage, residue and N rates treatments, the adoption of CA with high and low residue levels reduced the GWP by 10% and 16% due to lower CH_4 and N_2O emissions than the current management practices. The relatively high N_2O emission factors suggest that mitigation of this GHG in wetland rice systems needs greater attention.

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Biochar and Compost-Based Integrated Nutrient Management: Potential for Carbon and Microbial Enrichment in Degraded Acidic and Charland Soils

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Abstract
Soil acidification and charland formation through alluvial sand deposition are emerging threats to food security in Bangladesh in that they endanger crop production in about 35% of its territory. The integrated plant nutrient system (IPNS) is a globally accepted nutrient management approach designed to revive the damaged soils' fertility level. Total organic carbon (TOC) in soil is a composite index of soil quality that has consequences for agricultural productivity and natural soil ecosystems. This study assesses the impacts of using biochar, compost, poultry litter, and vermicompost-based IPNS approaches on labile and TOC pools, TOC stocks, lability and management indices, and microbial populations under different cropping patterns after two years in acidic and charland soils. The application of IPNS treatments increased microbial biomass carbon (MBC) by 9.1-50.0% in acidic soil and 8.8-41.2% in charland soil compared to the untreated soil, with the largest increase in poultry manure biochar (PMB). Microbial biomass nitrogen (MBN) rose from 20% to 180% in charland soil compared to the control, although no effect was observed in acidic soil. Basal respiration (BR) rose by 43% to 429% in acidic soil and 16% to 189% in charland soil compared to the control, exhibiting the highest value in PMB. IPNS treatments significantly improved SOC and POC but did not affect POXc and bulk density in both soils. The PMB and organic fertilizer (OF, compost)-based IPNS wielded the greatest influence on the lability index of MBC in acidic soils and the management index of MBC in both soils. This is despite the fact that IPNS did not affect the lability and management indices of active carbon (AC). IPNS treatments increased the stocks of SOC and MBC in both the soils and POC stock in acidic soil. IPNS treatments significantly boosted the bacterial and fungal populations in both soils, despite having no effect on phosphorus-solub+3.ilizing bacteria (PSB). Thus, PMB and OF (compost)-based IPNS may be a better nutrient management practice in degraded acidic and charland soils. This is especially the case in terms of soil quality improvement, soil carbon sequestration, and microbial enrichment.

Effects of Different Methods of Salicylic Acid Application in Alleviating Salinity Stress in Tomato

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Abstract
Mitigation of salinity stress is pivotal for increasing crop production in the world. Therefore, the present study was undertaken to investigate the comparative effectiveness of different methods of salicylic acid application in mitigating salinity stress in tomato. The response of various growth parameters of tomato plants were observed under salinity stress without or with salicylic (SA) application via root pretreatment, foliar treatment or both. The plants were grown for 2 weeks in river coarse sand which were fed regularly with Hoagland Nutrient Solution with or without salinity (100 mM NaCl). The results stated that salinity stress significantly reduced plant height, leaf SPAD value, shoot and root fresh weights, shoot and root dry weights, % dry matter, potassium, calcium,

magnesium, sulphur concentrations of both leaf and root, AsA and LRWC content compared to control plants. However, sodium content of both leaf and root, proline, leaf soluble sugars, H_2O_2 and MDA content were significantly increased under saline condition in comparison with the control plants. SA application particularly by root SA pretreatment + foliar SA treatment enhanced the growth and other traits of tomato plants those were diminished by salinity. Root SA pretreatment + foliar SA treatment also significantly increased leaf soluble sugars, proline content and lessened leaf and root sodium concentration, H_2O_2 and MDA content. Therefore, the result of this study provides a comparison of different methods of salicylic acid application in recovering the reduced growth characteristics of tomato plants under salt stress and demonstrates significant variation in their effectiveness.

Screening of High Capsaicin Rich and High Yielding Hot Chilli Genotypes for Future Varietal Improvement

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Abstract
Chili is the most essential and widely used spice crop in Bangladesh. Collection, conservation and evaluation of crop species is still having potential impact on agricultural research as it has a wide scope to find out higher yielding and year round chili genotypes for varietal improvement. Therefore, this study was undertaken to evaluate physio- morphological variations, growth, fruiting performance and nutritional status of 36 chili genotypes. This project work was conducted at the Horticulture Farm, Department of Horticulture, Bangladesh Agricultural University, Mymensingh during July 2019 to June 2020. This experiment was conducted following randomized complete block design with three replications. Thirty-six genotypes (among them 4 were check varieties collected from BARI and BINA) were used as treatment in this single factor experiment. Vegetative traits of chili genotypes were evaluated at full growth stage following IPGRI Descriptor for Chili. Reproductive traits were recorded during flowering and fruiting stage. Among the parameters plant height, number of secondary branches per plant and leaf area were measured from all tested genotypes but reproductive parameters were not completed from all the genotypes due to COVID-19 pandemic. However, from the results of the first year study it was observed that there were wide variations in plant growth, morphological traits, flowering and fruiting performance of tested genotypes. The maximum length of fruits (23.85 cm) was recorded from G13 (Egypt-1). In terms of fruit yield a good number of genotypes were performed superior yield potentiality as compared to check varieties. Yield per plot was highest in G4 (India-4) (12.91 kg). Moreover, it was found that the life cycle of a number of genotypes were longer than others. However, the superior chili genotypes will be used for second study to find out their suitable planting time for profitable yield and chemical analysis.

Evaluation of Common Bean (*Phaseolus vulgaris* L.) Genotypes for Drought Tolerance in Bangladesh

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Abstract
Drought is the important abiotic stress factor affecting agricultural productivity worldwide. In Bangladesh, French bean is being growing in the dry season with artificial water supply. Therefore, it

is necessarily important to select some drought stress tolerant common bean genotypes for successful cultivation in the dry season. This study was conducted in order to evaluate the drought stress responses of common bean genotypes and select drought stress tolerant genotypes. A pot experiment was conducted at Horticulture Farm, Bangladesh Agricultural University, Mymensingh during November 2020 to April 2021. This study was conducted following randomized complete block design with replications. Eleven common bean genotypes including BARI released varieties and exotic genotypes (G1, G2, G3, G4, G5, G6, G9, G10, G11, G12 and G13) were evaluated in two levels of water stress conditions [(well-watered) and soil drying]. Drought stress was applied in the pot soil before flowering and continued for 30 days after soil drying and well-watered pots were watered routinely. Leaf traits importantly leaf area, leaf chlorophyll index, flavonoid index, anthocyanin index and nitrogen balance index (NBI), relative water contents (%RWC), dry matter contents, proline contents in leaves and roots were determined using UV Spectrophotometer at various growth stages of plants (from 0, 10, 20 and 30 days after soil drying). Results showed that different genotypes performed differently in water limit condition. It was found that leaf area, leaf chlorophyll index, flavonoid index, anthocyanin index and NBI, % RWC declined as soil drying progressed. But dry matter contents in leaves increased with time in water limit condition. The % reduction in leaf area was higher in most of the genotypes (G3 to G11) and the least reduction obtained from G13 (28.28%) preceded by G2 (30.22%), G12 (42.67%) and G1 (43.78%). These genotypes keep high chlorophyll index during soil drying. Proline contents in leaves and roots increased rapidly after soil drying treatment imposed in the pots. However, the incensement of root proline is higher than that of leaf proline content. From the findings of this study it can be concluded that some genotypes showing drought stress avoiding tendency so it is necessary to further evaluation in the open field condition and also need to check the leaf gas exchange mechanisms under water limit condition.

Standardization of Production Technology of Colored Sweet Potato Variety and Promotion of Its Utilization to Combat Hidden Hunger

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Abstract

Colored sweet potato is a store house of nutrients for human health particularly anthocyanins, β carotene, potassium and other minerals. We have developed four colored sweet potato varieties namely BAU Sweet potato-1 (Purple skin and orange flesh), BAU Sweet potato-2 (Violet skin and deep violet flesh), BAU Sweet potato-3 (Radish skin and Creamy flesh) and BAU Sweet potato-4 (Radish skin and deep creamy flesh from the previous project funded by BAURES. The current project is undertaken in order to standardize the production technology of those colored sweet potato varieties for better plant growth and higher storage root yield. At the beginning stage of this project we have multiplied those new varieties at Horticulture Farm, Department of Horticulture, Bangladesh Agricultural University during March to October 2021. Vine cuttings of four colored sweet potato varieties were planted in separate plots of 10m×5m. Weeding, vine lifting, irrigation, drainage and pest control were done properly. Healthy and diseases free sweet potato vine cuttings were used in the following experiments in November 2021. Two separate experiments on planting dates, planting spacing with four released variety are conducting at Horticulture Farm. Moreover, sufficient vine cuttings were distributed among the four farmers in three different districts (Mymensingh, Munshiganj and Sirajganj). Detail findings of different experiments along with location based results will be noticed in the final report of the project.

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Exploration, Identification, Characterization, Multiplication and *Ex-situ* Conservation of Endangered Forest Genetic Resources Including Medicinal Plants of Bangladesh

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Abstract
The study was undertaken to explore, identify and collection of medicinal plants sapling/seedlings from the selected five districts like Natore, Modhupur, Jamalpur, Sherpur and Mymensingh; to multiply and *Ex-situ* conservation at BAU-GPC during the period from July 2018 to June 2021. Base line survey on medicinal plants at selected districts was carried out using Focus Group Discussion. At Natore 57, Modhupur 71, Jamalpur 09, Sherpur 17 and Mymensingh 23 medicinal plants were recorded. In Natore, aloevera, shimul and ashogandha are cultivating commercially. Kalomegh, gurbach, agar, basak and aloevera are cultivating commercially in Modhupur. In Mymensingh and Jamalpur most of the medicinal plants are found in homestead area, road and railway sides. Collected 126 medicinal plant species were conserved at BAU-GPC. The species were bashok, olotkombol, gritokumari, kalomegh, agor, sotomuli, neem, kanchon, punarnava, polas, mahua, sonalu, korpur, harzora, vuikumra, tulsi, sarpogandha, lalbherenda, shimul, ashok, arjun, bohera, horitoki, nisinda, ashawagandha, piperlongan, tejpata, torupchondal, akondo, elaichi, hijol, tomal, pthorkuchi, dholsomudro, stevia, jogdumur, gynura, arhar, ekangi, pudina, lemongrass, kontikari, nageshwarchapa, naglingom, kiamul, ishermul, goniori, euphorbia, kumarilota, boulagota, commifora, kanaidinga, nilchita, pasanbedi, shalpani, sugondhibala, dudhsor, telakucha, ada, mehedi, ararot, shoti, polaopata, gongasagor, kalonirbish, sadanirbish, kantati, nagdana, dadmordan, punagchampa, gurbach, bisullakoroli, Rokto chita, anatamul, kurchi, roktochandan, daruchini, udal, civit, babla, berela, pang, orthoshipon, kunch, bhuiamla and dudchkoruch etc. Morphological characterization was done. Due to COVID-19 pandemic, laboratory research works for molecular characterization was hampered and sufficient result was not obtained for summarize the result. The highest germination percentage (85.25%) and survival percentage (85.21%) were found when the seed of *T. chebula* were soaked in cowdung slurry for 6 days. The highest germination percentage and survival percentage of *T. bellirica*, were found in depulped seed before soaking.

Development of Improved Postharvest Handling Practices to Prolong Shelf Life and Maintain Quality and Safety of Important Climacteric Fruits of Bangladesh

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Abstract
The present research attempted to reduce postharvest loss and extend shelf life of climacteric fruits through adoption of environmentally-friendly and improved modified atmosphere packaging (MAP). Specific objectives of the study were to standardize MAP in terms of type and thickness; to find out effects of ethylene scavenging compound and edible coating on shelf life and quality of fruits. To achieve the objectives, number of experiments were carried with completely randomized designs. Parameters investigated were mainly physiological weight loss, ripening rates (colour and firmness),

total soluble solids, disease incidence, disease severity and shelf life. Results suggested that LDPE (low density polyethylene) bags of 50 thickness outperformed thin LDPE (25) and PP (polypropylene) bags irrespective of thickness in reducing weight loss, disease incidence and severity, and in extending shelf life of bananas. At the 12th day after storage, LDPE bag of 50 thickness showed no disease, whereas the unwrapped control fruit had 68.33% disease. Five levels of $KMnO_4$ (unwrapped control; LDPE+No $KMnO_4$; LDPE+1g $KMnO_4$-vermiculite mix; LDPE+5g $KMnO_4$-vermiculite mix; LDPE+10g $KMnO_4$-vermiculite mix) were tested in bananas, and fruits held in 50 LDPE with 10g $KMnO_4$-vermiculite mix exerted the best result in reducing weight loss, disease severity, and extending shelf life (22 days as compared to 8 days in unwrapped control at ambient condition). Mangoes (cv. Amrapali) when wrapped in 25µ LDPE bag with 1-15 g $KMnO_4$-vermiculite mix exhibited 15-20 days shelf life at ambient condition. Chitosan (an edible coating material) when applied at a concentration of 1-2% resulted in reduced weight loss and prolonged shelf life of guava (cv Thai 3).

Bio-fortification of Potato Tubers with Zinc through Soil and Foliar Application of Zinc Fertilizers

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Abstract

Dietary zinc (Zn) intake can be increased by producing crops with higher concentrations of Zn in their edible portions. The study aimed to develop a package combining Zn enriched variety and efficient Zn application method for enriched Zn in potato. Zn source fertilizer was $ZnSO_4.7H_2O$. In the first year, 47 released varieties were tested to response the yield and zinc concentration in tuber zinc fertilizer, consequently screened varieties were examined through soil and foliar application of zinc fertilizer. All the experiments were laid out in a Randomized Complete Block Design with 3 replications. Growth, yield and zinc content in potato tubers were recorded. Yield was found significantly 10.16% higher (28.86 t/ha) using 8 kg/ha zinc fertilizer in soil compared to control treatment (26.20 t/ha) and 25.17% higher zinc content (19.07ppm) in zinc treated potato tuber compared to control (15.15 ppm). The highest zinc content (41 ppm) was found in BARI 53 Alu and a wide range of zinc content found in different cultivars of potato. Out of 47 varieties, 31 varieties responded well with yield and zinc concentration in tuber influenced by zinc fertilizer application. In the second-year experiment, BARI 7 (Diamont), BARI 13 (Granola), BARI 25 (Asterix), BARI 53, BARI 73, BARI 77 (serpomira) was used. Out of these six varieties, BARI 53 and BARI 73 cultivars gave the highest yield when zinc fertilizer (4, 8 and 12 kg/ha in soil) was applied compared to control. The highest tuber yield was found from 12 kg/ha zinc application in soil to BARI 73 potato cultivar. On the other hand, BARI 53 and 73 cultivars showed the highest yield when zinc fertilizer was sprayed (4 kg/ha) at the 45 and 60 days after planting compared to other treatments. Overall, varieties response trialed can be repeated to observe the response of soil and foliar application of zinc fertilizer.

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Varietal Development of Garlic and Onion Through Selection and Molecular Techniques With Special Emphasis on Higher Yield and Allicin Contents

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Abstract
To achieve against the specific objectives already different germplasm of short day onion and garlic have been collected from different places of Bangladesh and abroad Nov 2018- Mar 2021. Twenty four Germplasm of garlic were planted in early November 2020 in the research field for trial. Twelve more germlasm of garlic has also been planted in late November 2020. Twenty onion germplasm also collected and studied the performance in respect of bulb and seed yield. Now it was harvested and post harvest operations also been completed. Sorting, grading, marking, data collection, drying and storage have been done in the laboratory and field store-house in March 2021. In order to get a fruit full research findings a number of MS and PhD student are attached with this project work. Within these Germplasm observation is going on to select clones with higher yield potential, long shelf life and higher allicin content. Observation of storage behavior of the collected germplasm is also going on. After selecting the quality germplams among the collecting germplasm will be planted for 2nd year trial for finalization of the project work. From this project a garlic variety viz. BAU-BAURES Garlic 5, BAU BAURES Winter onion and BAU Summer onion has been registered from Seed Wing, Ministry of Agriculture.

Exploring and In-Situ Development of Underutilized Fruits to Improve Nutritional Food Security and Livelihoods of the Poor Communities of Southern Bangladesh

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Abstract
This project was taken for Collection of underutilized fruit from southern and coastal areas of Bangladesh; to carry out integrated approaches to improve, manage and utilize underutilized fruits for increasing production in southern and coastal areas of Bangladesh; to demonstrate the outcome of integrated approaches to improve and manage underutilized fruits to growers, researchers, NGO's and to the related personnel; to arrange trainings, workshops and seminars for creating awareness of integrated approaches to improve and manage for increasing production of underutilized fruits; and for fine tuning of the collected germplasm from our previous BAS-USDA funded program. This program was seriously disrupted by different natural disasters (cyclones Bulbul & Amphan) and COVID 19. We planted from 15 to 21 September, 2019 in 30 farmers of three locations, after plantation the cyclone Bulbul (5 to 12 November, 2019 damaged 16.7 to 38% followed by cyclone Amphan (16-21 May, 2020) damaged in Jessore 31.4%; Khulna 39.6% and Satkhira 100%. However, we planted again on 12 to 15 February, 2020. Unfortunately, from 18 March 2020 due to COVID 19, lockdown broke down all activities in three districts. At the beginning we made a survey, from which it was observed that farmers from Khulna and Bagherhat are much more familiar with different underutilized fruits than other areas surveyed. Among the underutilized fruit trees grown in the farmers' field, higher

adaptability and survivability were recorded in Sofeda followed by Jambura. Leaf spot disease was observed in Lotkon and Sofeda. We conducted a workshop on 06 July 2021 (virtually) where a number of participants from different organizations attended. At BAU GPC we have conserved most of the underutilized fruits from the Southern part of Bangladesh. Care and management of all trees collected from the BAS USDA program has also been continued. From the field level study and followed by study in FTIP we have registered a BAU KGF Seedless bilati gab (Velvet apple) which is now given to farmers of Jessore and Khulna.

Carrot Germplasm Development and Farmer Training for Production in Stressful Environments

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Abstract

The tropical type of carrot lines (C1, Brasilia derivatives, Uberlandia derivatives) with root-knot nematode resistance are highly suitable for the areas where the seed system is not well developed. • Hundreds of local farmers were interested and trained in carrot root crop and seed production in several Asian countries. • A subset of trained farmers has indicated an interest and demonstrated an ability to become self-sufficient in producing their own carrot seed. Project Summary Statements Carrot seed from the USDA carrot breeding program was successfully delivered to project partners in Bangladesh, India, Pakistan, Thailand, and Taiwan for field trialing, although seed delivery was challenging for several trials. Trials were successful established and carrots were evaluated for performance in a range of Asian optimal and suboptimal (biotic or abiotic stress) production locales. New breeding stocks with potential for reliable production with improved stress tolerance, economic yield, nutritional value, and local seed production capacity by farmers were identified. The 'Brasilia' cultivar, as well as most of the nematode resistance pre-bred lines and entry P1129, were included in this project to provide early flowering (also known as annual or tropical) carrots, which are typically used in Asian carrot production. 'Brasilia' and its derivatives had been observed to flower readily in Bangladesh trials performed before this project, and flowering was again observed during this project, but unlike the general crop production performance and biotic stress tolerance noted above, which performed similarly to previous US, European, South American and Japanese trials, the 'Brasilia' cultivar demonstrated relatively limited flowering in India and Thailand during this project. To increase the prospects for flowering after year 1, seed of another annual carrot, 'Uberlandia' and several of its derivatives were included in subsequent 4 trials, and these lines generally flowered. Local cultivars were included in Indian trials (local OPVs) and Bangladesh (BA, PA), and these flowered well, indicating that these should have been included in all trials, and should be included in future breeding programs for South Asia to support local seed production. Training teams were assembled and they visited female and male farmers to train them about standard practices for carrot crop production and seed production. Carrot seed was successfully produced on carrots that flowered. Perhaps most importantly, a subset of the farmers trained in Bangladesh, India, Pakistan, and Thailand indicated an interest and capability to produce carrot seed after the training, confirming that a critical goal of this project was achieved.

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Characterization of Indigenous Banana, Aroids and Yams of Bangladesh in Referance to Geographical Indication Cultivars

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Abstract

An investigation was made to study "Characterization of plant genetic resources viz. Indigenous Banana, aroids and yams of Bangladesh in Reference to Geographical indication cultivars" at the Fruit Tree Improvement Programme, Germplasm Centre, Bangladesh Agricultural University, Mymensingh. For this purpose, seventy indigenous banana cultivars were collected from different parts of the country. Of them sixty cultivars were transplanted. Morphological and molecular characterization of these indigenous bananas (55 dessert and 5 plantain) were assessed during the period of 2014 to June, 2017. The genotypes were analyzed using 63 morphological descriptors; where descriptors, relating to plant and leaf, male bud and fruit were respectively 20, 11 and 32. Molecular characterization was done using RAPD and SSR markers. The IPGRI descriptors were efficient in the characterization and identifying specific characteristics. The experiment included both qualitative and quantitative characterizations. Genetic diversity of banana germplasm was estimated in two ways; univariate technique and multivariate technique, using the data obtained from morphological experiment. Results obtained using the descriptors showed wide variability of the characteristics that would facilitate its use in preparing the specification for geographical indication of the indigenous banana products. Among the dessert type accessions the highest yield was observed in MS044 (Aitta Kala, BAU; 32.68 kg); and the lowest yield was observed in MS040 (Shail Kala, SylhetSadar; 2.08 kg). In plantain type, the quantity ranged between MS056 (Anaji kala, BAU; 15.0 kg) to MS058 (Anaji kala, SylhetSadar; 10.79 kg). Among the top ten accessions out of forty three dessert accessions in respect of the highest yield per plant, only three were found in the group of seedless or less seeded type. In descending order of total yield per plant, they were MS020 (Joltaranga, Akra, Dumuria; 21.66 kg), MS006 (BouSundari/ Bodhu Sundarikala, Lalmonirhat; 21.61kg) and MS024 (Kanthali Kala, Pirojpur; 19.6 kg) and the observed 'pulp to peel ratio' in those accessions were 3.94, 2.92 and 5.68, respectively. Total days required from plantation to harvesting of these accessions were 510 days, 628 days and (690 days for MS020, MS006 and MS024 respectively. Differences between both the maximum and minimum genotypic and phenotypic variances (GVC and PVC respectable) for the collected genotypes were quite large. In case of genotypic it was from 0.005 to 25876.20, and for phenotypic it was 0.007 to 25918.62. The highest PCV and GCV ((64.01% and 63.87%) were recorded in weight of peel, and lowest PCV and GCV noted were 15.55% and 13.01%) in breadth of leaf blade. The low difference between GCV and PCV indicated the less influence of environment in the expression of the character studied. Genetic diversity from the multivariate analysis of 14 morphological characters of the 55 dessert accessions was grouped into eight clusters. It was observed that accessions collected from the same location had been grouped into different clusters. Cluster II contained the largest number of accessions (12); the other clusters depending on the number of accessions are as following: cluster III (9); cluster VII (8); cluster IV, V and VI each one with 6 accessions and cluster I and VIII having four accessions. The highest inter cluster distance was found between cluster VIII and V (90.47) and the lowest was observed between cluster III and II (38.11).

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Screening of Mango Rootstock for Saline Tolerance

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Abstract
An experiment was conducted at Fruit Tree Improvement Project, Fruit Tree Improvement Programme, Bangladesh Agricultural University-Germplasm Center (FTIP, BAU-GPC), Bangladesh Agricultural University (BAU), Mymensingh during the period of April 2020 to June 2021 to study the performance of selected mango rootstocks for the saline area. The two-factor experiment consisted of four mango rootstock varieties such as V1 = BAU Aam-9, V2 = BAU Aam-6, V3 = BAU Aam-4 and V4 = Amropali and six salinity treatments namely control S1 = 0 dSm-1 , S2 = 4 dSm-1 , S3 = 8 dSm-1 , S4 = 10 dSm-1 , S5 = 12 dSm-1 and S6 = 14 dSm-1 . The experiment was conducted following randomized complete block design with three replications. Results revealed that rootstock line and salinity levels had significant influences on various rootstock characters viz. length of rootstocks, number of leaves and percent rootstocks success and survivability. In case of varietal effect, the highest number of leaves (32.44) found in BAU Aam-6 and the lowest number of leaves was recorded in Amropali (22.55) at 90 days after transplanting. The longest rootstock length observed in 90 DAT which (54.83 cm) found in BAU Aam-9and shortest rootstock recorded in Amropali (47.94 cm). The highest survivability (51.44%) was recorded in BAU Aam-9 and the lowest survivability recorded in Amropali (33.88%). In case of salinity treatments, the highest survivability (95.83%) was recorded in control and the lowest survivability (0.00%) recorded in 14 dsm-1 at 90 DAT. Interaction of rootstock varieties and different salinity treatments showed significant variation on the length leave and survivability of rootstocks at 90 DAT. The maximum number of rootstock leaves recorded in V2S2 (46.33) and lowest number of leave recorded in V4S6 (7.66). The highest rootstock length was found in V1S3 (78.00 cm) and lowest in V1S2 (21.66 cm). The highest Survivability (100 %) observed in V1S1, V1S2, V2S1, V2S2 and V4S1. From the above mentioned it can be said BAU Aam - 9 and BAU Aam – 6 rootstock varieties performed best from 0-8 dSm-1 salinity. The overall salinity tolerance was graded as follows: BAU Aam - 9>BAU Aam – 6> BAU Aam-4>Amropali rootstock line.

Field Performance, Character Association and Genetic Diversity Analysis in Cucumber (*Cucumis sativus* L)

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Abstract
Two field experiments were conducted out at the Horticulture Farm, Bangladesh Agricultural University, Mymensingh during 2020-2021 to study the field performance, character association and genetic diversity of 46 short type cucumber (*Khira*) and 40 accessions of long type cucumber (*Shosha*), respectively. The field experiments were laid out in randomized block design with three replications. In experiment-1, significant variations were observed among 46 accessions of short type cucumber for different yield contributing characters and yield per plant. The characters under study showed higher phenotypic coefficient of variation than genotypic coefficient of variation indicating the presence of wide variability among the accessions. Correlation coefficient study indicated that fruit

yield per plant was positively and significantly correlated with number of branches, number of nodes, number fruit per plant, fruit length and individual fruit weight and negatively correlated with vine length. Genetic diversity analysis using morphological characters grouped the 46 accessions of short type cucumber into five groups with maximum number of accessions in Group-I and minimum in Group V. In case of experiment-2, there were significant variations among 40 accessions of long type cucumber for different yield contributing characters and yield per plant. Like experiment-1 dealing with 46 short type cucumber accessions, the characters under study for long type cucumber accessions in experiment-2 also showed higher phenotypic coefficient of variation than genotypic coefficient of variation. Correlation coefficient study indicate that fruit yield per plant was positively and significantly correlated with fruit length and width, flesh thickness and individual fruit weight. Genetic diversity analysis using morphological characters grouped the 40 accessions of long type cucumber into five groups with maximum number of accessions in group-I and minimum in group V. Results of the present study revealed that there were wide variations among 46 accessions of short type and 40 accessions of long type cucumber which can be used for future varietal improvement of the crop. Along with the above experiments, seeds of 229 accessions of cucumber (Short and long types) are preserved at -20^{0}C in a deep freeze for future use.

Management of Wheat Blast: A Holistic Approach With Emphasis On Early-Stage Detection for Forecasting

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Abstract

Wheat blast since its first appearance in Bangladesh in 2016 continued to reappear and spread to new areas of the country, until 2021 wheat blast has been detected in 20 districts of Bangladesh. In the investigative analysis of Mottaleb et al (2018), 0.28 million ha (out of 0.43 million ha) under wheat cultivation are predicted vulnerable to wheat blast located in 46 districts (out of 64) of Bangladesh. Some thoughts were seeded to explore the possibility of managing wheat blast epidemic in Bangladesh through an integrated approach. Research done during the three consecutive cropping seasons (2018-21), resulted in the development of a quick and economic moist blotter technique of detecting *Magnaporthe oryzae* Triticum (MoT), wheat blast pathogen in the seeds in 72 h @ cost of Taka 500. Field diagnostic developed through PCR technique is helpful in forecasting the presence of MoT in different growth stages of wheat prior to heading in 72 h @ cost of Taka 500. That blast is transmitted by seed has been proved through seed to plant to seed transmission of *M. oryzae* Triticum analyzing wheat plant anatomy supported by DNA marker records. Soil supplementation of Silicon and Boron and pre-heading foliar spray of Selenium proved effective in reducing the blast severity to an acceptable level. Trichoderma as a biological agent proved effective in reducing the blast severity. Cost-effective and environment friendly three IPM packages have been developed with BCR 1.1 – 1.5. 12 M5 blast free elite wheat mutants have been selected and the lines are being channeled for zonal trial in the blast hot spot areas.

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Morpho-molecular and Pathogenic Diversity Analyses of *stemphylium* spp. for Developing Sustainable Management of Blight of Onion and Garlic for True Seed Production

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Abstract

The present investigation was focused on morphological and molecular characterization, evaluation of pathogenic variation of *Stemphylium vesicarium* isolates and evaluating elicitors, bioagents and botanicals for controlling leaf blight of onion and garlic. Twenty-two isolates of *Stemphylium* spp. were isolated from several geological areas that belong to different agro-ecological zones in Bangladesh. *Stemphylium* spp. were identified both morphologically and at molecular level by sequencing of the ITS region. Isolated fungi produced cottony, fluffy, and velvety colony texture with circular and irregular colony shapes. The colony elevation was umbonate, raised, and flat type. Colony colors ranged from light yellowish, white, light green, light gray, dirty white, light brown, and ash. Oblong, ovoid, and ovoid to oblong shape conidia and light brown to deep brown conidial color were found in these isolates. The length of conidia varied from 15.49 µm to 33.57 µm and the breadth of conidia ranged from 10.20 µm to 18.74 µm. The fungal isolates were found in 82.92 to 100 percent identity with *S. vesicarium* and *Stemphylium* spp. compared with the NCBI GenBank database. The phylogenetic relationships among twenty-two isolates representing two species of *Stemphylium* revealed genetic variation among the isolates. For disease management study, elicitors, bioagents, botanicals and fungicides were screened for their growth suppressing ability against *S. vesicarium*. Chitosan @ 500 ppm, BS 41 (*Bacillus subtilis* 41), Pf 3 (*P. fluorescens* 3), *Achromobacter* spp., *Trichoderma* spp. and 10 % Garlic-Ethanol extract, Tropper @ 0.08 % showed the highest inhibitory effect (100 %, 75.95 %, 64.83 %, 66.98 %, 53.27 %, 100 % and 100 % respectively) against *S. vesicarium* in *in vitro* condition. The incidence and severity of Stemphylium blight disease was recorded highest in untreated control at all growth stages. Foliar application of single and combined treatments significantly reduced incidence and severity compared to control. On the other hand, in artificial inoculation study, in case of onion plants, treatments T5 (10 % Garlic- Ethanol extract), T4 (*Achromobacter* spp.), T2 (*B. subtilis* + Chitosan @ 500 ppm), T11 (*B. subtilis* + *P. fluorescens* + 10 % Garlic- Ethanol extract) and T3 (*P. fluorescens* + 10 % Garlic- Ethanol extract) showed 12.18 %, 13.47 %, 9.44 %, 9.93 % and 10.24 % reduction in incidence and 10.32 %, 12.31 %, 4.28 %, 6.68 % and 14.61 % reduction in severity respectively over control at 60 DAS. In case of garlic plant, T6 (Chitosan @ 500 ppm), T1 (*B. subtilis*), T12 ((*B. subtilis* + *P. fluorescens* + Chitosan @ 500 ppm) and T1 (*B. subtilis* + 10 % Garlic- Ethanol extract) showed 28.52 %, 29.53 %, 18.43 % and 18.95 % reduction in incidence and 19.81 %, 20.33 %, 18.50 % and 19.00 % reduction in case of severity over control respectively at 60 DAS. Promising results were also found by foliar application of single and combined treatments on vegetative and yield parameters of onion and garlic plants. From this study, it is revealed that T5 (10 % Garlic- Ethanol extract) and T2 (*B. subtilis* + Chitosan @ 500 ppm) gave the highest BCR (6.46 and 7.23) respectively and in case of garlic plants, T6 (Chitosan @ 500 ppm), both T12 (*B. subtilis* + *P. fluorescens* + Chitosan @ 500 ppm) and T13 (Tropper @ 0.08 %) resulted the highest BCR (3.79 and 3.95) respectively indicating that, those treatments were also found economically viable for the management of Stemphylium blight disease of onion and garlic.

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Chemical Inducers, Nutrient Management, Guava Intercropping and Insecticides Can Reduce Huanglongbing Incidence and Severity in Sweet Orange

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Abstract

Huanglongbing (HLB) or popularly known as citrus greening is caused by *Candidatus* Liberibacter asiaticus (*C*Las), a century old and most economically devastating disease of citrus in the world. HLB is a vector-borne disease and transmitted by Asian Citrus psyllid (ACP) (*Diaphorina citri*). HLB is now a serious threat to the expansion of sweet orange and mandarin cultivation in Bangladesh. As no suitable cure is available against the disease, inducing plant immunity by chemical inducers, nutrient management and intercropping could be an effective way to combat this challenge. In this study, two inducers *viz.,* Bion (Acibenzolar S-methyl) and Bactroban (Bismerthiazol), nutrients formulations SICOGREEN®, intercropping with guava, spraying guava leaf extract (10%), foliar application of insect growth regulators (IGR) [Heron (Lufenuron)], insecticide [Neonicotinoids/Imidachloropid + Thiomethoxam] and foliar application of *Beauveria bassiana* (commercial formulation) showed comparatively better performance in reducing both HLB incidence and severity of sweet orangeas compared with untreated control. All these treatments reduced HLB incidence ranged by 57.5 to 89.44% and HLB severity ranged by 54.16 to 80.35% in sweet orange considering both Haluaghat and Bhaluka orchards as compared with control. The results revealed that Bion (Acibenzolar S-methyl), nutrients formulations SICOGREEN® (soil and foliar application), intercropping with guava, spraying guava leaf extract, foliar spray of insecticides can be integrated to reduce HLB incidence and severity in sweet orange. Some of these treatments have also some positive effects on plant growth and yield parameters of sweet orange as compared with untreated control. These results comprehensively suggest that chemical inducers and nutrient management would be a better alternative to control HLB probably through inducing the phages of *C*Las in psyllids which is lethal to the bacterium and also aimed to increase tree life span and productivity.

Identification of Atoxigenic *Aspergillus Flavus* in Controlling Aflatoxins Contamination in Maize

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Abstract

Maize (Bhutta) is one of the important growing cereal crops in Bangladesh. Stored and field maize grains are subjected to infection by a variety of toxigenic fungi including different species of *Aspergillus.* Aflatoxins are mainly hepatocarcinogenic toxins comprising of major three metabolities named Aflatoxin G, M and B. The toxicity level of aflatoxins of different types chronologically are B1>G1>B2>G2. Basically, aflatoxin levels were found ascendency in the food markets of Bangladesh that pose a great threat for food and feed safety. The most effective aflatoxins reducing strategy is the pre-harvest application of *A. flavus* isolates that are naturally atoxigenic or incapable of aflatoxin

production globally including USA, SubSharan Africa, Italy and Pakistan. In order to identify the atoxigenic *A. flavus* from composite stored maize grains samples were collected from fifteen maize growing areas of Bangladesh to determine the total aflatoxin contamination by Enzymes linked Immusorbent Assay (ELISA). The highest (103.07 µg/kg) amount of total aflatoxin concentration was detected in Chuadanga followed by Gaibandha (68.48 µg/kg), Kushtia (31.48 µg/kg) and the minimum (1.07 µg/kg) was detected in samples collected from Dinajpur. The results clearly showed that aflatoxins concentrations in samples of six regions were beyond the regulatory limit of aflatoxin (10ppb). However, a positive correlation found between the aflatoxins concentrations and the associated toxigenic *A. flavus* that were identified by sequencing of ITS region. A total of 255 *A. flavus* isolates were isolated from stored maize grains collected from maize traders of 15 growing areas of Bangladesh and till date 60 were screened by PCR. To date, 11 atoxigenic and 49 toxigenic *A. flavus* isolates were identified by PCR using aflatoxins biosynthesis gene markers *nor*1, *apa* and *omt*1. Identification of remaining *A. flavus* as atoxigenic isolates and their capability in reducing afalatoxis contamination in maize are underway.

Development of Nutrient Based Innovative Technology for Improved Management of Citrus Greening Disease of Sweet Orange

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Abstract

Citrus "greening" also known as Huanglongbing (HLB) caused by *Candidatus* liberibacter asiaticus is arguably the most damaging disease of citrus in the world today and very difficult to control. The disease is now present in most of the citrus growing areas of Bangladesh and emerged as threat for expansion of sweet orange cultivation in the country. The application of macro-and micro-nutrients is one of the measures followed worldwide to maintain the normal production of HLB-infected orchards. Therefore, understanding the detailed process of interaction between nutrient disorders and HLB development is the key to effective nutritional management vis-a-vis prolonged orchard productivity. Experiments are underway to develop nutrient based innovative technology in reducing HLB severity and increasing tree productivity. Based on the available data on the status of phosphorus (P), Potassium (K), Calcium (Ca), Magnesium (Mg), Sulpher (S), Zinc (Zn) and Boron (B), the relationship between nutritional status of the soils in the areas to be surveyed and the citrus greening severity of that area were analyzed by regression analyses. The results of the regression analyses revealed that the relationship between deficiencies of P, K, Ca, Mg, S, Zn and B vs. citrus greening severity was positively correlated. That is one unit increase in deficiency of these nutrients in soils resulted one unit increase in HLB severity. Fifteen treatments were formulated to assess the effect of macro- (Ca and Mg) and micro- (Zn, B, Mn, Cu and Fe) nutrient management on citrus greening severity over time to enhance tree lifespan and productivity. Prior setting up nutritional trial, sweet orange (malta) trees were confirmed for citrus greening positive by nested PCR. PCR results confirmed that all the sweet orange trees of the experimental orchards are citrus greening positive. The severity of HLB in all the trees are belong grade 2 in a scale 0-9. The results of the canopy measurements conceded that the canopies of the sweet orange trees under investigation were also affected by HLB infection. Experiments on the assessment of the effects of macro- and micro-nutrient elements on reducing HLB severity, CLas bacterial titre and tree productivity are underway in year 2 and year 3.

Resistance Induced by Plant Growth Promoting Bacteria in Rice Against Bacterial Blight

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Abstract
Bacterial blight (BB) caused by *Xanthomonas oryzae* pv. *oryzae* (*Xoo*) considered as a most destructive disease and causes considerable yield losses in Bangladesh. Recently plant growth promoting bacteria (PGPB) emerged as an effective tool for management of rice bacterial diseases. Four potential PGPB isolated from rice phylloplane and rhizosphere were selected out of thirty two bacterial isolates that inhibited the growth of *Xoo* significantly. Susceptible check variety IR24 was used to study the induced resistance mechanisms in rice against BB by PGPB. The maximum reduction of BB severity (96.56%) was observed in plants treated with BDISOB222R *(P. plecoglossicida)* followed by BDISOB45R [(*B.paramycoides* (96.00%)], BDISOB05P [*p. putida* (95.71%)] and BDISOB01R [*B. amyloliquefaciens* (93.16%)] while the minimum (50.145%) reduction was observed in plants treated with BDISOB158R (*S. marcescens*) followed by BDISOB198P [*S. plymuthica* (52.36%)] and BDISOB15R [*P. asaccharolyticum*) (54.03%)]. The results showed that the maximum induction of some defense related enzymes viz. PAL activity (459 & 413 µmol transcinnamic acid min^{-1} g^{-1} protein), CAT activity (362 µmol$H_2O_2$$min^{-1}$$g^{-1}$FW) and PPO activity (391 Units $g^{-1}$$min^{-1}$) were recorded in plants treated with BDISOB45R (*B. paramycoides*) while the maximum POD activity (2715 Units g^{-1} FWmin^{-1}) was found in plants treated with BDISOB05P (*P. putida*) as compared to untreated control. The results showed the significant induction of some SA and JA-responsive genes in rice by some of PGPB. The levels of expression of *OsPR1* and *OsPR10* were observed maximum in plants treated with BDISOB05P (*P. putida*) and BDISOB222R (*P. plecoglossicida*). The higher expression levels of *OsWRKY45* was observed in plants treated with BDISOB222R (*P. plecoglossicida*), BDISOB05P (*P.putida*), BDISOB45R (*B. paramycoides*) and BDISOB0B1R (*B. amyloliquefaciens*). BDISOB222R (*P. plecoglossicida*), BDISOB01R (*B.amyloliquefaciens*), BDISOB222R (*P. plecoglossicida*), BDISOB05P (*P. putida*) and BDISOB222R (*P.plecoglossicida*), BDISOB05P (*P. putida*), BDISOB45R (*B. paramycoides*) and BDISOB01R (*B. amyloliquefaciens*) resulted higher expression of *OsWRKY62* and *OsWRKY71* over control. The expression of *OsACS2* and *OsHI-LOX* were observed maximum in plants raised from treated plants with BDISOB05P (*P. putida*), BDISOB222R (*P. plecoglossicida*), BDISOB45R (*B. paramycoides*) and BDISOB01R (*B. amyloliquefaciens*) over control. The results of the study primarily indicated that these PGPB reduced BB severity through induced systemic resistance by expression of some defense related enzymes and genes which are related to SA and JA pathways.

Molecular Detection and Characterization of Phytoplasma Causing Little Leaf of Brinjal With Special Emphasis on Its Management

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Abstract
Little leaf of brinjal causes losses up to 40% yield losses depending on the outbreak especially in modern hybrid brinjal varieties in Bangladesh. Experiments were conducted to assess the status of little

leaf of brinjal in some selected growing areas of Bangladesh, to characterize the causal bacterium, *Candidatus* spp. at molecular level and to develop an integrated approach to control little leaf of brinjal. Survey results in some selected locations viz. Dinajpur, Rangpur, Bogura, Jessore, Narsinghdi, Sherpur and Mymensingh showed that a regional variation of little leaf incidence in the country. The highest (46.66%) little leaf incidence was recorded in Dinajpur followed by Jashore (35%), Rangpur (31.67%), Bogura (28.33%), Norsingdi (26.67%), Sherpur (25%) while the lowest (15%) little leaf incidence was recorded in Mymensingh. The results of nested PCR confirmed that little leaf of brinjal is caused by *Candidatus* spp.. DNA sequence analyses of 16S rDNA of the *Candidatus* spp. by Basic Local Alignment Search Tool (BLAST) program revealed little leaf of brinjal was caused by *Candidatus* phytoplasma trifolli. Phylogenetic analyses showed that *Candidatus* phytoplasma trifolli causing little leaf of brinjal in Bangladesh showed 97-98% homology with *Candidatus* phytoplasma trifolli reported from India (accession numbers MK693146.1, MG566064.1, JX104336.1, KX588712.1, FJ427295.1 and AY390261.1) and *Candidatus* Phytoplasma trifolii isolate from Mymensingh was closest relative of *Candidatus* Phytoplasma trifolii isoplates reported from India. However, *Candidatus* Phytoplasma trifolii isolates from Rangpur was distantly related with *Candidatus* Phytoplasma *trifolii* isolates from India and from Sherpur, Jashore, Dinajpur, Narsingdi and Bogura. Field experiment data revealed that the minimum little leaf incidence and severity were recorded in foliar application of T_6 (BDISOF67R: *Trichoderma paraviridescens*) followed by T_2 (Bactroban), T_4 (Heron) and T_5 (Capture) as compared to T_0 (Control). The results clearly showed that T_6 (BDISOF67R: *Trichoderma paraviridescens*) and T_2 (Bactroban) remarkably reduced little leaf severity and increased yield as compared with other treatments and untreated control.

Eco-Friendly Management of Late Blight Disease of Tomato Using Bio-Control Agents, Neem Oil and Chitosan

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Abstract

Eco-friendly management of late blight disease of tomato was performed by applying some bioagents, neem oil and chitosan in field research plot, Department of Plant Pathology, Bangladesh Agricultural University, Mymensingh during 2019-2020. Based on previous year screening of fifteen treatments, most effective six treatments and a negative check (control) were selected for the present experiments viz., T1=BAU-Biofungicide (*Trichoderma harzianum*), T2=*Pseudomonas florescence*, T3= Neem Oil, T4= Chitosan (Elicitor), T5= Azonil 56 SC (Azoxystrobin + Chlorothalonil), T6 = Indofil M 45 (Mancozeb 75% WP) and T7= Control. Azonil 56 EC and Indofil M 45 were applied as a chemical check for comparison. Effect of these treatments on tomato yield and number of infected fruits having late blight of tomato variety BARI Tomato 14 was assessed. Highest number of late blight free fruits and highest fruit weight (kg) were recorded in T1 (BAU-Biofungicide) followed by T5= Azonil 56 SC, T2=*Pseudomonas florescence* and T4= Chitosan (Elicitor). Lowest percent late blight infection on tomato leaves was recorded by T2 (*Pseudomonas florescence*) followed by T5= Azonil 56 SC, T4 (Chitosan) and T1 (BAU-Biofungicide), respectively. In all respect of parameters, highest disease records and lowest yield were observed in untreated control treatment. Among the biocontrol agents applied in the field, three treatments were found superior to control late blight of tomato such as T2=*Pseudomonas florescence*, T1= *Trichoderma* based BAU-Biofungicide and T4= Chitosan; these treatments are comparable to chemical fungicides applied in field condition.

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Evaluation of Antifungal Activity of Some Phenolic Compounds Against *Alternaria Brassicicola* Causing Black Leaf Spot Of Brassica

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Abstract
The black leaf spot caused by *Alternaria brassicicola* is a widespread disease affecting the yield of brassica crop worldwide including Bangladesh. The disease may be managed by using fungicides but the need for research and development of new alternative antifungal treatment based on natural antifungal substances is obvious because of developing resistance against commonly used fungicides have become a critical problem. The aim of this work was to evaluate the antifungal efficacy of six phenolic compound(s) against *Alternaria brassicicola* in *in vitro* following poison food technique at the Plant-Microbe Interaction Lab, Department of Plant Pathology, Bangladesh Agricultural University, Mymensingh. About 90-100% mycelial growth inhibition of *A. brassicicola* was obtained by *trans*-Cinnamic acid containing PDA plates at the concentration of 0.05%, 0.1% and 0.2% followed by ferulic acid (58.82% growth inhibition at 0.2% conc.) , *p*-Coumaric acid (52.35% growth inhibition at 0.2% conc.) and 4-hydroxy benzoic acid (50.23% growth inhibition at 0.2% conc.). The antifungal activity of *trans*-Cinnamic acid was further evaluated against seven different fungi viz. *Sclerotinia sclerotium, Sclerotium rolfsii, Bipolaris sorokiniana, Aspergillus* sp., *Rhizopus* sp., *Pyricularia oryzae* and *Magnaporthe oryzae* pathotype *triticum*. The results showed that *t*-Cinnamic acid was found highly effective in low concentration (0.05%) against *Sclerotium rolfsii, Bipolaris sorokiniana, Pyricularia oryzae and Magnaporthe oryzae* pathotype *triticum* compared to *Sclerotinia sclerotium, Aspergillus* sp*. and Rhizopus* sp. After increasing the concentration at 0.1%, the radial mycelial growth of all mentioned fungi was decreased.

Molecular Analyses of Viruses Infecting Bean Crops in Bangladesh and Screening of Resistance Sources

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Abstract
The major antagonists of Bangladeshi bean crops production in Bangladesh are bean viruses (Milcovich, 2018). Bean viral diseases have not been reported or well characterized in Bangladesh. Due to that the present study was carried out to now the recent status of bean viral diseases, detection and molecular characterization of bean viruses, and resistance screening of bean cultivars during the period from July 2020 to June 2021. In this study, the surveys were conducted for the assessment of viral diseases of country bean in three different districts namely Mymensingh, Borguna and Dinajpur of Bangladesh. Two different viral disease symptoms such as common mosaic and leaf yellowing were observed on the naturally inoculated country bean foliage in the field during survey period. The survey results showed that the highest disease incidence (60%) and severity (80%) were observed in Dinajpur district followed by Mymensingh (24.66% and 44.27 %) and Borguna (4.43% and 35%) for common mosaic of country bean. On the other hand, the highest disease incidence (30.86%) for leaf yellowing was observed in Mymensingh followed by Borguna (24.84%) and Dinajpur (23.88%), whereas the highest leaf yellowing severity (75%) was observed in Dinajpur followed by Borguna (57%) and Mymensingh (50.76%). In this study, immunostrip was used to detect country bean viruses for rapid

virus detection. Potyvirus and Cucumber mosaic virus (CMV) detecting immunostrips were used. Country bean leaf samples showing mosaic symptoms showed positive result for both immunostrips and leaf sample showing yellowing symptom showed positive result only for CMV detecting immunostrip. Leaf samples of bean crops having common mosaic and leaf yellowing symptoms were tested by PCR with the primer pair MKBEGAF4/MKBEGAR5 for the preliminary detection of begomoviruses and yielded more than 1000bp target amplicons. Sequencing revealed that four samples (E21, G21, I21 and 21) had Dolichos yellow mosaic virus (DYMV) sequences. Phylogenetic analysis using NJ or ML techniques revealed that DYMV isolates from Bangladeshi country bean leaf samples are closely related to DYMV isolates from India. All of the samples were additionally examined by PCR with the genus specific begomoviruses detecting PA/PB primer pairs. Except for one sample, nine of the ten samples yielded positive results. Sequencing revealed that six samples had DYMV sequences. Amplified virus regions from investigated samples were found to be 87 to 96 percent identical to Indian DYMV isolates, In this study, 22 bean genotypes belong to common bean accessions (12) and country bean cultivars (10) were screened for resistance to virus infection in the natural field condition. In this resistance screening test, all of the country bean cultivars except BARI Sheem-8 showed resistant reaction to Dolichos yellow mosaic virus and all of the common bean accession except accession line 64 showed susceptible reaction to Dolichos yellow mosaic virus. Although in the molecular screening most of the commom bean accessions and country bean cultivars showed positive reaction with begomovirus genus specific primer for Dolichos yellow mosaic virus. Findings from this study will be important to develop strategies to sustainably manage bean common mosaic and Dolichos yellow mosaic virus diseases in Bangladesh.

Analysis of Genetic Diversity of *Magnaporthe Oryzae* Causing Rice Blast Disease in Haor Areas of Bangladesh and Its Bio-Control with Plant Growth Promoting Endophytic Microorganisms

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Abstract

Blast is one of the most important disease of rice in Bangladesh including haor areas. Due to that the experiment was performed to isolate and identify promising bacteria which could potentially act as plant growth promoting bacteria (PGBR) from rice phylloplane and rhizosphere that are antagonistic to Magnaporthy oryzae. This study was conducted at the Plant Microbe Interaction Laboratory, Department of Plant Pathology and Professor Golam Ali Fakir Seed Pathology Centre, Bangladesh Agricultural University Mymensingh-2202. Rice phylloplane and rhizosphereic bacteria were isolated from the plant surface (leaf and stem) of the plant as well as from the root region of rice plant collected from haor areas, respectively. The antagonistic performance of these isolated bacteria was observed in in vitro conditions by the dual culture triangular method. The bacterial isolates that worked well against blast pathogen were identified by measuring their inhibition area. Plant growth promoting activities of these beneficial bacteria was observed with the production of three plant growth determinates namely Indole Acetic Acid (IAA), phosphate solubilization assay and siderophore production. The growth promotion of the plant was assessed by the determination of root length, shoot length and vigor index. Sixty bacterial isolates were identified as antagonistic to M. oryzae out of 85 bacterial isolates by the dual culture triangular method. The maximum growth inhibition (91.60%) of

MoT was recorded in plate inoculated with bacterial isolate BBPMIL-40 while the minimum growth inhibition (50.41%) was recorded in BDPMIL-33. The rest of the bio-control study and analysis of the genetic diversity of Magnaporthe oryzae is going on.

Application of Zinc and Silicon Fertilizer: Influences on Yield and Nutritional Quality of Purple Rice in T Aman Season

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Abstract
The micronutrients are equally important as macronutrients although they are required in a minute quantity. Zinc (Zn) and silicon (Si) are important micronutrients for the healthy and competitive growth and yield of all cereals including rice in Asia. To explore the effect of Zn and Si on the growth and yield of rice, a two factorial experiment with three rice varieties *viz*. Purple rice, Pahari rice and Binadhan-7, and four fertilizer treatments *viz*. T_0- ControL (recommended dose of fertilizers; RDF), T_1- RDF + 6 kg/ha $ZnSO_4$, T_2- RDF + 40 kg/ha $CaSiO_3$ and T_4- RDF + 60 kg/ha $CaSiO_3$ was conducted following randomized completely block design at the T. Aman season of 2021. Results revealed that the application of zinc and silicon significantly influenced the growth and yield of rice. Plant height, flag leaf length and width, panicle length were recorded maximum with the application of recommended fertilizer dose. The number of primary and secondary branches per panicle and filled grains (no.) per panicle were recorded maximum with the application of RDF + 6 kg/ha $ZnSO_4$. Thousand seed weight was recorded maximum with the application of RDF + 60 kg/ha $CaSiO_3$; although the seed yield and harvest index did not affect significantly. The grain yield followed the trend Binadhan-7>Pahari rice>Purple rice. Assessment of the nutritional quality of rice grains is under process.

Phytofabrication, Characterization and Application of Silver Nanoparticles for Improving Vase Life of Cut Flower

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Abstract
Plant-mediated nanoparticles synthesis is preferred because it is possible to produce large scale nanoparticles with a negligible cost and environment friendly. Phytofabricated silver nanoparticles can improve the vase life of cut flower. Vase life of cut flower depends on microbial proliferation in vase solution and vascular occlusion as well. Enhancement of vase life of cut flowers applying plant based AgNPs has been a hot spot in postharvest flower physiology recently. In this study, AgNPs were successfully synthesized by *Camellia sinensis* leaf extract. The formation of phytofabricated AgNPs was characterized by means of visual observation, UV–Vis, and FTIR techniques. After bioreduction of Ag^+, a signatory color of AgNPs was developed and it was further characterized by UV–Vis spectrophotometer. In addition, FTIR data confirmed the presence both of the bioreducing and capping agents in the leaf extract. Finally, phytofabricated AgNPs were applied in the vase solutions of cut roses @ 0.01, 0.05 and 0.1mM and a control (without AgNPs). Treatments were replicated three times. Silver NPs (0.1mM) showed a strong antimicrobial activity in vase solution and vase life of cut roses extended up to 13 days while the control caused senescence and early wilting of flower in almost 5

days. Microscopic investigation showed that stem blockage due to microbial colonization (1.2×10^5 $CFUmL^{-1}$) was evident at the cut end of the control stem whilst AgNPs treated samples effectively inhibited the microbial growth (0 $CFUmL^{-1}$). Indeed, water uptake improved by applying AgNPs enhanced vase life of cut roses. The results suggest that phytofabricated AgNPs have the potential to extend vase life of cut roses mainly by inhibiting microbial growth.

Collection and Evaluation of oat (*Avena sativa*) Genotypes for its Introduction in Bangladesh as a High Value Functional Food Crop

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Abstract
Oat (*Avena sativa*) is a highly health benefitted cereals as it is rich in protein, fiber (water-soluble β-glucan), antioxidants, vitamins and mineral. In the recent years, the demand of oat for human consumption has increased because of dietary benefits of whole grain and β-glucan. A research project has been conducting to collect and evaluate oat genotypes with a view to introduce it as high value functional food crop. Two oat genotypes used for fodder cultivation were collected from Bangladesh Livestock Research Institute, and Central Cattle Breeding and Dairy Farm. These two genotypes were grown at the field laboratory of Department of Crop Botany, Bangladesh Agricultural University, Mymensingh, during the Robi season from November to April, 2019/2020 to study the effect of plant spacing viz. line to line spacing of 15 cm, 25 cm and 35 cm on the growth and grain yield of two oat genotypes. The experiment was laid out in a Randomized Complete Block Design with three replications. Results showed that plant spacing had significant effect on morphological traits, biomass production, grain yield and its components. Crop grown with line to line spacing of 25cm showed better performance in respect of grain yield and its components, and other parameters studied. Studies on grain yield and it nutritional quality, grain filling pattern under different management practices like fertilizer and water application are on progress.

Screening of Wheat Genotypes for Drought Tolerance Based on Physiological and Biochemical Attributes

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Abstract
Drought stress is one of the limiting factors for wheat production in Bangladesh. A research project was carried out to screen drought tolerant wheat genotypes from a large genetic pool of 180 genotypes. Among the genotypes collected, 127 wheat genotypes were evaluated at seedling stage under poly ethylene glycol (PEP) induced drought stress (1^{st} year) and 56 genotypes were selected for the phenotypic and spectral reflectance index (SRI) evaluation in the field (2^{nd} year). Fourteen wheat genotypes selected from previous experiment were evaluated in the filed for the physiological traits and osmolyte accumulation analysis in 3rd year (2019–2020). On the basis of drought tolerance index (DTI) of physiological traits and osmolyte contents, 14 genotypes were classified into 3 groups, viz. high drought tolerant (HDT, DTI >0.90, 3 genotypes), moderate drought tolerant (MDT, DTI 0.80-0.90, 7 genotypes) and low drought tolerant (LDT, DTI <0.80, 4 genotypes). Results revealed that all the physiological traits (cell membrane stability and relative water content) were diminished by drought,

but the magnitude was controlled by the tolerance level of the wheat varieties. The osmolyte such as proline, ornithine, glycine-betaine, free amino acids, sucrose, trehalose, mannitol and total soluble sugar contents were markedly upregulated due to drought stress. Genotypes of HDT group clearly showed higher relative increase in the osmolyte contents (except mannitol) under imposed drought compared to MDT and LDT. Genotypes of LTD group showed relatively higher accumulation of mannitol content under drought. Considering the findings this study, 6 genotypes (2 from HDT and 4 from MT) were selected for the advanced physiological, enzymological and molecular studies in the future projects.

Regulation of Wood Formation in Trees by Temperature and Water

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Abstract

Cambial activity in tropical trees is closely associated with environmental factors, thus, changes in climatic condition might have strong influence on the activity of cambium. To identify the environmental factors that regulate the cambial activity in tropical trees, cambial growth on the stem was investigated between two seasons on three tropical hardwood tree species namely, *Acacia mangium*, *Tectona grandis* and *Swietenia mahagoni* that grown in Bangladesh. During winter season, the above mentioned three tree species entered in cambial dormancy. The rising temperature in late winter or early spring initiated cambial reactivation earlier in *Acacia mangium* and *Swietenia mahagoni* trees as compared with *Tectona grandis*. In *Tectona grandis,* cambial reactivation occurred one month later than *Acacia mangium* and *Swietenia mahagoni* trees. Earlier cambial reactivation increases the duration for wood formation. These results indicated that, winter low temperature induced cambial dormancy however, the depth of dormancy is different depending on species. In contrast, during spring, in *Acacia mangium* and *Swietenia mahagoni* trees, leaf fall and emergence of new leaves was very closer. However, in *Tectona grandis,* it maintained distance from leaf fall to leaf emergence, indicating that new leaves might have some role on earlier cambial reactivation. During dry season, a small number of new cells and cambial derivatives were observed near the cambium in those three tree species indicating the slower rate of cambial activity. In addition, an artificial application of water induced a large number of vessels with bigger diameter in those tree species during dry season. These results suggested that the supply of adequate amount of water is one of the most important limiting factors that regulate the cambial growth during hot-summer summer in tropical trees. Therefore, it might be assumed that, in case of extreme dry condition, cambial cell division might be completely stopped due to lack of water in tropical trees.

Measurement of Adaptation Gaps Among the Stakeholders to Climate Change Shocks in *Haor* Agriculture

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Abstract

Nevertheless a huge expending for saving crop yield against climate shocks in *Haor* areas, some adaptation gaps exist between research and policy institutes, extension agencies and rural communities. (1) Most farmers in *Haor* areas are advised to cultivate rice with BRRI Dhan28 variety in *Boro* season

but to get higher yield many farmers use BRRI Dhan29 variety whose life span (160 days) is 20 days longer than the BRRI Dhan28 (140 days). As a result *Boro* crop grown with BRRI Dhan29 variety is often subjected to early flash flood. (2) Advancing *Boro* season is only the viable solution for avoiding early flash flood that ensure safer harvest but cool sensitivity or cool injury of rice plant is one of the main hindrances to do that. (3) The *Haor* farmers are advised to cultivate BRRI Dhan51, BRRI Dhan52, BINA Dhan7, BINA Dhan11 etc in *Aman* season as these varieties can tolerate up to a period of 2-3 weeks of submergence which is very important to mitigate the flood hit. However, no *Aus* rice with aforesaid traits is so far developed. (4) Most farmers use rice seed collected from local market, the seeds which varietal purity is already questionable as these seeds are being multiplied over the years through non-scientific cultivation practices. Varietal purity is highly important for getting optimum yield from a crop and BADC could play a significant role to this issue. (5) A majority of the farmers would like to get the crop insurance policy in the *Haor* region for getting compensation of yield loss especially for *Boro* rice from early or flash flood. (6) Harvest of *Boro* rice in *Haor* areas can be facilitate with mechanical harvester which could mitigate labour shortage problem for avoiding the risk of early flash flood to some extent.

Biofortification of Wheat with Zinc Through Zinc Fertilization

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Abstract
Zn deficiency is one of the leading health problems in people especially children and women of developing countries like Bangladesh. Different interventions could be used to overcome malnutrition, but biofortification is most impactful, convenient, sustainable and acceptable intervention. Wheat is one of the major crops grown and consumed in Bangladesh with prevalent Zn malnutrition; therefore, this is suitable target for Zn biofortification. Zn biofortification of wheat could be achieved through agronomic approach as soils in Bangladesh are deficit of Zn. Two wheat varieties such as BINA GOM-1 and BARI GOM-30 were grown with four Zn treatments including nil Zn (control), soil Zn application, foliar Zn application and soil + foliar Zn application in a split-plot design with three replications. The soil Zn application treatment consisted of 50 kg $ZnSO4{\cdot}7H2O$ ha^{-1}, incorporated into soil before seed sowing. The foliar Zn application treatment consisted of two times of foliar Zn application at the heading and milk stages. At each time of foliar Zn application, 0.5 % (w/v) of aqueous solution of $ZnSO4{\cdot}7H2O$ with generally 600~800 l per hectare was sprayed at the very late afternoon until most of the leaves were wet. Soil + foliar Zn application is the combination of soil Zn application together with foliar Zn spray. All Zn treatments increased zinc concentration in wheat grain as compared to nil Zn in the order of: nil Zn> soil Zn> foliar Zn> soil + foliar Zn. Thus people's malnutrition can be reduced with providing wheat grain biofortified through Zn.

Screening of Salt Tolerant Sunflower Genotypes for Cultivation in the Coastal Region of Bangladesh

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Abstract
Sunflower (*Helianthus annuus*) is an oil yielding crop with unsaturated fatty acid that has great health benefits. Due to saline tolerant ability, sunflower cultivation is gaining popularity in the coastal region

of Bangladesh where land remains mostly fallow during rabi (dry) season for higher concentration of salt in soil. Farmers of saline-prone areas will be more benefitted if they cultivate sunflower genotypes with higher tolerance to salt. However, no systematic screening data for sunflower germplasms are available for salinity stress. Therefore, a keen evaluation is of prime importance to screen suitable genotypes of sunflower which can tolerate higher degree of salinity. A pot experiment using five sunflower genotypes such as BARI Sunflower-2, Hysun-33, FH-689, FH-732 and FH-738 were grown each in five NaCl treatments viz. 0, 25, 50, 75 and 100 g NaCl salt/pot with 4 replicates where each pot contained 10 kg of field soil. The desired amount of NaCl salt was mixed well in dry, clean and pulverized soil before filling the pot when basic dozes of fertilizers were incorporated. Plant height, stem girth, leaf area, chlorophyll content (by SPAD reading), head or disc diameter, number of seed per capitulum, seed yield per plant etc. were reduced with increasing the salinity concentration in soil. Among the genotypes tested the sunflower cultivar Hysun-33 performed better with said parameters in higher salt concentration.

Phytochemical Screening of Medicinal Zingiberales in Bangladesh: Antioxidants and Their Free Radicals Scavenging Potential

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Abstract
Zingiberales plants being rich source of phytochemicals and medicines play important role in human health. The aim of the present study was to screen morphological characteristics, phytohemical constituents and radical scavenging potentials of twenty important Zingiberales medicinal plants namely *Alpinia calcarata*, *Alpinia conchigera*, *Alpinia malaccensis*, *Alpinia zerumbet*, *Amomum subulatum*, *Canna indica, Costus speciosus*, *Costus woodsoni*, *Curcuma amada*, *Curcuma caesia*, *Curcuma longa*, *Curcuma zedoaria*, *Hedychium coccineum*, *Hedychium coronarium*, *Kaempferia galanga*, *Kaempferia rotunda*, *Larsenianthus careyanus*, *Zingiber montanum*, *Zingiber officinale* and *Zingiber zerumbet*. Plants were cultivated using rhizomes in the medicinal zone of BAU Botanical garden. Leaves and rhizomes were analyzed to assess different phytochemical properties. Total phenolics content in leaves ranged from 76.14 (*Kaempferia galangal*) to 1395.37 (*Zingiber officinale*) mg GAE /100g FW, while in rhizomes from 48.73 (*Kaempferia galangal)* to 359.91 (*Costus woodsoni)* mg GAE /100g FW. Flavonoids content in the leaves ranged from 204.29 (*Kaempferia galanga*) to 3894.81 (*Zingiber officinale*) mg CE /100g FW, while in rhizomes from 157.87 (*Amomum subulatum*) to 768.9 (*Costus woodsoni*) mg CE /100g FW. Irrespective of plant parts analyzed, phenolics content varied between 62.43 (*Kaempferia galanga*) to 841.27 (*Costus woodsoni*) mg GAE/100 g FW, and flavonoids content between 229.89 (*Kaempferia galanga*) to 2069.05 (*Zingiber officinale*) mg CE /100g FW among the 20 species studied. When leaf and rhizomes were considered among 20 species, phenolics and flavonoids were almost 3.3 and 2.83-fold to that of rhizome, respectively. So, leaves are important source of phenolics and flavonoids, and superior to rhizome for their health beneficial biochemical constituents. Antioxidative capacities of leaf and rhizome extracts are yet to analyze.

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Drought Tolerance of Maize Cultivars Based on Physiological and Biochemical Attributes

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Abstract
Charlands are highly dynamic and no systemic crop cultivation is practiced in this area due to unavailability of seeds of early & short duration drought tolerant crop varieties Scarcity of water is a severe environmental constraint to plant productivity. Drought-induced loss in crop yield probably exceeds losses from all other causes, since both the severity and duration of the stress are critical. For this, it is necessary to find out short duration drought tolerant crops varieties for charland areas. Maize is the third most important cereal crop after wheat and rice. But abiotic stresses including water stress/drought is major limiting factors for crop yield of maize. As a part of this project, an experiment was conducted at hydroponic growth chamber of Plant Physiology Laboratory, Department of Crop Botany, Bangladesh Agricultural University, Mymensingh during the period from July to September 2019 to investigate the effect of polyethylene glycol (PEG 6000) on morphological, physiological and biochemical responses in maize genotypes. In this experiment, six hybrid maize varieties such as Pionear, BHM-9, Paloan, BHM-13, BHM-14 and 981 were used for screening against drought. The experiment was laid out in completely randomized design (CRD) with three replications. Seven days old maize seedlings were transplanted in hydroponics tray, comprised of two levels of PEG concentration i.e. 0 (control) and 10%. Different morpho-physiological and biochemical parameters viz., root length (cm), shoot length (cm), number of leaves/plant, fresh & dry mass production and proline content were measured. Results indicated that root and shoot length, leaf number, fresh & dry mass and proline content were greatly influenced by PEG treatment. Among the tested maize genotypes, Pionear showed the best performance and BHM-13 exhibited the highest sensitivity to PEG stress based on the morpho-physiological and biochemical parameters. Moreover, further study is needed to evaluate the genotypes at reproductive phase, in the field condition, especially in the charland areas in Bangladesh for their adaptability to grow in that particular ecosystems.

Production Potentials of Sunflower Germplasms in Salt Affected Areas Towards Food Security in Bangladesh

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Abstract
Soil salinity is a big threat to the world and major concern to agricultural productivity. Adoption of salt tolerant variety is more important because salt affected soils cover a huge area especially in coastal and offshore area which remains unploughed. As a part of this project, a field experiment was conducted in the salinity affected area at Mothbaria, Pirojpur to assess the growth and yield performance of the potential sunflower varieties. Five cultivars of sunflower namely BARI Sunflower-1, BARI Sunflower-2, BARI Sunflower-3, HYSUN-33, HYSUN-36, were included in the study to assess their performance based on growth and yield attributes. There were 15 (5×3) observations in a Randomized Completely Block Design (RCBD) including three replications. Different morphological parameters including plant height (cm) and number of leaves were recorded over 60 day after sowing (DAS); yield and yield contributing attributes *viz.*, head fresh weight (g), head dry weight (g), head diameter (cm),

number of seeds per head, seed weight head^{-1} (g), 1000 seed weight (g), and seed yield (t ha^{-1}) were also measured in that natural salinity conditions. Results revealed that the salinity affected significantly on plant height and number of leaves at 60 DAS. The highest plant height and number of leaves were observed in Hysun-33 while the lowest value of these parameters were observed in BARI Sunflower-2 at 60 DAS. The highest number of seeds head^{-1}, seed weight head^{-1} and seed yield ha^{-1} was found in the variety Hysun 33 followed by Hysun 36. The achene yield ha^{-1} (4.172 tha^{-1}) was recorded in case of variety Hysun 33 which was statistically similar to the variety Hysun 36 having achene yield (3.6357 tha^{-1}). On the other hand, lowest achene yield was recorded in the variety BARI sunflower-2 having the value 1.677 tha^{-1}. Thus, it can be concluded that among the five sunflower germplasms, Hysun-33 was performed better in terms of yield and yield contributing characters, which is the reflection of the tolerance of the variety in natural salinity conditions. Further, farmer's field trial would be conducted for validation of the performance of the potential varieties in the salinity affected areas.

Evaluation and Selection of Salt Tolerant Maize Germplasms Based on Morpho-Physiological Characteristics

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Abstract
Bangladesh is one of the most vulnerable countries in the world to climate change, sea level rise and salt water intrusion. Salinity stress adversely affects the growth and yield of maize plant. Therefore, we need to understand the mechanisms of plant adaptation to salinity and to develop salt tolerant maize genotypes under changing climate scenarios. This study was undertaken to screen 33 maize genotypes for salt tolerance based on morphological, physiological and biochemical attributes. To fulfill this purpose, four experiments were conducted in the Department of Crop Botany, Bangladesh Agricultural University, Mymensingh and Agricultural Research Station, BARI, Benarpota, Satkhira. Firstly, a germination test was done with 33 maize genotypes under three salinity levels; 0 dSm^{-1} (control), 8 dSm^{-1} and 16 dSm^{-1}. Based on the performances of germination percentage, stress tolerance indices and plumule and radicle length, 18 genotypes were selected for seedling growth study in hydroponic condition under two salinity levels (0 and 12 dSm^{-1}). Morphological, physiological and biochemical data such as root and shoot fresh and dry weight, relative greenness (SPAD), photosynthesis rate (PN) and total Na^+ and K^+ content were measured in control and stressed plants. Eight genotypes (six salt tolerant and two salt susceptible) were screened and selected for pot experiment on the basis of relative values of the measured traits in hydroponic condition. The plants were grown in pot under two salinity levels (0 and 12 dSm^{-1}). Data regarding root, stem and leaf fresh and dry weight, total Na^+ and K^+ content and proline contents were recorded. All these parameters were significantly affected by salinity stress and a significant variation among the genotypes was observed. Finally a field experiment was set to investigate the growth and yield performance of selected eight genotypes in a coastal saline area in Bangladesh. The study showed that the performance of maize genotypes in relation to growth, Na^+ and K^+ content were more or less similar in both field and pot conditions. In conclusion, considering the growth, ion uptake and other measured attributes, Star Beej 7Star, Bharati 981 and Unigreen UB100 were considered as salt-tolerant whereas Seed Tech Bisco Prince and Dekalb Elit were observed to be the most salt-sensitive maize genotypes. The salt-tolerant maize genotypes found in this study could be used for the cultivation in salinity affected areas of Bangladesh and further breeding program for the development of salt tolerant maize genotypes.

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Morpho-Physiological Responses of Foxtail Millet Genotypes for Drought Tolerance at Early Seedling and Vegetative Stage

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Abstract
Charlands are highly dynamic and no systemic crop cultivation is practiced in this area due to unavailability of seeds of early & short duration drought tolerant crop varieties.Scarcity of water is a severe environmental constraint to plant productivity. Drought-induced loss in crop yield probably exceeds losses from all other causes, since both the severity and duration of the stress are critical. For this, it is necessary to find out short duration drought tolerant crops varieties for charland areas. Foxtail millet is an important minor cereal in Bangladesh gaining much popularity. However, abiotic stresses especially drought is major limiting factors for crop yield of foxtail millet.For this reason, two experiments were conducted at hydroponic growth chamber of Plant Physiology Laboratory, Department of Crop Botany, Bangladesh Agricultural University, Mymensingh during the period from July to September 2019 to identify the drought tolerant foxtail millet genotypes based on morphological and physiological attributes during early seedling and vegetative stage. In the first experiment, 25 foxtail millet genotypes were collected and used for screening against polyethylene glycol (PEG 6000) induced drought stress including (0, 5 and 10% PEG) treatments in a completely randomized design (CRD) including three replications. Based on different stress tolerance indices (GSTI, SLSI, RLSI, FSTI and DSTI) and growth parameters viz. shoot and root length, fresh weight, dry weight, leaf area (LA) six genotypes (BARI Kaon-1, BARI Kaon-3, Ulipur (Local), Kaon BD-887, Kaon BD-876) were selected for further observation during vegetative stage in the hydroponic culture. Selected six genotypes were grown for 21 days in hydroponics with a full nutrient solution with 10% PEG-6000 was imposed as drought stress along with a control (0% PEG) treatment. Different morpho-physiological viz. Root length, shoot length, RLSI, SLSI, root and shoot fresh and dry weight, RFSTI, SDSTI, TDM, relative chlorophyll content (SPAD), Fv/Fm were measured. Results indicated that all the parameters were greatly influenced by PEG and decreased with increasing drought stress. Among the tested genotypes, BARI Kaon-3 and Kaon BD-887 showed better performance while by BARI Kaon-2 and Kaon BD-876 exhibited higher sensitivity to drought stress based on the morpho-physiological parameters. However, further study is needed to evaluate the genotypes at reproductive phase, in the field condition, especially in the charland areas in Bangladesh for their adaptability to grow in those particular ecosystems.

Phytochemical Analysis of Six Health Beneficial Medicinal Plant of BAU Botanical Garden

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Abstract
The medicinal plants have been primary and important source of healthcare in fight against various physical health problems. They probably constitute a single larger functional group of the plants globally. The main target of the study was to analyze presence or absence of Alkaloids, Saponins, Terpenoids, Tannins, Flavonoids and Phenolics as well as evaluate the phytochemical constituents as total alkaloids, flavonoids, phenolics, tannins, chlorophyll a, chlorophyll b, total chlorophyll (a+b) and

total carotenoids. Six different plants Allamanda (*Allamanda cathartica,* Family: Apocynacaeae), Bashok (*Justicia adhatoda,* Family: Acanthaceae), Swarpagandha (*Rauvolfia serpentina,* Family: Apocynaceae), Tejpata (*Cinnamomum tamla,* Family: Lauraceae), Gulancha (*Tinospora cordifolia*, Family: Menispermaceae) and Bhat (*Clerodendrum viscosum*, Family: Verbenaceae) were collected from The Botanical Garden of Department of Crop Botany, Bangladesh Agricultural University. In the first experiment, the samples were analyzed for qualitative test and in the second experiment; the samples were evaluated quantitatively and estimated the contents of alkaloids, flavonoids, total phenolics, tannin, Chlorophyll a,Chlorophyll b, total chlorophyll and carotenoids. The result of qualitative analyses of samples showed that higher amount of alkaloids were found in all samples whereas terpenoids were also found in all the samples except *C. viscosum* and other phytochemicals like saponins, tannins, flavonoids, phenolics were found positive in all the samples. In quantitative analysis highest percent of alkaloids content (2.45 g/100 g sample) was found in the sample of *J. adhatoda* leaf and other phytochemicals like total flavonoids,total phenols and tannins were also found highest in *R. serpentine* leaf (2.67 g/100 g sample), *C. tamala*leaf (156.9 mg GAE/g extract and 83.44 mg GAE/g extract) respectively. The samples were also evaluated for the pigments viz. chlorophyll a, chlorophyll b, chlorophyll (a+ b) and carotenoids. The highest chlorophyll a, chlorophyll b and chlorophyll (a+ b) contents were determined in *T. cordifolia* Leaf which was (1.25 mg/g FW), (0.94 mg/g FW) and (2.19 mg/g FW) respectively. The highest amount of carotenoids (0.35 mg/g FW) was detected in *C. viscosum* leaf. Further investigation is needed to explore these active ingredients for their pharmacological properties from these potential medicinal plants through isolation, identification, characterization, purification, separation, crystallization and elucidation the structure of the bioactive constituents.

Phytochemical Investigations of Traditionally Important Medicinal Plants

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Abstract
Medicinal plants are very much known for the presence of high amount of phytochemicals, like-alkaloids, tannins, saponins, carotenoids, terpenoids, phenolics, flavonoids, and also having high antioxidant capacity. Taking this information in consideration, six traditionally important medicinal plants were collected from Bangladesh Agricultural University Botanical Garden (BAUBG) to investigate the presence and status of these phytochemicals along with DPPH scavenging capacity and Ferric reducing antioxidant power of these medicinal plants. The leaf samples of Halkhusha (*Hyptis capitata* Jacq), Motmotia **(***Lippia alba* Mill.), Kharajura (*Litsea glutinosa* Lour.), Oregano (*Origanum vulgare* L.), Pink amrul (*Oxalis corymbosa* DC.), Nunia (*Portulaca oleracea* L.) were firstly set for the qualitative test ensuring the presence and absence of the compounds and later on investigated to find out the quantity present. Our results revealed that, all of these medicinal plants contained high amount of different phytochemicals, and, among which, Nunia (*Portulaca oleracea* L.) showed the best performances regarding the most of the parameters. In addition, these plants contained high amount of antioxidant as assessed by the DPPH scavenging capacity and the Ferric reducing antioxidant power. Based on the results of the present investigation, finally it may be concluded that, these medicinal plants contained a remarkable amount of phytochemicals and a good source of antioxidant, which indicates its potentiality in various ethno-medicinal study and therapeutic uses.

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Collection, Conservation and Phytochemical Analysis of Traditionally Important Medicinal Plants

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Abstract
The status of medicinal plants is threatened, risking our own future benefits and knowledge as a result of excessive usage and consumption. Considering the present situation and future need, conservation and management programmes for native plant resources are necessary. The medicinal properties of various medicinal plants are due to the phytochemicals present in the plant. Several phytochemicals exhibit a diverse spectrum of activities that contribute to the enhancement of the immune system and provide resistance to chronic disease, thereby protecting the body from dangerous infections. Thus, our objectives were to collect and conserve medicinal plants and associated knowledge, as well as to explore the phytochemicals contained in chosen medicinal plants that are commonly utilized in Bangladesh. Sixty medicinal plant species were collected for conservation in the Bangladesh Agricultural University Botanical Garden from Khadimnagar National park, Sylhet, Lawachara national park, Moulavibazar, and Madhupur national park, Tangail. Standard procedures were used to test the presence of various phytochemicals. Our study indicates that most of the plant species contained a good amount of different phytochemicals and among those *Litsea glutinosa* (Kharajora) leaf contained the highest amount of phenolics, flavonoids and carotenoids. The present study concluded that these medicinal plants had a variety of important phytochemicals that contributed to the therapeutic characteristics of the plants tested, which are widely utilized in Bangladesh. Total antioxidant activity was also found to be greater in *Litsea glutinosa*, as measured by DPPH radical scavenging ability and ferric reducing antioxidant power (FRAP). Leaf pigment content varied greatly as well, with Kalokeshi, Gobura, and Kharajora having the highest levels.

Physicochemical Investigation of Important Minor Indigenous Fruits of Bangladesh: A Defensive Shield for Combating 'Hidden Hunger' and Nutrition Security

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Abstract
Minor fruits rich in minerals, vitamins and phytochemicals of health benefit. The objective was to determine dry matter content, proximate compositions (crude protein, crude fibre, crude fat & ash) and phytochemicals (total phenols, flavonoids & free radical scavenging capacity) in seven minor fruits namely 'bon chalta' (*Dillenia pentagyna*), 'bilati gab' (*Diospyros discolor*), 'dephal' (*Garcinia xanthochymus*), 'china cherry' (*Muntingia calabura*), 'dumur' (*Ficus racemosa*), 'karamcha' (*Carissa carandas*) and 'bilimbi' (*Averrhoa bilimbi*) collected from Botanical Garden, Bangladesh Agricultural University. Results revealed that percent dry matter content ranged from 5.38 ('bilimbi') to 19.71 ('china cherry'). For proximate composition, crude protein was higher in 'bilati gab' (25.9%), crude fibre and ash was higher in 'dumur' (19.58 and 9.09%, respectively), and crude fat was maximum in 'karamcha'' (24.42%). Thus, the species, 'bilati gab', 'karamcha', 'china cherry' fruit appeared better for nutrient content. The five species were compared for the total phenols, flavonoids & free

radical scavenging capacity at three maturity stages (pre-physiological maturity, pre-PM; physiological maturity, PM; and post-physiological maturity, post-PM). Among the five fruit species at three maturity stages, total phenol content ranged from 25.38 (ʻdumur' at post-PM) to 315.045 (ʻbilati gab' at pre-PM) mg GAE /100 g FW, flavonoids ranged from 48.36 (ʻdumur' at post-PM) to 652.22 (ʻdephal' at post-PM) mg CE/100 g FW, and the IC_{50} value (the amount of antioxidant material required to scavenge 50% of free radicals in the assay system) of fruit extract to scavenge DPPH radicals ranged from 4.06 (ʻbilati gab' at PM) to 30.30 (ʻdumur' at post-PM) mg mL^{-1} fruit extract. Thus, according to species, ʻbilati gab', ʻdephal' and ʻchina cherry' fruit and according to maturity level, the pre-physiologically matured fruit species can be considered as superior to have phytochemical constituents. In conclusion, most of the minor fruits appeared with good nutrition and phytochemicals of health benefit.

Morphological Features, Seed Yield and Proximate Compositions of *Chenopodium Quinoa* Genotypes

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Abstract
Quinoa (*Chenopodium quinoa* Willd.) is an annual herb, a pseudo cereal, important for its uses of shoot as vegetable, seeds and sprouts as super food. Scanty information is available in Bangladesh for canopy trait, proximate composition, minerals elements and phytochemicals of health benefit in quinoa. The current research was carried out to investigate (**i**) morphological and growth features, & seed yield, (**ii**) proximate principle (crude protein, fibre, fat, ash and total carbohydrate on DM basis), (iii) important nutrient elements (N, P, K, Ca, Mg, S, Fe, Zn, Mn based on DM), phytochemicals (Chlorophyll, lycopene, beta-carotene, carotenoids, phenol and flavonoid on FW basis) in the four genotypes (designated by G_1, G_2, G_3, & G_4) of quinoa. Four quinoa genotypes (4 treatments) were established in the Crop Botany Field Laboratory in RCBD following standard protocols. Seed were sown in November and harvested in February and required 90-100 d from sowing. In the first year two objectives were achieved. Results revealed that plant height varied from 55.05cm in G1 to 59.35cm in G4 genotypes while number of leaf was 20.43 in G3 to a maximum of 28.40 in G4. Seed yield ranged from 336.50 kg/ha in G1 to 636.66 kg/ha in G4. Significant variations in proximate compositions of leaf and seed existed. In leaf, range of crude protein was 17.30 to 18.34%, crude fibre 9.96 to 10.66%, crude fat 5.64 to 6.30%, ash 16.24 to 18.22%, total carbohydrate 40.50 to 45.70% while in seeds, these figures were 14.59 to 16.25%, 3.06 to 6.24%, 4.96 to 5.85%, 3.91 to 4.39% and 64.94 to 67.60% for protein, fibre, fat, ash and carbohydrate, respectively. Generally, nutrient contents were noted higher in leaf than in seed except carbohydrate that was reverse trend in the seed. All the quinoa genotypes had appreciable nutrient contents in leaf and seed.

Regeneration of Year Round Fruit Producing Jackfruit Plantlets in Vitro for Micropropagation of True to Type Plantlets

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Abstract
An experiment was conducted on year round fruit producing cultivar of Jackfruit (*Artocarpus heterophyllus L.*) from July 2019 to June 2021 at the Tissue Culture Laboratory of the Department of

Crop Botany, Bangladesh Agricultural University, Mymensingh to assess the in vitro regeneration of explants for mass micropropagation. Different explants like root, stem, leaf, flower, floral bud, shoot apex etc. were sterilized with 2.5 mg L^{-1} of NaOCl for 5 minutes prior to culture in Murashige and Skoog (MS) medium and maintained the culture at 25 °C under light intensity of 50 µmol $m^{-2}s^{-1}$. Among different explants only young shot bud explants were responded in vitro and regenerated callus and or plantlets when MS culture medium was supplemented with BAP (6-benzyleaminopurine), 2,4-D and combination of 2,4-D and kinetin. Among the plant growth regulators 2.0–3.0 mg L^{-1} of BAP supported direct plantlet regeneration from shoot bud explants. Callus induction obtained when medium was supplemented with 3.0–5.0 mg L^{-1} of 2,4-D. Combination of 2,4-D and Kinetin (4+3 mg L^{-1}) was the best for callus like body induction as well as mini plantlet initiation from explants. Only BAP or combination of BAP and kinetin were also supported the growth and development of mini plantlets in vitro. In vitro grown plantlets were acclimatized and established in pot-soil successfully and confirmed protocol.

Development of Synthetic Hexaploid Wheat (SHW): A New Avenue of Improving Cultivated Wheat for Grain Quality, Biotic and Abiotic Stress Tolerances

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Abstract

Wheat is the second most important cereal crop of Bangladesh after rice, and grown in Rabi season. It is an introduced crop, therefore, its genetic variability in terms of germplasm diversity is absent in Bangladesh. Consequently, wheat often suffers with epidemic stress infestation and yield reduction, due to lack of variability and narrow genetic base, which in turn become the bottleneck for wheat improvement for different traits. Interestingly, ancestors (*Triticum turgidum* and *Aegilops tauschii*) wheat has composed with variability for different agronomic and stress tolerance traits, which can be transferred to wheat, if crosses made to develop synthetic Hexaploid wheat. It is therefore, a noble way to bring genetic variability in wheat for different traits. The project is aimed to develop synthetic Hexaploid wheat from distant parents through wide hybridization, therefore, a specialized lab with controlled growth room facilities comprising temperature, humidity and light regulations techniques, a lab space with basic lab storage and preservation facilities provided with recommend physical environment, chemicals to conduct hybridization, and for detection of distant hybrids have been established in the first year. After receiving seeds of the ancestor species (*Triticum turgidum* and *Aegilops tauschii*) from CIMMYT, Mexico, plants were grown in lab since November, 2018. After altering light wave length frequency by providing red light, plants started flowering from April, 2019 and were subjected for hybridization. In 2nd year, following successful hybridization program, a total of 102 seeds were obtained, which are believed to be hexaploid in status, and so as synthetic hexaploid wheat developed. In the final year, developed, Synthetic Hexaploid Wheat (SHW, 2n=6x=AABBDD) was confirmed by morphologically, genomic content (SSR markers) and chromosome counting as developed from parental *Triticum turgidum* (2n=4x=AABB) and *Ae. tauschii* (2n=2x=DD) species. The developed SHW might show better nutritional or stress tolerance features compared to domesticated wheat if the parental species possess that traits. Through these work, a convenient and easy to follow protocol of growing exotic materials, wide hybridization, chromosome doubling and confirmation through all three approaches were developed, which can be used routinely to develop such SHW with more diversified parental species to ensure more exotic features in wheat. These developed SHW can be used directly as variety or breeding materials to improve existing wheat varieties which are seriously lack of variations for different qualitative traits.

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Improved Crop Management and Strengthened Seed Supply System for Drought Prone Rainfed Lowlands in South Asia

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Abstract
Improved Ten rice varieties namely BR11, Swarna, BRRI dhan51, BRRI dhan52, BRRI dhan54, BRRI dhan71, BRRI dhan72, Binadhan-10 & Binadhan-11 seeds were taken as seed multiplication materials. The seed multiplication production program was conducted at the Genetics and Plant Breeding Experimental farm, Bangladesh Agricultural University, Mymensingh during the period from July to December 2019. In this rice seed multiplication project different crop management measures such as weeding, insecticide and fungicide application have been taken. One ton Rice seed for each variety was harvested separately with appropriate care and moisture content. After processing the seeds were stored in BADC storage for distribution to the farmer's in the next season.

Molecular Breeding for Maize Variety development Against Maize Mosaic Viruses

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Abstract
Maize has been recognized as a new world crop in Bangladesh because of its diversified use. Now a days, it is extensively used for the production of food, fodder, baby food, poultry feed, biofuels. It has been reported that this crop is seriously affected by viruses ***i.e.*** *Maize dwarf mosaic virus* (MDMV), *Sugarcane mosaic virus* (SCMV), *Johnsongrass mosaic virus* (JGMV),*Sorghum mosaic virus* (SrMV), *Zea mosaic virus* (ZeMV) and *Pennisetum mosaic virus* (PenMV).*Wsm* loci conferred resistance to the potyviruses -SCMV ,MDMV , MCDV, SrMV and JGMV (Jones et al., 2011) needs to identify those gene (s) bearing maize lines, their hybrids and subsequent generations for maize improvement. Five varieties of corn were identified through recurrent selection. Leaf inoculations of maize for viral overexpression, marker aided assay along with pathological tests make the results more accurate. The maize genotypes BHM-15, BHM-13, BHM-12, BHM-9 and BHM-7 were screened as the highest mean values of thousand kernel weight and other yield governing traits of which three of them were resistant against major viruses of maize. Heterotic hybrids of maize were obtained for further generation advancement.

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Molecular Breeding and Quality Assessment of Maize Under Drought Stress for Food and Nutritional Security in Bangladesh

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Abstract

Maize is one of the most promising cereal crops which have been used as food and feed in Asia, and is a source of income for several million of farmers. The present study was conducted with selected seventeen maize genotypes to evaluate field performance, genetic variability, heritability, genetic advance, correlation coefficient and principal component analysis of eleven yield attributing traits and to detect *opaque- 1&2* genes relating to QPM under water stress condition in maize genotypes based on molecular assays. The field experiment was carried out at the Field Laboratory of the Department of Genetics and Plant Breeding, Bangladesh Agricultural University and the molecular analysis was performed at the Genetic Engineering Laboratory of the Plant Breeding Division of Bangladesh Institute of Nuclear Agriculture in collaboration with Biotechnology lab of the BAU. The biochemical assay was conducted in the Central Laboratory of Bangladesh Agricultural University. Statistical analysis exhibited highly significant differences for all the traits among the studied genotypes. For all the traits genotypic coefficient of variation and phenotypic coefficient of variation estimates were moderate to low. The phenotypic coefficient of variation was higher than the genotypic coefficient of variation for all the traits studied. High heritability (>60%) was observed in plant height, ear height, ear girth, husk girth, 1000 kernel weight and days to anthesis. High genetic advance coupled with high heritability estimates were observed for plant height, ear height, ear girth and husk girth. High magnitude of genetic advance as percentage of mean (>20%) were observed for plant height, 1000 kernel weight and days to anthesis. Yield per plant exhibited positive and highly significant association with 1000 kernel weight and moderate significant association with ear girth and husk girth. Principal component analysis revealed that the first four principal components (PC) describe most of the variation showing eigen values more than 1 and explained 79.8% of total variation. Two sets of primers were used for identifying the presence or absence of *Opaque-2* gene in maize genotypes which confers protein quality. Detection of gene was carried out using *O2*-F1 & *O2*-R1 and *O2*-F2 & *O2*-R2, umc2038 and umc2214 & Pbnlg238 primers. *O2*-F1 & *O2*-R1 amplified expected fragments (165bp) in all the maize genotypes except a cross (Khoibhutta × BHM7). *O2*-F2 & *O2*-R2 amplified a fragment of 130bp. Biochemical assay was conducted to estimate total protein, lysine and tryptophan content. The findings of this study would be useful for further breeding programs for better utilization and molecular characterization of maize germplasm.

Diallel Mating in Short Duration Oilseed *Brassica* Genotypes to Produce Hybrid Genotypes and Their Peg Induced Osmotic Stress Tolerance

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Abstract

Short duration oilseed *Brassica* varieties are important to increase cropping intensity as well as total oilseed production. Bangladesh Agricultural University has a considerable germplasm collection of

rapeseed-mustard at the Department of Genetics and Plant Breeding. In our previous study, we have selected short duration genotypes for the existing collection of germplasms. In this study we have conducted 5 x 5 diallel mating with a view to develop short duration segregating generations. Days to 50% flowering, plant height, total number of siliqua per plant, number of seeds per siliqua, length of siliqua and days to maturity were recorded in F_1. In first year, five advanced breeding lines of *Brassica napus* and their five selected hybrid lines were chosen to assess the genetic variation in their root traits under polyethylene glycol (PEG) induced osmotic stress. Two treatments—0% and 5% PEG—were imposed at 25 days old seedlings. PEG-induced osmotic stress significantly increased the length of main axis, first order lateral roots, second order lateral roots and root hairs. Root hair length, second order later roots and root dry weight accounted for more than 30% genotypic and phenotypic coefficient of variation and more than 60% broad-sense heritability. The results indicated that selection for length of fine roots and root dry weight under drought stress could be effective in developing drought stress tolerant rapeseed genotypes.

Root Morphology and Biochemical Traits Associated Submergence Tolerance in Rice Genotypes Under Polyethylene Glycol Induced Hydroponic Culture

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Abstract
Rice is globally one of the most important cereal crops that faces osmotic stress under any kind of abiotic stresses. An experiment was conducted under controlled condition to study the effects of polyethylene glycol (PEG) induced osmotic stress on root and root hair morphology and associated biochemical traits in four morphologically diverse rice genotypes. Plants were grown hydroponically. Two treatments, 0% (control) and 5% PEG 6000 (*w/v*), were imposed on 38 days old plants for 17 days' duration. Main root axis length at first three youngest root bearing phytomers (Pr1-Pr3) was increased in Binadhan-11 but decreased in Binadhan-7 and BRRI dhan 71 under 5% PEG treatment compared to control. This result indicated that Binadhan-11 increased new root length perhaps to explore stress free environment. Length of L-type first order lateral root was also significantly increased by 2.03 fold in Binadhan-11 under 5% PEG treatment compared to control. Density and length of root hairs were increased at first order lateral roots in Binadhan-11 under 5% PEG treatment compared to control treatment those contributed largely to root surface area. Measurements of H_2O_2 and MDA revealed that Binadhan-11 was less affected by the oxidative damage caused by PEG. Data provides insight into the root morphological plasticity of four morphologically diverse rice varieties under PEG-induced osmotic stress.

Development of Oilseed *Brassica* Genotypes Resistant to *Alternaria* Blight Through Accelerated Genetic Gain

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Abstract
Mustard oil is the product of rapeseed and mustard, meets 21% oil consumption in Bangladesh. The genetic resources of rapeseed and mustard, belongs to genus oilseed *Brassica*, are indigenous resources

of Bangladesh. Every year we spend million dollars of currency to import edible oils from foreign countries. One of the major reasons of lower production of rapeseed and mustard is infection of a severe disease called the *Alternaria* blight caused by *Alternaria brassicae* and *A. brassicicola.* This disease cause severe infection at all plant parts including siliqua of the plants and that leads to upto 50% crop damage. By developing short duration and *Alternaria* blight resistant genotypes we can potentially increase at least 10% oilseed production domestically. This study initially screened 240 genotypes at the field conditions to assess their *Alternaria* blight resistance. This study also screened 50 selected oilseed *Brassica* genotypes in the laboratory condition. The laboratory screening was based on detached leaf infection. Spores of *Alternaria brassicicola* were isolated in V8 culture medium for the detached leaf infection. The spore concentration was adjusted to 10^7 spores per mL. The detached leaf infection identified five completely resistant genotypes. We screened five resistant and five susceptible genotypes using 20 gene-specific markers. Five out of 20 markers clearly separated the resistant and susceptible genotypes due to presence and absence of genomic DNA bands. In the second year we have grown 30 selected moderately resistant lines together, to induce further selection pressure.

Molecular and Biochemical Characterization of Tomato Germplasm for *Tomato Mosaic Virus* (*ToMV*) Resistance in Bangladesh

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Abstract

The study was conducted to evaluate the phenotypic performance of tomato genotypes for Tomato Mosaic Virus (TMV), their molecular and biochemical characterization. A number of genotypes were evaluated for TMV resistance *in vitro* and also *in vivo* condition. Based on phenotypic evaluation the genotypes TC0131-41, TC242-14, TC233-9, VI006136, VI005583, Tm-2 were considered as resistant. Twelve genotype were further studied for the presence of three know resistance gene *Tm-1, Tm-2* and*Tm-2*^{2} using sequence characterized amplified region (SCAR) markers. The genotypes showed diversity for different markers indicating the presence of resistance gene in different manner. The markers information provides a convenient and rapid assay for mosaic virus resistance to be used in tomato breeding programs and hybrid seed production. Biochemical response of tomato genotypes upon viral infected were also tested. Upon viral infection, the enzymatic activity of Ascorbate peroxidase (APX), Catalase (CAT) and Guaicol peroxidise (POD) were increased and the content of reactive oxygen species (ROS), hydrogen peroxide (H_2O_2) is decreased in a time dependent manner. Malondialdehyde content was positively correlated with H_2O_2 content. Further research that aims to investigate the antioxidative system in the most productive tomato cultivars will play a pivotal role in the development of biochemical markers that can be used in breeding programs to select resistant or tolerant cultivars that can be grown in areas in which severe epidemics of TMV occur.

Biochemical Changes of Rice Genotypes Against Blast (*Magnaporthe Oryzae*) Disease and Ssr Marker Validation for Resistance Genes

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Abstract

Rice blast caused by *Magnoporthe oryzae* is a major devastating fungal disease and represent a potential threat for world rice productions. However, information about genetic and biochemical basis

of disease tolerance is still limited. In this study, we tested the presence and diversity of resistant R genes using SSR markers, and the antioxidant enzymes catalase (CAT), ascorbate peroxidise (APX) and guaicol peroxidise (POD), activity and also the concentration of hydrogen peroxide (H_2O_2) and malondialdehyde (MDA) in resistant (BAUdhan 3) and susceptible (BRRIdhan 28) genotype. Molecular marker analysis reveals the presence of all ten studied resistant genes in BAUdhan 3. Among the marker studied, three markers namely RM224, RM72 and RM206 produce distinct band only in resistant genotype BAUdhan 3, which might be used to screen resistant genotype. The enzymatic activity of APX, CAT and POD increased in the inoculated plant for both cultivars but the increase were more prominent for BAUdhan 3. The *M. oryzae* infections significantly increased the H_2O_2 content in BRRIdhan 28 and not much changed in BAUdhan 3. The MDA concentration was higher in the leaves of inoculated plants of BRRIdhan 28. The higher activities of APX and POD in the leaves of the inoculated plants of BAUdhan 3 resulted in lower H_2O_2 accumulation which can minimize the cellular damages possibly caused by reactive oxygen species. The result shows that presence of more resistance gene and effective antioxidative system in BAUdhan 3, which limits the damage caused due to fungal infection and thus contributing greater resistance. Additionally advanced mapping populations were also developed using tolerant and susceptible genotypes.

Genetic Dissection for Yield and Fruit Quality Traits in Tomato (*Lycopersicon Esculentum* Mill.)

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Abstract

The purpose of this study was to assess the yield and fruit quality of 38 tomato genotypes based on their varietal performance and genetic diversity. Twenty five morphological and biochemical parameters were considered in data collection. Analysis of variance exposed high degree of variation among the genotypes. Phenotypic coefficient of variation was greater than genetic coefficient of variation for all the selected traits meaning all the traits had small amount of environmental influence. Most of the traits expressed moderate to high heritability. Plant height, seed/fruit, chlorophyll content in top leaf, number of fruit per plant had high heritability with high genetic advance denoting selection can improve these traits. Lycopene content, beta-carotene, soluble solid content in red fruit exocarp and endocarp, titratable acidity of red tomato juice, red fruit weight had high heritability along with high genetic advance in percentage of mean indicating the preponderance of additive gene action in the inheritance of this character and offers the best possibility of improvement through simple selection procedures. Yield per plant showed significant positive correlation with number of fruit per plant, number of flower per cluster, red fruit girth, red fruit length, red fruit weight, and soluble solid content in exocarp of green fruit. Path analysis revealed that plant height, flower/bunch, seed per fruit, green fruit girth, red fruit girth, red fruit length, number of fruit per plant, soluble solid content in exocarp of green and yellow fruit, soluble solid content in endocarp of red fruit, lycopene content and beta-carotene content had direct positive effect on yield per plant. Principal component (PC) analysis depicted first eight PCs with Eigen-value higher than 1 contributing 76.74% of total variability for different traits. The PC-1 showed positive factor loadings for red fruit girth, length, weight.

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Replacement of Older Varieties of Rice: Introduction of Stress Tolerant Rice Varieties for Ensuring Food Security in Bangladesh

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Abstract
Rice has a crucial role to play in the agro-economy and national health of Bangladesh. It is the major staple food of Bangladeshi people. Bangladesh is already affected by the unfavorable changes of climate and has become one of the potential victims of climate change. Thus rice production in Bangladesh faces several biotic and abiotic stresses which threaten the food security of the whole nation. For upholding the desired production of rice under stressed condition, it is urgent to adopt the modern STRVs (Stress tolerant rice varieties) instead of traditionally growing one. Therefore this research has been undertaken to accelerate the replacement of old varieties of rice by increasing adoption of STRVs through market oriented extension by seed dealers, distributors, growers and other stakeholders. The research area comprises of Haluaghat, Gouripur and Sadar Upazila of Mymensingh district. Information will be obtained by the government offices, NGOs, rice seed dealers in the upazilas. Remarkable changes were observed in sustainable development of seed system for the production of quality seeds of rice and developing the delivery systems of quality rice seed and entrepreneurs within project period.This research accomplishes the food and nutritional security of the poor farmers in the project implementation regions thus ultimately ensuring the food and nutrition security for the population of rural Bangladesh.

Collection and Characterization of Potential Germplasm of Rapeseed Mustard and Participatory Salt Tolerant Short Duration Variety Development for Increasing Cropping Intensity in Southern Bangladesh

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Abstract
Salinity is an alarming problem which causes serious losses in crop production especially in oilseed crop. In order to develop salt tolerant and short-lived rapeseed mustard varieties for southern coastal areas of the country, an effort was made to increase cropping intensity and increase the income of farmers through the use of salt-affected land in the southern coastal belt. A total of twenty seven upazilas were selected for the study among 13upazilaswere considered under the direct supervision of Bangladesh Agricultural University, Mymensingh (BAU). During the first (2017-2018) year activities, five advanced promising lines along with two recommended variety namely BD-6950, BD-7104, BD-10115, Jun-536, BJDH-12 (Table-12) among 25 promising genotypes were selected.Data collections on seed production are in progress.During second year (2018-2019) activities, a total of 840 farmers from rest 14 upazilas will receive training to achieve knowledge and about the aim and objective of the project, improved cultivation technology of salt tolerance, short duration and high yielding advanced promising lines of rapeseed and mustard. From 101 local and exotic genotypes only three genotypes were salt tolerant, stable and high yielding and thus, released as BAU Sharisha1, BAU Sharisha2 & BAU Sharisha3

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Field Performance Evaluation and Quality Seed Production of Baudhan3 for The Farmers of Rural Areas of Bangladesh

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Abstract
Rice production in Bangladesh has been affected by various abiotic and biotic stresses, of which rice blast (c.o.: *Pyricularia oryzae*) has been the most significant in recent years. Bangladesh has experienced several epidemic outbreaks of blast disease since 1980 and recently it become epidemic for both rice and wheat in Bangladesh. It can cause 11-15% yield loss yearly. Most of the popular rice cultivars mostly in Boro season, including mega varieties like, BRRI Dhan28, BRRI Dhan29, are highly susceptible to blast. Research has been conducted since then to develop blast resistant rice varieties, and a recent breakthrough has been released in 2019. A new blast resistance rice variety, BAU dhan3 has been developed by Principal Investigator, approved by SCA. This is an excellent remedy over the blast prone rice cultivation risk in Boro season. Along with that, this variety is also high yielding, therefore, can be a better alternative to BRRI Dhan 28 and BRRI Dhan 29 for farmers, who depend solely on a few mega varieties for more than two decades. Recent dissemination attempts of BAU dhan3 at several areas of Mymensingh demonstrated better performance with no record of any disease infection, and produced) 6.4 ton in paddy (personal communication and field day demonstration. Therefore, this variety has the potential to replace the blast susceptible HYVs in Bangladesh. The purpose of the project was to disseminate BAU dhan3 rice variety as an alternative to the farmers in rural areas for Boro season by convincing them with the field evaluation in their field. Upon demonstration, the advantage of cultivating the variety over others has been evident, based on which farmers are willing to accept the variety for mass cultivation. This will eventually help to produce more rice by overcoming the damages by blast and contribute to the national food security.

Development of Salt Tolerance Phenotyping Protocol and Isolation of Morphological and Biochemical Determinants Conferring Tolerance in Wheat

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Abstract
Two separate experiments were conducted to isolate potential biomarkers of salinity tolerance and to optimize a reproductive-stage specific phenotyping protocol using two salt tolerant (Binagom-1, BARI gom25) and one salt susceptible (BARI gom20) varieties. In experiment I, seedlings were grown in hydroponic culture under control condition (Temp: 25±2°C, RH: 80%). Fourteen-day-old seedlings were subjected to two different levels of salt stress (EC= 12 dS/m and 16 dS/m) for 7 days. Salt stress resulted in a significant decrease in shoot length, shoot fresh weight, root fresh weight, shoot dry weight, root dry weight and leaf chlorophyll content. In contrast, a significant increase in root length, root and shoot length ratio, shoot Na^+/K^+ and root Na^+/K^+ were recorded. Proline content, ascorbate peroxidase and peroxidase activities were increased in tolerant genotypes whereas the glyoxalase-I decreased. The highest increases in H_2O_2 and lipid peroxidation were recorded in susceptible variety BARI gom20. Experiment II was conducted employing four leaf cutting treatments (Setup A: no leaf cutting, Setup B: remaining top three leaf, Setup C: remaining flag leaf and penultimate leaf, Setup D:

remaining only flag leaf) under control and salinity stress. The seedlings were grown in perforated pot filled with field soil and at the late booting stage plants were subjected to salt stress (12 dS/m) after trimming of the leaves and continued up to 18 days. The results of the control study suggest that trimming all leaves except flag leaf and additional two leaves had no significant effect on plant yield. The combine analysis of the data of control and salt stress treatment reflected that the imposition of salt stress resulted in a significant decrease in yield attributing traits but a less decrease was observed in the tolerant varieties. However, further studies are required to optimize the screening protocol at various phases of growth.

Development of Leaf Based Morpho-Physiological, Biochemical and Metabolic Markers Linked to Reproductive-Stage Drought Stress Tolerance in Rice

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Abstract
Drought tolerance is a complex polygenic trait largely depends on plant developmental stages. An experiment was conducted in a rain-out shelter at the experimental farm of the Department of Genetics and Plant Breeding, Bangladesh Agricultural University, Mymensingh during the period of July 2019 to December 2020 to identify potential leaf based biomarkers linked to reproductive-stage drought stress tolerance in rice. Two drought tolerant (BRRI dhan71 and Binadhan-17) and one drought susceptible rice variety (BRRI dhan49) were grown in plastic-tub filled with field soil under sufficient soil moisture conditions until the reproductive phase of growth. At the reproductive-stage, plants were subjected to drought stress by maintaining 15-20% soil moisture for two weeks. The experiment was conducted following a randomized complete block design with three replications. Data on various morphological and biochemical traits were recorded. Drought stress resulted in a significant decrease in yield and yield attributing traits whereas number of unfilled grains per panicle increased. The levels of biochemical traits (proline (Pro), methylglyoxal (MG), hydrogen peroxide (H_2O_2) and malondialdehyde (MDA) were increased significantly whereas the SPAD value decreased. Importantly, a greater increase in MG, H_2O_2 and MDA was observed in susceptible genotypes. A sharp increase in Pro content was found in the tolerant genotypes. A lower decrease in SPAD value was found in the tolerant genotypes. Yield per plant showed significant negative correlation with MG, H_2O_2 and MDA whereas it showed positive correlation with SPAD value and Pro. Based on the results of the experiment, the number of filled grains per panicle, number of unfilled grains per panicle, yield per plant, SPAD, Pro, MG, H_2O_2 and MDA can be considered as potential biomarkers for drought stress tolerance. However, further studies are required to confirm their suitability as biomarkers of drought stress tolerance.

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Development and Characterization of Rice Mutants for Drought Stress Tolerance

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Abstract

By the year 2050, drought stress will lead to a significant decrease in rice yield. Development of new rice (*Oryza sativa* L.) varieties with improved drought tolerance is therefore urgently needed for sustainable agricultural production. To develop and isolate high-yielding drought tolerant rice mutants, a series of experiments were conducted during the period of 2019-2021 in different research organizations. Initially, a large number of rice mutants have been developed through gamma irradiation of seeds of three diverse genotypes **(**Binadhan-17, NERICA-4 and Galon). Based on phenotypic performance for yield attributing traits at M_3 generation, thirty-four rice mutants were selected and screened for drought stress tolerance at various phases of growth. Based on their drought tolerance at seedling and reproductive stage, ten promising mutants were selected to study their yield performance at three locations (Magura, Rangpur and Mymensingh) of Bangladesh. Different biometrical methods and parameters were employed to estimate their stability performance. The results of analysis of variance showed significant difference for genotypes, locations and genotype x location interaction. Among the genotypes studied, higher grain mean yield was recorded in the genotype Binadhan-17/M_5/P-5 (17.20 g/plant) while the lowest grain yield was recorded in the susceptible check genotype IR-64 (5.34 g/plant). Based on regression co-efficient (bij), the mutants Binadhan-17/M_5/P-3, Binadhan-17/M_5/P-5, and Nerica-4/M_5/P-5 showed the values close to unity. The mutants Binadhan-17/M_5/P-3, Binadhan-17/M_5/P-5, and Nerica-4/M_5/P-5 also showed less deviation (close to zero) from regression (Sdij). Considering the stability parameters, the mutant Binadhan-17/M_5/P-5 conferred the highest rank over the locations. Binadhan-17/M_5/P-5 also showed the highest yield stability index value. Hence, the promising mutants isolated from these studies can be used as stable lines adapted to drought stress in terms of yield for developing high yielding drought tolerant rice variety.

Morpho-physiological, Biochemical and Molecular Characterization of Rice (Oryza sativa L.) Genotypes at the Reproductive Stage for Salinity Tolerance

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Abstract

Salinity stress is a major problem for rice production in the coastal regions of Bangladesh. In this research, sixteen better performing salt tolerant genotypes were selected through morpho-physiological and molecular characterization compared with established checks from previously screened fifty-seven (57) local rice landraces. Standard protocol developed from IRRI was used to screen the genotypes both at the seedling and reproductive stages. Three environmental and biological replications were used in a well-controlled completely randomized design (CRD). 25 days old rice seedlings were transplanted into perforated pots. Before seven (07) days of booting, rice genotypes were imposed

under different level of salinity treatments (Control, EC - 08 dSm-1, 10 dSm-1, 13 dSm-1 and 15 dSm-1) up to 14 days. Significant variations, genotypic and phenotypic correlation coefficient, path analysis, higher heritability (81.7% to 99.9 %), genetic advances, principal components, stress tolerance indices and diversity with nature of magnitude clustered the salt tolerant genotypes together. Salt tolerant genotypes showed better performance to give higher yield and yield contributing traits with viable pollen grains and lower reduction in chlorophyll content. Later, superior genotypes (12) were selected for biochemical analysis. Hydrogen peroxide (H2O2) and malondialdehyde (MDA) were estimated from leaves of salt treated plants. Lower content of H2O2 and MDA were found in salt tolerant genotypes than the susceptible genotypes. Molecular analysis was performed to detect the presence of Saltol QTLs which were present among the tolerant genotypes. Rajashail, Pokkali, Gotalia, Bohorimota and Hatibejor were identified as salt tolerant at 15 dSm-1; Benapole and Morichshail survived at 13 dSm-1; Khoiramota, Mouthamota and Panbota were survived at 10 dSm-1. This finding is really intriguing as any rice variety tolerant to 15 dSm-1 has might not been reported or released to date which could be the outstanding materials for future breeding of rice.

Rice Genes for Salinity and Submergence Tolerance: Pyramiding Into Elite Genotype Mitigating Tidal Surges and Measuring Their Antioxidants Activities

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Abstract
In the coastal areas of Bangladesh, tidal flooding with saline water is common scenario in recent years due to global warming and rising sea levels. Few rice varieties are released suitable in either salinity or submergence conditions but the ideal rice varieties for the harsh conditions in coastal areas really need multiple tolerances for better adaptability in adverse climatic situation. A short duration elite rice variety Binadhan-7; susceptible to submergence and salinity, Bindhan-8 is salt tolerant and Binadhan-11 submergence tolerant rice varieties were crossed in all direction and harvested F_1 seeds. These F_1s were confirmed through PCR assay using *saltol* (168 bp) and *SUB1* (203 bp) loci specific primers. For pyramiding of both *saltol* and *SUB1* loci, we crossed between two single locus introgressed F_1s together. We harvested 53 F_1s of the double crossed F_1 out of 101 cross. In the PCR amplification of the double crossed, 32 F_1s were amplified for both of the loci. We performed back crossing using both of the single crossed and double crossed F_1s with their recipient parents Binadhan-7. We performed PCR test using the *saltol* and *SUB1* loci specific markers and found 1:1 segregation of *saltol* and *SUB1* loci. The selected materials were crossed back with Bunadhan-7 for recovering recipient genome. The pyramided *SUB1* and *saltol* genotypes will be checked for ROS and antioxidant properties and make multi-locational yield trial to propose a variety for coastal belt.

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Capacity Development of Rural Women for Household Food and Nutrition Security: *A Field Level Investigation In* Kishoreganj *Haor Areas*

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Abstract
The study objectives were to determine extend of need for capacity development of *haor* women towards household food and nutrition security and to explore the relationships between some selected characteristics of women with their need for capacity development. Existing role of women in managing household food and nutrition security and exploring problems of their household food and nutrition security. The study was conducted in selected five blocks of women for data collection. Those are under Tarail upazila of Kishoregonj district. Need for capacity development towards household food and nutrition security was the focus variable. Appropriate scales were used to measure the concerned variables. For each scale item, a respondent was asked to indicate need for capacity development against four options, namely "high", "medium", "low" and "no" need while the corresponding scores were 3, 2, 1 and 0, respectively. Eleven personal characteristics of rural women were measured by using the measuring techniques. Focus Group Discussions and a case study was conducted to identify different aspects of need and different problems. Correlation Coefficient (r) was computed to explore relationships between the characteristics of the respondents and their extent of need for capacity development. Most of the respondents had low status in managing household food and nutrition security. All of the respondents had high need for capacity development towards household food and nutrition security. The women had the highest extent of need for capacity development in physical facilities, decision making ability, access to increase support services, and skill development, respectively. Majority of them faced high problems in managing their household food and nutrition security. Some policy recommendations were suggested based on the findings and conclusion of the study. Thus, it is necessary to undertake and follow up women focused development initiatives in rural *haor* areas through better access to resources, inputs and services.

Capacity Building of Sub-Assistant Agriculture Officer (SAAO) on Using ICT Based Extension Methods

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Abstract
The purposes of the study were to find out the existing ICT based extension methods in Bangladesh Agriculture, to determine the capacity of using ICT based extension methods by the Sub Assistant Agriculture Officer (SAAO),to determine the relationships between the extent of capacity of using ICT based extension methods by the Sub Assistant Agriculture Officer (SAAO) and their socio-economic characteristics, to determine the factors of the extent of capacity of using ICT based extension methods by the Sub Assistant Agriculture Officer (SAAO) and to identify the problems faced by the Sub Assistant Agriculture Officer (SAAO) on using ICT based extension methods. Data were collected from 64 selected Sub Assistant Agriculture Officer (whole sampling) from 4 upazilas of Mymensingh district. A pre-tested and structured interview schedule was used to collect data from the SAAO during the period of June to July 2020. The extent of capacity building of the SAAOs in using ICT based

extension methods was the dependent variable of the study. To measure the extent of capacity building of the SAAOs in using ICT based extension methods five dimensions of capacity building were included. They were: i) capacity on identifying appropriate ICT based extension methods ii) capacity on identifying farmers' knowledge on ICT based extension methods iii) capacity on handling the ICT based extension methods iv) capacity on solving problems about ICT based extension methods v) capacity on using a range of ICT based extension methods. The dimensions were measured on a four-point rating scale. Scores were assigned as 0, 1, 2 and 3 for 'Not satisfactory', 'medium satisfactory', 'satisfactory' and 'highly satisfactory' respectively. The scores of all items of each dimension were added to obtain the total score of a single dimension. Finally, scores of all the five dimensions formed the total score of the extent of capacity building of the SAAOs in using ICT based extension methods. The independent variables, however, were measured by using suitable scales and techniques. Pearson's Product Moment Correlation Coefficient (r) was used to explore the relationships between the dependent and independent variables. It was found that 71% of the SAAOs belonged to 18-50 years old category (mean 41.18 years), average educational level was 13schooling years, average household size was 5 person. Most of the SAAOs (48%) had short duration training experiences, Average annual income was 415 thousand taka. All of the SAAOs had medium to high communication capacity, around 88% had medium to high knowledge on ICT, and around 90% had medium to high level access to ICT services. The majority of the SAAOs (48%) had medium level capacity and 41% had high level capacity in using ICT based extension methods. Out of eight selected characteristics, age had negative significant relationship with extent of capacity of SAAOs. However, level of education, training attendance, annual family income, knowledge on ICT based extension methods, and access to ICT showed significant positive relationships with their extent of capacity in using ICT based extension methods. Thus, DAE should consider the significant variables to make any plan to increase the capacity of Sub Assistant agricultural Officer in using ICT based extension methods.

Measures of Reducing Health Risks of Rice Farmers From Occupational Exposure to Pesticides

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Abstract
The purposes of this study were to determine the risks perceived by the rice farmers on occupational exposure to pesticides and to explore it's relationships with eleven selected characteristics of the farmers. The study was conducted at Khagdohor *union* of Mymensingh Sadar *upazila* under Mymensingh district. Data were obtained from randomly selected 100 farmers from a population of 1009 rice farmers in the two villages namely Khagdohor and Kismat. Data were collected by using an interview schedule during 25 March, to 20 April 2019. Assessment of risks perceived by the rice farmers on occupational exposure to pesticides was ascertained through a five-point Likert type scale. Eleven selected characteristics of the rice farmers namely: age, education, household size, farm size, annual income, farming experience, organizational participation, training received, extension media contact, type of pesticide applicators, and perception of rice farmers on the use of pesticides were the explanatory variables, while the assessment of risks perceived by the rice farmers on occupational exposure to pesticides was the focus variable of the study. Correlation test was used to ascertain the relationships between the concern variables. Majority of the rice farmers (57 percent) had perceived medium risk score on the assessment of risks perceived by them compared to 27 percent having perceived low risk score and 16 percent rice farmers had perceived high risk score on occupational exposure to pesticides. Correlation analyses indicated that the education, household size, farm size, annual income, organizational participation, training received, extension media contact, type of

pesticide applicators, and perception of rice farmers on the use of pesticides had significant positive relationships with assessment of risks perceived by the rice farmers on occupational exposure to pesticides but characteristics of rice farmers such as age and farming experience had no significant relationship with the risks perceived by the rice farmers. In order to minimize the potential risks among respondents, several actions need to be taken towards good agricultural pesticides practices such as the use of hazard and safety measures, monitoring programme, awareness programme and alternative methods.

Transformation of Agriculture for Food Security and Poverty Reduction

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Abstract
Shifting of agriculture towards livelihood improvement through changes in traditional farming practices is usual for a community. Thus, it stands as an important matter to investigate the extent of transformation on how it impacts towards food security and overall improvement of livelihoods. The study, anyway, was designed to investigate through achieving the following objectives as to a) analyze the nature and extent of agricultural transformation, b) identify the drivers of changes in agricultural transformation and livelihood pattern /status, and c) estimate the effect of agricultural transformation on food security and poverty reduction. Shifting from traditional farming practices to mango and flower cultivation were considered as the aspects of transformation in this study. The study was conducted accordingly in Chapainawabganj (Shibganj and Gomostapur upazila), Naogaon (Porsha and Shapahar upazilas) and Satkhira (Tala and Kolaroa upazila) districts considering a representative sample of mango growers. While, Jhikargacha upazila of Jashore district was considered for flower cultivation. FGD, KII, Stakeholders' workshop and questionnaire survey were conducted to achieve necessary data to fulfill the objectives of the study. In Naogaon, the rate of transformation from traditional farming to mango was high in both temporal and spatial dimensions.

Shifting of Conventional Agriculture Towards High Value Enterprise for Better Livelihood of the Rural People

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Abstract
As the Bangladesh agriculture made a remarkable progress in terms of overall production of crops and increasing resource efficiency, huge transformation is visible in overall agriculture sector. Such transformation is evident not only in the form of commercialization of farming and achieving food autarky, but also development of rural non-farm sectors and overall improvement of livelihoods of rural people. The project was undertaken to investigate the nature of shifting of selected conventional agricultural practices towards high value enterprises and its impact on livelihoods of the members of farming communities. Three component organizations, namely Department of Agricultural Extension Education, BAU, Bangladesh Agricultural Research Council and *Sheba Sangstha* (an NGO) have been jointly executing the research project. For BAU component, two agricultural practices under huge transformation were selected and was planned to investigate in specific appropriate locations. The

selected research locales are Chars of *Gaibandha* (Barren *chars*' shift into special sandbar farming) and *Bandarban* sadar upazila (natural vegetation into fruit orchard). Data would be collected from ranges of respondents that include farmers, market and input actors, agricultural extension personnel, researchers, NGO staff, local government bodies and other key informants. A total of 870 persons will be interviewed by using structured questionnaire and checklists (FGD, KII and Stakeholder Workshop). These methods were followed after desk review and preliminary assessment of the study locations, and were finalized through an inception workshop of the project. The preliminary field assessment in two locations is complete. A number of FGD, KII and Stakeholder Workshop have been conducted while some capacity development training is already organized. The process of finalization of the questionnaires for field survey is under progress. Due to COVID-19 pandemic situation in the study areas and frequent lockdown imposed by the government some targets including follow up field visits were not achieved in time.

Zinc and Iron Enrichment in Lenti L-Rice-Tomato Cropping System

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Abstract

Three sequential researches were carried out at Bangladesh Agricultural University Farm, Mymensingh and Gazipur during *rabi* season from November, 2018 to March, 2020 to find out an effective fertilizer dose and strategy of Zn and Fe bio fortification in rice, lentil and tomato. In case of rice and tomato experiment, 6 levels each of Zn (0, 2, 3, 4, 5 and 6 kg ha^{-1}) and Fe (0, 1, 2, 3, 4 and 5 kg ha^{-1}) from ZnSO□.7H□O and FeSO□.7H□O, respectively were used following CRD with three replications in the first year. In rice experiment, Zn and Fe showed significant influence on the yield and yield contributing characters of rice and tomato @ 4 kg Zn ha^{-1} and 3 kg Fe ha^{-1}. In the 2nd year, different fertilizer strategy *viz* soil application, foliar spray (30, 45, 60 DAS / DAT), seed priming (with same dose), soil application + foliar spray (50% + 50%), seed treatment + foliar spray (50% + 50%), seed treatment + soil application (50% + 50%), soil application + seed treatment + foliar spray (33% + 33% + 34%) for the application of Zn and Fe were used to find out the suitable method. The seedling + foliar spray of zinc and soil + foliar spray of Fe were found as a best method in terms of yield, yield components and zinc enrichment. In case of lentil, 4 successive experiments were conducted at Pulses Research Sub-Station, BARI, Gazipur. In experiment I 10 local varieties of lentil were used to find out the suitable varieties of lentil for Zn enrichment. Both the yield and yield contributing characters were highest in BARI Masur-3 variety followed by BARI Masur-5. Based on the findings of experiment I, experiment II was performed to examine the effects of different levels of Zn (0, 2, 3, 4, 5, 6, 7, 8 and 9 kg ha^{-1}) on the yield and yield attributes of lentil varieties following RCBD with three replications. The result showed that zinc application @ 3 kg ha^{-1} on BARI Masur-3 showed the significant effect on the yield, yield attributing character and zinc content. To identify suitable source of Zn fertilizer for Zn biofortification in lentil, experiment III was carried out in the same location. Among the 3 sources of zinc fertilizer (Zinc Sulfate heptahydrate ($ZnSO_4.7H_2O$), Zinc nitrate ($ZnNO_3$) and Zn-EDTA), Zinc Sulfate was found as most suitable source for Zn enrichment in lentil. Experiment IV was done to find out the most effective Zn application method among 5 methods {(soil application (basal dose) single application, Foliar spray (Seedling, branching, before flower initiation), Seed priming (with same dose), Seed priming (25%) + Soil application (75%) and Seed priming (25%) + Foliar application (75%)} for Zn enrichment in lentil grains where single application of Zn (basal dose) in soil was found as the best method.

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Nutritional, Medicinal and Cosmetic Compounds of *Aloe vera* as Influenced by Integrated Application of Inorganic Fertilizers and Poultry Manures

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Abstract
Aloe vera is called a miracle plant for its many pharmaceutical and cosmetic values. Since ancient times it works against ulcers, diabetics, AIDS, and cancer. Though this important medicinal herb is now commercially cultivated in some areas of Bangladesh, proper fertilizer management is not followed. Considering this, a field experiment was conducted at farmer's field, *Kashiganj*, Tarakanda, Mymensingh to examine the integrated effects of inorganic fertilizer (IF) and poultry manure (PM) on the growth, yield, and yield components, nutrient concentration, medicinal and cosmetic compounds of *A. vera* and post-harvest fertility of the soil. Nitrogen, P, K, and S were used @ 150, 80, 120, and 45 kg ha^{-1} from urea, TSP, MoP, and gypsum and PM @ 5 t ha^{-1}. Eight treatment combinations were used following RCBD with three replications. Integrated applications of IF and PM exerted significant influence on all plant and soil parameters. The highest plant height, leaf number, number of suckers, and leaf biomass yield were obtained when 45% PM was applied along with 55% IF. The macronutrients (N, P, K, and S) of the leaves were highest @ $IF_{85}PM_{15}$ treatment but other nutrients (Fe, Zn, and Mn) were highest @ $IF_{40}PM_{60}$ treatment. The chlorophyll concentration total phenolic compounds, aloin concentration, and total flavonoid content of the leaves were highest when 100% PM was applied. Integrated application of IF and PM significantly improved soil fertility. The organic matter content of the soil increased with the increase of PM. All the macronutrients (N, P, K, S, Ca, and Mg) and micronutrients (Zn and B) of the post-harvest soil were highest with 100% PM treatment. Farmers may be advised to apply 40% IF and 60% PM for producing higher yield and better-quality *A. vera* maintaining soil fertility.

Response of Black Rice to Integrated Fertilization in Relation to Growth, Yield and Nutritional Quality

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Abstract
Black rice is considered a superfood due to its various health benefits to human beings. In Bangladesh, this rice is cultivated in a very limited area and the knowledge of its production technique is still unknown. Integrated fertilizer management is important for the advancement growth, yield, chemical composition, and nutritional quality of black rice. Considering those facts, a study was undertaken to develop an appropriate IPNS for the cultivation of black rice to boost up its production in Bangladesh. The experiment was performed at Farmers field, Kewatkhali and in the Department of Agricultural Chemistry, Mymensingh from July 2020 to December 2020. The experiment comprised of 6 doses of inorganic fertilizer (IF) and cowdung (CD) viz. 0% IF+0% CD, 100% IF+0% CD, 75% IF+25% CD, 50% IF+50% CD, and 0% IF+100% CD. The experiment was laid out in an RCBD design with three replications. The initial soil was found as slightly acidic having a pH of 6.42. Organic carbon was

0.87% categorized as a medium class. The amount of EC (µS cm^{-1} at 25°C), total N (%), available P, S, Zn and B (µg g^{-1} soil) was 83.2, 0.13, 12.6, 9.21, 1.28, and 0.24, respectively. Exchangeable K was found as 0.15 me $100g^{-1}$ soil. It has been found that treatment 75% IF+25% CD produced the tallest plant. A maximum number of total tillers, effective tillers, longest panicle length, the highest number of sterile spikelets, and the maximum number of grains $panicle^{-1}$ was also found in treatment 75% IF+25% CD. However, the opposite scenario was found in the case of 1000 grain weight. The highest grain yield (4.00 t ha^{-1}) was observed in treatment 75% IF+25% CD and the lowest grain yield was observed in control (3.10 t ha^{-1}). But the highest protein and other nutrient contents were obtained from 50% IF+50% CD treatment. Considering yield attributes, grain yield, physiological and biochemical parameters, it can be suggested that 75% IF combined with 25% CD can be used for increasing yield and obtaining high-quality black rice.

Screenings of Some Salt Tolerant Fodder Crops and Study Their Yield Performances on Saline Soils

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Abstract

Severe shortage of grazing land and fodder crops for cattle due to salinity intrusion has had serious economic and nutritional consequences on local communities in coastal districts of Bangladesh. In this study we screened some major fodder crops including napier (local), napier (Pakchong), fodder sorghum (Jumbo), black gram, and a minor fodder crop job's tears for their salt tolerance in different levels of salinity. The salt-tolerant fodder varieties suitable for coastal regions of Bangladesh need to combine both germination tolerance and improved fodder production under salt stress and are also tolerant to water stress as the saline areas are often wet. All fodder crops tested showed better germination under higher salinity except local napier. Considering the scope for multiple cuts we have selected Pakchong napier, fodder sorghum and job's tears to assess the agronomic parameters and nutritional quality after growing on soils with different salinity levels. Number of tillers, plant height, stem diameter, number of leaves, leaf length, leaf width, fresh weight and dry weight of fodder crops decreased with increasing soil salinity. Pakchong napier showed higher biomass yield than fodder sorghum and job's tears but job's tears showed better tolerance to water stress. Though the agronomic attributes and plant biomass showed a decreasing tendency with increasing soil salinity, Pakchong napier, fodder sorghum and job's tears plant might be cultivated in the coastal regions of Bangladesh to provide livestock farmers an additional means of minimizing salinity-related production losses and an opportunity to improve profits by fully utilizing all the farm ground available to them.

Removal of Heavy Metal from Water Using Eggshell, Limestone and Tea Waste Powder

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Abstract

A study was conducted in the Department of Agricultural Chemistry, Bangladesh Agricultural University, Mymensingh, to evaluate eggshell, limestone, and tea waste's comparative efficiency to

remove As, Pb, Cd, Fe and Mn from water. A stock solution of 100 ppm of Cd (II), Cu (II), Pb (II), Zn (II) and Ni (II) was prepared by dissolving the necessary amount of $Cd(NO_3)$, $Cu(NO_3)_2.3H_2O$, $Pb(NO_3)_2$, $Zn(NO_3)_2.6H_2O$, and $Ni(NO_3)_2.6H_2O$ in Milli-Q water. For determining the effect of contact time and the adsorbent dose of eggshell, limestone and tea waste used as adsorbent materials, batch adsorption tests were conducted. Biosorption of heavy metals using dose experiment was conducted through seven (07) different adsorbent dosages like 0%, 0.5%, 1%, 2%, 4%, 6% and 8% for a period of 90 minutes. Biosorption of heavy metals using contact time was conducted through seven (07) predetermined time intervals like 0, 90, 60, 120, 180, 240 and 360 minutes, respectively, using 2% biosorbents. After the completion of the experiment, filtrates were separated by filtration using Whatman No. 42. Contaminants concentration in the extracts were analyzed by atomic absorption spectrophotometer (AAS). Highest biosorption of heavy metals were observed at 2% biosorbent dose. However, biosorption of all metals did not follow the same trend. Cr, Cd and Pb showed a similar result. Biosorption of Cu and Zn was maximum when treated with 1.5%, with some exception. Hence, the biosorbent dose of 2% effluent sample was selected for all metals as the optimum dose for further experiments. Experiments conducted at different contact time intervals revealed that Pb and Cd's uptake increased remarkably up to the first 24hr and in the case of Cu and Zn, it was at 12hr with some exceptions. In the case of Cr, biosorption capacity by eggshell was the highest. Moreover, a further increase or decrease in contact time and biosorbent doses had no significant influence on removing both metals ions. Eggshell showed comparatively better performance than limestone and tea waste.

Effect of Silicon Supplements on the Severity of the Wheat Blast Disease

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Abstract

Silicon can alleviate biotic and abiotic stresses in several crops, and it has beneficial effects on plants under nonstressed conditions. However, there is still doubt about foliar-applied Si efficiency and Si effects on management of blast disease and yield performance of wheat. The objective of this study was to evaluate the effect of foliar application of soluble Si along with three fungicides on wheat blast disease. The experiment was carried out during rabi 2020-21, at Bangladesh Institute of Nuclear Agriculture, Mymensingh. A highly susceptible wheat variety BARI Gom 26 was planted in Complete Randomized Design and the application of various fungicides viz Nativo 75Wp, Filia 525 SE and Trooper 75WP were made with dose rates of 0.6 g L^{-1} water, 2ml L^{-1} water and 0.8g L^{-1} water.The silicon sources were rice hull ash and calcium silicate. The treatment were T_0: Control (Without Si or Fungicide), T_1: Si_{Ash} (Ash as Silicon source +Without Fungicide), T_2: Si_{CaSi} ($CaSiO_3$ as silicon source+Without Fungicide) T_3: Si_0Fil (Without Si+Filia 525 SE), T_4: Si_0Nat (Without Si+Nativo 75WG), T_5:Si_0Tro (Without Si+Trooper 75 WP), T_6 :Si_{Ash}Fil,(Ash as Silicon source+Filia 525 SE), T_7:Si_{Ash}Nat(,(Ash as Silicon source+Nativo 75WG), T_8: Si_{Ash}Tro (Ash as Silicon source+Trooper 75WP), T_9: Si_{CaSi}Fil($CaSiO_3$ as silicon source+Filia 75WP), T_{10}: Si_{CaSi}Nat ($CaSiO_3$ as silicon source+Nativo 75WG) and T_{11}: Si_{CaSi}Tro ($CaSiO_3$ as silicon source+Trooper 75 WP). All the treatments proved to be affective in the management of wheat blast disease but T_{10}, T_7 and T_4 proved more effective in the final count day (15^{th} DAI) with 3.94%, 8.17% and 12.45% disease severity matrix, respectively. $CaSiO_3$ as silicon source+Nativo 75WG (T_{10}) was proved the best effective in controlling wheat blast.

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Effect of Post-Harvest Application of Chitosan on Shelf-Life and Quality Attributes of Some Seasonal Vegetables of Bangladesh

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Abstract
An experiment was conducted to study the effect of chitosan application on post-harvest storage of some seasonal vegetables in Bangladesh. There were four chitosan treatments, namely- control, 0.1, 0.2, and 0.3% solution, and two winter vegetables viz. tomato and beans were selected for the study. Tomato fruit samples were collected at 10, 20, 30, and 50 days after post-harvest storage (DAPS), while bean samples were obtained at 2, 5, 8, and 10 DAPS to assess physiological parameters viz. shelf life and weight loss. Biochemical quality for both vegetables was measured based on pigment, polyphenol, and mineral constituents. The mean weight loss of tomato fruits was 0.88, 1.84, 2.60, and 4.80% at room temperature after 10, 20, 30, and 50 days of post-harvest storage. The shelf life of tomato fruits ranged between 66.8-100.0, 50.0-100.0, 33.3-75.0, and 0.0-41.8% at room temperature after 10, 20, 30, and 50 days after post-harvest storage. Lycopene content in tomato fruits increased significantly up to 10 days after post-harvest storage and then decreased remarkably. In the case of beans, total chlorophyll contents were increased while the total phenol contents were decreased at different DAPS compared to fresh beans. However, the mean Ca, Mg, Na, and K contents in both vegetables slightly increased at different DAPS than fresh ones. Regarding weight loss and shelf life, the study results inferred that chitosan coating with a 0.2% solution is useful at post-harvest storage of vegetables.

Health Risk Assessment Due to Heavy Metal Intake from Brinjal Cultivated in Jamalpur District of Bangladesh

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Abstract
The study was conducted to determine heavy metal contents in brinjal samples and to assess possible human health risks due to dietary intake of the product. For this purpose, a total of 20 brinjal samples were collected directly from the farmer's fields of Islampur and Melandaha Upazila of Jamalpur district, Bangladesh, and analyzed for this study. The concentration of Ni, Mn, Cd, Fe, Cu and Zn in brinjal samples ranged from 0.010-0.210, bdl-0.866, bdl-0.061, 3.27-5.91, 1.82-2.67 and 2.16-3.85 μg g^{-1}, respectively, while the content of Cr in all samples was below the detectable limit. The mean chronic daily intakes (CDI) of metals for females was greater than for males and the calculated CDIs of metals followed the sequence as Fe > Zn > Cu > Mn > Ni > Cd > Cr. The study results found that the CDIs of all metals were higher than that of upper tolerable intake level, which indicates serious adverse effects have been associated with intake of brinjal grown in the study area. The measured hazard quotient (HQ) values for Fe, Cu, Ni and Zn in all locations surpassed 5.0 for both males and females indicate that the exposed populations are unsafe. Similarly, HQ values for Mn and Cd for both males and females in 17 and 7 sites, respectively surpassed 5.0, which also indicates potential non-carcinogenic health risks to the exposed populations. The calculated combined mean non-carcinogenic health risks for brinjal i.e., hazard index; for males and females was 1.53×10^{4} and 2.14×10^{4}, respectively, which were found to be many folds higher than the prescribed limit (1.0). The calculated incremental lifetime cancer risk (ILCR)

values of Cd and Ni for brinjal ranged from 0.00×10^{0} to 1.28×10^{2}, and 1.28×10^{0} to 3.75×10^{1}, respectively. The average ILCR values for adult males and females were 3.46×10^{1} and 4.84×10^{1} for Cd, and 1.43×10^{1} and 2.00×10^{1} for Ni, respectively. Similar to non-carcinogenic health risk, ILCR values were found to be many folds higher than the prescribed limits of 1.00×10^{-4}. Therefore, immediate steps must be taken to reduce the levels of different metals in brinjal from the study area.

Screening and Molecular Characterization of Salinity and Drought Tolerant Rhizobacteria for Plant Growth Promotion

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Abstract
Plant growth promoting rhizobacteria can effectively reduce the severity of different abiotic stress like, water stress, temperature stress, salt stress, etc on plant growth and development. The study screening salinity and drought tolerant bacteria that could be used in mitigating abiotic stresses like salinity and drought. Totally 151 rhizobacterial isolates were screened for potential salinity and drought tolerance, if any. Forty-nine isolates were selected based on salinity tolerance and their drought tolerance was evaluated. Out of 49 salt tolerant bacteria, 9 bacteria were again selected based on drought tolerance. These nine bacteria were bothe salt and drought tolerant and examined for their plant growth promoting traits. Most of the bacteria showed to possess more than one biofunctionalities to promote plant growth.The phosphate solubilization, IAA and siderophore production and nitrogen fixation ability were considered in selecting rhizobacteria for plant trial experiment under salinity and drought stress. A microbial consortium consisting of OS29(3), KK34, WS6 and FR4 were used to evaluate their effect on plant growth of mung bean under salinity and drought stress. The results indicated that the consortium was able to mitigate 100 mM of NaCl stress in mung bean and produced similar biomass as normal condition. Furthermore, the same consortium was able to migiate drought stress in mung bean and produced higher biomass compared to uninoculated plants. The rhizobacteria MR8 and KK34 were also positively responded to rice seedling when grown under 150 mM NaCl stress compared to uninoculated plants and enhanced growth parameters. The rhizobacteria isolated studied in current research work showed some potential plant growth promoting traits which seems applicable for crop production especially, under salt and drought stress.

Screening of Water Logging Tolerant Brinjal Genotypes through Induced Mutation and Advanced Techniques

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Abstract
The project was under taken to indentify brinjal genotypes which are tolerant to excess soil moisture (100% field capacity) condition. Three experiments were conducted in the consecutive year 2019 and 2020. The germplasm were evaluated for water logging tolerance. Survivility (%), yield and yield attributes were studied.
1st Experiment:
Preliminary screening for excess moisture was done using nine genotypes collected from Bangladesh Agricultural Research Institute (BARI) and different locations of Bangladesh by pot culture

experiment.
The nine accessions was irradiated with gamma source of 0, 50Gy, 75Gy and 100Gy. The pot culture experiment was carried out in a completely Randomized Design with three replications. Water logging was imposed at maximum vegetative stage in the pots.
Water level was maintained 2 cm above soil surface by alternate drying and wetting. Out of irradiated nine genotypes, Baishya begun was survived in excess soil moisture condition as well as in water logging condition. Observations of the genotype differed significantly for the characters viz. Morphological and yield attributes under study.
Experimental results revealed that Baishya begun showed higher plant height(75.81 cm), branch/plant (6.26), leaves/plant (38.65), fruits/ plant (6.57), flowers/plant (21.71) and single fruit weight/plant (136.44g) under water logged condition at 75Gy dose, than 50Gy Irradiation dose. At 100Gy irradiation dose. Baishya begun did not survive in excess soil moisture condition as well as under water logged condition and rest of the genotypes were died under water logged condition.

2nd Experiment:
Under waterlogged condition selected ten mutants of Baishya begun viz BM_1-$_{50}P_5$, BM_1-$_{50}P_8$, BM_1-$_{50}P_{15}$, BM_1-$_{50}P_{33}$, BM_1-$_{75}P_{11}$, BM_1-$_{75}P_{19}$, BM_1-$_{75}P_{27}$, BM_1-$_{75}P_{36}$, BM_1-$_{75}P_{39}$, BM_1-$_{75}P_{46}$ showed better performance. Out of ten mutants BM_1-$_{75}P_{19}$ Showed the longest plant height (79-49 cm) which was similar to BM_1-$_{75}P_{19}$, BM_1-$_{75}P_{36}$, BM_1-$_{75}P_{39}$ and BM_1-$_{75}P_{46}$. These five mutants showed better performance in branch/plant, single fruit weight/plant under water logged condition.
3rd Experiment:
Out of ten mutants populations from 2nd year experiment five mutants were selected for 3rd year experiment. Out of five mutants, the longest plant height (80.86 cm) was found in BM_1-$_{75}P_{36}$, under water logged condition which was similar to BM_1-$_{75}P_{19}$, and BM_1-$_{75}P_{11}$. The mutant BM_1-$_{75}P_{46}$ showed higher branch/plant (6.78) and leaves/plant (46.19). The number of fruits/plant (7.67) was also recorded by BM_1-$_{75}P_{46}$ which was responsible for higher fruits weight/ plant (145.95 g) under water logged condition.

Evaluation of Hypoglycemic and Hypolipidemic Potential of Jackfruit Seed Flour Supplementation in Diets: an Approach to Achieve Sustainable Food Security

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Abstract
The prevalence of obesity and other metabolic syndromes is rapidly increasing in Bangladesh and other South Asian countries, leading to increased mortality and morbidity due to diabetes and cardiovascular diseases. Intake of high sugar diets is strongly associated with the development of obesity, diabetes, and other metabolic diseases. Diets that are rich in dietary fiber have been reported to have substantial health benefits. The beneficial effects of a fiber-rich diet are prevention of obesity, improved glucose levels, and control of the profile of blood lipids. Jackfruit seed flour (JSF) is a good source of dietary fiber and can be a possible candidate to fight against metabolic diseases. Therefore, we designed this experiment to evaluate the beneficial effects of JSF supplementation on the development of metabolic syndromes. Four diet paradigms were selected for this experiment- Normal diet (ND), normal diet with 20% jackfruit seed flour (ND+JSF), 20% sucrose (HSD), and 20% sucrose with 20% jackfruit seed flour (HSD+JSF). Feeding experiments were conducted for a period of 8 weeks. The food intake, body weight, blood glucose, organs weight, and blood lipid profile were

measured. Jackfruit seed flour supplementation significantly reduced high sugar diet-induced hyperphagia. Additionally, the body weight was significantly lower in JSF supplemented group as compared with that of the HSD control group. JSF supplementation significantly improved glucose tolerance in HSD-fed mice. A significant difference in liver weight and weight of WAT was observed between the HSD control and JSF supplemented group. Total cholesterol and triglycerides were significantly reduced in the JSF group in comparison to the HSD-fed group. However, serum LDL-C concentration tended to decrease in the HSD+JSF group though the HDL-C concentrations were comparable between the groups. Overall, jackfruit seed consumption could play a crucial role in the management of metabolic disorders caused by high sugar diets.

Assessment of the Hypoglycemic and Hypolipidemic Effects of Mushroom in High-sugar Diet-fed Mice

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Abstract

Diabetes mellitus and other metabolic disorders are the most common non-communicable disease which is characterized by hyperglycemia and hyperlipidemia. The main reasons for hyperglycemia are the insufficiency of insulin, the inefficiency of insulin, or both. For the management of hyperglycemia, there are several kinds of oral anti-diabetic drugs available, although practically all of these treatments have negative effects. As a result, we require a revolutionary treatment technique that can lower blood glucose levels without causing any negative effects. Mushrooms are a rich source of fiber and protein and also have very low lipid content. The high content of fiber is known for hypoglycemic properties and low-fat content reduces insulin resistance. Therefore, this experiment was designed to investigate the hypoglycemic and hypolipidemic effects of mushrooms in the high-sugar diet-fed mice. Mice were fed with mushroom powder in supplementation with or without a high sugar diet (HSD). Supplementation of mushroom powder (MP) significantly reduced the food intake in comparison to HSD- fed group. Moreover, mice fed with MP enriched diet significantly reduced body weight as compared with the HSD group. Furthermore, the blood glucose level of the MP supplemented group was lower than the HSD group in almost all the time points. The inclusion of MP in diets had no effect on the heart weight and kidney weight of mice. However, MP treatment significantly attenuated the increased weight of the liver in the HSD-fed group. MP supplementation also attenuated the HSD-induced elevation of serum concentration of TC, TAG, and LDL-C. Considering the above findings, the mushroom powder could effectively sustain a normoglycemic state as well as body weight and food intake against the development of diabetics and obesity caused by HSD in mice. Therefore, this powder could be an important tool in the management of metabolic disorders.

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Ethanolic Extract of Amla Precludes the Development of Hyperglycemia and Hyperlipidemia Caused by High Sugar Consumption

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Abstract
Diabetes mellitus and obesity are the major metabolic diseases that are caused due to disorders in the metabolism of glucose and lipid metabolism. A high sugar diet (HSD) leads to a well-characterized metabolic syndrome such as hyperinsulinemia, insulin resistance, hypertension, hypertriacylglycerolaemia, dyslipidaemia, and a decrease in serum HDL-cholesterol concentration. Hence, the current study was aimed to evaluate the beneficial effects of amla (*Emblica officinalis*) extract on mitigating the detrimental effect of high sugar and sugary food consumption. Mice were treated with or without amla extract in both normal and HSD (30% sucrose)-fed mice. Amla extract (20 mg/kg BW) also exerted a remarkable effect to hamper the hyperphagia due to high sugar diet consumption in mice. Administration of amla extract (AE) effectively precluded the excessive body weight gain caused by HSD. Furthermore, oral administration of AE also improved glucose tolerance in high sugar diet-fed mice. Liver weight but not the heart and kidney weights were significantly different in AE treated group. Weights of white adipose tissue (WAT) and brown adipose tissue (BAT) were significantly reduced in the AE group when compared with the HSD-fed group. Total cholesterol and triglycerides were significantly lower in the AE treated HSD-fed group. These findings suggest that the ethanol extract of amla could normalize the metabolic dysregulation caused by high sugar diet consumption.

Selenium-Mediated Enhancement of Germination and Growth Parameters in Maize Under Drought Stress

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Abstract
Drought stress is one of the most frequent environmental threats for maize cultivation at the global level, as maize is sensitive to drought. In order to elucidate the mechanism to improve drought tolerance by selenium (Se), the morphological and biochemical features including antioxidant enzymatic activity of drought-stressed maize at germination and seedling stages of maize variety (BM 518) were analyzed. The experiment was comprised with four different treatments in triplicates viz. control (C), drought (D), drought + 1 μM selenium (D+Se) and 1 μM selenium (Se). At the germination stage, supplementation of Se at 1 μM increased the germination percentage and accelerated shoot growth and root growth under drought stress condition. These results suggest that exogenous Se could be used to improve drought tolerance in maize.

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The Effect of Traditional Processing Methods on Nutritional Composition and Anti-Nutritional Factors in Perole (*Vigna Unguiculata* L) Seed, A Wild Cowpea Grown in Bangladesh

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Abstract
The study was conducted to investigate the effect of traditional cooking process: boiling and pressure cooking on the proximate composition, macro elements and ant-nutrient: phytate content of Perole (*Vigna unguiculata* L.) cowpea seeds. This research showed that heat processing amounted to loss of nutrients; this may be due to leaching during heat application. There was drastic reduction of anti-nutrients content of boiled and pressure cooked peroles and this probably is because the anti-nutrients are heat labile. The Boiled Peroles (BDP) had the lowest values of crude protein (17.09%), crude fat (2.46%) and crude fibre (1.71%) while Pressure Cooked Peroles (PCP) had values of crude protein (18.93%), crude fat (2.54%) and crude fibre (1.88%). There was comparable value of ash content in all the samples except for BDC with the least. The decreasing order of anti-nutrient factors in treated cowpeas is: RWC > PCC > BDC. This result inferred that boiling is an adequate processing for drastic reduction of the anti-nutrient factors (phytate) in perole. On the other hand, the macro elements composition of perole showed that heat processing amounted to loss of nutrients; this may be due to leaching during heat dec application. Boiling and pressure cooking had increased the amount of this macro element content when compared with the raw sample. Therefore, it could be concluded that the heat treatments had significantly reduced that anti-nutrient factors in peroles. More research should be conducted into ways of reducing anti-nutritional factors, improving in-vitro protein digestibility (IVPD) and improving cowpea proteins.

Upliftment of Farmers Livelihood and Enrichment of Environment Through Improved Agroforestry Practices in Char Land Ecosystem of Bangladesh: Component-1(Bau-Af)

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Abstract
This Coordinated project has been implemented in Mymensingh district during January 2018 to June 2021. The objectives of project were to identify existing agroforestry and livelihood status farmers, develop improved/sustainable agroforestry models, uplift farmers livelihood status and enrich environment. Four different char villages viz. South Char Kalibari, North Char Kalibari, Char vatipara and Char Gobadia at the bank of old Brahmaputra river of Sadar Upazila of Mymensingh district were selected as study site of this PBRG sub project. Total 17 (seventeen) experiments were done regarding the above agroforestry practices and types during the winter season 2018 to winter season 2020. Different winter and summer vegetables were cultivated along with different fruit, medicinal and timber tree species. Moreover, under lombu tree multistoried agroforestry system chui jhal and papaya also cultivated. As evidence from the results of these 17 experiments, it was found that growth and yield of all cultivated crops/vegetables were gradually decreased over time with increasing the size and shape of the planted tree species. Yield reduction of crops/vegetables also varied by different tree

species. Land Equivalent Ratio (LER) was estimated for different tree-crop combinations. It was found that values LER all tree-crops/vegetable combinations were more than one which indicated better use of resources or more productive. After seasonal flooding it was found that horitoki and guava tree species can tolerate ≥ 20 days water logging condition. Soil fertility analysis also done before and after this sub-project implementation it was found that different soil parameters were slightly improved by practicing agroforestry activities. Average C:N ratio of all experimental plots before and after experimental study of this PBRG sub project were 9.77 and 11.38, respectively. Based on above fact, four suitable agroforestry models were identified for charland ecosystem and which are (i) Multi-storeyed agroforestry system in charland ecosystem, (ii) Agroforestry practices under boundary planted mahogany trees (iii) Guava fruit tree-based agroforestry model in charland ecosystem (iv) Horitoki medicinal tree-based agroforestry model in charland ecosystem.

Dissemination of High Income Generating Agroforestry Practices to the Ethnic Farmers of Madhupur Ghar Area for Their Better Livelihood

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Abstract

Agroforestry in the diminished forestland has gained an enormous shift from traditional forest management approaches in Bangladesh. Products provided by the agroforestry production systems support the basic needs and uplift the livelihood of millions of small-scale farmers throughout the world. The benefit of the agroforestry systems and their livelihood prosperity strategies are, often not systematically recognized in Bangladesh. Thus, the objective of the study was to figure out and disseminate the impact of agroforestry on income generation and livelihood development of the ethnic farmers in Madhupur Garh, Bangladesh. Using different qualitative and quantitative data collection techniques, the study identified mainly five types of agroforestry models which were comprised of pineapple, ginger, turmeric and aroid crops in association with Acacia and Mango trees. The economic analysis revealed that the Acacia-Pineapple-Ginger agroforestry model gave the highest gross income. However, in terms of the benefit-cost ratio (BCR), the Pineapple-Aroid-based agroforestry model was the most profitable and low-cost production system in the Madhupur Garh. Moreover, these agroforestry models have simultaneously enhanced ethnic farmers' social, physical, human and ecological capitals. The study also organized ethnic farmers' training and workshop in order to build the capacity of ethnic farmers on high-income generating agroforestry models and disseminate the models in the entire Madhupur Garh. Therefore, the study concluded that the Pineapple-Aroid-based agroforestry model not only provided high economic returns but also uplift the livelihood of the ethnic farmers and thus, developed their community as a whole.

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Enhancing Livelihood and Food Security of the Poor Farmers Through Inclusion of Improved Agroforestry Models in the Madhupur Garh of Bangladesh

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Abstract
Agroforestry production systems are underappreciated for their role in meeting the SDGs on poverty, food security, and climate change. In Bangladesh, low-productive agroforestry practices also provide ecosystem services and supply food to more than 22 million poor families. Accordingly, the Mdhupur area's agroforestry practices are very promising and can play a vital role in offering multiple outputs and opportunities for over 50,000 farmers with a view to improving farm productivity, livelihoods and resource conservation. Therefore, the objectives of the project were to identify the potential agroforestry practices and improve those practices for enhancing the livelihood of the poor farmers of Madhupur Garh, Bangladesh. The study conducted a baseline survey to identify eight potential agroforestry practices from the three different villages of Madhupur Garh, Bangladesh. The identified agroforestry practices were gone through field experiments using scientific knowledge and locally available resources for further improvements. The initial results revealed that these potential agroforestry practices would substantially improve the yield and five livelihood capitals of the poor farmers in the study area. However, the project is in its implementing phases and it will require another 6 months to get the total production data of the agroforestry practices and their impacts on resources conservation. Moreover, the project will also build farmer capacity on improved agroforestry cultivation technology through training and field demonstration. Therefore, the project activities would be a boost up for the improvements of local agroforestry practices and enhancing livelihood of poor farmers in Bangladesh.

Development of Cotton-Based Agroforestry Model for Farmer's Livelihood Improvement in the Charland Areas of Bangladesh

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Abstract
A project was conducted in two chars viz. North Char Kalibari and South Char Kalibari at Char Ishwardia Mouza under Sadar upazila of Mymensingh district to increase farm productivity, changes farmers' livelihood and environment enrichment through cotton based agroforestry. During the period (July 2019 to June 2020), baseline survey, focus group discussion, practical observation, selection of sample farmer and suitable trees, preparation of plots, plantation of tree saplings were successfully executed. To explore the socio-economic conditions of the farmers and existing agroforestry systems a bench mark survey was conducted. Total 100 farmers were surveyed following a multistage random sampling. Through the baseline survey total of 12 farmers had at least 0.10 ha land were selected to establish cotton based agroforestry practices following an appropriate model 2m□2m for planting selected tree saplings. The results of baseline survey showed that majority of the peoples were day labourer and 25-30% was agriculture based with mean annual income of the farmers of North Char Kalibari and South Char Kalibari were Taka 131300 and 56221, respectively. A total of 19 tree species were identified of which 6 timber and 13 fruit species where Mahogoni, Akashmoni, Albizia spp,

Jackfruit, Pomelo and Guava were dominating species. The average tree population density and tree species density were 0.11 and 0.53 per 100m2 land area, respectively. It was found that people's knowledge on tree plantation; agroforestry and environment were not satisfactory. 315, 296 and 289 tree saplings of Mango, Mahogoni and Guava were planted on selected farmers plot to establish cotton based agroforestry model. In addition, some seasonal crops like Kangkong, Turmeric was intercropped in association with trees for generating farmer's income. Therefore, there is a great scope to upgrade livelihood of the farmers as well as environment through establishing agroforestry practices in the Charland areas of Mymensingh district.

Potentiality of Cotton Production Under Existing Agroforestry Systems for Improving Farm Productivity and Income in the Charland Areas of Bangladesh

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Abstract

Despite having insufficient land for the sole cultivation of cotton, some scopes to produce cotton under different tree species still exists in the Charland ecosystem of Bangladesh. The experiment was carried out in South Char Kalibari at Sadar Upazila of Mymensingh district during the period from July 2020 to June 2021 to assess the feasibility of cotton production under existing agroforestry systems to increase farm productivity and farmers income in Charland area. To view with this, a hybrid variety of cotton cv. White Gold-1 (T J6-2) was cultivated as sole crop and in association with existing mahogany, mango and guava trees as agroforestry practice following Randomized Complete Block Design (RCBD) with 3 replications and 4 treatments. The treatments comprise of T_1=Control (sole cropping of cotton), T_2=Mahogany tree + Cotton, T_3=Mango tree + Cotton, T_4=Guava tree + Cotton. The result revealed that cotton's vegetative parameters except the number of branches/plant and the number of leaves/plant were statistically non-significant. The highest (124.97 cm) plant height was observed in T_0 treatment, followed by guava + cotton association (124.43 cm). The result also showed that cotton's yield and yield attributes were better in T_1 (control), which was 4190.3 kg/ha. Among the cotton-tree association, yield and yield contributing characters of cotton were varied minor, and the highest yield was found in T_2 i.e. mahogany tree + cotton association (4169.3 kg/ha) followed by T_4 i.e guava tree + cotton association (4123 kg/ha). The lowest yield obtained from T_3 i.e. mango tree + cotton association in which was 4104.7 kg/ha. Analyzing vegetative and reproductive parameters, it was clear that the tree components have a very low and negligible negative impact on cotton. Therefore, it can be concluded that cotton cultivation through agroforestry practices is feasible and economically viable in the Charland areas of Bangladesh.

Performance and Economic Profitability of Cotton-Based Agroforestry Practices in Charland Area of Mymensingh District, Bangladesh

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Abstract

Bangladesh has many unproductive or wastelands that can be produced through different agroforestry practices (AFPs). Among them, Charland is the most important venue for practicing AFPs. A MoE

funded project was conducted from July 2019 to June 2022 at Char Kalibari Village under Sadar Upazila of Mymensingh district to evaluate the feasibility and economic performance of cotton-based AFPs in the Charland area. A two factorial Randomized Complete Block Design (RCBD) experiment was conducted with sole and three tree species viz; T_0=Control (Cotton sole cropping), T_1=Mahogany, T_2=Mango, T_3=Guava and three varieties viz; V_1=White Gold-1 (T J6-2), V_2=CDB 12 and V_3=CDB 14. The result revealed that the highest number of balls/plant (63.13), seed cotton weight/plant (151.57gm), seed cotton yield (4.19t/ha) was found at the T_0 control plot with V_1 variety. Among the tree-variety combinations, the highest number of balls/plant (61.00), seed cotton weight/plant (150.81gm), seed cotton yield (4.16t/ha) was found from the $T_1 \times V_1$ combination where White Gold-1 (T J6-2) variety of cotton associated with a mahogany tree. Other yields and yield attributes of cotton were also higher in the $T_1 \times V_1$ combination. As in the agroforestry systems, the tree components were in the initial stage of establishment and the cost for their establishment was high. So, the economic output of those systems was very low. Except for the control plot, the highest BCR was found at cotton associated with the mahogany tree that was 1.10. However, the analysis of growth data showed a very positive increment. As a result in the future when the tree components will start to produce positive output, these systems would be profitable. Therefore, it can be elucidated that the tree components have a negligible negative impact on the cotton, and cultivation of cotton in combination with different trees will be economically profitable in the Charland areas of Bangladesh.

Genetic Diversity Studies of Pabda Catfish (*Ompak* Spp) Using Partial Sequencing of Mitochondrial DNA Coi Gene Regulatory Region

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Abstract

Pabda (*Ompok* sp) is a freshwater small indigenous catfish that has a fabulous taste and a high nutritional value. The fish is currently categorized as endangered in nature. However, due to tremendous demand, this fish is widely cultured in Bangladesh. There are three species namely *O. pabda*, *O. bimaculatus* and *O. pabo* were reported to be found in the freshwater of Southeastern Asian countries. In this study, a part of mitochondrial CO1 gene (~655 bp) was used to determine genetic variation in different populations of pabda. Fish were collected from Nilakkhiya beel of Mymensingh, Nabaganga river of Magura, Medir haor of Brahmanbaria, Satli beel of Netrokona, Akbar hatchery of Mymensingh and Fahad hatchery of Jashore districts. An universal primer pair was used to amplify the part of the CO1 gene from total genomic DNA of 60 fish of the six populations. Purified PCR products were subjected to Sanger sequencing. Sequence data of 3 populations viz. Nabaganga river, Nilakkhiya beel and Akbar hatchery produced preliminary results. The sequence had 85-99% homology with *O. pabda* mtDNA CO1 gene (GeneBank Accession Number # MK007074.1). The sequences were G deficient (18.5%) compared to other bases (T/(U- 27.4%, C-28.1% and A-26.0%). The A+T and G+C contents were 53.4% and 46.6%, respectively. There were a number of point mutations found in the studied sequences when sequences of 3 studies populations were aligned with the reference sequence. A phylogeny tree was constructed on the basis of polymorphic sites. The tree had two clusters. Cluster 1 contained samples of the Nabaganga river and reference sequence (MK007074.1) whereas cluster 2 had samples of Nilakkhiya beel and Akbar hatchery. Our preliminary results suggested that Nabaganga river samples were close to *O. pabda* whereas samples of Akbar hatchery and Nilakkhiya beel were close each other and had a distant relation with the *O. pabda*. More precise results and conclusive remarks will be generated after inclusion of sequence data of other three populations in the analysis.

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Estimation and Evaluation of Genetic Diversity in Mango (*mangifera indica* l.) Using Microsatellite Dna Marker

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Abstract

Knowledge of intra-specific genetic variation is a crucial step to develop coherent strategies for future gain in productivity, conservation, utilization and improvement of mango germplasm. This study was conducted to determine intra-specific genetic variation in mango (*Mangifera indica* L.) genotypes using microsatellite DNA markers. A total of 86 mango genotypes including 25 varieties developed by Bangladesh Agricultural University (BAU), 17 varieties developed by Bangladesh Agricultural Research Institute (BARI) and 44 local as well as exotic genotypes were collected from BAU-Germplasm Center, BARI, and Mango Research Institute, Chapainawabgonj district. Out of 86 mango genotypes, 67 were analyzed so far using 7 SSR loci viz., *MMCT35, LMMA7, MiIIHR30, MMCA268, MiIIHR32, LMMA15 and MMCA92*. Differences were found in the observed number of alleles and heterozygosities. All the loci were polymorphic and had a total of 67 alleles. The average number of alleles per locus was 9.5. The allele size ranged from 160 to 236 bp. Average genetic differentiation (Fst) and gene flow (Nm) values were 0.70 and 0.14, respectively indicating a high level of genetic variation among the genotypes. The genetic distance between different genotype pairs ranged from 0 to 2.59. Genetic distance-based unweighted pair group method of arithmetic mean (UPGMA) dendrogram separated 67 mango genotypes into six clusters consisting of 19, 7, 16, 19, 2, and 4 genotypes. Distantly related mango genotypes identified through the present study could be used as valuable genetic resources in breeding program to develop new varieties having improved productivity.

Morphological Variations in Different Stocks of Hilsa Shad, *Tenualosa ilisha*

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Abstract

Hilsa shad (*Tenualosa ilisha*), the national fish of Bangladesh is a migratory fish found in marine, coastal and freshwater open water bodies of Bangladesh and many Asian countries across the Bay of Bengal. In order to investigate genetic variation among different stocks of hilsa, we collected 93 fish from 6 different locations namely Chandpur district (CP = 12), Goalanda of Rajbari district (GP = 15), Hakaluki haor of Moulavibazar district (HP = 15), Kuakata of Patuakhali district(KP = 15), Sundarban of Khulna district(SP = 20) and Goadagari of Rajshahi district (RP = 16). A total of 18 morphological and 8 meristic measurements were recorded from the collections. The effects of the size on morphological dataset was eliminated before the analysis. Multivariate analysis of variance (MANOVA) showed significant differences in fish of GP vs RP ($P<0.05$), HP vs RP ($P<0.05$), SP vs RP ($P<0.05$) and SP vs HP ($P<0.001$) locations. In linear discriminant analyses, 5 discriminant

functions (LD1, LD2, LD3, LD4, LD5) were constructed where LD1 and LD2 covered 43.82% and 40.03% discriminant variables, respectively. The scatter plot of LD1 and LD2 showed a clear separation of the different stocks or locations of hilsa with some tiny overlapping. In Euclidian dendrogram, we found two major clusters where HP alone in one and other 5 stocks in second cluster. Second cluster sub-divided into two groups where RP was found to be separated from other four stocks namely GP, KP, SP and CP. Our preliminary data suggested that among the six locations, fish of Kuakata and Sundarban locations were closely related whereas fish of Hakaluki haor was distantly related from fish of other locations. Multivariate analysis of variance of meristic data showed no significant variation among the fish locations. However, the study is going on. We will include fish from two more locations, some more morphological parameters and consider sex of fish in the shape analysis and morphological difference of hilsa from different locations.

Collection, Molecular Characterization and Evaluation of Country Bean (*Lablab purpureus L.* Sweet) Germplasm for Pod Borer Resistance

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Abstract

Country bean (*Lablab purpureus* L. Sweet), is one of the popular crops in Bangladesh. The pod borer is the most destructive pest, causing 80-100% yield loss. Spray of toxic insecticides leads to pest resurgence, secondary pest outbreak, destruction of natural enemies, increases production costs and causes environmental pollution. The use of resistant varieties is an ideal component of pest management at no additional costs and is free from environmental pollution problems. The present study analyzed the variability among the germplasm of Country beans collected from different sources with a combination of genetic, phenotypic, and molecular approaches for pod borer resistance with high yielding capacity. The study comprised morphological characterization, field evaluation for yield, screening for pod borer resistance, and molecular diversity analysis using SSR markers. Leaf shape was Ovate and the leaf length ranged from 39.0 to 16.0 cm. The plant height ranged from 279.40-60.96 cm. Five different types of flower colour, namely white, light purple, light violet, purple, and very light violet, were recorded among the collected germplasm. The pod colours of the collected germplasm were mainly green, while a few were purple. The short-necked pods were found in the majority of germplasm, while some are having long-necked pods. Most of the germplasm produced straight or slightly constricted pods. The seed colours were mainly brown and black, while white creamy seed coat colours were found only in BD-10803. On average, 92.48 pods/plant, and 687.25 g green pods/plant was observed. The pod damage ranged from 4.75 to 24.82%. The lowest pod damage was found in BD-10799, and the highest was observed in accession BD-11089. Thirteen germplasm had <10% pod damage, nine of them produced higher pod yield (at least 500g/plant). The molecular diversity using UPGMA and Neighbor-Joining clustering model showed that BARI released and local varieties of country bean except two were grouped in cluster I. On the other hand, the 30 collected PGRC genebank accessions were grouped in the rest of the five clusters. The 13 germplasm with lower pod damage were segregated into different groups. However, cluster VI contains three germplasm, all of which had low pod borer infestation, while 50% of the germplasm belonging to cluster IV had lower pod borer damage (<10%). Three of them grouped in Cluster IV, two grouped in Cluster III, one in cluster II, three belong to Cluster VI, and the rest four grouped in Cluster I. It was found that nine of the germplasm with lower pod borer damage produced higher pod yield and can be considered high yielding resistant germplasm. Cluster VI contained three germplasm having low pod borer infestation

(resistant), and two of them were high yielder. Cluster VI included resistant germplasm only, while cluster V did not include any of the resistant germplasm. Clusters I-IV had both resistant and susceptible germplasm. The results show that rich diversity exists between the cultivars and the genebank accessions. For future references, these germplasm could be used for future variety development.

Vegetable Pest Management Practices in Bangladesh and Their Impacts on Environment

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Abstract
Agro-chemicals have become an integral part of crop production and knowledge on their use is an essential factor in gaining an optimum yield under any set of climatic conditions and production practices. For optimum utilization of production technology and inputs, it is essential to avoid unnecessary use of agro-chemicals. Pesticide abuse is increasing in Bangladesh with negative consequences on environment. The indiscriminate uses of pesticides in vegetable cultivation have adverse effects but the actual figures are not available. The study has been designed to assess the pest management practices by the farmers; to investigate into the pesticides used for vegetable production in Bangladesh; to analyze the residues of pesticides on selected vegetable crops, soil and water and to investigate the farmers' perception on the effects of pesticides on ecosystem. The study was conducted in ten districts (Cumilla, Chattogram, Narshindhi, Naogaon, Jessore, Rajshahi, Bhola, Dinajpur and Sylhet) based on major productivity of the selected vegetables in Bangladesh. The study consisted of interviews with randomly selected vegetables farmers in each upazilla of selected ten districts, where vegetables are mostly cultivated using pesticides in particular. The sample comprised of 1000 farmers (100 from each district). Data were collected on five summer vegetables and five winter vegetables (Bitter Gourd, Lady's Finger, Pointed gourd, Snake Gourd, Yard Long Bean, Red amaranth, Tomato, Cabbage, Cauliflower, Country bean). Pesticide residues in the vegetable samples are being analyzed in the National Food Safety Laboratory (NFSL) in the Institute of Public Health (IPH). Data will be analyzed, and tabulated using the Statistical Package for Social Sciences (SPSS) and the Chi-square test was used to compare the categorical data. The study is expected to provide a baseline information on the pest management practices in Bangladesh; a list of pesticides commonly used in selected vegetables; elucidate the presence of residues of the pesticides in vegetables, soil and water and give picture of environmental degradation due to pesticide use.

In Vitro and Morpho-Molecular Screening for Salt Tolerance in Wheat Genotypes

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Abstract
Wheat (*Triticum aestivum*) is a globally important staple food crop. Soil salinity limits agricultural land use and crop productivity and thereby is a major threat to global food safety. However, the salt-affected soils can be better utilized by growing salt-tolerant wheat varieties. Genetic diversity is a useful resource for crop improvement and the development of abiotic stress-tolerant crops. In the present

study, we examined the effects of salt-induced toxicity on the growth of 44 wheat genotypes for screening salt-tolerant ones by assessing morpho-physiological, and molecular responses *in vitro*. Three highly regenerative varieties of wheat were selected and treated with four salt stress treatments (0, 9, 12, and 15 dS/m) for *in vitro* screening. The morphological study revealed that NaCl has a suppressive effect on callus growth and development and shoot regeneration. The genotype BARI Gom-27 exhibited the best performance in both callus induction and regeneration under salt stress treatment. Screening of 44 genotypes at the seedling stage was performed at three salinity treatments including control (no salt stress), moderate salt stress (EC 9 dS/m), and high salt stress (EC 15 dS/m) in hydroponic culture. Most of the wheat genotypes showed an apparent reduction in growth traits, while fewer showed less reduction under salinity stress. Salt stress response indices (SSRI) were used to classify the 44 wheat genotypes into four groups: viz., very susceptible, susceptible, tolerant, and highly tolerant. Results of SSRI revealed Akbar, Pavon-76, ESWYT P-11, BARI Gom-22, and BARI Gom-20 and BAW-1284 as the most salt-tolerant wheat genotypes. The molecular analysis by simple sequence repeat (SSR) markers also strongly supported it. The grouping of the genotypes using 11 SSR markers linked to the saltol QTL indicated that Akbar, BAW-1147, BAW-1274, ESWYT P-6, ESWYT P-20, ESWYT P-33, BARI Gom-20, and BARI Gom-22 were salt-tolerant genotypes considering their genetic similarity in the dendrogram. The polymorphism information content (PIC) values ranged from 0.2318 in Xbarc45 to 0.6760 in Xgwm296, with an average value of 0.4967 per marker. In conclusion, based on the *in vitro* selection, morphological traits based SSRI, and molecular separation, Akbar, BARI Gom-20, BARI Gom-22, BARI Gom-27, BAW-1147, and ESWYT P-6 were identified as the salt-tolerant genotypes. Therefore, these identified salt-tolerant genotypes could be useful in the breeding program for the improvement of wheat through the development of salt-tolerant high-yielding wheat cultivars in the future.

Collection of Seeds of Selected Rice Varieties, Preparation of Rice Seedlings and Induction of Submergence Stress

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Abstract

Although plants need water for growth but surplus water that happens during flooding or submergence is harmful or even lethal. Nowadays, submergence is to be considered an important hazard to the agriculture of Bangladesh related to climate change which seriously affects crops specially rice. Thankfully, some rice varieties show tolerance to different flooding conditions due to their physiological, metabolic and molecular adaptations. Therefore, the proposed study has been designed to understand the adaptive mechanism of rice varieties against submergence stress as well as assess their tolerance level under submergence. For this, some selected rice varieties were collected from BINA and BRRI. Then, pre-germinated healthy seeds were transferred to plastic pots filled with paddy soil and cowdung (2:1). When seedlings were 21 days old, they were subjected to complete submergence in water, 1 m above the soil surface for 14 days. The research work is ongoing now. Leaves of each plant will be harvested after 14 days of submergence as well as after 7 d of recovery under normal growth conditions. Finally, these leave tissues will be used for biochemical and alcoholic fermentation genes expression analysis to assess their tolerance level under submergence. After 2nd year of the research activities, the expected outputs will be full fill the objectives of the research work

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Pesticide Residue Analysis in Different Water Sources of the Selected Districts in Bangladesh-Emphasizing Health Hazards and Environmental Pollution

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Abstract
The use of chemicals has been significantly increased in Worldwide, and pesticides used to protect the crops from pest attack in agricultural fields pose harmful effect to the non-target organisms such as human and many other aquatic and terrestrial organisms either directly or indirectly through food chain. The pesticide residues in different sources of water were investigated to evaluate their potential environmental pollution and risks on human health. A total thirteen (13) pesticide residues under organochlorine, organophosphorus and carbamate groups in four different sources of river water, pond water, rice field water and tube-well water collected from randomly selected 5 unions of selected 5 districts. Total 100 water samples were anlaysed using HPCL (High performance liquid chromatography) equipped with UV detector (HPLC, SIL-20ACHT, SHIMADZU). For survey, a structured questionnaire and a guideline for in-depth-interview were developed and 469 respondents were interviewed. Fifty (50) in-depth-interviews were conducted in 25 selected unions to focus the impact of pesticide residues on human health and environmental pollution. Initially, the calibration curves and retention times were recorded from the pesticide standards matrix after repetitions of HPLC injection. In case of organophosphorus pesticides, malathion was detected in 3 water sample at concentrations ranging from 6.25 to 402-90 ppm; whereas diazinon was detected in 4 water samples at concentration of 284.46 ppm and trace amount of carbaryl was recorded but the detection was very limited. No such detection observed with DDT. As compared to ground water (tube well water), higher concentrations of organophosphates and organochlorines pesticides were found in surface water (pond and rice field water). Surface water was reported to be more contaminated than ground water. Regional comparison of pesticide residues in water samples will be studied presently. The case study reveals that Bangladesh agriculture is conventional with heavy usage of pesticides and chemicals, highly concentrated on paddy cultivation. After analysis of collected primary data, the survey results will be shared in future. To manage the misuse of pesticides and to reduce the possible health risk, appropriate control systems of pests should be implemented immediately by the proper authority of the country.

Observation Studies of Environmental Pollutants on the Anatomical Features of Roadside Plants

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Abstract
Environment pollution is one of the major worldwide threat in recent anthropogenic era of rapid industrialization and urbanization. These pollutants have great impact on roadside vegetation, particularly air pollution. This study was conducted to investigate anatomical changes in leaves and stems of plants nearby roadsides. Three roadside plants namely mango (*Mangifera indica*), Sil koroi (*Albizia procera*) and mahogany (*Sweatenia mahogany*) were examined during Aug 2020 to May 2021. Fresh leaves and stems were collected from two polluted sites (Mauna upazilla in Gazipur and Bhaluka

upazilla in Mymensingh) and one control site (Bangabandhu Sheikh Mujibur Rahman Agricultural University campus in Gazipur). For anatomical study leaves and stems were cut into sections in the laboratory and changes were identified under the light microscopy. Results revealed that leaves of selected roadside plants had reduced cell size with black dot like substance deposited in the epidermis, palisade and spongy parenchyma in the polluted sites. But leaves of plants in control site had normal anatomy. Meanwhile stem showed changes in vascular bundle of pollution affected sites but no change was found in control site. In conclusion, this study indicated that pollutants emitted from automobile vehicles and other sources had a decisive influence on anatomy of roadside plants. So, this study will help to undertake more future research on the impact of environmental pollutants on the anatomy of roadside plants.

Climate Change and Anthropogenic Interferences for the Morphological Changes of the Padma River in Bangladesh

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Abstract

This research aims to identify the morphological changes of the Padma river due to the effects of anthropogenic climate change. The morphological changes were measured by aerial satellite images and their historical comparison, terrestrial survey, sedimentation in the riverbed, water flow, water discharge, siltation, and erosion along the river etc. The Padma River has been analysed over the period from 1971to 2020 using multitemporal Landsat images and long-term water flow data. The climatic parameters data related to temperature and rainfall were collected from 21metrological stations distributed throughout Bangladesh over 50-year period (1965-2015) to evaluate the magnitude of these changes statistically and spatially. The Padma, traditionally considered as a dominantly meandering river, is switching over into a braided river due to its highly susceptible nature of erosion and deposition. Results reveal that the tidal range is high during the dry season and increases from upstream to downstream of the river. Climate change may bring changes upstream by changing rainfall intensity, flood severity and extreme temperature. More inundation can occur due to sedimentation, and more bank erosion can occur at the same time. An exponential increase of morphological activity with increased river flow, water discharge, bank erosion might substantially increase in the future. The changes in the flow introduced by climate change would impact the morphology of the Padma river of Bangladesh during monsoon. A major change has been observed in the location of the bank and channel, as well as bars, along with their geometry and morphology over time. It is also observed that the bank line is not stable and migrated continuously. The overall width of the Padma Rivers varied significantly during the last 50 years. Maps and Landsat images represented that the river channel is shifting abnormally. Both climatic parameters and anthropogenic activity play an important role in fish biology and production. From this study, it is hypothesized that this assessment's findings might help understand the overall hydrodynamic and morphological nature of the Padma River. It will suggest possible future developmental works that might be implemented on this river.

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Exploring Water Pollution of Major Three Rivers – focusing Social and Environmental Impact Assessment

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Abstract

A river is an important component of environment which carries freshwater, keeps a boundless significance for harmonizing a suitable environment in this earth. But most of the river of Bangladesh especially near the cities is being polluted through discharging various wastes such as industrial wastes and household wastes without any measures and treatment into it. Padma, Meghna and Jamuna are the major rivers of them, which are being extremely polluted in the recent time. This study has been undertaken to investigate water pollution scenario and to assess the social impact of water pollution of the three major rivers on human health, the society and environment. Metal contamination of sediment of Padma, Meghna, Jamuna and its possible health impact to the local people were evaluated at three different sites from Oct 2019 to September 2021. Followed by wet digestion, the water and sediments/soil samples were analysed by Atomic Absorption Spectrophotometer. In water samples, mean concentration of Cu, Fe, Zn, Pb, Cd, Ni and Cr were 20.92, 179.06, 1.35, 1.42, 2.16, 7.05 and 2.80 ppm, respectively in Padma. In Meghna river, water samples contain 8.52, 23.78, 11.08, 1.02, 0.02, 7.05 and 0.14 ppm respectively. In case of Jamuna river water, the metals were assessed 13.20, 98, 44, 18.32, 2.45, 0.32, 2.25 and 3.50 ppm respectively. Based on the permissible limits of EPA, the measured metal concentrations of all water samples of studied three rivers exceeded the limits rather than Cd concentration in Meghna river water. In all sediment samples of Meghna river contain the highest concentrations of Cr, Pb, Ni, Cd, Mn, As, Cu and Zn ppm than Padma and Jamuna river. Therefore, the sediment of the rivers was not contaminated enough to prevail high risk on ecological health of river and to pose health risk on local people, but regular practice of discharging contaminants can somehow worsen the river quality in the coming years. Results indicate that concentrations of major elements in the river water were related to the source of the agricultural, industrial and municipal sewerage linked with river channels. Some metals were even above irrigation standard in water from several rivers. Sediment data showed very much higher metal concentrations in most of the rivers especially peripheral rivers in Dhaka and Karnaphuli, Korotoa, Teesta, Rupsha and Meghna River. Metal concentrations in sediment was above US EPA threshold value in most of the rivers. Metal concentrations in fish and agricultural crops showed that bioaccumulations of metals had occurred. The concentration of metals showed the trend like: water. Most of the industries were established on the bank of the rivers. Thousands of tons of waste materials have been releasing into the river water every day. There are rules and regulations but they do not obey it properly. Some industries have effluent treatment plant (ETP) but they do not like to run it due to high profit goal. As a result, river water becomes toxic for living biota. Agricultural area close to the polluted river is affected as well. Farmers using this polluted water for irrigation made the toxic materials to enter into the food chain and ultimately come to human. The poor usually use this polluted water for washing and cooking, which is very harmful. Lack of proper management of industrial wastages release and lack of proper implementation of the policies are the main reasons of it. It can be improved the scenario of water pollution of the river by taking care about recommendations of the study which can have the positive changes to the human and aquatic life, environment and ecosystem of the river area.

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Strengthening the ICT Activities for Postgraduate Programs in Environmental Science

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Abstract
This project is focused only the development of ICT facilities funded by ICT Division, The Government Republic of Bangladesh. To strengthen postgraduate research works in environmental issues, the project designed for the building of capacity improvement of research team and modernization of ICT based laboratory facilities for access new knowledge. A room was allotted to develop a modern GIS Laboratory based on the plan of the project. After following the procurement procedure, the required computers, multimedia, computer desks, printer and scanner etc. were procured to develop the GIS laboratory under the Department of Environmental Science, Bangladesh Agricultural University. Now the well equipped laboratory is ready to serve for the postgraduate students. The established laboratory will be helpful for post-graduate students who will be work with GIS.

Developing Forecasting Technology of Extreme Weather and its Impact on Coastal Areas Food Security

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Abstract
Bangladesh is a disaster prone country where cyclone occurs more frequently in recent decades. In this study, cyclone data were obtained from BMD; DPC, AIT; and BBS. PCA and Clustering was used to find out the temperature (^{0}C) variations, and NCEP–NCAR reanalysis data were used to find out the temperature anomaly over Bangladesh and over the Bay of Bengal. PCA analyses shows that cluster 2 and 3 were mostly responsible for the formation of total 21 cyclones in past 40 years. Existence of a relatively cooler zone (negative anomaly) near to surface level and domination of warmer zone (positive anomaly) at 850, 700, 500, and 300hPa level was responsible for cyclogenesis. The atmospheric sounding indices for 62 cyclones from 1900 to 2015 were observed in this study. The results shows five destructive cyclones named *Nargis*, *Aila*, *Mahasen*, *Sidr* and *Rashmi* took place when the average correlation coefficient (*R*) values of SHOW, LIFT, CAPE CIN, KINX, SWET, LCLT, LCLP and PW showed instability from April to May and from September to October. Therefore, utilizing all of the above parameters a simple equation has been developed for predicting cyclone and/or extreme weather forecasting. The formula can be stated as, *Extreme Weather Forecast Index (ExFI) = f X Te850 (N-1) + KINX (N)*. The present study finds that, rice production is secure in the districts namely Barguna, Barisal, Bhola, Patuakhali, Feni, Bagerhat and Satkhira. The production of Aus rice will be increased in next 5 years in Barguna, Chittagong, Bagerhat and Satkhira district. Aman production will be increased in next 5 years in Bhola, Patuakhali, Feni and Satkhira. The findings of this research would be very useful for the environmental scientists to forecast severe storm weather as well as to understand the process of cyclogenesis in the coastal areas of Bangladesh.

Transboundary River Pollution - Threats to Water Quality of Haors and Their Impacts on Wetland Ecosystems and Livelihood Status of North-Eastern Bangladesh

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Abstract
The trans-boundary river water stretching over 71% of the earth's surface. Out of 405 rivers in Bangladesh 57 are trans-boundary. In the north-eastern part of Bangladesh, direct discharge of Acid Mine Drainage (AMD) into trans-boundary rivers causes huge losses of fish and crops. Contamination of AMD originating from mines and therefore, leaching of heavy metals are major causes of degradation of water quality in the north-eastern wetland ecosystems of Bangladesh. The purpose of this study is to investigate impact of coal mines on water quality on the basis of physico-chemical parameters such as temperature, pH, electrical conductivity (EC), dissolved oxygen (DO), biological oxygen demand (BOD), chemical oxygen demand (COD), total dissolved solids (TDS), and heavy metals viz. Fe, Pb, Cr and Cd. For this purpose, yearly a total of 15 samples were collected with 3 replications from 5 different locations of Jadukata river. The mean values of the analyzed parameters for 5 different sampling sites ranged: pH: 6.63-8.47; temperature: 25.77-26.8 °C; EC 344.51-383.50 µS cm^{-1}; DO: 7.60-8.30 mg l^{-1}; TDS 337.33-454.33 ppm; BOD: 0.70-1.93 mg l^{-1}; COD: 1.20-2.30 mg l^{-1}; Fe: 0.69-0.86 mg l^{-1}; Pb: 0.05-0.07 mg l^{-1}; Cr: 0.04-0.06 mg l^{-1}. Analyzed results show that, most of the values of the considered parameters were higher at Lakmachara sampling point which is the nearest site to Indian border and low at Rajargao which is the farthest from the border, almost all the values were higher than the permissible limits set by different standards. The gradual descending variations of the values within the sampling sites were mostly due to the effect of AMD which were mixed with the water of Jadukata river. Though the water can be used for irrigation purposes but it is absolutely hazardous for drinking and contributing a gradual degradation of the north-eastern wetland ecosystems of Bangladesh.

Carbon Sequestration and Carbon Stock Mapping at Bangladesh Agricultural University

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Abstract
The ongoing rapid urbanization will influence the vegetation with huge reduction of green spaces, which eventually enhance emission of Greenhouse gases like CO_2. The purpose of this study is to investigate the amount of carbon sequestration and to construct carbon stock map within the 1205 acre green areas of BAU. The methodology involves the steps of calculating the amount of CO_2 sequestered in a tree $year^{-1}$, determining the total (green) weight of the tree, determining the dry weight of the tree, determining weight of C in the tree, determining weight of CO_2 sequestered in the tree, and finally determining the weight of CO_2 sequestered in the tree $year^{-1}$. BAU possess huge green areas with more than 370 different plant species within its 1205 areas of land. It also has the World's 2nd largest fruit repository named BAU Germplasm Center. For this study only perennial tree species are considered within the huge area of BAU. The total tree count is 29147 that comprises of 231 perennial tree species. Among 231 species, the total tree count is largest for Mahogany (6303). Other top 9 species are Mango

(3820), Areca palm (2570), Weeping debdaru (1782), Guava (1438), Jackfruit (1343), Coconut (1305), Koroi (637), Akashmoni (602) and Mahua (565). The top 10 CO_2 sequestering species are Koroi, Shimul, Ficus, Rubber fig, Debdaru, Teak, Christmass tree, Minjiri, Burlflower and African Mahogony. They are sequestering CO_2 at a rate of 409.47, 338.71, 154.86, 453.82, 327.56, 274.88, 207.39, 250.99, 250.87 and 259.16 pounds $year^{-1}$, respectively. A couple of carbon stock map has been constructed dividing the whole study areas into several segments that shows the necessity of conserving perennial tree species in a priority basis. Furthermore, these data will support Carbon Credit under CDM that established under Kyoto Protocol for developed country to mitigate greenhouse gas emission.

Assessment and Evaluation of Noise Exposure Index and its Impact on Student's Health at BAU: a GIS Approach

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Abstract
The menace of noise pollution is growing in the world day by day due to increase in population, rapid industrialization, urbanization, commercialization and phenomenal growth in automobiles. To ensure fruitful teaching environment, all stakeholders of the rank-1 University like Bangladesh Agricultural University should take an effort to create a noiseless academic environment. Therefore, to assess and compare noise exposure index and pollution levels in six faculties of Bangladesh Agricultural University, the study was undertaken. Data were collected during the period from 9:30 am to 5:30 pm with one hour interval. The Sound Level Meter was used to get the data. The maximum high sound level was recorded 102.4 dB, 99.63 dB, 98.56 dB and 79.43 dB at Jobber moor, Helipad, K.R. Marker and Fisheries Faculty, respectively and the maximum low sound level was recorded 75.6 dB, 72.63 dB, 70.7 dB and 48.23 dB at Jobber Moor, Helipad, K.R. Market and Faculty of fisheries respectively. The maximum ranges of average sound level at Jobber Moor, K.R. Market, Helipad and Faculty of Fisheries were 85 – 89 dB, 80 – 84 dB, 75 – 79 dB and 60 -64 dB, respectively. The Equivalent Continuous Level (Leq) varies from 0- 0.8 with the maximum sound level from 58.84 dB to 81.73 dB. The Noise Pollution Levels (Lnp) were higher in jobber Moor at 4.40 pm, in K.R. Market at 1.30 pm, in helipad at 2.30 pm and in Fisheries Faculty at 3.30 pm. The findings of this study would be very useful to create awareness as well as to formulate some suitable strategies to protect noise pollution at Bangladesh Agricultural University to assist a noise free academic culture.

Indoor Air Pollution from Household Cooking Fuels and Its Health Hazards in Rural Communities in Bangladesh

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Abstract
The study focuses on the Indoor air pollution from household cooking fuels and its health hazards in selected areas of Tangail and Mymensingh districts. Two hundred and fifty air samples were collected from the kitchens by using *Airveda* air quality monitor and Testo 317-3 - Ambient CO meter to monitor the particulate matter and carbon-monoxide concentrations during cooking and non-cooking time. Considering all the data, the concentration of $PM_{2.5}$ during cooking ranged between 112 μgm^{-3} to 999 μgm^{-3} with a mean value of 401.88±231.63 112 μgm^{-3} whereas the mean value of $PM_{2.5}$ during non-

cooking was 81.38 ± 40 μgm^{-3}. This concentration is much higher than the limit set by Bangladesh National Ambient Air Quality Standard which was set at 65 μgm^{-3}. The concentration of PM_{10} during cooking fluctuated from 114μgm^{-3} to 1999 μgm^{-3} with a mean value of 523.1±413 μgm^{-3} whereas it varied from 55-429 μgm^{-3} with a mean value of 109.51±51 μgm^{-3} at non-cooking period. The mean concentration of CO during cooking period was 257.6±85.2 ppm and it varied from 100 ppm to 482 ppm. On the contrary, the mean concentration of CO during non-cooking was 6.60± 6.07 ppm and it varied from 0 to 40 ppm. During cooking time, the mean CO concentrations are higher than the 1-hr average Bangladesh National Ambient Air Quality Standard (BNAAQS), which were set at 35 ppm. The average concentrations of $PM_{2.5}$ at during cooking time according to fuel use in ascending order were: twig and leaves< coconut leaves < straw< wood, twig and leaves< jute stick< wood < twig< bamboo < cow-dung stick. During cooking time, the average maximum concentration of particulate matter PM_{10} (960 μgm^{-3}) was found from the kitchens where used cow-dung stick. The minimum average concentration (337.00 μgm^{-3}) was found from the kitchens where used twig and leaves. The average maximum concentration of CO (415 ppm) was recorded from the kitchens where used cow-dung stick at cooking time. The mean concentration of Mn, Co, Ni, Cu, Zn, As and Pb was 148.45±66 mg/Kg, 25.59±9.50 mg/Kg, 12.59±12.02 mg/Kg, 35.82±22.42 mg/Kg, 91.99±40.62 mg/Kg, 6.61±2.85 mg/Kg and 48.16±54.92 mg/Kg, respectively. Overall, the Hazard Index value of each element and the total value were lower than 1 that means these elements are not responsible for noncarcinogenic risk. The cancer risk of Co, Ni, As and Pb has been estimated from the average daily exposure doses through inhalation, ingestion, dermal pathways and the values of cancer risk for the trace elements are below the acceptable limit of European Union (10^{-6} to 10^{-4} per year: EC, 2001), indicated that these four elements are not responsible for carcinogenic risk.

Phytoremediation and Phylloremediation Approaches: Exploring the Potential of Plants for the Remediation of Air Pollutants

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Abstract

This study collected eaves of the plants (Approximately 120) from roadsides of Traffic areas and industrial areas of Dhaka city and Mymensingh-Dhaka highway to assess the tolerance level of plants against air pollution through APTI (Air Pollution Tolerance Index), Metal Accumulation Index (MAI) and phyllosphere microbial community for the recommendation of suitable species of plants for the remediation of air pollution. Concentration of air pollutants were monitored from the roadside of Mymensingh district and the mean concentration of CO, $PM_{2.5}$ and PM_{10} was 6.13±6.7 ppm, 272±158 and 401.9±346.6 μgm^{-3}, respectively. So far, thirty-five leave samples were collected from Mymensingh-Dhaka highway where the higher APTI value was found in Ghora neem (19.7) and Rhadhachura (16.3). These higher APTI values indicated that these two species regarded as efficient and tolerant plants to grow in roadside. The lowest APTI value was found for Musanda (5.64) and Jujube (7.36) indicated sensitive to grow for roadside.

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Biomonitoring of Wetland Ecosystems Using Benthic Macro-Invertebrates

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Abstract
This study was conducted to assess the water quality of the River (Dhaleshwari and Turag and Brahmaputra River) and Hoar wetlands (Tanguar Haor, Sunamganj and Mithamain Dhakhin Haor, Austagram, Kishoregong) using benthic macro-invertebrates. Samples were collected from nine locations of the Dhaleswari and the Brahmaputra river and Mithamain haor whereas five locations from the Turag river and Tanguar haor. Chemical parameters such as pH, Electrical Conductivity, Dissolved Oxygen, Total Suspended Solid and heavy metals were determined from water samples. Samples of macro invertebrates were collected from the selected sites using a net (25cm X 25cm) and collected macroinvertebrates were preserved in 4% formaldehyde for further identification and sorting. The mean concentration of DO level in the Dhaleswari, Turag, Brahmaputra, Tanguar and Mithamain hoar was 7.31ppm, 9.0 ppm, 6.04 ppm, 5.57 ppm, 6.15 ppm, respectively. The concentrations of Heavy metal (As, Cu, Fe, Pb, Cr, Mn and Zn) of the river Turag, Brahmaputra and Mithamain haor have been determined and it was observed that heavy metals (Pb and Cr) determined from the river Turag showed higher concentration than the recommended limit. Biological Monitoring Working Party (BMWP) score and Average Score Per Taxon (ASPT) were estimated from the number of taxa to assess the quality of water. The mean ASPT scores of the Dhaleswari, Turag, Brahmaputra, Tanguar hoar and Mithamain haor were 3.47, 2.53, 5.05, 4.93 and 5.58, respectively. Considering DO level, water of both the rivers and haor are suitable for fishes and aquatic organisms. The mean ASPT score of the Turag river was 2.52 which means the quality of water is poor and highly polluted. From the experiment, it could be concluded that Macro-invertebrate based multimetric indices are reliable tools for assessing water quality of the rivers as well as haor ecosystems.

Development of Yield Scaled Low Carbon Emission Technique Through Introducing Climate Smart Agricultural Practices in Irrigated Paddy Soil Ecosystem

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Abstract
This research experiment was undertaken to investigate the effects of biochar amendments on rice yield scaled carbon emissions and rice productivity under suitable cropping patterns. Paddy soil fertility deterioration is a major constraint to sustainable rice production in Bangladesh, which may be due to increasing land use intensity without proper use of nutrients fertilizers and organic manures, thereby; badly affected rice yield per unit area. The rice-rice cropping system is highly nutrients exhaustive, which causes negative nutrients balance in paddy soils. The content of organic matter in paddy soil has been decreased without return of organic biomass resources such as rice straw due to utilization as livestock feed in the country. Therefore, introducing a legume in rice-rice cropping system and biochar, carbon rich materials produced from the thermal decomposition of crop residues and animal manure under high temperatures, amendments in paddy soil holds the potential scope to resist soil degradation, increase carbon storage in soil, improve soil fertility and rice productivity in the

changing environment. Field Experiments were conducted during the Kharif season with T. Aman rice cultivar BRRI dhan 49 and Rabi season with BINA Dhan 10, at the field, Dept. of Environmental Science,BAU. In cropping pattern 1 (T.Aman Rice –Fallow-Boro Rice) the experimental treatments were: T1:F0CP1; T2: F1CP1, T3:F2CP1; T4: F3CP1, T5: F4 CP1, T6: F5 CP1, which were replicated three times. Similar combinations of biochar and vermicompost with NPKS were followed in Cropping pattern 2 (Boro rice-Mung bean-T.Aman Rice). In the first year the experiment was started in Kharif season (July, 2019) with transplanted Aman rice BRRI Dhan 49 and in Rabi season (January, 2020) with BINA dhan-10. Two years data on rice growth and grain yield of the cultivars, soil properties and methane emissions under different Cropping patterns were recorded properly. At the end of two years trials, it was observed that the combined application of biochar with NPK fertilizers (50% of the recommended doze) and vermicompost with NPK fertilizers (50% of the recommended doze) increased rice yield, improved soil physic-chemical properties such as soil porosity, organic C status, soil pH, redox status (Eh), total nitrogen, available P, water extractable iron, free iron oxides and exchangeable cations such as K, Ca, Mg, while a discrepancy observed in regards to methane emissions. The CH_4 emissions significantly decreased in both cropping patterns with biochar amendments. Higher rice yield was recorded in cropping pattern Boro rice –Mungbean-T. Aman rice (CP2) than T. Aman rice –Fallow-Boro rice (CP1). Considering the overall conditions, the integrated use of biochar and vermicompost with inorganic fertilizers (50% of the recommended NPK) could be a feasible strategy for sustainable rice farming and reducing (CH_4) emissions from rice paddy ecosystem. Furthermore, incorporation of Mumgbean biomass in paddy field after harvesting boro rice and before transplanting Aman rice significantly improved soil properties and influenced yield scaled methane emissions.

Development of Yield Scaled Low Carbon Emission Technique through Introducing Climate Smart Agricultural Practices in Irrigated Paddy Soil Ecosystem”

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Abstract

Paddy soil fertility deterioration is a major constraint to sustainable rice production in Bangladesh, which may be due to increasing land use intensity without proper use of nutrients fertilizers and organic manures, thereby; badly affected rice yield per unit area. Rice-rice cropping system is highly nutrients exhaustive, which causes negative nutrients balance in paddy soils. Moreover, the utilization of rice straw biomass as livestock feed has been decreased the content of organic matter in paddy soil in the country. Therefore, this research experiment was undertaken to investigate the effects of biochar amendments on rice yield scaled carbon emissions, increase carbon storage in soil, improve soil fertility and rice productivity in the changing environment. Field Experiments were conducted during the Kharif season with T. Aman rice cultivar BRRI dhan 49 and Rabi season with BRRI Dhan 89, at the field, Dept. of Environmental Science,BAU. In cropping pattern 1 (T.Aman Rice –Fallow-Boro Rice) the experimental treatments were: T1:F0CP1; T2: F1CP1, T3:F2CP1; T4: F3CP1, T5: F4 CP1, T6: F5 CP1, which were replicated three times. Similar combinations of biochar and vermicompost with NPKS were followed in Cropping pattern 2 (Boro rice-Mung bean-T.Aman Rice). In the first year the experiment was started in Kharif season (July, 2019) with transplanted Aman rice BRRI Dhan 49 and in Rabi season (January, 2020) with BRRI dhan-89. Two years data on rice growth and grain yield of the cultivars, soil properties and methane emissions under different Cropping patterns were recorded properly. At the end of two years trials, it was observed that the combined application of biochar with

NPK fertilizers (50% of the recommended doze) and vermicompost with NPK fertilizers (50% of the recommended doze) increased rice yield, improved soil physic-chemical properties such as soil porosity, organic C status, soil pH, redox status (Eh), total nitrogen, available P, water extractable iron, free iron oxides and exchangeable cations such as K, Ca, Mg, while a discrepancy observed in regards to methane emissions. The CH_4 emissions significantly decreased in both cropping patterns with biochar amendments. Higher rice yield was recorded in cropping pattern Boro rice –mungbean-T. aman rice (CP2) than T. aman rice –fallow-Boro rice (CP1). Incorporation of mungbean biomass in paddy field after harvesting boro rice and before transplanting Aman rice significantly improved soil properties and influenced yield scaled methane emissions. Conclusively, the integrated use of biochar and vermicompost with inorganic fertilizers (50% of the recommended NPK) could be a feasible strategy for sustainable rice production and reducing (CH_4) emissions from rice paddy ecosystem.

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Molecular Genetic Analysis of Oocyte and Embryo Developmental Competency in vitro with Respect to the Presence of Corpora Lutea in Bovine Ovary

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Abstract
Certain ovary mediated effects and stimulation influences the recovery of quality oocytes and outcome of in vitro embryo production. Therefore, characterization of ovaries should provide crucial information to assist in vitro embryo production. Presence or absence of corpora lutea (CL) in the ovary has been considered as an important characteristics which is associated to follicular development as well as in vitro embryo development. However, the molecular regulation due to the presence of CL in the ovary on the developmental competence of oocytes and embryos in vitro is yet to be elucidated. Considering this, present research has been designed to study the changes in the expression of key regulatory genes associated to the oocyte and embryo developmental competency due to the presence or absence of CL in bovine ovary. For this, ovaries were collected from the slaughterhouse, transported to lab, grouped according to CL, aspirated the oocytes separately from each category, in vitro maturation, fertilization and embryo culture has been performed. Developmental rate has been recorded as well as mature and immature oocytes; 2-cell, 4-cell, 8-cell embryos and blastocyst has been freezed for the isolation of RNA and subsequent study of gene expression for both groups. The study revealed a significant effect on the number and quality of oocytes from ovary in respect to CL as well as presence of CL has been found to negatively affect the outcomes in terms of maturation, cleavage and blastocyst rate. During the second year, the expression of genes associated to oocyte and embryo developmental competency in respect to the presence or absence of CL. Proposed study will identify the key regulatory genes important for oocyte and embryo developmental competency as molecular tool with respect to CL in the ovary as phenotypical tool to be used for in vitro production of bovine embryos.

Devising Embryo Biopsy System and Separation of Male and Female Bovine Embryo in Vitro Through DNA Technology

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Abstract
There has been an increasing demand to multiply the genetics of valuable cow and accelerate genetic improvement through embryo transfer. The present research project has been conducted with the goal to standardize the procedures of in vitro production of transferable cattle embryo with desired sex through development of embryo splitting and PCR based method. Through this study, 45% blastocyst rate (day-7 embryo) has been achieved which is comparable to any standard lab in the world. During in vitro embryo production, high quality embryos at 2-cell stage are microsurgically bisected using microneedle immediately after digestion of zona pellucida of embryo using pronase enzyme or through mechanical disruption. Separated blastomeres from the same embryo are being cultured in well-in-well dish for the assessment of developmental competency. The results revealed optimized procedure for IVM, IVF and IVC for in vitro production of transferable bovine embryos. Around, 45% blastocyst rate (day-7 embryo) has been achieved which is comparable to any standard lab in the world. During in

vitro embryo production, high quality embryos at 2-cell stage are microsurgically bisected using microneedle immediately after digestion of zona pellucida of embryo using pronase enzyme or through mechanical disruption. The experiment has obtained cleavage and blastocyst rate more than 80% and 40%, respectively in some batches (with an average 34% and 85% by batch). The methods for biopsy of embryo has been adopted where, the sex of a biopsied one half blastomere has been successfully determined through PCR based method. Culturing of other half has revealed 60% blastocyst like clustered cells with known sex. The results of the study suggest that the adopted culture system efficiently supports development of bovine embryo in vitro and hence this optimized system could be used for commercial production of bovine embryo for embryo transfer.

Improving Lamb Production Potentiality of Native Sheep through Selection and Genetic Enhancement

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Abstract
Sheep stand third in number among ruminant species in Bangladesh and are reared by the farmer mainly for meat production. Although, the productivity of the native sheep are very low compared to improved sheep around the world but they possess many positive attributes. They are capable of bi-annual lambing with multiple births and tolerant to various common diseases. Little attention has been paid till now for increasing their productivity. Present research work is being carried out to improve lamb production potentiality of native sheep through a systematic breeding and genomic information through high throughput genotyping. For this, morphometric, productive and reproductive characteristics of different types of sheep (Garole, Coastal, Tangail, Barendra and Muzzafarnagri) from the sheep populated areas has been performed. For the community based sheep improvement, a farmer's society in Bhuanpur, has been established. Rams selected based on the phenotypic characteristics have been distributed among the farmers of the baseline flock along with systematic ram rotation program to reduce inbreeding depression. To support with the good genetic resources, nucleus sheep breeding station is operating at the AI center of Bangladesh Agricultural University. Elite sheep breeding flock has been established at BLRI, where selection of ewes and ram from the existing flock of BLRI has been performed for systematic sheep breeding. A total of ninety six DNA samples from the blood of selected native sheep of five different types has been used for throughput genotyping analysis using 50k SNP bead chip. Genome-wide genotyping and association studies identified the molecular genetic diversity at both national and international level, genetic architecture and admixture, trait-wise important molecular polymorphisms in five types of sheep in Bangladesh has been identified.

Effect of Diluter (s) and Protocol (s) on Frozen Semen Production of Black Bengal Goat

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Abstract
The research work was conducted at the Artificial Insemination Center under the Department of Animal Breeding and Genetics, Bangladesh Agricultural University, Mymensingh to compare the efficacy between Egg Yolk Citrate (EYC) and Tris diluter for frozen semen production in Black Bengal buck. The parameters of semen characteristics included volume per ejaculate (ml), percentage of individual motility (progressive), normal and live sperm and sperm concentration (billion/ml). After dilution with EYC extender, It revealed from statistical analysis of frozen semen that individual bucks had significant effect ($p<0.05$) on sperm motility and but insignificant on motility after cooling with and without glycerol. In the same way, with Tris diluter, it was insignificant ($p>0.05$) on diluted semen motility and motility after cooling with and without glycerol. Motility and morphology of the sperm after equilibration and thawing showed insignificant difference among the bucks using EYC diluter. On the contrary, variation in the motility after equilibration and thawing was found significant ($p<0.05$) using Tris diluter and insignificant on normal and live sperm percentages. Overall non-return rate was found 50% at BAU surrounding villages. The work has hampered due to pandemic Covid-19 during research period. So trail of frozen semen production with different protocols is continuing with regular basis in Reproductive Biotechnology Laboratory and AI is also continuing in target villages.

Refinement of Oocyte Collection Technique and Culture Method for in Vitro Production of Goat Embryos

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Abstract
The purpose of this study was to refine the technique used to collect oocytes from slaughtered caprine ovaries to obtain a higher rate of competent oocytes for in vitro goat embryo production and to develop a standard protocol for IVEP of goats. Ovaries were collected from the local slaughterhouse and placed in 0.9% NaCl saline solution at 31 in a 1-liter thermo-flask. Cumulus Oocyte Complexes (COCs) were collected aseptically from ovaries by two techniques (aspiration and slashing). *In vitro* maturation of selected COCs was performed at 27 hours in TCM-199 with Earle's salts and necessary supplementation at 38.5 in a humidified atmosphere of 5.5% CO_2. *In vitro* fertilization (IVF) of the matured oocytes was performed using the frozen semen in a drop of modified IVF-TALP medium at 38.5°C in 5.5% CO_2, for 16 hours. At the 16 hours of IVF, the presumptive zygotes were *in vitro* cultured for 7 days post-IVF in a drop of modified SOF-BE2 medium at 38.5 in a humidified atmosphere of 6% O_2, 5.5% CO_2, and 88% N_2. It was found that the number of COCs recovered per ovary in the slashing technique (2.74) was higher than the aspiration (2.29) technique. Greater percentage of grade A (27.32%) and B (64.53%) oocytes recovered through slashing techniques compared to aspiration (A: 12.53%, B: 31.25%) and a higher rate of grade A oocytes (46.73%) reached in MII stage recovered from slashing method compared to aspiration (22.78%). The above findings were summarized base on the results of four batches. However, to draw a better conclusion, the research activities is still ongoing in our reproductive biotechnology laboratory.

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Red Chittagong Cattle Breeding and Revealing Their Genetic Architecture Using High Density Single Nucleotide Polymorphism Array

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Abstract
The objectives of this research project were: (1) to assess the performance of pure and graded RCC with a view to make available pure young meritorious RCC bulls to national breeding service providers and (2) to investigate the genetic diversity and genomic architecture of RCC using high density SNP markers. Detailed data on a total of nearly 1000 pure RCC of different ages, stages and sexes available in the hands BAU, BLRI, DLS, BRAC, ADL, PKSF (IDF, Momota, Desha) Green Farming Cooperative, Nahar Dairy Ltd, private owners, etc. have been collected. A standard database of the compiled pedigree and performance information has been developed and then uploaded to National RCC website. Further, Non-descript Local cows/heifers are being bred with RCC semen produced at the BAU AI Centre and graded RCC progeny produced in the vicinity villages of BAU are being tracked using the developed RCC Herdbook and performance being recorded. For molecular study, 281 blood samples from pure and unrelated RCC, Pabna, North Bengal Grey, Munshiganj, Sahiwal and Indigenous were collected from the institutional herds of BLRI, DLS, ADL, BAU as well as from the farmers' herds of Naogaon, Rajshahi, Sirajganj and Mymensingh. In total, 240 samples have already genotyped by Illumina 50K SNP bead chip (TNT Research Co. Ltd, South Korea). Our results provide insight information on genomic diversity and population structure of the aforesaid cattle genetic resources of Bangladesh. On the other hand, whole genome sequence of four RCC samples have already been completed using Illumina NGS technology and the NGS data analyses are about to be completed. In three batches a total of twenty-six potential pure young RCC bulls with known pedigree were identified, purchased and brought to BAU AI Centre for routine recording of their body weight, growth, testicular measurement and semen characteristics. Meanwhile, with test results a total of 12 (twelve) Certified RCC Bulls have already been dispatched for use to American Dairy Ltd. (ADL), Lal Teer Ltd., ACI Genetics Ltd., IDF and Momota, Chottogram, Desha, Kushtia and a private owner of Dinajpur. Some growing RCC bulls are still under test while disqualified ones already culled. Moreover, with sufficient scientific evidence an application to the national body for registration of RCC as a breed has already been filed and upon getting registration from their end, RCC will be declared as a dual-purpose breed of cattle of Bangladesh.

Development of Meat Type Crossbred Using Boer and Black Bengal Goat

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Abstract
Black Bengal (BB) is a dwarf, prolific, early maturing meat type indigenous recognized breed of goat of Bangladesh with an average mature body size of 20 kg in male and 14 kg in female. Population of BB goat in the country is constituted by 25.43 million and most of which are reared by subsistence or zero input system of rearing. However, low birth weight (0.80-1.20 kg), slower pre-and post-weaning growth rate (40 g/d) and poor milking ability (300-600 ml/d) affect adversely kid survival rate as well

as overall profitability. On the contrary, African originated Boer goat grows very fast (400 g/d), possesses optimum reproductive ability, commonly kids twin and daily milk yield averaged at 1.75 L. Mature body size of male and female Boer goat are 75 kg and 65 kg respectively. That's why this breed of goat recently got distributed almost all the countries of the world. Goat farming system in our country is not so much conducive to rear Boer goat. Farmers are not very capable to fulfil the nutritional, health care and managemental requirements of Boer goat. Since goat meat is of high demand in Bangladesh particularly during religious festivals, social and cultural occasions of the people of all religion and caste, we need to develop an intermediate type of goat which will require less amount of feed, health care and attention. Considering the above-mentioned circumstance, current investigation has been designed to make a crossbred between Boer and BB goat. For this purpose, 3 Boer bucks have been using in breeding BB does in 3 different communities at the vicinity of BAU to produce F1 progeny. Approximately 50 services will be made with each buck and replicated in 3 communities. Birth weight, weight at 3,6,9 and 12 months of age; carcass quality; reproduction and milk production in females and kid survival will be recorded and analyzed to evaluate the performance of F1 progeny. Till now a total of 35 natural services have been done in does belonging to 3 different communities. F1 kids will hopefully be available from 3 months later.

Evaluation of Economically Important Quantitative Traits of Pure Beetal Goats and Their F_1 Generation in The Farming Condition of Bangladesh: A Gateway to the Entrepreneur's for Profitable Goat Farming

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Abstract

Beetal goat is one of the best dual purpose goat breed among the Indo-Pakistani breeds of goats. It is becoming popular because of its weight and height which attract people to buy it. Though this breed has a good adaptability in India and Pakistan but the performance of important quantitative traits in pure Beetal goats and their F_1 generation in our farming condition is still unknown. Therefore, the present study was conducted to evaluate the economically important quantitative traits of pure Beetal goats and their F_1 generation under our farming condition. A total of 12 pure Beetal goats were selected for this research work of which four (5) were breeding bucks and eight (8) were does. After selective breeding, they produce kids (F_1 generation) of which 10 were considered for this study. It was revealed that from birth to 12-month of age, body weight of pure Beetal goats and their F_1 generation did not differ significantly ($p>0.05$). Birth weight of pure Beetal goats and its F_1 generation were 3.16±0.38 and 3.08±0.56 kg, respectively. The weight at weaning was 11.87±0.31 kg in pure Beetal goats and 10.53±0.21 kg in F_1 generation. Average daily gain of male Beetal goats were significantly ($p<0.01$) higher (82.57±1.21 g) than the female goats (64.86±1.61 g). On the other hand, test day milk yield in pure Beetal goat was 373.78±8.75 ml. Litter size in pure Beetal goats and their F_1 generation was 1.46±0.29 and 1.52±0.57, respectively. Service per conception also did not vary significantly ($p>0.05$) and was 1.16±0.26 and 1.19±0.25 in pure Beetal goats and its F_1 generation, respectively. Gestation length of pure Beetal goats (147.50±1.64 days) and their F_1 generation (146.50±2.10 days) did not differ significantly ($p>0.05$). These results suggested that Beetal goats can be a potential breed for our entrepreneurs for profitable goat farming.

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Entrepreneurship Development among Women through Community Based Goat Rearing in Char Areas of Bangladesh

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Abstract
This study was conducted to evaluate the present socio-economic condition and develop entrepreneurship among women in char areas. A benchmark survey was conducted using a pre-tested questionnaire following purposive random sampling technique to know the socio-economic condition. Rearing goat was used as a tool for income generation and poverty alleviation. Selected women were trained for scientific goat rearing and build up entrepreneurship among them. It was found that most of the respondents (67.44%) were middle aged groups (30-45 years). About 65.12% families in char areas consisted of 4-6 members. More than half of the char dwellers (53.49%) were very much poor and vulnerable having land size below 10 decimal. About 39.53% women can sign only and 30.23% completed primary education whereas 15.12% were illiterate and could not take the advantage of different GO and NGOs initiatives. Most of the respondent's family dependent on agriculture (32.56%) and daily labor (25.58%). The average monthly income was low (<10,000 Tk) in case of 56.25% char dwellers. Half (50%) of the respondent's family expenditure for food was 4001-8000 Tk and the 17.50% char dwellers did not expend any money for education. As an initiative to develop entrepreneurship among women, community based goat rearing was introduced and it was evident that 52.33% women reared 1 to 3 goats, 36.05% reared 4 to 6 goats and 11.63% women reared more than 6 goats. About 95.35% women's sold their goats in their personal needs and 71.61% women received benefit from 10,000 Tk to more than 20,000 Tk which facilitated them to help their husband during crisis moment and also can spend money according to their needs. After developing entrepreneurship, confidence of the women is increased, leadership skill is developed as well as 70% women opined that their livelihood has been improved through community based goat rearing.

Analysis of Genetic Polymorphisms in β-Casein Gene for Determining A1 and A2 Allelic Variants in Indigenous and Crossbred Cattle of Bangladesh

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Abstract
Beta-casein (CSN2) is the most explored gene in cattle due to its potential impact on human health. Here, we investigated the entire coding sequence of CSN2 gene for detection of polymorphisms in different cattle populations of Bangladesh as well as genotyping of A1 and A2 allelic variants using newly developed allele specific polymerase chain reaction (AS-PCR) based genotyping protocol. Five primer-pairs were used to amplify the coding sequences of CSN2 gene. This study included a total of 258 DNA samples from five Bangladeshi indigenous populations, one zebu breed (Sahiwal) and one Holstein Friesian (HF) derived crossbred cattle population. Sequence analysis detected five nonsynonymous mutations in the coding sequence of CSN2 gene that defined five allelic variants as A1, A2, B, F and I. In addition, substitution of GTA (Val) by GCA (Ala) at 197th position resulting an undefined allele in indigenous cattle population of Bangladesh that has not yet been reported elsewhere. Like other Bos indicus cattle populations, A2 allele is predominantly available in the indigenous populations. The mean frequencies of A1A1, A1A2 and A2A2 genotypes were 0.02, 0.16

and 0.82, respectively in indigenous cattle populations while the corresponding allele frequencies were A1 (0.10) and A2 (0.90), respectively. In opposite, the aforesaid genotype frequencies were 0.14 (A1A1), 0.50 (A1A2) and 0.36 (A2A2), respectively in Holstein-Indigenous crossbred population with allele frequencies of 0.39 (A1) and 0.61 (A2). The adopted AS-PCR method was found cost-effective, rapid and had high specificity for genotyping of A1 and A2 allelic variants. Altogether, this study provides information for the selection of desired indigenous and crossbred individuals in order to produce premium quality milk as well as to design breeding plan in crossbreeding program.

Development of Meat-Type Duck Through Reciprocal Crossing Suitable for Semi-Scavenging System in Bangladesh

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Abstract

The aim of this study was to develop a meat-type crossbred duck suitable in semi-scavenging condition of Bangladesh. Growth, production and reproduction performances of foundation (G_0), G_1 and G_2 crossbreds between Pekin (P) and Nageswari (N) ducks were investigated from day old to 42nd weeks of age under intensive management conditions. Feeding and management practices were similar throughout the experimental period. Genotype had significant differences ($P<0.05$) among the four genotypes in morphometric measurements, except wing and shank length. Growth performance was highly significant among the four genotypes ($P<0.001$) from one-day to 12 weeks (marketing age) of age in G_1 generation. Meat yield parameters varied significantly ($P<0.05$) among the different genotypes for all studied traits, except for liver and gizzard weight. Moreover, no significant differences ($P>0.05$) were observed between P and P♂×N♀ crossbred for important meat yield traits such as hot carcass weight, dressing%, back half weight, drumstick with thigh weight and breast meat weight. Based on the results of G_1, the best performed P♂×N♀ crossbred was selected for production of G_2 and subsequent generations. Our study revealed that the growth performances of the selected G_2 at marketing age (10th and 12th week) were 1706.67±24.74 and 1922.62±24.92 g, respectively and was a bit higher than the G_1 generation. The age at first lay of selected P♂×N♀ G_2 crossbreds was almost similar (143 days) to G_1 crossbreds (139 days). The number of eggs up to 280 days increased from 83.14 (G_1) to 94.08 eggs (G_2) in P♂×N♀ crossbreds. Heterosis estimates showed that crossing between Pekin drakes and Nageswari ducks (P♂×N♀) gave the better heterotic effects for live weight up to 12th week compared to its reciprocal N♂×P♀ counterpart. Taken together, our results revealed that P♂×N♀ genotype could be suitable for higher meat production with better adaptability in the agro-climatic conditions of Bangladesh.

Selection of Crossbred Dairy Cattle Using Phenotypic and Genomic Information for Efficient Productivity and Resilience in Tropical Environment of Bangladesh

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Abstract

Dairy animals' selection in Bangladesh is mostly phenotypic performance based that often inappropriate and the selection accuracy is low. The aim of the project is to establish a system of recording and utilize genomic tools to select better performed crossbred cows and bulls precisely. Database establishment is the first and foremost element in genetic evaluation process which is not

usually practice at farmers level in Bangladesh. For this, establishment of performance database of Holstein-Local (H×L) and Sahiwal-Local (SL×L) crossbreds has been accomplished through farmers' participatory approach. A total of 138 dairy farmers were selected so far from Chottogram, Dhaka, Mymensingh and Khulna divisions. The herd size of the selected H×L crossbred farms ranged between 36 to 234 individuals in contrast to 2 to10 individuals in case of Sahiwal or SL×L crossbreds. Importantly, we selected only potential dairy cows those had maximum 2nd to 3rd lactation records and have possibility to continue their production at least couple of years in the enlisted farms. Accordingly, farmers' training, Herdbook preparation, purchase of ear tag and tagger, and animal selection from the selected farmers were performed. A total of 5 farmers' training were organized at Chottogram, Dhaka, Kushtia, Khulna and Faridpur districts where 40-50 dairy farmers were participated in each training. In addition, printed Herdbook were distributed to those of the selected farmers. The accumulated information will help us to screen potential crossbred bull mothers and candidate crossbred bulls as well as to establish database on animal's productive and reproductive performances in order to fulfil the project objectives.

Community Driven Breeding Approach Using Brahman Inheritance for the Genetic Improvement of Indigenous Cattle for Beef Production

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Abstract

A well infrastructure to execute community driven breeding approach have developed in the Department of Animal Breeding and Genetics of Bangladesh Agricultural University through the previously completed sub-project financed by Higher Education Quality Enhancement Project. Sufficient number of artificial insemination field technicians was also trained-up to run the breeding activities at the farmers' level. A huge number of progeny (around 4000 heads) were produced and some positive findings were observed from the sub-project. Out of the 4000 progeny around 1000 heifers at Bhabokhali, Boyra and Dowakhula areas (near to BAU campus) are ready to breed. The proposed study are covered the selected indigenous heifers/cows and 1000 Brahman F_1 graded heifers owned by the community farmers to produce F_1 and F_2 progeny, respectively. Indigenous heifers/cows and Brahman heifers will be inseminated continuously using Brahman semen. The average birth weight of 50% Brahman cross was (21.40kg) higher than the birth weight (18.59kg) of 25% Brahman cross calves. The 12-month weight of Brahman crossbred calves was slightly higher than that of 25% Brahman calves. Daily gain of 25% Brahman cross was 529.9g/d and 50% Brahman cross calves was 570.52g/d). The health of twin calves was not so good as expected. The reason may be that the farmers were not interested to give sufficient milk to the calves. Farmers took special care for their male calves rather than females. Genetic evaluation of Brahman progeny will be done using modern breeding technique in the last year of the project.

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Evaluation of Growth Performance of Grade-2 Brahman Crossbred Progeny in a Farmers' Participatory Beef Breeding Program

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Abstract
The present study was carried out using growth performance data on 225 Brahman (25%) cross calves in a farmers' participatory breeding program under the Department of Animal Breeding and Genetics, BAU, Mymensingh. Growth traits considered were birth weight, weight at three-, six-, nine-, twelve-month of age and average daily gain from birth to twelve-month of age. The birth weight, weight at three-, six-, nine- and twelve-month were 19.87±0.06, 52.01±0.49, 85.03±0.62, 127.12±0.81 and 171.19±1.20 kg, respectively. Area, bull and sex had significant effect ($p<0.01$) on birth weight, three-, six-, nine- and twelve-month body weight of calves. The average daily gain of calves was 426.00±4.99 g. Area, bull and sex had also significant effect ($p<0.01$) on average daily gain. Growth performance results on Indigenous, Red Chittagong, Pabna, and crosses of Holstein-Frisian, Jersey, Sahiwal and Sindhi cattle were also collected from published literature and they were compared with 25% Brahman cross calves. The highest birth weight (19.87±0.87 kg) and yearling weight (171.19±17.9 kg) was found in Brahman cross calves and lowest birth weight (14.81±2.50 kg) was in Indigenous calves and lowest yearling weight (92.28±1.73 kg) was in Sahiwal cross calves. Average daily gain was highest (426.00±4.99 g) in Brahman and lowest (146.78±91.96 g) in Indigenous calves. Thus it may be concluded that growth performance of Brahman cross calves is better than the other existing cattle genotypes of Bangladesh. However, further study with large number of data and different management systems is required to draw a final conclusion.

Influence of Dietary Energy Levels During Late Pregnancy on Performances of Black Bengal Does and Their Kids

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Abstract
The aim of this study was to know the effect of dietary energy levels at late pregnancy on growth, milk production and the length of post-partum anestrus of Black Bengal does and also birth weights and growth rates of kids. Fifteen preprubertal female Black Bengal goats (1 year-old) were divided into 3 groups. Each group contains 5 goats. Three isonitrogenous diets containing 3 different levels of metabolizable energy i.e., low energy (8.67 MJ/Kg DM), medium energy (10.2 MJ/Kg DM) and high energy (11.73 MJ/Kg DM) were randomly assigned to 3 groups of goats. During the experimental period the live weights of does were measured. Milk yield, post-partum estrus and weights of kids were also recorded periodically. All data were subjected to one way ANOVA, and the significance of difference among means was determined by Duncan's Multiple Range Test (DMRT). The highest live weight gain was 4.5 ± 0.9 kg in high energy group which was significantly ($p<0.05$) higher than others. There were no significant differences on dry matter intake among treatment groups. The average live weight gain of does after parturition to post-partum heat was significantly ($p<0.05$) higher in high energy consumed goats (14.05± 0.08 Kg) than medium (13.83 ± 0.11 Kg) and low (12.61 ± 0.13 Kg) energy groups. Milk yield of does was higher in high energy group than others at 10^{th} weeks of

lactation. Birth weight of kids did not differ significantly among the treatment groups. At weaning stage, live weight was significantly higher in kids of high energy offered does. Post-partum heat period was shorter in high energy fed goats than others although the values did not differ significantly. In conclusion, maternal dietary energy during late pregnancy positively influenced the growth and milk yield of Black Bengal does and growth of their kids.

Effect of Melatonin on *in Vitro* Development of Goat Oocytes

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Abstract

The study was aimed to examine the effect of melatonin on *in vitro* development of goat oocytes. Goat (Black Bengal) ovaries were collected from the slaughterhouse of Mymensingh City Corporation. After collection, the ovaries were washed in saline solution (0.9% sodium chloride) 3 times. Cumulus oocyte complexes (COCs) were aspirated using syringe with the 18-G needle. COCs were washed two times in washing media and one time in maturation medium and placed into the final maturation droplets. The droplets were covered with paraffin oil. To study the effects of melatonin, the maturation media were supplemented with 0, 0.1, 1.0 and 10 µM melatonin. After 24 hours of maturation culture, oocytes were mechanically denuded, fixed in aceto-ethanol, stained with aceto-orcein and the nuclear stages of oocytes were examined under a differential interference contrast (DIC) microscope. All data were subjected to one-way ANOVA, and the significance of difference between means was determined using Duncan's Multiple Range Test. All data were analyzed in "IBM SPSS Statistics 22". Differences at $p< 0.05$ were considered statistically significant. All oocytes showed cumulus expansion after 24 hours of culture. The results showed that significantly higher proportion of oocytes matured to the MII stage in 10 µM melatonin group compared with other groups. The number of oocytes reached the MII stage was lowest in non-treated (0 µM) and highest in 10 µM oocytes. The numbers of MII oocytes did not differ between 0.1 and 1 µM groups. Percentages of oocytes reached the MII stage were higher in 0.1 and 1 µM supplemented groups than the control. These results suggest that melatonin supports in vitro maturation of goat oocytes. The present study also showed that melatonin did not play a significant role in protecting the oocytes from degeneration. In conclusion, melatonin enhances in vitro maturation of goat oocytes.

Production and Characterization of Banana Stem Haylage as Ruminant Feed in Bangladesh

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Abstract

Banana stem *haylage* production technology is an emerging 21st Century bioengineering technology for sustainable livestock production; the protection of animal health and the environment. *Haylage* is a form of dry silage that uses small pieces of chopped green grass. Following 14 to 21 days of fermentation, the grass is again dried by sunlight to decrease the moisture level. *Haylage* decreases the moisture content at least ranges from 30-40% and that were storage ensile plastic drum or polythene bag for animal feeding. Different types of feed additives can also be used throughout processing to

increase the nutrient value of the *haylage.* In this study, banana stem *haylage* was produced from banana stem after harvesting fruits. The banana stem *haylage* was of high physical quality – yellowish in color, sweeter smelling, acidic, and resistant to spoiling for certain period when kept in specific containers and bags. The nutrient content was standard, including the DM (50-60%), CP (9-12%), CF (10-13%), and was higher in organic matter digestibility and high in ME content. The voluntary feed intake was about 3.15 Kg per 100 kg live weight. The live weight gain was 520-610 g/d in comparison to 220 to 275 g/d for farmers practicing cattle. The market retail price would be 15-20 Tk/kg of *haylage*. An entrepreneur can produce five MT of banana stem *haylage* per month from available banana trees in the study area. Banana stem *haylage* can be used for rearing growing bulls, heifers, and dry cows. It can be stored without spoilage for more than six months. It is easy to transport and keep in open spaces, even during floods, rain, or other natural calamities. It is a great opportunity for women's empowerment, youth development, and generation of employment opportunities. This technology is environmentally friendly, economically viable, and socially acceptable.

Monthly Changes in Temperature and Humidity of Concrete and Compost bedded Pack Floor Cattle Barn at Satkhira District in Bangladesh

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Abstract

An experiment was conducted to investigate the changes of temperature and humidity in cattle shed on different months of the year at Satkhira district in Bangladesh. Two types of floor were selected: one was concrete floor with mat (10 in numbers) and another was compost bedded pack floor (three in numbers). The experiment was conducted from March 2021 to December 2021 at Tala Upazilla of Satkhira district in Bangladesh. A LCD digital temperature humidity meter with clock was set up in each farm both in inside and outside of the shed. The data were recorded at six hours interval every day. Results indicated that the average outside temperature of the shed was recorded at 36.1°C, 39.2°C, 36.5°C, 36.4°C, 33.8°C, 33.2°C, 32.7°C, 32.4°C, 31.3°C and 28.5°C in successive months from March to December. Similarly, average shed temperature for concrete floor barn with mat was found 35.8 °C, 36.6°C, 35.3°C, 32.1°C, 33.9°C, 33.4°C, 34.45°C, 32.1°C, 29.0°C and 24.9°C from March to December 2021 respectively. Likewise, average bedding temperature in compost bedded pack barn for the same periods were 31.0, 31.5, 30.5, 30.5, 29.7, 30.2, 30.2, 29.6, 27.8 and 26.3°C, correspondingly. The maximum temperature was observed in April and the minimum in December for all the cases i.e. outside the barn, concrete floor barn and compost bedded barn respectively. In addition to that, difference in environment temperature, shed temperature and bedding temperature were found 10.7°C, 11.8°C and 5.2°C, respectively. Furthermore, environment humidity was recorded 69.2, 72.4, 75.3, 82.6, 85.4, 85.3, 86.5, 82.4, 77.2 and 75.7% from March to December consecutively. The maximum humidity (85.84%) was found in April and the minimum (54.4%) in July. It is, therefore, observed that well managed deep bedded pack has less fluctuation in temperature and humidity thus it provides more comfort to the animals.

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Deep Bedded Pack System in Manure Management for Environment Friendly Animal and Safe Food Production in Bangladesh

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Abstract

The aim of this experiment was to evaluate the year round heat stress to cattle reared in deep bedded pack system versus concrete floor system. The quality of bedding materials as organic fertilizer was also studied. Temperature and humidity were recorded in both systems. Classes of heat stress were calculated by using temperature and humidity values. Animals kept in concrete floor suffer severe heat stress (THI values more than 90) in July and September, moderate (THI values from 80 to 89) in August, October, March, April, May and June and mild (THI values from 80 to 89) in November, December and February. However in case of deep bedded pack barn; animals were never affected with severe stress, moderate in June to October and the March and April and mild in November, December, February and May. In January it was in comfort zone with THI value 71.67. The THI values observed in CBP system was at least one class lower than the concrete floor barn. Furthermore, after 12 months of cattle rearing on deep bedded pack, all the bedding materials were removed and kept in a compost pit for compost preparation. In each 7 days interval, indigenous microorganisms (IMOs) was sprayed for quicker decomposition and reducing bad odour. Samples were collected after maturation of compost and different nutrient compositions were analyzed in Animal Science Lab and Soil Science Lab, Bangladesh Agricultural University. The results showed that the moisture content of final deep bedded pack compost was found 66.47%. Nonetheless, pH, organic carbon, total nitrogen, C: N, phosphorus, potassium, and sulfur were found 8.3, 21.89, 1.6, 13.68, 0.29, 1.57 and 0.3, respectively. The fertilizer value of the deep bedded pack compost was higher than manure compost. Finally, introduction of cattle rearing in deep bedded pack system has great potential in Bangladesh.

Study on the Dynamics of Primordial Follicle Development in Black Bengal Goat

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Abstract

Mammalian oogenesis starts at the embryonic period and primordial germ cells are the primary cells in oogenesis which constitute the ovarian reserve. This reserve contains all of the oocytes potentially available for fertilization throughout the fertile lifespan. So far, however, the ovarian reserve of Black Bengal goats has not been studied yet. Therefore, the objective of this study was to examine the primordial follicle dynamics of Black Bengal goat during fetal and neonatal stage. Black Bengal goats were purchased from local market and reared in Goat, Sheep and Horse farm under the department of Animal Science. Diets were formulated using commonly available feed ingredients to meet the recommended level of metabolizable energy (10.40 MJ/kg DM) and crude protein (14%). The goats were mate naturally with buck after estrus. Growing fetus were removed surgically from the goat uterus at 100 days of pregnancy and ovaries collected from the fetus. The ovaries were also collected

from the female kids after 3 days of parturition. The ovaries were fixed in Bouin's solution, dehydrate in alcohol, clean with xylene and embed in paraffin to prepare paraffin block from the ovarian tissues. Histological sections of the ovarian block were prepared by using rotatory microtome. The sections were stain with haematoxylin and eosin. Finally the stain sections are now observing with the help of a light microscope to count the number of primordial follicles in the ovary. There was a delay to start the project work on desired time frame due to the COVID-19 and lack of female Black Bengal goats. As a result we could not complete the whole project work yet. In conclusion, hopefully we will complete the work soon and able to explore the ovarian reserve of Black Bengal goats.

Investigating the Effects of Tannin and Saponin Rich Fodder on the Productivity of Black Bengal Goat

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Abstract

One of the greatest challenges in the years ahead will be to produce the amount of food needed to feed a rapidly expanding human population which is predicted to be approximately 1.5 times higher than the present level by the year 2030. This research program was mainly designed to determine the effect of tannin and saponin on rumen fermentation characteristics specially protein protection and availability in the rumen and post ruminally and the effect of tannin and saponin on the productivity (milk and meat) of Black Bengal goat (BBG). For this purpose, an *in vitro* incubation was conducted to ascertain measurements of protein fermented in the rumen and protein sparing ability (by-pass protein) from ruminal degradation and an *in vivo* feeding trial was conducted with the addition of tannin (Jackfruit leaves) and saponin (Dhancha leaves) rich fodders to ensure either tannin and saponin could be used as an additive to increase the productivity (milk and meat) of BBG. In the *in vitro* fermentation study, gas production, soluble and pellet protein and ammonium concentration were found almost similar pattern as of growth promoting antibiotics (GPA) Monensin, revealed that Dhancha may have the ability to work as GPA in ruminant productivity. On the other hand, tannin rich Jackfruit leaves restricted the breakdown of protein in the rumen and increased the availability of by-pass protein post-ruminally thus may increase the productivity of ruminant animals. Finally, *in vivo* feeding trial with BBG demonstrated that Dhancha leaves as saponin has highly potentials to efficiently increase growth and milk production of BBG compared to Napier grass. On the other hand, tannin rich Jackfruit leaves are also found better performances for growth and milk production of BBG than feeding Napier but Dhancha was the best between the three. The milk constituents as DM, fat, protein, lactose, solids not fat, ash, total solid and water were found higher in Dhaincha group compared to Jackfruit leaves and Napier group. Therefore, feeding Dhancha and Jackfruit leaves could be useful for meat and milk production and the findings of *in vivo* results are highly comparable with *in vitro* study. Therefore, it can be predicted from the present findings that both saponin and tannin may use as natural source of feed additives as of monensin to alter rumen fermentation characteristics especially it increased the availability of soluble and protected protein in the rumen and ensured ruminant productivity.

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Studies on the Impact of Flock Size of Lamb Towards Livelihood Improvement

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Abstract

The study was conducted in the upland and char areas to assess the impact of flock size lamb production towards livelihood improvement of farmers in Sherpur district. The impact study was assessed after completing baseline and end line survey. A total 600 sheep was taken from Sherpur district divided into 5, 10 and 15 sheep flock sizes having one BLRI proven ram in each group. The data was analyzed using paired t-test with SPSS software. Income from cattle, sheep and homestead garden significantly ($p<0.01$) increased. Physical capital like cultivable, rented in and fodder land ($p<0.05$) except homestead land (farm size-decimal) from 156.5 to 199, sheep population except goat, value of agricultural equipments, household assets, borrowing amount had significantly increased ($p<0.01$). Goat had significantly ($p<0.01$) decreased due to increased lambs and some homestead land significantly ($p<0.01$) decreased due to fodder cultivation for their lambs. Financial capital (income from cattle, sheep, homestead gardening, job, service and expenditure for fish, meat, vegetables, onion/garlic) showed significantly ($p<0.05$) increased. Human capital (training, decision making) significantly ($p<0.001$) increased than their male counterparts. Social capital (exposure to institute) increased from 19.30 to 66.67% and (collaboration with institution) increased from 7.23 to 100%.Their social network and linkages strengthened after rearing lambs. Market access and bargaining capacity of lamb farmers increased in the selected areas. Self employment opportunities were created by lamb production in the studied areas. Hence, it may be concluded that rural poor beginners 5 flock sizes performed better than that of 10 and 15 flock sizes regarding remarkable livelihood improvement through calorie-protein balance, decreased hard core and absolute poor, significant increased income and expenditure in the studied areas.

Awareness Creation and Impact Assessment of Meat Retailers During Covid-19 Lockdown in Sherpur District

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Abstract

The COVID-19 pandemic impacted meat production, supply chain, and meat prices that caused a severe socio-economic crisis worldwide. Initially, meat and meat products' prices increased due to less production and increased demand because of panic buying. Later on, both meat production and demand were significantly decreased due to lockdown restrictions and lower purchasing power of the consumers that resulted in a decrease in meat prices. The research was conducted to evaluate the impact assessment of meat retailers during Covid-19 lockdown in Sherpur District. A total number of 50 meat retailers were surveyed from Sherpur district for collecting necessary data and information. The experiment was conducted to increase awareness among meat retailers from July-December, 2020. An amalgam of descriptive statistics, mathematical and statistical analyses was used to analyze the data. It was observed that all the meat retailers faced problems in terms of selling meat and lowering return during the period of pandemic lockdown. During Covid-19situation the income of meat retailers

became much lower compared to any other critical conditions. Statistics showed that the income of meat retailers decreased about 60% during lockdown period. The supply chain of meat industry was fully interrupted during that time. About 100% meat retailers faced various problems towards buying and selling of animal, lack of consumers, lack of demand for meat. The prices of all kinds of meat such as beef, goat meat, and chicken meat became lessened during pandemic. During pandemic about 84% meat retailers used face mask for keeping them safe from corona virus. Only 2% people tested for corona virus. During lock down period it was seen that about 60% maintained physical distance at the time of selling of meat. During the time of pandemic lockdown 98% meat retailers did not get any financial support from government organizations or NGOs or any other private organizations. They did not also get any kind of help to create awareness from public health department or from local authority. Despite facing all these problems, about 98% meat retailers liked to continue their meat business.

Prediction of Broiler Meat Quality through NIR Spectroscopy and Multivariate Analysis

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Abstract

The aim of this study was to evaluate the feasibility of NIRS to predict broiler meat quality. Samples of broiler breast muscle (*pectoralis major*) (n=94) were collected from K.R. market at BAU, Mymensingh and spectra were obtained prior to broiler meat quality analysis. A total of 282 NIRs were collected and stored in computer by DLP NIRscan Nano Software. Partial least square regression model for calibration and cross validation were developed through Unscrambler X software. Accuracies of the calibration models were evaluated using the root mean square error of calibration ($RMSE_C$), root mean square error of cross-validation ($RMSE_{CV}$), coefficient of calibration (R^2_C) and coefficient of cross validation (R^2_{CV}). Calibration equations were developed from reference data (n=94) of color traits (lightness, redness and yellowness), pH, drip loss (%), cooking loss (%), CP (%), EE (%), moisture (%), DM (%), and Ash (%) using partial least squares regressions. The standard deviation is 3.54, 0.82, 1.59, 0.06, 0.58, 1.47, 1.08, 1.08, 0.97, 0.45 and 0.1 for *L**, *a**, *b**, pH, drip loss, cooking loss, DM, moisture, CP, EE and Ash, respectively which indicates that all values are adequate for analytical purposes. Predictions were good (R^2_{CV}=0.84) for lightness (*L**), (R^2_{CV}=0.82) for redness (*a**), (R^2_{CV}=0.79) for yellowness (*b**), (R^2_{CV}=0.78) for pH, (R^2_{CV}=0.86) for drip loss, (R^2_{CV}=0.77) for cooking loss, (R^2_{CV}=0.89) for CP, (R^2_{CV}=0.83) for EE (R^2_{CV}=0.82) for moisture, (R^2_{CV}=0.82) for DM and (R^2_{CV}=0.87) for ash. The results showed potential use of near-infrared spectroscopy as a suitable tool for a rapid, nondestructive and reliable prediction of broiler meat quality.

Fermented Rice in Cost Effective Healthy Beef Production

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Abstract

Introduction: Cooked Fermented rice is one of the traditional food items in South East Asia. Its nutritional values are appreciated due to the positive change during fermentation process. Therefore, cooked fermented broken rice fermentation might be used for beef cattle fattening.

Methodology: A series of research with cooked broken rice fermentation at different temperature (37, 28, 20°C), oxygen availability (aerobic and anaerobic), seasons (summer and winter), moisture level (1:1, 1:2), with or without bakery yeast (*Saccharomyces cerevisiae*) had been conducted in the Department of Animal Science Laboratory, Bangladesh Agricultural University. Samples were collected at different time intervals (6 hours intervals upto 48 hours) for physical (smell, texture and observation) and chemical (pH, CP and minerals) analyses.
Findings: Initial pH was 7.3 and it reduced to pH 5 and 4.49 at aerobic and anaerobic condition respectively after 24 hours fermentation at room temperature (28°C) in summer and it was decreased (pH 4.35) at incubation temperature (37°C). Addition of bakery yeast enhances the fermentation process. Initial CP was 6.2% and it increased with incubation time and addition of yeast (12.1%) and without yeast (10.2%) also. Better fermentation with good aroma was observed in anaerobic condition with the addition of bakery yeast for 12 hours. After 30 hours of fermentation in all conditions, the unpleasant smell started to develop, rice particle started to be fragile and produced gas at high amount both in aerobic and anaerobic conditions.
Conclusion: Considering the above parameters, anaerobic fermentation of cooked broken rice with 1:1 water level for 18 to 24 hours, we found the best results at summer temperature (28-37°C) and 24 to 30 hours at winter temperature (20-25°C). Although more analyses and feeding trial are required to know the changes of important minerals (Ca, P, Mg, K, Fe) and suitability of fermented rice for beef fattening.

Low Cost Feed for Ruminant by Ensiling Poultry Droppings, Sugarcane Bagasse and Molasses

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Abstract
An experiment was conducted with sugarcane bagasse (SCB) treated with poultry droppings (PD) and ensiled with molasses to increase the nutritional and preservation quality of sugarcane bagasse. Sugarcane bagasse was preserved in plastic container under airtight condition at room temperature based on the treatment T_0 (0% PD), T_1 (15% PD), T_2 (30% PD), T_3 (45% PD) with 5% molasses as dry matter basis in each treatment to investigate the physical quality, chemical composition, in vitro organic matter digestibility (IVOMD) and metabolizable energy (ME) content at 0, 30, 45 and 60 days. The physical quality (color, smell and hardiness) of sugarcane bagasse mixer were improved in poultry droppings added treatment till 60 days. The crude protein (CP) and ash were increased ($P<0.05$) and dry matter (DM), crude fiber (CF), and ether extract (EE) were decreased ($P<0.05$) in all treatments T_1, T_2, and T_3 compared to control T_0. The highest CP and ash content were found to be 8.47% and 15.46% in T_3 and highest DM, CF and EE content were found to 51.27%, 14.95% and 1.20% in T_3, respectively. The lowest CP and ash content were found to be 6.5% and 5.55% in T_0, respectively. The CP was increased decreased ($P<0.05$) and DM, CF and EE were decreased decreased ($P<0.05$) after ensiling. The EE contents were not significantly different decreased ($P<0.05$) between T_1 and T_2. The CF content was decreased ($P<0.05$) with the increase of poultry droppings and ensiling time. The highest OMD and ME content were found to be 54.89% and 7.89 MJ/Kg DM in T_3. Considering all the physical and chemical properties, among all the treatments, T_2 up to 45 days and T_3 up to 30 days were acceptable for preparing wastelage.

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Production of Bio-oil and Biochar from Poultry Manure: Development of a Sustainable Waste Management System

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Abstract
The present study was aimed to produce bio-oil and biochar from poultry manure and to evaluate its characteristics as soil amendment and bio fuel. For this reason, a reactor was designed for the pyrolysis of poultry litters at different operational conditions. Pyrolysis is an alternative solution to the management of large amounts of manure, while simultaneously producing bio-oil and biochar in the absence of oxygen at high temperatures (600 °C). A total of 496 g of biochar was produced from 1500 g of layer litter. An average, 33% biochar was produced that would be utilized as soil amendment. Gas produced during pyrolysis was converted into liquid through a condenser. About 100 ml of bio-oil was produced from 1500 g dry manure (12.5%). This bio-oil might be utilized as bio fuel. It may be concluded that poultry manure is a good source of biochar and bio-oil that might be helpful to increase soil fertility and for the supplementation of bio-energy.

Replacement of Wheat Bran by De-oiled Rice Bran on Growth Performance and Economic Feasibility of Rearing Native Sheep

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Abstract
This study examined the evaluation of the effects of dietary replacement of wheat bran with de-oiled rice bran on feed intake, digestibility and growth performance of native sheep in Bangladesh. Diet replacing 0, 25, 50, 100% wheat bran with de-oiled rice bran (T0, T1, T2, T3 respectively) were formulated and ad libitum green grass and water were also provided. Twelve 1st pair permanent native sheep were taken and divided into four group of treatments (T0, T1, T2, T3) for this feeding trial. Local sheep production survey was also conducted to understand the real scenario of sheep and its feeding system in Bangladesh. In case of feeding trial, after completion of adaptation period experiment was started with the designed feed formula of respective treatments. The results of survey data highlighted that 76% sheep in local were kept for meat purposes and 80% sheep were reared under semi-intensive production system. Only grazing was found in 17% sheep whereas 83% sheep were supplied concentrate along with grazing. In case of concentrate supplement, 77% farmers supplied 40-50 g concentrate per sheep per day. In local sheep the dressing percentage was 39.09±3.1% and crude protein was 19.35±1.85%. In case of the feeding trial, the growth performance was evaluated from the initial and final body weight of sheep. In 0% replacement of wheat bran (T0), the growth performance was the lowest. However, in T1 (25%) and T2 (50%), the growth was significantly higher (p<0.05) than other treatments. In feed cost analysis, 25% replacement of wheat bran with de-oiled rice bran reduce the amount of feed cost also. Therefore, it can be concluded that 25% replacement of wheat bran with de-oiled rice bran will reduce the feed cost and improve the growth performance of native sheep as well.

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Effect of Phytobiotics and Organic Acid Supplementation on Immune Response and Bone Mineralization in Broiler

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Abstract
The demand for broiler meat is increasing day by day. To meet up the increasing demand, farmers use different types of antibiotic growth promoter which enhance growth but make the birds susceptible to various diseases and create heath problem to human. Moreover, rapid growth of broiler has negative effect on bone and muscle formation which makes broiler meat tasteless. This study investigated the effects of phytobiotics and organic acids on production performance, immune response and bone mineralization in broiler. In total, 150-day-old chicks were randomly divided into five groups with three replications (10 birds in each replication). The first one is control group (T_0), second one was control + 1% dried Neem leaf powder (T_1), the third one was Control + 1% dried moringa leaf powder (T_2), the fourth one was control + 1% ascorbic acid (T_3) and the last one was Control + 1% citric acid (T_4). The energy and CP content of the control diet (C) were 3000 kcal/kg DM and 22% respectively. Rations were prepared and provided ad libitum to broilers for 28 days, and broiler blood samples were collected on the 28th day. Meat samples were also collected at 28th days of the feeding trial from each replication after slaughtering and stored for analysis. FCR was lower ($p < 0.05$) in T_2 group but energy and protein efficiency ratio was higher in T_1. Water holding capacity was significantly higher in T_1 than the others. In case of blood metabolites, cholesterol (74.18 mg/dl), urea (5.50 mg/dl) and uric acid (5.15 mg/dl) was lower ($p < 0.05$) in T_2. Calcium and phosphorus concentrations in blood were 8.61 mg/dl and 9.20 mg/dl in T_1 which were significantly higher than the other groups of broiler. Albumin and globulin content was maximum in T_1. Therefore, addition of phytobiotics such as dried Neem and Moringa leaf powder enhances broiler growth performance, reduces their blood cholesterol levels as well as increase immunity.

Influence of Phytogenic Supplements on Nutritional Status, Endocrine Profiles, and Meat Quality in Broiler

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Abstract
This research work has been designed to find the influence of plantain (*Plantago lanceolata*), moringa leaf (*Moringa oleifera*), and henna leaf (*Lawsonia inermis*) on nutritional status, endocrine profiles, and meat quality in the broiler. A total of 450 Cobb-500 commercial broiler chicks were divided into 5 treatments, each with 3 replications (30 birds). The basal diet was corn-soya with CP=23% and ME=3080 kcal/kg DM (**CON**). In addition to the basal diet, 10 gDM of plantain (**PL**), 10 gDM of moringa leaf (**ML**), 10 gDM of henna leaf (**HL**), and 10 gDM of commercial phytogenic vitamin C (**Pol-C**) was supplemented. The herbal-treated groups had 3–5% higher feed intake than the CON group. Herbs and Pol-C resulted in increased weight gain ($P<0.001$). Though the herbal supplemented groups had higher feed intake ($P=0.003$), the feed conversion ratio did not differ. In addition, serum triglyceride and VLDL concentrations were lower in herbal-treated groups compared to the CON group ($P<0.05$), but the higher concentrations were recorded in the Pol-C group. Furthermore, ML and HL diet groups exhibited lower abdominal fat than the CON group ($P<0.05$). Except for the ML diet

group, which had a similar dressing percent to the CON group, the herbal supplemented group had a higher dressing percentage (P<0.05). The meat fat content was substantially lower in all herbal supplemented groups compared to both Pol-C and CON groups. Moreover, the herbal supplementation improved meat sensory qualities, with the NL diet group exhibiting the best. Overall, all the tested herbal supplements could be used in broiler feed to increase growth, lean meat production, and improve the meat's sensory qualities.

Influence of Herbal Supplementation on Neurobiological Modulation and Cholesterol Biosynthesis in Indigenous Sheep

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Abstract

In present century, changing the dietary food pattern like taking less fiber in diet, feeding trans-fat, lower intake of vegetable and fruits are the most potent causes for developing chronic degenerative disease. Antioxidant rich foor could be a solution. Since antioxidant can scavenge free radicals and thus reducing its capacity to damage (Al-Mamun et al., 2007). Inclusion of bioactive components through forage herbs to diet could serve as antioxidant function in animal system and boost up the performance resulting safe and functional animal sourced food. Therefore, the present project aimed to determine the efficacy of plantain and garlic supplementation in neurobiological status of indigenous sheep, and to identify the correlation of cholesterol biosynthesis from plasma to mutton due to herbal supplementation. The animal trial has been performed using twenty-four indigenous sheep (*Ovis aries*) through a RBD design to investigate the effect of plantain (*Plantago lanceolata*), and garlic (*Allium sativum*) supplementation on neurobiological, and cholesterol biosynthesis modulation in sheep. The animals were offered a control diet comprising with total mixed ration of roadside grass plus concentrate mixture (CL-Diet), and then the CL-Diet will be supplemented with plantain herb at 10 g DM/d (PL-diet), garlic 10 g DM/d (GL-diet), plantain and garlic mix 10 (5+5) g DM/d (PG-diet). Blood samples (5 ml) were taken once a week from the jagular vein without any noticeable stress during the last 30 days. Blood samples were centrifuged at 10,000 ×g for 10 min at 2^{o}C (RS-18 IV, Tomy, Tokyo, Japan), and stored at -30 ^{o}C awaiting further analysis. We are in the second half of the project period and hopefully the project will end with potentially a new feeding strategy using bioactive components of plantain and garlic herbs leading to improvement of low cholesterol and functional mutton production.

Quantification of Bioactive Components of Locally Potential Herbs for the Safe, Sustainable and Antioxidants Enriched Dairy Production

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Abstract

Research was undertaken to investigate the phytochemicals and specific bioactive component of some locally available medicinal herbs in Bangladesh. Initially, eleven medical herbs were cultivated. The phytochemical and antioxidant status of these herbs were then determined using thin layer chromatography and DPPH (2, 2- diphynyle-1-picryl hydrazyl), respectively. Seven herbs were chosen

based on TLC and DPPH results for total phenolic and flavonoids content determination in different forms (freeze, shade, and sun dried), with Vit-C quantified in fresh form. Then only six herbs with potential as dairy animal feed were chosen, and their Vit-E and bioactive components were quantified by HPLC and GC-MS. Furthermore, kaempferol and myrecytin in moringa, gallic acid and caffeic acid in pineapple peels and leaves, alkaloids and saponins in ivy-gourd, and rutin and caffeic acid in spearmint, as well as allicin and rutin in garlic leaves and limonene and citral in lemongrass herbs was determined. These herbs (ivy-gourd and pineapple waste) were chosen for their phytochemical profiles (antioxidants), bioactive components (specific bioactive components), mineral content (available minerals), biomass yield (cost-effectiveness) and availability. In order to get more bioactive components and antioxidants from the herbs, and to make the technology viable and sustainable for farmers, shade dried was chosen. Forage herbs (pineapple peels, moringa leaves, lemongrass and ivy gourd vines and leaves) were mixed to find the optimal threshold level for increasing milk production and milk antioxidant levels in dairy cows. A feeding trial using 20 mid-lactating cows (4 groups; 5 cows/group) was performed. The HPM improved digestibility and milk yield. This HPM increased antioxidant levels in both blood and milk of dairy cows. The HPM supplementation improved the unsaturated fatty acids level in HPM groups compared to HPM0 (Control). This new herbal technology (HPM) might be used for quantitative and qualitative improvement of milk.

Effect of Herbal Supplementation on Growth, Immunity, Rumen Histology, Serum Antioxidants and Meat Quality of Sheep

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Abstract

The present study was designed to investigate the effect of plantain (*Plantago lanceolata* L.) and/or garlic leaf (*Allium sativum*) dietary supplementation on growth, plasma metabolites, serum antioxidants, and mutton quality of sheep. The experiment consisted of a completely randomized design with 32 one-year-old sheep (initial mean live weight 9 ± 0.2 kg) allocated to four groups (eight sheep per group). Rice straw and concentrates based pelleted total mixed ration (TMR) (ME = 2390 kcal/kg DM, CP = 15.1%) were offered as a control diet (CL-diet). Herbal treatment diets included (i) CL diet + 10 g DM/ day/sheep of plantain herb (PL-diet); (ii) CL diet + 10 g DM/ day/sheep of garlic leaf (GL-diet); and (iii) CL diet + 5 g DM/ day/sheep of plantain herb and 5 g DM/day/sheep of garlic leaf (PG-diet). The tocopherol content of plantain and garlic leaves was 7.2 mg/g and 1.7 mg/g, respectively. The specific bioactive components acteoside and allin were quantified using the HPLC in plantain and garlic leaves, respectively. Compared with the CL-diet group, the live weight gain and feed conversion ratio were 18–26% and 13–20% higher in herbal-supplemented groups, respectively. Additionally, the herbal–supplemented groups, particularly the PG-diet group, had significantly higher serum plasma metabolites and antioxidant capacity than the control group. Additionally, the PL-diet group had the lowest caul fat and pelvic fat levels, followed by the PG-diet, GL-diet, and CL-diet groups. Additionally, all herbal supplemented groups had lower saturated fatty acid levels and higher polyunsaturated fatty acid levels. Additionally, the PL-diet was found to be the most profitable, followed by the PG-diet, GL-diet, and CL-diet groups. In conclusion, dietary supplementation with plantain and/or garlic leaf may be used to promote growth, health, and lean mutton production in sheep.

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Response of Dried Moringa Leaves Supplementation on Nutrient Digestibility, Serum Lipid Status and Milk Yield in Dairy Cows

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Abstract
The focus of this research was to determine the optimal dose of dried moringa leaves (dML) to improve digestibility, serum lipid profile, urea nitrogen concentration, and milk production in dairy cattle. A total of 12 cows were divided into 4 dietary groups (3 cows/group) for a period of 45 days. Total mixed ration (TMR) without dried moringa supplementation (ML0) was considered as the control group. Moringa supplemented groups were ML50 (TMR + 50 gdML), ML100 (TMR + 100 g dML), and ML150 (TMR + 150g dML). The quercetin equivalent in dML was 4.78mg/gram. Supplementation of dML had a significant impact on the nutrient digestibility of dairy cows. Compared to ML50 and ML0, the ML100 and ML150 groups increased crude protein digestibility in dairy cows ($P<0.05$). The digestibility of NDF and ADF improved in ML50, ML100, and ML150 groups compared to ML0. The ML100, ML150, and ML50 groups had significantly lower serum triglyceride and total cholesterol levels than ML0. Various levels of dML supplementation had a significant effect on serum HDL-C, LDL-C, and urea nitrogen in dairy cows ($P<0.05$). The addition of dML had no effect on dry matter consumption or milk yield, milk total solids, protein, and fat percentage but with increasing level of dML showed the raising trend, compared to ML0. The energy corrected milk and fat corrected milk were higher in the ML100, ML150, and ML50 groups compared to ML0 ($P<0.05$). Overall, adding dried moringa leaves improved nutrient digestibility, reduced bad cholesterol levels, increased milk yield, and increased energy and fat corrected milk yield in dairy cows.

Potentiality and Validation of Forage Herbs as Green Additive to Livestock Feed for the Production of Safe, Functional and Sustainable Meat, Egg and Milk Production

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Abstract
Feed grade antibiotics had been a common practice in animal feed industry over the past 4-5 decades. However, due to ban of feed grade antibiotic use by European Union since 2006, the use of medicinal herbs got much attention by the scientists. Therefore, the current project was designed to screen polyphenolic components of some locally available medicinal forage herbs by TLC, and specific bioactive components were quantified using HPLC, GC-MS. Then *in-vivo* animal trails using dairy cows, sheep, broiler, and layer were performed to investigate herbs(s) impacts, correct threshold level and finally used mouse model to know the effect in human. Sheep feeding trial was performed using plantain and garlic leaves and investigated growth performance, serum lipid profiles, antioxidants and immune status, meat quality and carcass characteristic. Broiler feeding trial was performed using plantain, spearmint, garlic and ivy-gourd mixed powder and studied production performance, meat chemistry, and shank mineralization and found improved meat quality, bone metabolism without compromising feed conversion efficiency. Then the same herbs mixed powder was used in a layer

feeding trial and found increased of egg production, and egg external and internal quality. A dairy cattle trial was performed using crossbred cows supplemented with plantain and lemongrass powder to assess production performance. Greatest concentration of milk polyunsaturated fatty acids including ω-3 fatty acid were obtained in plantain compared to lemongrass and then control. A mouse model was performed using plantain and synthetic acteoside using albino mouse (*Mus musculus*) model. Plant bioactive components acteoside positively improved the serum antioxidant status, liver enzymatic activity and liver health. The health of gastrointestinal tract was improved in mouse by herbal bioactive components. That assure that the meat, milk and egg produced using herbs like plantain is safe for human consumption.

Ensiling Cabbage with Tomato During Last Season of their Production for Feeding Livestock

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Abstract
Considering low price of white cabbage (*Brassica oleracea*) and tomato (*Solanum lycopersicum*) during last part of the season and possibility to use as feed for cattle and to reduce wastage of those vegetables a study was conducted on its productivity, biomass and nutrient yield and ensiling as feed for livestock. Initially several cabbage and tomato farmers had selected and survey was conducted on cultivation and yield as well as economics of its production in different phases of the season. Data was collected during initial, middle and later stage of the season. Furthermore those were ensiled with rice straw in polythene bag for three weeks. Six different type of ensiling practiced like - 1(24.0kg straw+6.0kg cabbage), 2(18.0kg straw+12.0kg cabbage), 3(12.0kg straw+18.0kg cabbage), 4(24.0kg straw+3.0kg cabbage+3.0kg tomato), 5(18.0kg straw+6.0kg cabbage+6.0kg tomato), 6(12.0kg straw+9.0kg cabbage+9.0kg tomato). It was observed that the biomass and nutrient yield was higher during later stage of production. pH of group 3(12.0kg straw+18.0kg cabbage) and 6(12.0kg straw+9.0kg cabbage+9.0kg tomato) reduced gradually till 21 days. Day 21 it was 4.96 and 4.10 respectively which indicated good quality silage. Crude protein content was 8.06 and 10.31 in 3 and 6 respectively. The result also reflected that both cases the ratio of straw was similar which is related to moisture content (76.6% in group 3 and 75.56% in group 6) for good quality silage. Further addition of tomato enhances reduction of pH of silage in group 6 than 3. Considering the pH value group 3 and 6 identified good quality silage and was offered to the cattle and found tomato added silage (6) was mostly accepted by the cattle. So it would be concluded that ensiling cabbage and tomato with rice straw maintaining proper ratio (12:9:9) would be a good feed source for livestock and would be useful during scarcity for economic livestock production.

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Production of Fermented Rice Bran as Value Added Feed Ingredient for Poultry

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Abstract
Fermentation of rice bran by yeast (*Saccharomyces cerevisiae*) would improve the nutritive value, so it was fermentation in different level of moisture (0, 30, 40, 50 and 60%) and urea (1.0, 2.0, 3.0%). After fermentation the rice bran was dried under sun light. Then a feeding trail was conducted for a period of 42 days with a number of 240 day old straight run broiler chicks (Cobb 500). Fermented groups were; 1. Unfermented Rice bran (control); 2. yeast fermented Rice bran; 3. yeast fermented Rice bran+0.5% citric acid; 4. Yeast fermented Rice bran+2%urea; 5. yeast fermented Rice bran+2%urea+0.5%citric acid. At the end of the trial few birds were slaughtered for determination of carcass traits. Blood sample were collected to know some blood parameters and antibody titre against vaccines. The details histological study was done of some organs as innate immunity using a light microscope. Fermentation of rice bran showed that the increased moisture level till 50% increased fermentation and lowers the pH up to 5.6. Normally broiler birds are rearing till 28 days of farming. But in this case it was reared till 42 days only to see the antibody titre against ND cvaccine and IBD vaccine. When urea was added (group 4) the final body weight was higher than further addition of citric acid (group 5). Only fermented group (group 2) found better than fermented with citric acid group (group 3). In general the entire fermented groups showed better live weight gain than control except urea and citric acid added simultaneously. Fermented along with urea and addition of citric acid decrease feed intake than other groups. Again FCR found higher (1.91) in urea and citric acid group than others groups (1.84, 1.74, 1.72, 1.73 in 1, 2, 3 and 4 respectively). In general only fermented, addition of citric acid in fermented, urea fermented citric acid found similar FCR but better than control. When urea added fermented rice bran further supplemented by citric acid showed significantly higher FCR. As per weight of spleen and bursa it observed that all the fermented groups showed better innate immunity than control. Feeding trial shows that considering all aspect fermentation of rice bran improve live weight gain, feed intake and feed conversion ratio, except when added citric acid and urea simultaneously in diet of broiler. Non specific immunity increased when offered fermented rice bran in broiler diet.

Use of Buckwheat *(Fagopyrum Esculentum*) as a Natural Source of Phytase in Chicken Diet

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Abstract
Phytase can improve the digestibility of phytate phosphorus in chicken, as well as reduce the negative impact of inorganic phosphorus excretion to the environment. Addition of phytase rich cereals in chicken diet is getting positive approach in recent research. In current study, effect of Buckwheat (*Fagopyrum esculentum*), a phytase rich pseudocereal was studied; *in-vitro* study results proved that buckwheat possessed high phytase activity and germination process further increased this activity. Therefore, buckwheat seemed to be effective to use as a source of phytase in chicken diet, however an *in vivo* study is essential to ratify the above mentioned points. So, a feeding trial was conducted where a total of one hundred and five one-day-old Indian River broiler chicks were allotted to one of five

dietary groups with three replicates in each, and were fed experimental diets from 3-35 d of age. Diets included a positive control (PC) contained 0.46% available phosphorus, negative control (NC) diet was based on PC diet with reduced level of available phosphorus (0.25%), NC diet with commercial phytase I (*Aspergillus niger* derived), NC diet with phytase II (*Escherichia Coli* derived), and NC diet with germinated buckwheat where 20% buckwheat was added at the expense of maize. Results clarified that, body weight gain, feed intake and feed conversion ratio in birds fed buckwheat added diet was comparable to birds fed PC and commercial phytase added diets. Tibia ash and phosphorus contents in birds fed phytase II or buckwheat added diets were comparable to birds fed PC diet. In addition, percent of phosphorus retention was increased (P<0.05) in birds fed NC diet with buckwheat compared to birds fed only NC diet, and phytase fed birds showed similar trend. In conclusion, there is a promising prospect to use germinated buckwheat as a natural source of phytase in chicken diet.

Effect of Day-Old Body Weight on Productive Performance and Carcass Characteristics of Commercial Broiler

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Abstract

The objective of this study was to investigate the effect of day-old chick weight on subsequent growth, feed efficiency, uniformity and carcass characteristics of broiler chickens. A total number of 500 Arbor Acres broiler chicks were randomly allocated for four treatment groups based on their initial body weight (37g, 38g, 39g and 40g namely T1, T2, T3 and T4 respectively). There were five replications in each treatment and 25 birds per replication and the birds were reared until 35 days of age. Feed was supplied as *ad-libitum* basis and other management was almost similar for all treatment groups. Feed intake, body weight gain, and final body weight, feed efficiency (FCR), carcass parameters were recorded during the trial period. The results of the study revealed that the productive performances were not statistically different among treatment groups but a positive effect of initial body weight on the future performance was observed. The highest final body weight was found in the 38g DOC weight groups (2300g) followed by 39g (2259g), 37g (2230g) and 40g (2226g) DOC weight group. On the other hand, FCR was found to the best in 40g DOC weight group (1.50) followed by 38g (1.52), 37g (1.54) and 39g (1.58) body weight groups respectively. Interestingly, the 39g DOC weight group consumed highest amount of feed (3516g) followed by 38g (3444g), 37g (3381g) and 40g (3287g) treated groups. In the same time, 38g DOC weight group showed better performance in the carcass characteristics than the other initial body weight groups. Taken together, it may be concluded that, initial body of broiler chicks have positive effect on the final body weight and other productive performance of commercial broilers.

Development of Digital Poultry Feed Formulation Package for Small-Scale Producers Based on Their Need Analysis

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Abstract

A total 60 feed millers and/or poultry farmer-cum-feed millers in 12 districts of Bangladesh under different geographic zones were interviewed to assess their current feed milling practices, problems

and scopes for further improvement through integration on digital support in a cost-effective and user friendly manner. The quality and market dynamics of feed ingredients and finished feeds, and feed miller's knowledge and attitude on scientific and safe feed production were critically studied through face-to-face survey and spot visiting using a pre-tested questionnaire with open and closed type questions. During survey, a total of 250 individual feed ingredient samples under different categories like, energy source, protein source, mineral source, and additive sources were collected from the small-scale feed miller's and/or poultry farmer-cum-feed millers houses and feed ingredients seller's shops. The samples were assessed for physical and chemical composition, particularly for the proximate composition, metabolizable energy content, and calcium and phosphorous contents. Each ingredient was classed into several grades based on an innovative combined nutrients score concept those were identifiable in pictures. The results obtained from field activity and laboratory works indicated that every single feed ingredient used by the small-scale poultry feed mills were of several physical and chemical grades depending on their combined nutrients content score. The knowledge of the feed millers were deficient of scientific ration formulation, and analytical techniques and facilities. The findings suggested that the digitally accessible least cost feed formulation software embedded with combined nutrient score-dependent digital pictographic library of the ingredients may helpful for cheaper and efficient poultry feed production. Following this need analysis, a user friendly and digitally accessible least cost feed formulation package has been developed under this study which is usable both at off- and on-line.

Newly Developed Poultry Feed Additive Mixtures of Local Origin Can Enhance the Older Hen Performance in Bangladesh

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Abstract

This study was conducted to test the effects of two novel feed additive mixtures of local origin on older hen's performance. The additive mixtures were of feed-supplement (Feed-Mix) and water supplement (Water-Mix) types. The Feed-Mix type was prepared from a logical assortment of 14 additives those are locally available and already have been proven for their beneficial effects on bird's physiology, production and reproduction. The Water-Mix mixture was made from an aerobic fermentation product/ by-product of organic acid, sugar, fats and non-pathogenic bacteria. The Feed-Mix type one was supplied to 64 hens through mash feed at a rate of 0%, 0.5% and 1% during 81-93 weeks of age, while the Water-Mix one was fed via drinking water to another 64 hens at a rate of 0, 10, and 20 ml/ litter water during 81-122 weeks of age. In both cases, the effects of the novel additive mixtures were monitored on survivability, feed intake, body weight, egg production, egg quality parameters and reproductive organ status. The data collected under this experiment were tested by t-test and one-way ANOVA using the Minitab 2017. Results indicated that either of the novel additive mixtures were not harmful to the hen's body maintenance. The 1% Feed-Mix one increased feed intake, and maintained a comparable feed conversion rate (FCR) and egg weight and a trend of longer production life, larger yolk, higher albumen index and higher Haugh Unit values with thicker and heavier egg shells. The Water-Mix one resulted significantly ($P<0.01$) higher number of heavier eggs along with thicker shell of desired colour, shape and strength. The Feed-Mix one accounted approximately 0.5 Tk/bird/day additional cost, while it was 0.20 Tk/bird/day for the Water-Mix ones. In terms of benefit-cost ratio, convenience of preparation and length of increased productive life, the Water-Mix one was relatively better. However, the food safety issue of the eggs and meat of the experimental birds are need to be investigated before recommending these additive mixtures at field level.

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Construction of Recombinant Plasmid Encoding Short Peptide for Poultry

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Abstract

Bioactive peptides can be defined as small fragments of proteins which often provide some physiological benefits to the organisms. They act as a potential modifiers in different metabolic pathways. Thus, these peptides play a major role in the development of various functional foods. Amino acids are organic compounds that combine to form peptide and proteins. Amino acids and proteins are the building blocks of life. Like other mono-gastric animals, poultry birds cannot synthesize all the amino acids within their body. Therefore, several amino acids such as lysine, methionine, threonine and tryptophan must be supplied in their diet for optimum growth and production. Bangladesh poultry industry is exclusively depended on the imported synthetic amino acids and every year we are spending substantial amount of foreign currency for importing feed grade amino acids mainly for commercial poultry. In this study, we were employed rDNA technology to construct recombinant plasmid vector containing $(ATG\text{-}AAG\text{-}ACC\text{-}TGG)_{5\text{-}8}$-TAG DNA sequence for the synthesis of methionine-lysine-tryptophan polymer. We have constructed four rDNAs containing different combination of methionine-lysine-tryptophan monomer and cloned into PGEM-T vectors. Transfection of the vectors into BL21 cells and characterization of these synthetic constructs by SDS (sodium dodecyl sulfate) and Native poly acrylamide gel electrophoresis confirmed the expression of desired short peptides. Structural analysis suggests that three (*pbgl_01*, *pbgl_02* and *pbgl_05)* of them has potential for expression in yeast expression system. Finally, we have successfully cloned three of these constructs into pPlinkα-HC vector and expressed desired short peptides in the yeast based expression system. Further *in vivo* feeding trial with these newly developed short peptides might shed light on the usability of short peptides for poultry.

Screening and Characterization of Health Promoting Lactic Acid Bacteria From the Available Fermented Milk in The Market of Bangladesh

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Abstract

The experiment was conducted to study the microbiological and molecular identification and characterization of lactic acid bacteria (LAB) from the available fermented milk in the market of Bangladesh. Four areas in Mymensingh district were selected for the collection of fermented dairy products samples that were produced by using lactic acid bacterial starter designated as "A" (BAU University Campus), "B" (Mymensing city-Notun Bazar), "C" (Mymensingh city-town hall) and "D" (Trishal). A total of 16 samples were collected from different producers from those areas. The chemical analysis were done by AOAC procedure (AOAC, 1995). The isolated strains were identified at species level on basis of their physiological and biochemical characteristics. Microbial parameters (viable bacteria, yeast and mold counts) were determined by the standard plate count method according to APHA, (1983). The results of chemical analyses (pH, acidity, moisture, fat, total solids and ash) and

microbial analysis (yeast count) were differed significantly. But the protein, sugar content and viable bacteria and mold content were non-significantly differed. The isolated LAB was identified to the genus level on basis of their morphological characteristics, gas production from glucose, and lactic acid isomer produced. Of the 82 isolated strains, genus *Streptococcus* (15%), *Lactobacillus* (65%), *Leuconostoc* (3%), *Lactococcus* (15%) and *Pediococcus* (2%). Therefore, it is evident that there are diverse varieties of organisms are found in fermented dairy products available at Bangladesh.

Screening and Characterization of Health Promoting Lactic Acid Bacteria from the Available Fermented Milk in the Market of Bangladesh: An Approach Against the Inappropriate Labeling of the Products with Possible Implications in Human Health

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Abstract
The study was focused on isolation of culture bacteria from cheese sample available at local market of Bangladesh. A total of 10 isolates were isolated from 3 samples collected from local available markets in Mymensingh. These bacterial isolates were identified using the morphological, physiological and biochemical characteristics, the ability to ferment sugar. The identified isolates were small, medium and very few were large. Most of the isolates were round in shape and some were elongated. Their colors were creamy and white and their elevation was convex, raised and flat. The isolated isolates were observed in MRS solid medium. The physiological and biochemical characteristics of isolated isolates were done by salt tolerance test, P^H tolerance test, ammonia production test, carbohydrates fermentation test.The isolated strain was shared by cocci. The dominant bacteria were *Lactococcus lactis* subsp. *lactis* and *Lactococcus raffinolactis*. Catalase activity, microscopy, growing at 4^0C, 10^0C and 45°C and in the presence of 4, 6.5, 18% of NaCl were used for phenotypical characterization of isolates. By phenotypical characterization 10 isolates represented *Lactococcus* profile. The results of the present study suggest that *Lactococcus* is the widespread in the flora of cheeses and would have important role in the formation of desired flavour and textural properties

Designing a Sustainable Feeding Strategy for Dairy Cow Production in Bangladesh - Importance of Roughage Variation

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Abstract
A KGF funded research project was planned to find out the best suited roughage and concentrate combination for dairy cow in Bangladesh based on nutritional status, growth, milk production and composition, lactation persistency of the cows and farm economics. Total three feeding trial will be conducted at Dairy Farm, Department of Dairy Science, Bangladesh Agricultural University, Mymensingh in replicated Latin square design during the three year time period of the project. During the first year (current year) of the study, variation will exist among the types of roughage and concentrate mixture will remain fixed to the all dietary groups (4 groups, containing 3 animal in each).

First feeding trial has been started and we have already got the data of Napier group and German group and we will get the next two data (Maize and Rice straw) after completion of the first trial. Results revealed that body weight (301 – 306 kg/cow) and body condition scores (3.16 – 3.25) differs non-significantly ($p>0.05$) between the group. Similarly, av. daily milk yield (7.36 vs 4.07, L), morning milk yield (301 vs 261, d), and evening milk yield (2244 vs 1172, L) was varied non-significantly between the dietary groups. All the milk quality attributes were found similar between the groups ($p>0.05$) and the fat and solids-not-fat (SNF) content of the milk were ranges from 35 – 36 g/kg in morning milk and 49-52 g/kg in evening milk and 75 – 76 g/kg in morning milk and 76-77 g/kg in evening milk, respectively. In addition, whole blood β-hydroxybutyrate value was found below 1.0 mmole/L. In addition, glucose, triglycerides, total protein, albumin, blood urea (BU), calcium and inorganic phosphorus will be estimated and Benefit cost analysis of ration will be calculated considering all the input and outputs.

Nitrogen Distribution Based Screening of Adulterated and Reconstituted Market Milk Made from Poor Quality Powdered Milk

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Abstract

The current research looked at the feasibility of employing the nitrogen distribution pattern of reconstituted powdered milk as a method for detecting market milk adulteration. Bangladesh Agricultural University Dairy Farm, Mymensingh-2202, Bangladesh was the known source of raw milk. Market milk, low quality powder milk, local brand powder milk were collected from local markets of Mymensingh municipality area. The known source raw milk was adulterated with reconstituted milk made from low quality powder milk in 75:25 and 50:50 ratio at laboratory. All the samples [(i) T1, milk from known source (control); (ii) T2, reconstituted low quality powder milk; (iii) T3, reconstituted local brand powder milk; (iv) T4, market milk collected from goala; (v) T5, mixture of 75% control and 25% reconstituted low quality powder milk; and (vi) T6, mixture of 50% control and 50% reconstituted low quality powder milk] were tested for their gross composition as well as for their protein distribution pattern (nitrogen fractions). Statistical analysis showed significant variation ($p<0.05$) among the groups for their specific gravity, acidity, total solids, ash, milk fat, lactose and total protein contents. Reconstituted low quality powder milk (T2) and raw milk adulterated with reconstituted low quality powder milk (T6) ranked 1st and 2nd, respectively from the bottom line for total protein content ($p<0.05$). Again, the casein protein content of T2 and T6 was much lower ($p<0.05$) than the normal average value. The non-casein nitrogen (NCN) contents exhibited by all the samples were close to the normal reference range although the groups differed significantly ($p<0.05$). Similarly, all groups showed similar non-protein nitrogen (NPN) content ($p>0.05$) except T1 group that contained slightly higher ($p<0.05$) NPN content than other groups.

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Refining and Validation Trial on Milk Replacer for Raising Dairy Calves

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Abstract
The present research project was carried out to evaluate the feasibility of using milk replacer for raising dairy calves. This was a validation trial of previously prepared milk replacer from another research project. Milk replacer (MR) having 22% CP and 10% fat was prepared by using locally available feed ingredients (soy flour, whey powder, skim milk powder, vitamin mineral premix and rock salt). For feeding trial fifteen crossbred dairy calves aged ranged from 3 to 6 weeks were selected from BAU Dairy Farm and divided in to five nearly similar groups (T_1, T_2, T_3 T_4 and $T_{5)}$ depending on the body weight of calves. Milk replacer was compared with whole milk (WM) and it was fed to calves of different groups alone or by mixing with whole milk in different proportions. Calves on T_1, T_2, T_3 T_4 and T_5 group was given 100% MR, 75% MR +25% WM, 50% MR + 50% WM, 25% MR + 75% WM and 100% WM respectively. In addition, calves of all five treatment groups were give 0.5 kg calf starter per calf per day and good quality green grass ad libitum. Parameters used to monitor the quality of milk replacer were growth related (changes in body weight, body length, heart girth and wither height) and blood metabolic profiles (serum urea, blood urea nitrogen, serum glucose, serum albumin, inorganic calcium, inorganic phosphorus, hemoglobin and packed cell volume). It was observed that weekly body weight gain in calves of T_1, T_2, T_3 T_4 and T_5 groups were 2.190 ± 0.170, 2.293 ± 0.10, 2.255 ± 0.170, 2.266 ± 0.170 and 2.870 ± 0.170 kg respectively. Statistically there was no significant difference ($p>0.05$) in body weight gain of different groups. Results of other growth parameters e.g. body length, heart girth and wither height showed similar trends. Values of all blood parameters were within normal range and did not differ significantly except for serum albumin which differ significantly ($p< 0.05$). Prepared milk replacer was cheaper than whole milk. Finally, judging from all parameters studied it could be concluded that milk replacer could be used successfully to raise dairy calves as it is cheap, However, a combination of 50% MR + 50% WM would be a good choice for farmers which will perform nearly similar to 100% whole milk feeding and farmers would be able to reduce rearing cost by about 25 to 30%.

Effect of Corn Starch and Flavouring on the Quality of Stirred Yogurt

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Abstract
The research was conducted at the laboratory of the Department of Dairy Science, Bangladesh Agricultural University, Mymensingh to invent a cost effective technology for the preparation of flavored stirred yogurt. Whole milk was collected from different dairy farms at Mymensingh, and milk powder was purchased from the Bangladesh Milk Producers Cooperative Union Ltd. (Milk Vita). Yogurt starter culture was collected from Christian Hansen, Denmark. Yogurt prepared from different proportions of whole and milk powder (100% whole milk, 100% milk powder, 95:5 whole milk and milk powder) were flavoured with vanilla essence, mango essence and strawberry essence along with suitable colour. All the samples were tested for organoleptic quality, and also for various

compositional parameters. Yogurt from milk powder was lower ($P < 0.01$) in flavour, body and texture, and total score than those prepared from a combination of powdered milk and whole milk and exclusively whole milk. However, all the products were similar in colour and appearance, and sweetness. On the other hand, yogurt prepared from a combination of powdered milk and whole milk was superior ($P < 0.05$) in contents (g/kg) for total solids, fat and protein to other types, but all the products were statistically identical in sugar and ash contents. Strawberry flavoured yogurt was found to be significantly ($P < 0.01$) better as compared to other two types. The yield of yogurt from whole milk with milk powder supplement was significantly better ($P < 0.05$), and hence its benefit-cost ratio (BCR) as well as the profitability was also high. Considering all the parameters it could be concluded that strawberry flavoured yogurt prepared from whole milk with 5% milk powder supplement was better than other types. In order to prevent syneresis, it is advisable to mix 1% corn flour to the whole milk while making stirred yogurt.

Refining and Validation Trial on Milk Replacer for Raising Dairy Calves

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Abstract

The study was conducted to determine the effect of feeding milk replacer (MR) on growth performance, nutritional status and cost of liquid feeding of crossbred dairy calves. Fifteen selected crossbred dairy calves (38.93±0.93) were assigned in a completely randomized design as 5 treatments (T1=100% MR; T2=75% MR + 25% whole milk (WM); T3=50% MR + 50% WM; T4=25% MR + 75% WM; and T5=100% WM) offered at 2 kg/h/d. During the 56-d of experiment, growth parameters were measured in every 7-days interval and blood samples were analyzed at 0, 21, 42, and 56-day. All the groups showed similar ($p>0.05$) body weight gain (BWG), body length gain, and blood metabolites content (serum glucose, total urea, blood urea nitrogen, calcium, and phosphorus) except albumin. Contrarily, wither height gain, and heart girth gain were greater ($p<0.05$) in T5 than in T1 group. Serum albumin content was lower ($p<0.05$) in T2 than in T5 group. The cost of liquid feed/kg BWG was higher ($p<0.01$) in T5 group followed by T4, T3, T2, and T1 groups. The results were further supported by a 56-day on-farm trial where 9 crossbred dairy calves (32.211±1.09) were assigned to three groups (M3=calves got the usual ration supplied in the farm; M2=supplemented with 1 kg MR; and M1=supplemented 2 kg MR daily). BWG of the calves was recorded in every 7-day intervals whereas blood metabolites were analyzed in 28-day intervals. BWG in M1 was higher ($p<0.05$) than in M3 while all the blood metabolites level was similar ($p>0.05$) among the groups. Results revealed that feeding MR at up to 75% of the WM diet maintained similar growth performance, and nutritional /status of crossbred dairy calves. Moreover, liquid feed related raising cost dropped by about 40%. Results introduced MR as an economic partial substitute for WM in calf-raising facilities.

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Overview of Energy System for Crop Irrigation in Bangladesh: A Study on Techno-economic Feasibility

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Abstract
Bangladesh agriculture particularly the boro season crops is highly depends on irrigation systems which is energy dependent. Irrigation systems mostly dominated by diesel operated system followed by electricity operated system. However, under the changing climate, increase in diesel price and non-availability of electricity, renewable energy based irrigation system is expanding throughout the country. Solar irrigation may be used for irrigating the marginal lands to enhance crop production and to increase cropping intensity. Therefore, for large scale adoption, diffusion and sustainability it is very important to examining the prospects of adopting solar irrigation system and its feasibility compare to other systems. Since the technology is new and very few studies are conducted, it is necessary to analyze feasibility, factors affecting adoption and its various impact which will help to understand the prospect of this technology and what should be done for large scale adoption diffusion in Bangladesh. To achieve the objectives, the study uses primary farm household survey data collected through structured questionnaires. Data were collected from different irrigation systems owner as well as users from western and norther regions of Bangladesh. Preliminary results shows that there are number of stakeholders involved in Solar irrigation (e.g. IDCOL, BADC, BMDA, NGOs, Private Companies, DAE, Bangladesh Rural Electrification Board, etc.) and their terms and conditions are also different. Both ground water and surface water are used for solar irrigation and mostly operated through group approach than individual. Most notably, highly subsidized, solar irrigation is only competitive and feasible with diesel operated irrigation but not with electricity operated systems.

Economics Analysis of Community-Based Seaweed Production in the Coastal Areas of Bangladesh

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Abstract
Seaweeds are increasingly seen as a potential component for blue economy growth. It is alternative to land-based products in food, feed and medicinal applications. Production of seaweeds in coastal waters is rising which in turn an additional activities to the offshore fishing as complied by the local community. This study attempts an investigation of the economic feasibility of seaweed production in the Bay of Bengal using economic modelling. Often, an overly positive picture of the profit of seaweed production is sketched. However, based on the available information, the coastal area of Cox's Bazer is found feasible for offshore seaweed production under the community management. A survey has been carried out on 100 seaweed farmer using purposive random sampling method. The farmer's opinion revealed that the technology of seaweed cultivation is simple and needs relatively low initial investments. The results showed that for only 4 weeks cultivation cycle, with an initial investment of 38,400 BDT (plot size of 10 decimal), the estimated net profit was 193,956 BDT per unit. Overall, a positive picture of the seaweed production is obtained. However, the research also identified few challenges to commercial seaweed cultivation in Bangladesh where the major challenge is fragile market. Nevertheless, despite of the challenges identified, seaweed would open a new avenue for blue

economy-based GDP and can be a sector of sustainable trade potentials in future. Introduction of technical innovation and the design of scientific production systems enable multiple harvests which eventually reduce the production costs. Furthermore, successful marketing of the product as food, feed, medicine and the development of bio-refinery theories can increase the value of the produced seaweed in the days to come.

Analysis of Agricultural Policy on Food System and Rural Development in Bangladesh: Case of Haor Area (Wetland) Management Practice

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Abstract

Agricultural production in Bangladesh is characterized by subsistence orientation, low productivity, low level of technology and inputs, lack of infrastructures and market institutions, and extremely vulnerable to farm income variability. It has a rapidly increasing population currently close to 174 million and yet about 24 percent of the population lives on absolute poverty. The government of Bangladesh has formulated policies and strategies to guide over all development with focus to rural and agricultural development. The government has approved the National Agriculture Police 2018 with a view to achieving sustainable food and nutrition security through efficient utilization of the natural resources. The new agriculture policy has given emphasis on investment including quality seed production, fertilizer and irrigation management, bio-technology, farm mechanization, agriculture cooperative and marketing, women empowerment in agriculture, natural resource management, specialized agriculture, regional special agriculture, involvement of the youth force, agriculture rehabilitation, agriculture afforestation, safe and nutritious food production, use of information and communication technology. This new agriculture policy has addressed new issues and concerns for sustainable food production.This research was conducted in *haor* communities of 7 districts, in the Grater Sylhet and Mymensingh region where development intervention has been introduced at a massive-scale aiming at achieving food security and poverty alleviation among the rural poor. The research has initiated to investigate the impact of policy interventions on capacity of smallholders in the case of household. The main goal of the research was how, the policy interventions were dominated by top-down approaches reflected in rural development processes in wetland. Data were collected using both quantitative and qualitative methods which incorporated structured interviews, focus group discussions (FGD) and a new method of participatory policy evaluation technique merging of knowledge (MoK). A mixed methodology of research is applied to analyze the panel data collected through field surveys. The results demonstrate that the incidence of agricultural policy interventions on household poverty reduce 11.54 percent significantly. The estimated effects of intervention on household income were found 78,445 BDT per year. While the employment contributions increase 9 units and the labor productivity increases 59 BDT per years by successive agricultural intervention. The selected household income is highly influenced by public investment in rural infrastructure. The rural development dynamics reveal that the exposure of resource pauperization to poverty has increased overtime in the *Haor* area. The flood control, roads and communications, mechanizations in agriculture, tourism and sand stone exploring reduced seasonal unemployment. Still policy weaknesses are among the most important causes of backwardness in the *Haor* area. But agriculture policy interventions by subsidies of agricultural inputs like, fertilizer, seed, irrigation water and mechanization substantially improve rural farm income. The farmer's support policy by govt. rice

procurement was found common policy directed to the farm household. The impact of these policy approaches substantially affects the capacity of smallholders on poverty alleviation and food system of the study.. The theoretical and empirical findings of this research would provide inputs for policymakers to create a long-term framework for poverty reduction and sustainable livelihood development for the poor households in the *Haor* area of Bangladesh.

Variation Between Farm-Gate and Retail Price of Fish and its Effect on Fishers' Livelihood in Bangladesh

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Abstract
This study was conducted to estimate the profitability of tilapia and pangas farming in four major carp fish farming areas of Bangladesh. It also estimated the fish price variation between farm gate and retail markets and its impact on livelihood of fish farmers. Primary data from randomly selected 200 pond fish farmers and 80 fish traders were collected from four districts of Bangladesh based on the high concentration of fish farmers. Three main analytical techniques viz. descriptive statistics, activity budgets and functional analysis were employed to achieve the objectives.Major findings of the study are that family size of pangas farmers is higher than tilapia farmers. Family size of tilapia farmers of Sirajgonj was the highest among the districts and it was higher than the national average. Highest percentage of tilapia farmers of Sirajgonj district were found illiterate (69.42%) and the lowest was in Cumilla. Majority of the tilapia and pangas farmers of the four selected districts were running their farming having pond area of 0.51 to 1.5 ha. It was evident that per hectare total costs for tilapia and pangas farming were Tk 18,75,493.00 and Tk 17,00,724.00, respectively. Per hectare net returns from tilapia and pangas farming were Tk 9,22,757.00 and Tk 12,91,776.00, respectively. Undiscounted BCR for tilapia and pangas farming was 1.5 and 1.76, respectively indicating both the enterprises profitable from the view point of individual farmer. Results of the functional analysis showed that fingerling, feed, fertilizer, lime and medicine costs had significant impact on tilapia and pangas farming. The study revealed that there is a considerable gap between farm gate and retail price of tilapia and pangas fish. Finally, some policy recommendations based on the findings of the study were suggested for the improvement of tilapia and pangas farming in Bangladesh.

Economic Benefits and Factors Affecting Adoption of Agroforestry Practices in Selected Char Land Areas of Greater Mymensingh Disrict

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Abstract
Agroforestry is one of the sustainable land management techniques, involving a combination of different agricultural, horticultural, and forestry practices to maximize productivity and sustainability of land. Well planned interacted land use system combining woody perennials and other production enterprises in accordance with the farmers' need and resource base can lead to viable farming system towards sustainable livelihoods for the rural people, especially in the disadvantaged areas such as char lands. This study therefore is undertaken to examine the economic benefits of agroforestry practices

and the factors that determine agroforestry adoption and problems associated with agroforestry in the greater Mymensingh region of Bangladesh. Certain char areas of Mymensingh, Jamalpur and Sherpur districts were selected as study areas. A total of 240 farm households were selected for the survey following multistage random sampling. Cost and return analysis were done for main eight vegetables, i.e. brinjal, tomato, chilli, bitter gourd, pumpkin, okra, bottle gourd, and amaranth. The results show that all the vegetables production are profitable for the char land farmers. Benefit-Cost ratio (BCR) was the highest (1.98) for bottle gourd followed by tomato (1.96). Mahogany, Akashmoni, Lambu, Eucalyptus, Mango were considered with different vegetables for estimating economic benefits of agroforestry. It was found that agroforestry gives higher BCR, NPV, and IRR than any single investment and farmers can take decision based on these analyses. Age, education, household size, own farm land, farming experience, training, extension services, market access were found to be significant factors that affect adoption of agroforestry practices. Farmers' problems were also identified and ranked by using Problem Confrontation Index (PCI). The SWOT analysis shows that farmers are receptive and char land has good potential for agroforestry practices but framers have lack of knowledge and extension services to adopt this technology and they expect support (cash or kind) from government.

Farmers' Health Risk Due to Use of Pesticides in Agriculture and Their Attitude Towards Biological Control

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Abstract

The present study was designed to assess the current practices of pesticides use by farmers, their health risks due to pesticides use, knowledge and attitude towards pesticides use, and willingness to pay for biological measures. The study was conducted in several villages of two upazilas namely Mymensingh Sadar and Ishwarganj of Mymensingh district. Primary data were collected using farm survey method. A total of 220 farmers were interviewed throw a pre-tested structured questionnaire. Farmers use pesticides heavily in vegetables field particularly in brinjal, chili, okra, spinach, and cucumber. The prominent pesticides include virtako, aktara, ecofuran, magister, proclaim, impel, thimid, etc. Farmers do not have much knowledge about biological control methods of pesticides. Farmers are familiar with Sex pheromone trap (42%), Trico compost (43%), and Poultry refuse for soil amendment (43%) methods. Most of the farmers perceived that biological control methods are not effective as chemical control and therefore they are not much interested to use the biological methods. Farmers are willing to pay around 8741 Tk. per year for biological control method. The associated health risks of pesticides use include headache, weakness, skin irritation, excessive sweating, and vomiting. Farmers mainly get to know about pesticides from dealers or retailers. They do not use any protection while applying pesticides but they usually take shower after pesticides application. Maximum farmers take home remedies against health problems related to pesticides. Majority of the farmers (86%) do not have any training on pesticides use. Farmers perceive that pesticides have harmful effects on human health, soil, and environment. Following the research results some recommendations were made such as proper training to the farers, strengthening extension services, availability of applying and safety equipment, awareness and motivation programmes for using biological methods, and proper diagnosis of health risk due to pesticides use.

Adoption of Climate Resilient Crop Varieties in Selected Environmentally Vulnerable Areas of Bangladesh

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Abstract
Bangladesh is one of the countries in the world which is worst affected by climate change. The adoption of agricultural technologies that can withstand climatic stress is crucial for maintaining food security of the country. Therefore, it is essential to comprehensively investigate the varietal adoption addressing all the climatic stresses in Bangladesh. This research aims to investigate the adoption of climate resilient crop varieties covering five different environmentally vulnerable areas of Bangladesh. A total of 1,200 farmers will be surveyed of which 800 farmers will be rice farmers and the 400 farmers will be wheat farmers, and 600 will be adopters and 600 will be non-adopter farmers. Moreover, in total 18 focus group discussion (FGDs) and several Key Informant Interviews (KII) will be done. Socioeconomic characteristics of farmers, logit regression analysis, Problem Confrontation Index, gross margin, net return, Benefit-Cost Ration (BCR), Cobb-Douglas production function, and Asset Index will be estimated to achieve the objectives. Moreover, t-test, Chow test will be estimated to see the differences between adopter and non-adopter farmers. The pre-tested questionnaire is transferred to the smart-phone version and data are collected electronically. Data are collected after the harvesting of the crop so that farmers can give the proper information. So far, 430 data were collected from Jamalpur and Sunamganj districts for Aman crop where flood and flash flood are the main problems. Submergence tolerant rice varieties such as Binadhan-11, Bibnadhan-12, BRRI Dhan-51, BRRI Dhan-52 are the major varieties that are adopted by the farmers. Farmers mostly depend on dealers for the seed and fertilizers. They are satisfied with the yield and resilient level of these varieties but mentioned the problems of training and lack of information. They suggested training, seed availability and showcasing field to popularize these varieties.

Development Scope of Agribusiness in the Major Fields of Crops, Fisheries, and Livestock Sub-Sector in Bangladesh

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Abstract
Agribusiness is regarded as a useful tool for ensuring food security throughout the world. Bangladesh has a positive agro-climatic zone, which is perfect for producing many kinds of agro-products with different high-value agricultural products such as Jam-jelly, shrimp, seafood, fruits, and vegetables that have a huge demand locally and internationally. To cope with the international business environment, it is required to develop the agribusiness sector of Bangladesh. The aim of the study is to assess the current status, challenges, and future potentials of agribusiness sectors in Bangladesh with a major emphasis on crops, fisheries, and livestock sub-sectors. A cross-sectional survey questionnaire is being used to collect data from 180 participants in these three sectors by using stratified random sampling techniques. The researchers have already distributed 90 questionnaires, of which 36 (40% response rate) were returned and found to be valid for further analyses. The SPSS software is being used for the required statistical analysis of the collected data. Regarding the partial results of the study, most of the respondents (85%) have identified the key challenges faced by the agribusiness sectors of Bangladesh,

such as the financial crisis in the start-up phase, decreasing revenues due to COVID-19, lack of high-quality production, lack of enough training institutions, and the lack of favorable government policies whereas opportunities are identified as the low-cost production, adoption of e-commerce, and the increased government support. The initial findings suggest that policymakers should advance the agribusiness sectors by incorporating more favorable government policies, facilitating the bank loans, establishing new training institutions to solve the existing drawbacks of these sectors. A complete picture will be available after having a thorough analysis of the data of this study. Moreover, the researchers will be able to identify future research areas that provide scholars opportunities to push theoretical and empirical boundaries and offer further insights into the study of the agribusiness sectors.

Rural –Urban Migration: Poverty and Food Security Assessment of Farm Households in Rural bangladesh

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Abstract

households in Bangladesh. The study focuses on assessment of rural household's welfare, poverty and food security status due to rural- urban migration. The study also aimed to analyze the driving factors of migration and remittances at the household level. A total of 172 farm households were interviewed purposively for collecting data from three upazilas of kishoreganj district. Among 172 households, 89 households were with migrant members and remaining 83 were households without any migrant member. Socioeconomic characteristics of the farm households are analyzed using descriptive statistics. Migration determinants are analyzed using probit model and remittance determinants are analyzed using OLS regression technique. The model results showed that variables household head age, no of active males, household asset value, significantly influence the migration decision of the farm households. The study found that average monthly income, expenditure, value of housing is significantly higher in the case of remittance receiving households compared to the households without any migrant member. These indicators of poverty imply that household poverty situation has been improved due to migration of their one or more family members to the city. Empirical findings revealed that households with migrant are also in a better position in terms of food security compared to households without migrant. 89.9% farm households revealed that their livelihood has been improved in one or more aspects due to migration of one or more family member to the urban areas. Daily workload of the different family members is significantly high in the case of households with migrant compared to the households without any migrant member. The study findings conclude that better management and policy of internal migration is needed to reduce the negative effects of migration on the economy and to accrue the benefits of internal migration.

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Practice Change in Dry Season Cropping of Non-saline Areas in Southern Bangladesh: Perspective on Project Intervention

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Abstract
Australian Centre for International Agricultural Research (ACIAR) seeks to introduce pulse production as alternative of rice cropping and thus improve the socioeconomic status of the farm households in Southern Bangladesh. This study was carried out to assess the changes on agronomic practices, crop diversification and profitability, women empowerment, and food security and livelihood of non-saline areas' farmers after the ACIAR project intervention (both cash and kind) at the end-line period. A total of 240 farmers (i.e., 120 focal and 120 control) was investigated during 2020-2021 following stratified random sampling technique from Patuakhali, Barisal, Jhalokathi, and Barguna districts. The collected data were analyzed using a combination of descriptive statistics (sum, averages and percentages) and mathematical analyses (Simpson's index of cropping diversity, partial budget analysis, women's empowerment index, food group consumption frequency score and German correlation sensitive poverty index). The majority of the farmers were found to follow the cropping patterns of Fallow – *Aman* rice – Pulses, *Boro* rice – *Aman* rice – Fallow and *Aus* rice – *Aman* rice – Pulses. Pulses covered around 37.0 and 33.0 percent of the total cropped area of focal and control farmers, respectively. The average cropping diversity was at medium level for both categories of farmers. The revenue from pulses production was found much higher than rice farming for both focal and control farmers. The extent of women empowerment was increased at the end-line period by 2.8 and 0.8 percent for focal and control farmers, respectively after adopting the project intervention. The study found focal farm households more food secure compared to control farm households at the end-line period. As a response to the project support, the livelihood of focal farm households improved more than control farm households at the end-line period based on poverty dimensions (71.0 and 65.2 percent, respectively). The study recommends direct input provision by the government to motivate the farmers continuing pulse production over rice monocropping, and time-to-time monitoring for bringing efficiency in cropping system.

Farmers' Perception and Factors Affecting Adoption of Mungbean Production in Some Selected Areas of Southern Bangladesh

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Abstract
This study was carried out to understand farmers perception towards mungbean production, to estimate the financial profitability and the factors that affect mungbean production. A total of 90 stakeholders of different villages of Patuakhali Sadar upazila under Patuakhali district were interviewed using a structured questionnaire to collect field level data. A combination of descriptive, mathematical and statistical techniques was used to analyze the data. The study depicts that all the farmers used local variety for mungbean production. Profitability analysis shows that labour cost was the highest among all the input costs and production of mungbean was found profitable based on benefit cost ratio (BCR). The study also identified six significant factors i.e., cultivating short duration crops, sharing work within household members, practicing crop diversification, zero/minimum tillage, employment

creation and income generation which influence farmers to adopt mungbean production than any other crop. Problem facing index pointed out that higher price of seed and fertilizer, lack of good quality seed and fertilizer, shortage of feeds and fodder as well as inadequate extension services were the major problems related to input; low price of output, temporal and spatial price fluctuation, lack of fair market, storage of product during harvesting were the major production related problems while lack of facilities to develop value added product, lack of transport facility and lack of grading knowledge were the main marketing related problems according to the respondents. To overcome the problems, the study recommended to ensure reasonable price of the inputs along with better infrastructure and transportation facilities. Furthermore, monitoring facilities of government and non-government organizations should be strengthened to improve the quality of mungbean.

Economic Viability and Production Efficiency of Rice: A Macro Level Study in Bangladesh

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Abstract

The study was conducted to assess the economic viability of *Aus*, T. *Aman* and *Boro* rice through evaluating the profitability, risks, production efficiency and constraints in the different ecosystems of Bangladesh. Four agricultural regions namely Dhaka, Bogura, Faridpur and Rangamati were selected for the study. A total of 2,800 farm households were interviewed for data collection. The study found seven ecosystems which were: favorable, deep water, low lying, submergence, *haor*, *char* and hill in the study areas. The study identified that *Fallow-Aman-Boro* was the dominant rice cropping pattern in all ecosystems. Most of the farmers under different ecosystems preferred high yielding rice varieties over the local varieties for better output in terms of yield and profit. Human labor, seeds and fertilizers were found as the major inputs for rice production, the requirement of which in *Boro* rice production was comparatively higher than *Aman* and *Aus* rice production. In terms of profitability, large *Boro* farm earned higher profit compared to small *Aman* farm and medium *Aus* farm in favorable ecosystem. The stochastic frontier production function approach for measuring farm-specific efficiency revealed that human labor, fertilizer and insecticide had significant influence on rice production. The study also revealed that education, extension service and training had positive impact on technical efficiency in different ecosystems. In addition, *Boro* farmers were technically more efficient in comparison to *Aman* and *Aus* farmers. Severity ranking model showed that biotic risk was the main reason for the declination of rice production. Based on the Garrett's ranking technique, low price of paddy, scarcity of labor, lack of short duration and high yielding rice varieties, and lack of proper training and extension service were found the major constraints faced by the famers. The study recommended that ecosystem-based rice production technologies; short duration, high yielding and pest tolerant rice varieties; and proper training and extension support are necessary to encourage farmers for making rice production economically more viable and technically efficient.

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Improving Farmers' Income and Livelihood through Green Grass Production in Major Milk Pocket Areas of Bangladesh: A Socioeconomic Study

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Abstract
With a view to analyze financial profitability, production practices as well as farmers' income and livelihood through green grass production, this study is being conducted at different villages of three upazilas of three districts which are: Shahjadpur upazila of Sirajgonj district, Bera upazila of Pabna district and Badorgonj upazila of Rangpur district. A total of 180 respondents were supposed to interview for data collection. The observations from field survey depict that green grass is one the major ruminant food items and its nutritive value is high. Regarding farmers perception, green grass production emphasized on cost minimization of cattle feeding as well as increasing milk yield. Financial profitability analysis shows that green grass production is profitable and its BCR is higher than that of rice production. Estimates of Logit model indicates that age of household head, annual income from grass production, households' training, experience in grass production are the significant factors that influence farmers' decision for adoption of green grass production. As green grass production is more beneficial, sampled farmers' acknowledged that their existing human capital, social capital, financial capital, natural capital and physical capital are significantly better than before. SWOT analysis indicates less requirement of labour and other inputs as strength, inadequate marketing facilities as weakness, higher productivity from livestock as opportunities, and uncertain flood as threat, respectively. Lacks of credit facilities, lower selling price of grass product, higher prices of grass seedlings as well as lack of marketing facilities are the main problems faced by the green grass farmers.

End-line Study on Non-saline Areas' Dry Season Cropping of Southern Bangladesh

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Abstract
This research will aim at conducting end-line study for practice change on non-saline areas' dry season cropping of Southern Bangladesh as a response of ACIAR project. The end-line study will assess the change in (i) farmers' socioeconomic characteristics and labour migration; (ii) crops, cropping pattern, farming practices, cropping intensity, diversification and profitability; (iii) Intra-household men/women labour allocation and women empowerment; (iv) employment creation, income generation, food security and livelihood status of non-saline areas' farmers of Southern Bangladesh after incorporating pulses into their farming options with the project support and intervention. This study will cover four districts which are: Barisal, Jhalokathi, Patuakhali and Barguna. A total of 240 farmers (i.e., 120 focal and 120 control) from non-saline areas of eight upazilas will be surveyed with the help of BARI and DAE personnel for data collection using stratified random sampling technique. Questionnaire survey, focus group discussions (FGD) and key informant interviews (KII) will be used to collect the primary data and other necessary information. A combination of descriptive, mathematical and statistical techniques will be applied to achieve the objectives and to get the

meaningful results. However, the information and materials of the study will be useful for farmers and traders to gain more production and economic benefit; academician and researchers for further research; and government for necessary policy options.

Waste to Energy Generation" at Bangladesh Agricultural University Campus: Possible Scenarios to Generate Energy and Organic Fertilizer

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Abstract
The aim of the study is to assess the status of solid waste generation, present waste management system and to finally choice proper technology/ies for waste management in Bangladesh Agricultural University Campus area in Mymensingh. This research is being continued for two years while first year has been running and will complete the research by end of 2022. The different types of waste are produced in BAU campus like household, market, hostel, dairy, poultry, agricultural farm waste and medical waste etc. The research team has only collected the data for first year the household and market waste in the selected areas and remaining waste data will be collected very soon. Sixty two households including teachers, officers and other employees, and a market named K. R. Market were selected for data collection. Data were collected in winter-spring and summer seasons in 2021. The result found that per capita waste generation by Senior teachers was 1.564 kg for organic waste and 0.18 kg for inorganic waste in winter-spring season and 2.756 kg for organic waste and 0.114 kg for inorganic waste in summer seasons of 2021 respectively. Per capita waste generation by Junior teacher and officer was 1.6 kg for organic waste and 0.12 kg for inorganic waste in winter-spring season and 2.359 kg for organic waste and 0.101 kg for inorganic waste in summer seasons of 2021 respectively. Per capita waste generation by Employee was 0.968 kg for organic waste and 0.065 kg for inorganic waste in winter-spring season and 1.412 kg for organic waste and 0.051 kg for inorganic waste in summer seasons of 2021 respectively. Daily waste generation by K. R. Market was 80.22 kg for organic waste and 5.734 kg for inorganic waste and 57.987 kg for organic waste and 6.901 kg for inorganic waste in winter-spring and summer seasons of 2021 respectively. Lack of regulations or standard for waste disposal, lack of proper awareness, improper choice of technology and inadequate financial support are the major constraints for waste management at Bangladesh Agricultural University Campus area in Mymensingh. With the assistance of strong and integrated cooperation effort by the BAU authority, necessary awareness of major stakeholders of this university, Mymensingh City Corporation, professional and voluntary organizations, the faulty system of waste management in BAU Campus can be reduced and the situation can be improved for its residents.

Understanding Gender Bias in Intra-Household Food Allocation: A Logit Model Analysis

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Abstract
This project has been undertaken with the aim of understanding how gender influence intra-household allocation of food in the context of rural Bangladesh. By using a country-level household survey of the

International Food Policy Research Institute (IFPRI) and by using quantitative analytical methods, this study has revealed that there is strong evidence of bias against women in the allocation of food within households in rural Bangladesh. It has been found that among the sample individuals, about 65 percent are nutrient deficient i.e., they are consuming less than required level of calorie considering their age, gender, and physical activity. Of those nutrient deficient individuals, about 53 percent are women which clearly shows that the incidence of nutrient deficiency is high amongst women in contrast to men in rural Bangladesh. The Logit model estimates suggests that irrespective of age and relation, female household members are more likely to be nutrient deficient as opposed to their male counterparts. However in communities in which women feel that they can bring change at the society, the significance of female members being energy deficient is not observed. This implies that food allocation amongst household members is possibly equitable in the household of those villages. This bears an important policy message that discrimination against women at household level with regard to food allocation may be reduced by changing social attitude towards women. Importantly change in societal perspective may result in the reduction of the incidence of undernutrition especially among adult girls and women and thereby contribute to the attainment of the international development targets such as Sustainable Development Goals (SDGs).

Assessing Effect of Mothers' Workload on Children's Nutritional Status in Agricultural Households of Rural Bangladesh

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Abstract

Existing literature on children's nutritional status in the context of Bangladesh primarily focuses on the socioeconomic determinants and the relative importance of those determinants, ignoring the fact that mothers' workload could negate the beneficial effect of those determinants. This inadequacy in literature can be attributed to the fact that no previous studies in Bangladesh were able to use childcare and mothers' time use data in a single analysis. While childcare is a multi-dimensional concept and difficult to measure; time usage data for a nationally representative sample of rural women in Bangladesh have been scanty. In view of this, by using a comprehensive care index and mothers' time use data from a national level household survey, the current research explores how mothers' workload in various activities influence the effect of 'childcare' on children's nutritional status in rural Bangladesh. The empirical evidence of this study suggests that although childcare is a highly significant determinant of child nutrition; its effect varies considerably with mothers' workload. In particular, mothers' workload in unpaid household works completely attenuates the significance of childcare. Additionally, there is evidence that a given level of childcare would exert varying effect on child nutrition when mothers' workload varies. This finding has important policy relevance because rural women's workload has been intensified by agricultural and rural development over the past years in Bangladesh. Unless mothers can be freed from excessive workload of household chores, policy interventions on improving child nutrition may not be as successful as one would expect. Finally, this research finds evidence to suggest that if mothers spend more time in particular activities, for instance, socializing, the effect of childcare tends to be high. Thus, this study concludes that worktime does not always negatively affect child nutrition, rather workload in different activities affect child nutrition differently.

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Impact of Covid-19 on Vegetables Marketing in Bangladesh

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Abstract
The spread of novel coronavirus, SARS-CoV-2, and the COVID-19 disease it causes has had unprecedented impacts on all food markets, including the market for vegetables. Getting vegetables from the fields to the table is extra challenging amid COVID-19 from restrictions on movement to high transport costs and closed markets. Thus, this study investigated the overall impact of COVID-19 on vegetables supply chain especially economic losses in terms of wastage due to un-sale and financial losses due to low price, impact on farmers' income and livelihood, and problems and obstacles faces by the farmers and market intermediaries. Three vegetables, i.e. tomato, brinjal, and potato were considered for this study. A total of 480 (300 farmers and 180 market intermediaries) were interviewed for collecting primary data from three districts (Jessore, Bogura and Narsingdi). Simple random sampling technique was used for selecting farmers and convenient sampling technique was used for selecting market intermediaries. The results showed that farmers had to sell their vegetables at a quarter of their normal price. Travel restrictions have led to disruptions in vegetables transportation, preventing producers from reaching markets. Vegetables farmers have to count a 10 times higher cost for labor and transport compared with the normal time. The economic loss in terms of wastage due to un-sale of tomato, brinjal and potato incurred by the farmers were Tk. 11750.95, Tk. 8380.24, and Tk. 5400 per acre respectively as a result of COVID-19. On the other hand, the financial loss incurred by the farmers due to low price sale of the selected vegetables were Tk. 8875.60, Tk. 6370.25, and Tk. 4190.35 per acre of tomato, brinjal and potato, respectively. The income of the bepari, wholesaler and retailer decreased by 45%, 37%, and 54%, respectively during the Covid-19 period due to restricted opening and shut down time of sale, sitting of shop in open area, and restriction of movement. The main problem during this crisis period was availability of transport, high transport charge, and reduce of sales volume. The decreased income increases farmers' and traders' likelihood of vulnerability, uncertainty, and food insecurity and poses a challenge to continued produce and trading of vegetables. 'Cash support' is more important than 'food support' in order to keep vegetable farmers in farming which need to be continued.

Value Chain Analysis of Fish Seed in Some Selected Areas of Mymensingh District

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Abstract
This study was carried out to evaluate the value chain performance of fish seed in four upazilas of Mymensingh district namely Mymensingh Sadar, Gauripur, Muktagasa and Trishal. Quantitative data were collected through 56 fish seed farmers and 224 fish seed traders during July to October, 2019. Five important fish seed species were taken as a sample under two categories- Rui, Catla, Mrigel for carp fish; and Shing and Pabda for catfish. The results indicated that the average total net marketing margin per 10 Kg. spawn and per 100000 pieces' fingerlings were Tk. 20204 and Tk. 43148 respectively for carp fish. And for cat fish this figure was Tk. 3294 and Tk. 31165 respectively. A large percentage of value addition was covered by paiker for both categories and that was 20.85 percent, 10.6 percent for carp fish and 31.2 percent, 14.46 percent for catfish, respectively. Yearly net return

form spawn production was Tk. 4324775 and Tk. 2388126 for carp fish and for catfish this figure was Tk. 2811138 and Tk. 1494658 in nursery and hatchery respectively. The study reveals that fish seed farms with hatchery were more profitable than fish seed farms with nursery. In this study some serious problems like lack of information about good quality seed, higher price of various inputs, price fluctuations were faced by fish seed farmers and traders in conducting fish seed farms. For solving these problems, some recommendations such as training of hatchery operators on appropriate technologies, testing of seed quality should made for the development of fish seed farms and traders. Fanally, Government should provide incentives by determining appropriate policies and should take proper steps to establish organized fish seed selling markets which will encourage expansion of fish seed farming in the country as well.

Post-Harvest Losses, Supply and Value Chain Analysis of Fisheries Sub-Sector in Bangladesh

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Abstract

Food losses are of great attention in the efforts to combat hunger, raise income, and improve food security in Bangladesh to meet sustainable development goals (SDGs). This study aims to generate in-depth information on post-harvest loss, supply (PHL), and value chain in the fisheries sub-sector of Bangladesh. This is the first empirical study of fisheries in Bangladesh in where a massive primary data were collected from 24,672 stakeholders of which 21575 from inland (3850 fishers, 4656 fish farmers and 13069 traders) and 3097 from marine (889 fishers and 2208 traders). The study covered 1463 fish markets, 173 upazilas from 64 districts of Bangladesh where 202 inland and 86 marine fish species were accounted to estimate the PHL. Alongside the primary data collection, 87 Focus Group Discussions (FGDs) were arranged to validate the collected data. The findings of this study revealed that the estimated overall PHL in capture, culture and marine fisheries was 59.70 kg/ton, 6.74 kg/ton and 36.53 kg/ton respectively. Consequently, Bangladesh is losing about BDT 2940 crore every year in terms of PHL. The study identified fifteen supply chains for capture, twelve for culture, and ten for marine fisheries. The overall supply chain performance score of efficiency and capability were dissatisfactory for the entire stakeholders and market arrangements. In case of value chain, the study found 1.63 times value addition took place in the process of retail distribution (from fish farmers to consumers) for carp fish, while it was 1.49 times for pangas in terms of monetary value. Besides, processing (salting) added up the highest value for marine fisheries. Based on the findings, the study suggested several policies for reducing the PHL and improving supply chain efficiency.

Impact of Rural Electrification on Livelihood in a Selected Area of Bangladesh

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Abstract

Rural electrification is the lifeblood of rural development in Bangladesh. The study was conducted to examine the socioeconomic conditions of sample households, investigate the impact of rural electrification on user's livelihoods, and identify the problems and constraints faced by the households.

A total of 70 households were randomly selected from Chargobodia and Charkalibari villages of sadar upazila under the Mymensingh district. All of the respondents were clients of the Mymensingh Palli Bidyut Samity-1. Primary data were collected through field survey using an interview schedule. Simple statistical techniques were employed to analyse the data. The DFID livelihood approach was carried used to determine the impact of the rural electrification on livelihood. The findings revealed that the highest 74.29% of the selected respondents belonged to the age group 30 – 64. About 47.14% farmers ended their primary level education and 44.28% did not receive institutional education. About 65.71% respondents' main occupation was agriculture and 21.43% respondents considered agriculture as subsidiary for their earnings. The overall average family size in the study area was 5.15 persons in a family with dependency ratio 3.33. The average farm size was 237.21 decimal. On the basis of farm category, 5.71% of the respondents belong to landless, 75.72% respondents belong to small, and 12.86% respondent's medium and 5.71% respondents were a large farm category. An average income and expenditure of the respondents were Tk.270485.71 and Tk.236500 respectively. The all five types of assets such as human, natural, social, physical and financial were positively changed after rural electrification in the study area. Wrong bill, load shading, the high price of electricity, low voltage, damage of electric equipment and difficulty of new meter set up were the main problems and constraints. So, the government should address these issues in the development policies and programmes for rural Bangladesh.

Enterprise Development for the People of Chittagong Hill Tracts (CHT): Impact on Livelihood, Food Security and SDGs

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Abstract
This study aims at assessing the potentiality of enterprise development and income generation by people in the Chittagong Hill Tracts region. Enterprise development has important role in generating employment and enhancing livelihood opportunities of rural people. This study was carried out in 2019 and 2020 towards enterprise development and income generation in three districts namely Khagrachari, Rangamati, and Bandarban of the CHT in an attempt to attaining poverty alleviation, food security and SDGs. To attain the objective both descriptive and functional analyses are carried out. The functional analyses are estimation of Cobb-Douglas stochastic revenue frontier function to estimate farm specific and average revenue efficiency of people in the CHT and exponential model to estimate poverty line towards estimating cost of basic needs. Total household's yearly incomes in the year July 2019 to June 2020 and July 2020 to June 2021 are respectively BDT 215345.07 and BDT 191895.08. Similarly, Total household's yearly expenditures during that period are respectively BDT 228260.42 and BDT 199366.99. People of the CHT consumed 20 food items. Rice is the most important staple food in terms of the highest daily per capita food consumption, calorie and protein intakes. Daily per capita consumption of all food items in the year July 2019 to June 2020 is 1128.35g whereas in the year July 2020 to June 2021 it is 1050.54 g. Increased rice consumption increases the calorie and protein intakes. Daily per capita calorie intakes during that successive years are respectively 2443 kcal and 2289.19 kcal and protein intakes are respectively 78.55 g and 76.48 g. It was observed that income, expenditure, food consumption, calorie and protein intakes reduced in the year July 2020 to June 2021 compared to the previous year. Poverty increases relatively in the year July 2020 to June 2021 compared to the previous year. These scenarios might happen due to Covid-19 pandemic. Food security condition increased with the increase in weekly cost on family food and decrease with the increase

in family size. Average revenue efficiency is 56 percent, which states that per farm revenue can be increased by 44% by allocating limited resources optimally on all enterprises.

The Mediating Role of Farm Performance Between Agro-Technologies and Farmers' Livelihoods in Bangladesh

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Abstract
This study aims to seek new insights into how vegetable farmers in a developing country can benefit from using modern agro-technologies to induce their farm- and family livelihood performance. The results based on a structural equation model on data collected from 192 Bangladeshi vegetable farmers suggest that (1) the use of modern agro-technologies directly triggers the farm performance; (2) the use of modern agro-technologies directly and positively influences the family livelihood; (3) the farm performance directly fuels the family livelihood; (4) the farm performance positively mediates the influence of using modern agro-technologies on the family livelihood. Based on the results, this study suggests that modern agro-technologies can improve the farm- and the family livelihood performance of vegetable farmers in Bangladesh. This study enhances the use of modern agro-technologies, farm- and family livelihood performance literature by providing conceptual-, empirical-, and policy-oriented implications for vegetable farmers in a developing country context.

Business and Family Livelihood Performance of Bangladeshi Pond Aquaculture Entrepreneurs: do Business Networks and Entrepreneurial Orientation Matter

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Abstract
The model between business networks, entrepreneurial orientation (EO), business performance, and family livelihood in challenging contexts is yet an underexploited potential for addressing poverty and its roots. Adopting theoretical perspectives of social capital and EO, this study aims to provide new insights into how entrepreneurs in a challenging business environment can benefit from business networks and EO to induce business and family livelihood performance. The results of the structural equation model on data collected from Bangladeshi pond aquaculture entrepreneurs suggest that (i) business networks positively influence the EO; (ii) next to financial capital and business experience, both business networks, and EO positively influence the business performance, while obstacles (e.g., political instability and high-and-volatile price of fish-feeds) in business environment exert a negative influence; (iii) both EO and business performance stimulate the family livelihood; (iv) the EO positively mediates the impact of business networks on business performance; and (v) the influence of EO on family livelihood is positively mediated by business performance. This study enhances aquaculture entrepreneurship, antecedents of EO, and performance literature by offering theoretical, empirical, and policy-oriented implications.

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Preparation of Hygienic Compost From Agricultural Waste At Farmer's Level

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Abstract
The study aimed at developing a hygienic and self-aerated composting method by using agricultural waste at farmer's level. This study is in progress now and after completion, the effectiveness, cost and nutrient content of the compost for the adopted method would also be determined. The adopted method is hygienic and self-aerated because it has no adverse effect on its surrounding environment as well as this method doesn't need turning of the compost heap during the composting proses. The compost heap was designed by using four bamboo pieces forming a grid (1m×1m) having a total dimension 2m×2m×1m. The agricultural waste like, straw, grass and cow-dung were used as raw material for the compost heap by maintaining the optimum carbon nitrogen (C-N) ratio of 30:1 and moisture content of about 70%. The expected outcome of the adopted method is to produce hygienically safe compost after a period of about 60 days comprising a 30 days of active stabilization and 30 days of maturation period. The effectiveness of the system will be determined by noticing the temperature growth in different stage of composting. Moreover, a maximum temperature of 61℃ rise was noticed. Quality of the prepared compost will be determined in terms of essential plant nutrient in the laboratory. It is expected that, the adopted method would be neither labour nor capital intensive and it can be practiced even by unskilled farmer. Furthermore, farmer would be able to use a nutrient-rich compost for boosting crop production.

Application of Porous Concrete for Natural Slope Protection

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Abstract
Natural slope protection is challenging in all over the country. The study assessed the application of porous concrete over the conventional concrete in slope protection. Therefore, the study selected an earthen canal which is situated near the concrete and material testing laboratory, Department of Farm Structure and Environmental Engineering, Bangladesh Agricultural University, Mymensingh. In the study, porous and conventional concrete block placed on the slop in 3 row and 11 column format. The study revealed that the porous concrete was vegetative than the conventional concrete. In addition, the study found that each of the porous concrete block required less volume of sand (0.0476 cft) and khoa(0.0253 cft) that reduced Tk. 3.81 over the conventional concrete block. It is concluded that the porous concrete was more cost-effective than the conventional concrete. Furthermore, porous concrete is light weight over the other types of concrete. Therefore, the study suggests applying porous concrete to protect the slopes.

Propose a Multipurpose Pump House for Haor Areas of Bangladesh

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Abstract
The study deals with the present situation of the traditional pump house used in our country and proposes a multipurpose pump house for Haor areas. The study helps to identify the problems of traditional pump house and suggested the probable solutions of the traditional pump house. The problems were identified by collecting data from the farmers, field stuff, and management stuff under Bangladesh Agricultural Development Corporation (BADC), Netrokona. An interview schedule was prepared to collect the information. A multipurpose, economical, efficient and durable pump house structure was suggested. A pump house constructed with proposed layout will ensure the basic requirements of farmers' of Haor area.

Assessment of the Seasonal Variation of Wastewater Quality in Mymensingh Municipality Discharged into the Brahmaputra River

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Abstract
The present study was undertaken to monitor the seasonal variations in wastewater quality of Mymensingh municipality area discharged into different locations at the Brahmaputra River. Five sample collection points were purposively selected from five different discharge locations of the study area. The samples were collected during January to September 2020. Collected samples were analyzed for pH, Electrical Conductivity (EC), Total Dissolved Solids (TDS), Dissolved Oxygen (DO), Total Nitrogen and Available Phosphorus. The study results revealed that the value of EC, TDS, DO, Total Nitrogen and Available Phosphorus of the wastewater samples varied with seasons. The pH was consistently same during the study period, EC, TDS, Total Nitrogen and Available Phosphorus were relatively low in rainy season and high in winter, but DO was high in rainy season and low in winter. Considering the investigated parameters, the wastewater of Mymensingh municipality area that discharged into the Brahmaputra River was suitable for rice irrigation. For aquacultural purposes most of the discharge points of wastewater were not suitable except in rainy season, because the majority part of the year Dissolved Oxygen level was very low that may results in fish mortality. The wastewater containing excess phosphorus and nitrogen may cause algae growth in quantities sufficient to create bad odor. Dead and decaying of algae may also cause oxygen depletion which can kill fish and other aquatic organisms in the Brahmaputra River in winter season.

Design and Development of Improve Storage Technology by Locally Available Materials for Prevention of Storage Loss of Cereal Crops

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Abstract
Hermetic storage is based on the principle of generation of an oxygen depleted and carbon dioxide enriched interstitial atmosphere caused by the respiration of the living organisms in the ecological system of a sealed storage. The study was carried out to develop hermetic storage technology for

paddy seeds by locally available materials. BRRI dhan49 was collected for the experiment and sun dried to reduce moisture content of it equal or below 12% at threshing yard before storage. Experiment laid out in completely randomized design (CRD) with three replications and four treatments in the departmental laboratory. Treatments of the study were metal bin, improved plastic drum, improved plastic container and jute bag. Moisture content, weight loss, insect infestation, storage loss and germination rate were calculated during storage and after 8 months of storage. The O_2 and CO_2 were monitored first 28 days of storage. After 17^{th} days O_2 level dropped to 7.40%, 7.18% and 7.64% respectively in metal bin, improved plastic drum and improved plastic container with slight increase in O_2 level in last 12^{th} days. Levels of CO_2 was inversely proportional to the levels of O_2. After 17^{th} days CO_2 level increased to 13.06%, 13.85% and 12.01% respectively and slight decrease in 12^{th} days. Highest moisture content was found 14.2% in Jute bag and lowest moisture content was found 12.71% in metal bin. Maximum storage loss was recorded 11.38% in Jute bag and lowest storage loss recorded 0.92% in metal bin. Paddy moth, Rice weevil, and Red flour beetle were observed in storage technologies. Dead insects were found in metal bin, improved plastic drum and improved plastic container as O_2 level decrease and CO_2 level increase in developed hermetic storage technology. The highest germination rate (84%) was observed in metal bin, followed by improved plastic drum (82%), improved plastic container (81%) and lowest germination rate (57%) was recorded in jute bag. Metal bin showed in controlling insect, weight loss, moisture content, and appropriate temperature in comparing with other treatments. Metal bin is easily manufacturing in different sizes up to 3 tones holding capacity by local with locally available materials. Improved plastic drum and improved plastic container are commercially available in Bangladesh local market. The developed hermetic technology could be effective for stored paddy, which enhances the livelihood of smallholder farmers in Bangladesh.

Developing a Model of Sensor Controlled Plant Growth System: Application in Precision Agriculture

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Abstract

Precision Agriculture increases crop quality & production efficiency, minimizes environmental impact and reduces the use of resources (energy, water and other inputs). In Bangladesh, the agricultural systems are mostly followed by conventional method whereas developed countries use precision/automated system to control their agrarian economy to grow more products at same lands and same conditions. In addition, dry spells are connected with the late arrival or an early withdrawal of monsoon rains furthermore because of discontinuous droughts agreeing with cultivated phases of different harvests in the north-western and northern areas of Bangladesh. Irrigation scheduling and water budgeting is the main key factor to the optimum growth of the plants/crops. When smallholder farmers are too busy in the urban area and have a short time to maintain their small farm production, it's hardly needed regular irrigation to the plants. A GSM based precision irrigation system was developed on the base of a moisture sensor. The circuit design and experiment were conducted in the Precision Agricultural Lab, Department of Farm Power and Machinery, BAU, Mymensingh. The developed system will determine accurate soil moisture value for irrigation start and stop on regular basis. Excess water and lack of water must be harmful to the plant's growth. Therefore, exact amount of water circulation was determined through predetermined system which measures the amount of water by sensing the moisture level of the soil. This system will be a powerful and flexible tool that will offer this service at any time and from anywhere over the world. This automated GSM-based precision irrigation system will reduce users time, money and resources as well as will contribute to

increase quality crops. Therefore, the developed system could be used by the both urban and semi-urban user in low cost.

Development of a Solar Dryer for Drying Pineapple in Bangladesh

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Abstract
Drying is a process of thermally removing moisture and maintaining a safe moisture level for storing perishable agricultural products. In developing countries, natural convection solar dryer could be an option for preserving various types of fruits and vegetables, especially in rural sites. A solar dryer was designed, constructed, and investigated experimentally at the advanced drying lab (ADL), Bangladesh Agricultural University, and measured parameters based upon spatial temperature distribution, relative humidity, solar radiation, and moisture content of pineapple. The results showed that the system is capable of producing a maximum 69.45℃ temperature inside the dryer when the ambient solar temperature was 42.18℃ which is around 28℃ higher than the ambient air temperature. During the experiment, the mean ambient conditions, solar radiation, and relative humidity were 260 W/m^2 and 59% respectively. The moisture content of freshly sliced pineapple was reduced from 92% to 20% (wet basis) in solar dryer conditions when the pineapple was pretreated and the moisture content was reduced 90% to 21% (wet basis) when the pineapple was controlled in 15 hours sunny days. At the same time, in the open sun drying method, the moisture content was reduced from 92% to 43% (wet basis) in pretreatment and 90% to 34% (wet basis) in control conditions. From this result, it is presumed that the removal of moisture content in the solar dryer was faster than open sun drying and it is obvious, solar dryer takes less time compared to open sun drying. Through visual inspection, the quality of pineapple in terms of brightness, color, taste, and flavor is independently recognizable and suitable for small-scale farmers in rural areas.

Design and Fabrication of a Soybean Thresher

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Abstract
Soybean (Glycine max L.) is an annual leguminous plant that grows in tropical, subtropical and temperate climates. It is usually used for producing edible oil, feeds for livestock and fish and as food for human consumption such as soy milk, soy flour, soy protein and tofu. Due to the increasing demand for soybean oil for human consumptions and soymeal to meet the feed requirement of livestock and fisheries, production of soybean gradually increased in Bangladesh. Production of soybean is incomplete without threshing operation. Usually, the threshing of soybean is done manually (beating), using animal power (trampling) and mechanical threshers. Grain spoilage, incomplete separation of grain from the chaff, grain damage due to excessive striking, wastage of time and high drudgery are some of the limitations of a manual threshing system. To overcome the problem associated with manual threshing, soybean producers used existing power-operated closed-drum paddy threshers for the threshing of soybean. Though the use of existing power-operated closed-drum paddy thresher for the threshing of soybean reduces human drudgery and increases threshing capacity, the problem is that accommodate soybean gets choked up easily because of the stalk hardness and low grain to stalk ratio. Besides, the use of a power-operated paddy thresher for the threshing of soybean

could result in above 10% of grain damage. In this research, a power-operated soybean thresher was designed to reduce the seed damage thereby increase the germination rate and yield. It consists mainly of five parts: the feeding assembly, the threshing unit, fan assembly and power transmission unit. Although the design and fabrication of the soybean thresher were completed successfully, however, due to the COVID-19 pandemic, it was not possible to evaluate the performance of soybean threshers in the field.

Present Status and Prospect of Four-Wheel Tractor Mounted Planter for Conservation Agriculture in Bangladesh

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Abstract

Conservation agriculture (CA) based tillage technology permits direct seeding through the moderate level of crop residue. Farmers accept CA-based tillage technologies due to the advantages of higher yields, reduced cost of tillage operation, and minimum turnaround time between the crops. A survey study was undertaken to ascertain the present status of the tractor-mounted CA-based planter in Bangladesh. During this study, secondary data were collected from different government and non-government organizations involved in agricultural machinery development research, manufacturing and marketing business. Results revealed that about 7500 power tiller operated seeder is available in the field and playing important role in mechanized seeding practice. The power tiller operated seeder has created positive farmer attention towards the mechanized seeding practice due to local availability and affordable price. On the other hand, there is only one tractor-mounted seeder available in Wheat Research Center, Dinajpur, Bangladesh. The reason behind the scene is that the four-wheel tractor-mounted planter is not familiar among the farmer due to the lack of a four-wheel tractor operated seeder and the price of the four-wheel tractor itself. However, the tractor-mounted planter has a high prospect since about 56000 four-wheel tractors are available in Bangladesh and the number of four-wheel tractors is increasing rapidly every year. Therefore, a four-wheel tractor operated seeder could gain popularity among the farmer if a community-based machinery business is developed.

Machine Vision Technique for Identification and Classification of Plant Diseases

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Abstract

Diseases in the plant are quite natural. However, several diseases of plants cause devastating economic, social and ecological losses. Existing plant disease detection techniques are simply naked eye observation of the experts which depend on the guide book or their experience. Since each plant disease has different stages of growth, it requires continuous monitoring of the plant throughout the growth stage. Therefore, identification of plant diseases by naked eye observation is laborious, time extensive, prone to error due to tiredness of the experts and can be done only in limited areas. In this research, a digital image processing technique is proposed for the recognition and classification of rice and potato plant leaf diseases. During experiments, rice and potato plant leaf images were captured using a CANON EOS 800D DSLR camera (24.2 megapixels) in field condition and RGB images were

converted into L*a*b images. Later, based on the luminosity, chromaticity and colour information binary images were split into the diseased and non-diseased part. Then, diseased portion, normal portion and background area segmentation were done through the K-means clustering method and textural features were extracted using the GLCM algorithm. ANN was used to train the features thus creates a database of information and an SVM classifier was implemented for the disease characterization. Results revealed that the rice plant leaf diseases classification model could classify bacterial leaf blight, bacterial leaf streak, brown spot and healthy leaf with an accuracy of 97.2%, 96.5%, 91.0% and 98.5%, respectively. Whereas the potato leaf diseases classification model could classify early blight, late blight and healthy leaf with an accuracy of 95.4%, 88.2% and 93.5%, respectively. Finally, it could be concluded that machine vision technology is a cheap alternative system for plant health monitoring. Besides, early detection of diseases should help farmers in selecting the type of pesticide.

Hyperspectral Imaging for the Characterization of Soil Properties

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Abstract

Preservation of soil health is critically important for sustainable crop production and environmental sustainability. Overdoses of fertilizer, herbicide and other agricultural inputs although increase yield but cause degradation in soil health. Existing methods could monitor soil quality from qualitative to quantitative scale based on field and laboratory analysis which is time-consuming and costly. To overcome the limitation of existing methods, a machine vision-based soil nutrient quantification technique is proposed in this study. During this study, 100 soil samples were collected from the BAU farm and samples were prepared for image acquisition and chemical analysis through drying, grinding and sieving. Chemical analysis of soil sample was done at Agri-Humboldt Soil Testing Lab, Department of Soil Science, BAU. A laboratory-based push-broom hyperspectral imaging system (HS-Vis-12bit, HYSPIM, Lund, Sweden) was used to acquire the hyperspectral images of soil samples in the spectral range of 400-800 nm and necessary preprocessing technique was employed to develop multivariate prediction model for the rapid and non-destructive prediction of SOC, pH, total N, Total P and total S of soil samples were investigated. The quantitative PLS regression model with the appropriate preprocessed technique was established using full wavelengths. Results revealed that the developed calibration model could predict the SOC, pH, total N, Total P and total S content of the soil with a correlation coefficient of 0.76, 0.80, 0.75, 0.87 and 0.85, respectively. These findings indicate that the HSI technique combined with PLS regression has the potential to predict the chemical components of soil samples. Although this result is promising, further study is needed to develop a robust model.

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Design and Development of an E-advise System for Combine Harvester using Data Mining and Machine Learning Algorithms

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Abstract
Agricultural mechanization plays a vital role to increase the labor productivity, cropping intensity and cost reduction. One of the crucial tasks of sustainable agricultural mechanization is to diagnose machines anomalies and to fix them within the shortest possible time. In the study troubles or anomalies of combine harvester during rice harvesting will be resolved by developing a telematics (***Tele***communication and infor***matices***) which is a real time smart decision support system. An e-advise system (telematics) for combine harvester will be designed and developed using data mining and machine learning algorithms to facilitate sustainable use of combine harvester for rice harvesting in Bangladesh. The core components of telematics including inputs (received through sensors) and outputs (through interactive websites) are considered in the design of an e-advise system. Sensor data acquisition, data pre-processing, parsing, identify business process, data mining and building model are the sequences for developing e-advise system. The model will be built by applying an existing data mining and machine learning algorithm based on the historical data. This data is also known as the training data. Once the data mining model is built based on the training data then it can be used to detect the troubles or anomalies of the harvester. Finally the system will be recommended the possible ways to resolve the anomalies of troubles.

Appropriate Scale Mechanization Innovation Hub-Bangladesh

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Abstract
Bangladesh is predominately an agricultural country and farming plays a key role to improve the overall livelihood status of Bangladesh. The Southern Delta region of Bangladesh is lagging behind in adoption of agricultural mechanization due to its agro-ecological characteristics. The main objective of the project is to promote appropriate-scale agricultural mechanization for smallholder farming systems in Southern Delta region of Bangladesh. The project concentrates its adaptive research activities involving rice transplanting, harvesting and conservation agricultural machinery in selected areas in Khulna, Barisal, Patuakhali and Noakhali districts for assessing technical robustness, economic feasibility and end-users acceptance to identity appropriate technologies for this region. Several experiments in Boro 2020 reported that hybrid rice can be transplanted successfully using transplanter machine. The recommended amount of seed for each tray is 130g for proper transplanting by minimizing missing hill and floating hill. Two different models of combine harvesters were tested in limited areas at Netrakona and Tangail and found suitable for harvesting in technical and financial point of views. During *Rabi* (Mid October-Mid April) 2019-20 season, mungbeans were also planted in Wazirpur, Barishal and Kolapara, Patuakhali and soybean was planted in Subarnachar, Noakhali project areas. Project has always been encouraged to engage both men and women in different field days, refreshers advanced hands-on training program in both *Aman* 2019 and Boro 2020 for understanding clearly about the role of women in harvesting machines, transplanting machines and conservation agricultural machinery systems. Training on “Gender and Women Entrepreneurship” was

also imparted in village Boratia of Dumoria Upazila, with 30 women participants who are currently involved in seedling raising activities using project introduced modern technology. Project activities have an impact on transforming agriculture from manual to mechanized farming in a great pace and enhance food security through cost and loss saving agricultural operations.

Training and Implementation of Off-Farm Hermetic Grain Storage in Bangladesh

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Abstract
Storage of paddy is one the most crucial postharvest operations in Bangladesh. In traditional storage, insect, rodent infestation and atmospheric conditions cause both qualitative and quantitative losses of stored paddy. Therefore, alternative improved storage technologies need to be introduced among the farmer/trader/miller which allows paddy to be stored safely for extended periods. In the study, the main objective was to assess the technical and financial performances of alternative improved storage of paddy in hermetic cocoon along with the traditional storage at rice miller level. Five storage approaches with 5 ton capacity cocoon namely, PVC indoor, PVC exposed, laminated PE indoor, laminated PE exposed, PE indoor, traditional indoor and traditional exposed were considered. In the study O_2 and CO_2 levels inside the hermetic cocoon were monitored in first one month of the storage. Moisture content, insect infestation, storage losses and germination test were conducted using standard methods. O_2 concentration levels of stored paddy in all hermetic cocoons were decreased and CO_2 concentration increased. Maximum insect population was found in traditional indoor (TRI) storage (about 28 insects/250g paddy in *Boro* and 18 insects/250g in *Aman*). No insect was detected in hermetic cocoons. In both seasons, maximum number of damaged paddy was found in TRI. No damaged grain was observed in hermetic cocoons. In *Aman* and *Boro* 2020 maximum weight loss of paddy was found 8.17 kg and 11.21 kg/100 kg, respectively in TRE. Minimum weight loss was found in PEI type cocoon in both the seasons (*Aman*: PEI 0.12 kg/100 kg; *Boro*: 0.08kg/100kg). Users would get return on investment after two seasons (1 year) of storage in PEI type hermetic cocoon. Based on the technical and financial performances and user friendly status, PEI type hermetic cocoon is feasible to store paddy in the miller/trader/farmers' level for consumption and selling purposes.

Post-Harvest Loss Reduction Innovation Lab (PHLIL)-Bangladesh Phase II

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Abstract
Paddy is the staple food grain of Bangladesh. Paddy is dried and stored traditionally both at farmers level and at commercial level like major rice mill which incurs considerable amount of postharvest loss for both consumable and seed paddy. Even, public seed processing centers of Bangladesh Agricultural Development Corporation (BADC) experience difficulty in bulk paddy seed storage. Hence, the project is introducing climate smart drying and storage solutions according to the necessity and capacity of the stakeholders. Farmers found BAU-STR dryer as an efficient grain drying technology round the year in any weather condition. Drying practice of grassroots level farmers of Mymensingh,

Netrokona, Bogra, Jashore, Jhalokathi and Barishal districts of Bangladesh were strengthened providing more than 200 BAU-STR dryer. An integrated 12 ton capacity medium scale recirculating dryer has been designed for drying both parboiled and aromatic paddy controlling the operating parameters. The dryer has been installed at a major rice mill to assess the proposed six-step drying method in actual conditions. A generalized drying rule will be developed based on the experimental results. Quality of farmers' seed stored in GrainPro bag remained intact and more than 90% germination percentage was found. Efficacy of 30 ton capacity hermetic cocoon for large-scale storage of paddy seed was evaluated along with traditional gunny bag at BADC seed processing center, Madhupur, Tangail. The experiment reveals that moisture content was varied in the traditional gunny bag 11.37% to 12.01%, however it remained the same in the hermetic cocoon. Hermetic cocoon performed better in maintaining anaerobic condition and seed vigor than that of gunny bag and found suitable for bulk storage of paddy seed. Farmers, BADC officers and employees and rice mill owners (M: 717, F: 411) were trained on the identified technologies and its gender dimension through field demonstrations, FGDs and training programs.

Development of a Mathematical Model to Calculate Optimized Distance Between Furrows in Raised Bed Water Saving Techniques for Rice and Non-rice Crops Cultivation

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Abstract

An experiment was conducted at the Field Irrigation Laboratory, Bangladesh Agricultural University, Mymensingh, for investigating the effects of bed width on soil water content, growth and yield attributes of rice and wheat cultivated under raised bed (RB) water saving irrigation techniques. In 2020, RB45 (bed size 45 cm) irrigation treatment produced the highest yield (5 t/ha) over other treatments including conventional continuous flooding (CF) irrigation treatment. The same experiment when repeated in 2021 yielded highest yield of 8 t/ha for CF treatment followed by RB45 treatment (7.6 t/ha). For the experiment on wheat, RB45 also produced the highest yield (2.5 t/ha). Therefore, this research concludes that RB45 irrigation treatment may be taken as an alternative irrigation to CF irrigation. For the rice experiment in 2020, RB45 treatment resulted in the highest water productivity (WP) of 0.5 kg/m^3 whereas the corresponding value under CF treatment was 0.37 kg/m^3. In the experimental rice plots, the upper soil profile where root zone exists is subject to rapid dryness due to evapotranspiration whereas lower soil profile remained relatively wetter throughout the growing period. Darcy's infiltration model showed a relationship between the measured and calculated infiltration rates with mean R^2 values of 0.3536, 0.294 and 0.3651, respectively for 65 cm, 45 cm and 25 cm RB treatments. Though RB65 treatment required the lowest amount of water, its yield was found lower than that of RB45 treatment. The RB45 treatment produced the highest water productivity and grain yield. Sufficient water could not be reached to the central portion of 65 cm wide RB which caused its lower productivity. For RB25 treatment, although the beds were well wetted but lower net cultivable area (i.e. RB area) due to higher number of furrows was the prime reason behind its lower water productivity. This study concludes that for a particular field condition, it is necessary to grow rice with optimum bed size to get maximum yield and water productivity.

Quality Assessment and Environmental Consequences of Dairy Farm's Wastewater Irrigation in Rice and Wheat

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Abstract
An experiment was conducted at the Field Irrigation Laboratory of the Bangladesh Agricultural University (BAU) to investigate the consequences of dairy farm's wastewater irrigation on Boro rice production during 31 January 2021 to 4 May 2021. Six treatments were applied in the experiment, which were combinations of irrigation application techniques and types of irrigation water. The treatments were- T_1: Conventional irrigation method with fresh water, T_2: Conventional irrigation method with mixed water (fresh water: dairy wastewater= 1:1), T_3: Conventional irrigation method with wastewater, T_4: Alternate wetting and drying irrigation method with fresh water, T_5: AWD irrigation method with mixed water (fresh water: dairy wastewater= 1:1 and T_6: AWD irrigation method with wastewater. Raw wastewater contained high amount of Total viable count (TVC), *E-Coli* and Salmonella but leached water collected from lysimeter showed only TVC. The highest TVC of leached water (3×10^5 CFU/ml) was found in treatment T_6 at 80 days after transplanting (DAT). After harvesting the highest TVC was found (7.5×10^5 CFU/g) from the top soil of treatment T_6. The highest grain yield (7.88 t/ha) and water productivity ($0.69 \pm 0.09 kg/m^3$) of rice were obtained under the treatment T_6. The lowest grain yield (5.82 t/ha) and water productivity ($0.36 \pm 0.01 kg/m^3$) of rice were obtained under the treatment T_1. The highest value of plant height (99.15 ± 5.1 cm), panicle length (24.97 ± 1.84 cm), number of productive tillers/hill (19.61 ± 5.91), and number of tillers/hill (22.17 ± 6.73) were obtained in treatment T_3. The lowest value of growth parameters was found in treatments where fresh water was used. So application of wastewater apparently increased nutrient content in soil which contributed to growth and yield. Sodium adsorption ratio, soluble sodium percentage, residual sodium bi-carbonate, total hardness and magnesium adsorption ratio of dairy wastewater were suitable for irrigation. The AWD technique saved 32.3% water than continuous flooding. It is clear that dairy farm's wastewater can be used as an alternative source of irrigation but it should be used with proper management practices to maintain proper soil health.

Rating of Power Plant Disposed Water for Irrigation at Different Available Power Plants in Bangladesh

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Abstract
A study was conducted to evaluate the extent to which power plant disposed water is suitable for irrigation. Thirty water samples were collected from the main, secondary, and tertiary irrigation canals of Ashuganj and Ghorashal power plants. These irrigation schemes are mainly used for rice cultivation. Collected water samples were tested for the following parameters pH, electrical conductivity (EC), total dissolved solids (TDS), Ca, Mg, S, K, S, Cl, CO_3, HCO_3. Based on the chemical parameters, sodium adsorption ratio (SAR), soluble sodium percentage (SSP), residual sodium carbonate (RSC), magnesium adsorption ratio (MAR), total hardness (TH), Kelly's ratio (KR), permeability index (PI), potential salinity (PS) and alkalinity hazards were calculated for the analysis. Soil samples from the

irrigated fields of both sites were also collected and analysed to see the impact of the disposed water on-field soils. The Ghorashal powerplant's disposed water is perfectly suitable in terms of acidity with minimum pH of 6.1 in contrast to Ashuganj powerplant's. In terms of EC, TDS, SAR, SSP, RSC, TH, KR, PI, and PS the water from both the study areas is suitable for irrigation. Maximum EC is found 356.92 µS/cm which is desirable along with the average SAR for Ghorashal is 0.932 and the mean RSC value is -1.140 meq/L for Ashuganj powerplant disposed water. Though the highest MAR was found to be 63.58, both of the areas have an average value below 50. For Ashuganj powerplant's disposed water, only KR and PI showed a strong correlation with other parameters and the rests combinations are moderately correlated. Likewise, the water from the Ghorashal powerplant showed a strong correlation with other parameters for PI and KR, but the rest correlations are below moderate level. From the above analysis, it can be concluded that disposed water from the studied powerplants is suitable for irrigation.

Predicting Yield and Water Productivity of Sunflower Under Deficit Irrigation Using Aqua Crop model

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Abstract

An experiment was conducted at Field Irrigation Laboratory of the Department of Irrigation and Water Management, Bangladesh Agricultural University, Mymensingh during November 2020 to March, 2021 to study the effects of deficit irrigation on yield of sunflower and to calibrate the obtained data in Aquacrop model. The experimental site has a silty loam soil that is poor in organic matter (1.26%) and rich in potassium. Each experimental plot was designed as 2m wide and 3m long. Field trials were laid out in a randomized complete block design with three replications. Three sunflower growth stages: vegetative, flowering and grain filling stage were identified and a total of 5 irrigation treatments including a non-irrigated treatment (rainfed,T1) were applied. The experimental fields of T_5 treatment were watered at each growth period. In T_3 treatment, fields were watered at flowering plus grain filling stage. In T_2 and T_4 treatment, fields were watered at flowering and grain filling stages, respectively. Plant height was measured for each plot prior to each irrigation application or at 10 days apart. From harvested data effective and non-effective seed number, seed yield, biomass yield, dry matter yield and 1000-seeds weight were collected. Highest plant height (162.27 cm) was obtained from T_4 treatment. Maximum seed yield (2.08 t/ha), straw yield (3.5 t/ha) and biomass yield (5.6 t/ha) were observed in T_4 treatment. But T_1 and T_5 treatment had the highest harvest index (40%). The results revealed that during water scarce condition maximum yield and water productivity can be obtained from a single irrigation in flowering stage. Observed field data were calibrated using Aquacrop model and potential yield was simulated for sunflower. Simulated sunflower yield was found to be much higher than the observed yield. Therefore, flowering stage is the most critical stage to avoid water stress when we consider deficit irrigation.

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Experimental and Modeling Approach of Maize Yield and Water Productivity Under Deficit Irrigation

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Abstract
An experiment was conducted at Field Irrigation Laboratory of the Department of Irrigation and Water Management, Bangladesh Agricultural University, Mymensingh during December 2019 to May, 2020 to study the effects of deficit irrigation on yield and water productivity of maize. The experimental site has a silty loam soil that is poor in organic matter (1.26%) and rich in potassium. Each experimental plot was designed as 2m x 2m land maize seeds were sown in line with spacing of 50 cm x 20 cm.. Field trials were laid out in a randomized complete block design with three replications. Four known maize growth stages: vegetative (V), tasselling (T), cob (ear) formation (C) and milk (M) stages of maize were identified and a total of 6 irrigation treatments including a non-irrigated treatment (rainfed) were applied. At VTCM treatment all the experimental treatments were watered at each growth period. Individual treatments were treated similarly except for omitting the irrigation application at a specific growth stage. Water application at the beginning of growth period increased the plant height of all treatments receiving water at this time. Irrigation applied at the tasselling period resulted in plant height up to 231.25 cm. Plants of non-irrigated and C treatment exposed to water stress during tasselling period had the shorter heights ranging from 222 to 224 cm. The yield of any treatment exposed to water stress at one or more growth stage was significantly lower than the fully irrigated (VTCM) treatment. The highest grain yield (4152.09 kg/ha) and biomass yield (7400.42 kg/ha) were obtained from TCM treatment and water deficit in tasselling period resulted in grain yield reduction. Maximum grain yield/ear (0.18 kg/ear) was obtained from TCM treatment. Maize grown under condition of water deficit during both tasselling period and rainfed treatment gave the least grain yield per ear. The highest weight of 1000 kernels (364.41g) was recorded for the treatment including irrigation in the cob formation stage and the highest kernel number (509) was found for TCM treatment. The highest water productivity was obtained from C treatment. Observed field variables such as weather data, soil, irrigation application and cropping period were calibrated in Aquacrop to determine potential yield of maize. The highest potential biomass yield (15480 kg/ha) and grain yield (7646 kg/ha) were obtained from VTCM treatment which were different from our observed result. In field we found the highest yield from TCM treatment and yield was also very low compared to simulated yield from Aquacrop. This difference in results can be caused due to data error or some adverse field conditions which is not included in Aquacrop model.

Environmental Fate of Water and Nutrient Applied in Agricultural Land as Affected by Water Management Techniques

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Abstract
Maize as a promising cereal crop for delivering food and feed in Bangladesh, cost reduction in maize production with optimal usage of water and nutrients is critical. Partial root zone drying irrigation techniques are known for increasing water use efficiency; however, their effects on maize yield and water productivity are somewhat unclear. A study was conducted in two experimental setups (field and

lysimeter) in 2019–20 and 2020–21 in Mymensingh, Bangladesh with the following five treatments: (i) full irrigation, (ii) half irrigation, (iii) fixed furrow partial root-zone drying irrigation (FPRD), (iv) alternate furrow partial root-zone drying irrigation (APRD) and (v) no irrigation (rainfed). Results show that the treatments slightly affected soil water, nitrogen and phosphorus distribution in the root zone soil. Plant heights both in the field plots and lysimeter were not affected by the FPRD and APRD treatments. The full irrigation gave taller plants especially in the vegetative stage, but the values did not significantly differ from the values obtained in PRD. In the field, the yield components were not affected by the irrigation techniques in any of the seasons, whereas in the lysimeter, only cob length and grains/cob were significantly reduced by the rainfed treatment. The PRD irrigations did not reduce grain yield compared to the full irrigation except in the 2nd season lysimeter experiment. The rainfed treatment had lower yields in lysimeter in both seasons. The FPRD had higher water productivity than the full irrigation in the 1st season field experiment only. The study suggests that PRD irrigations can successfully be used for maize production in Bangladesh.

Groundwater Recharge Potential and Pollution Risks from Paddy Field as Affected by Geologic Formation

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Abstract

In order to sustain long-term groundwater use, it is essential to know the hydrogeochemical responses and seasonal nutrient dynamics in groundwater as affected by intensive pumping. This study was undertaken to investigate the nutrient content at different layers in the vadose zone of the local geologic formation and the seasonal nutrient dynamics in the aquifers. Observation wells installed by hand percussion method were used to monitor groundwater level before and during pumping. Samples of geologic formation materials were collected during the drilling of the observation well to investigate the characteristics of the geologic formation, and a bore log was prepared. The bore log showed that a deep confined aquifer and an upper water table aquifer were apparently separated by a clay layer. Total 48 weekly water samples were collected from both observation wells for chemical analysis. Results show that the aquifers are not hydraulically connected because the static water levels in the two aquifers were not the same. The deep confined aquifer had quicker response to local rainfall than the overlying shallow aquifer. Moreover, during pumping from the deep aquifer about 1-m drawdown occurred only in the deep confined aquifer, but the shallow aquifer did not experience any drawdown. Water quality parameters of these aquifers were different indicating that the aquifers are not chemically connected. Nitrogen and phosphorus concentrations were higher in the layers of the vadose zone where clay content was higher. Nutrient inputs to the farmland and irrigation return flow contributed to the nutrient accumulation in the vadose zone, which can threaten the groundwater quality. Nitrogen concentrations in both aquifers had a seasonal pattern, with high values in wet seasons and low values in dry seasons. On the contrary, phosphorus concentrations in these aquifers were higher during February-June and lower during September-January.

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Efficacy of Solar Powered Submergible Pumps in Sustaining Irrigated Boro Rice Cultivation in Off-Grid Haor Areas

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Abstract
Hundreds of haor wetlands in the north-eastern part of Bangladesh have a great potential for boosting the country's irrigated agriculture. These lands are heavily cultivated with high yielding Boro rice in the dry season (December–May). Carbon rich top soils of haor areas have been a natural additive for bumper Boro production. Nonetheless, scorching heating weather most often dries rivers and haors in March and onwards leaving growing rice vulnerable to water stress. Low capacity (~0.5 cusec) and cheaper diesel operated surface water pumps (suction mode) are the main pumping mode that lifts water from aquifers using shallow tube wells (STWs). However, success of this approach most often is stumbled when groundwater level (GWL) drops below the practical suction limit (15–18 ft). Because vast of haor areas except peripheral villages is not under the coverage of power grid together with farmers' poor economic conditions, employing high capacity force-mode pumps (e.g. submergible type) to lift irrigation water below the suction limit has hardly warranted until today. This project is based on the hypothesis: irrigation with solar powered submergible pumps will be a viable and sustainable approach for haor Boro rice cultivation. To test the hypothesis, a haor site (Agolpa) at Itna, Kishoreganj district was selected. A baseline questionnaire survey was conducted to get information about current irrigation status of the area. A solar powered irrigation (SPI) system was designed and deployed in the haor site to irrigate Boro rice using groundwater (GW). Meteorologic data including solar radiation was monitored with a portable weather station and GWL was monitored with a pressure transducer. It was found that majority of farmers' STWs ran dry in April because of dropping GWL below practical suction limit. This study demonstrated that using SPI systems can be a viable option for off-grid haor rice cultivation in critical periods.

Classification and Adulterants Detection in Spices Powder Using Portable NIR Spectroscopy

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Abstract
The present research project has been taken to detect the adulteration of the three types of spices powder namely Chilli, Turmeric and Coriander powder available in the local markets. The portable Near-infrared spectroscopy (NIRS) was applied in this research for the classification of different types of spices powders and detection of adulterants usually added with spices powders. The samples were prepared with the addition of different percentages of adulterants such as brick powder, saw dust, rice powder, plant husks etc (i.e., 5%, 10%, 15% etc) with pure spices powders. The Near-infrared spectroscopy was then applied for measuring spectral responses from 400nm to 1000nm. With the application of necessary pre-processing and digital smoothing polynomial filters for smoothing out the noisy signals, the Rayleigh scattering rays were removed from the spectra. The chemometric analysis such as principal component analysis (PCA) and partial least squares-discriminant analysis (PLS-DA) were then applied for classification of the samples. A reasonable sensitivity (from 0.93 to 1.000) and specificity (from 0.83 to 0.940) for class predictions was obtained. The results showed that portable

NIR spectroscopy has potential for the discrimination of different spices powder based on origin. It is seen that both the pure/adulterated samples and adulterants can be classified 100% with the use of portable NIRS. Another experiment conducted with the same samples for the detection of adulterants added with the samples. The result also gave an indication that the samples under consideration have been adulterated with unwanted materials or adulterants can be detected by the applied NIR technique. However, the level or amount of adulterants added to the pure samples is yet to be determined. It is expected that in the consecutive investigations it would be possible to make a conclusion regarding the concentration of the adulterants have been added to the pure spices sample.

Detection of Pesticide Residues Used on Vegetables at Local Market in Mymensingh

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Abstract

The studies were conducted for the assessment of residue level of Dimethoate and Cypermethrin on hyacinth bean & broccoli and left over residues of pesticides in different vegetable samples such as hyacinth bean, brinjal, broccoli, red amaranth, cauliflower, cabbage and pea at local market in Mymensingh. The dissipation rate of Dimethoate was detected up to 11 days after spray (DAS) on hyacinth bean and 13 DAS on broccoli. All of the detected quantities were found above Maximum Residue Level (MRL) up to 11 DAS on hyacinth bean and 13 DAS on broccoli. The time of degradation was faster in hyacinth bean compared to broccoli. The dissipation rate of Cypermethrin was detected up to 6 days after spray (DAS) on hyacinth bean and 7 DAS on broccoli. The detected quantities were found above MRL up to 4 DAS on both in hyacinth bean and broccoli. But in case of broccoli, it was 5 DAS for Cypermethrin and 14 DAS for Dimethoate. Out of the 35 collected samples of vegetable like hyacinth bean, brinjal, broccoli, red amaranth, cauliflower, cabbage and pea from different local markets of Mymensingh region, 14.29% were found contaminated with pesticides. Most of the samples contained Diazinon and Dimethoate Acephate residues. Diazinon, Dimethoate and Acephate residues were found as multiple insecticide residues in few samples. Multiple insecticide residue represents 5.71% of the total samples and the rest 8.57% contained single insecticides residue. All of the contaminated samples had residue above MRL irrespective of single and multiple residues. Diazinon residues were found in two samples of hyacinth bean. Out of 5 analyzed brinjal samples only one sample had Dimethoate residue. Dimethoate, Acephate and Diazinon multiple insecticides were found in one sample of broccoli. Diazinon and Dimethoate multiple insecticides were found in red amaranth.

Improving Energy Use Efficiency of the Agar Oil Extraction Plant Set-Up in Haluaghat, Mymensingh

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Abstract

Agarwood is a resinous substance that has a wide range of commercial potentials. First-grade agarwood is one of the most expensive natural raw materials in the world, with prices in consumer countries ranging from a few dollars per kg for low-quality material to more than US$30, 000 per kg

for top-quality wood. In Bangladesh, agar oil is being extracted in Sylhet and Maoulivibazar Districts by traditional method and exported to the Middle East. The agar oil extracted by the traditional method is a low grade which gets low price in the international market. Also, the existing traditional extractors are not energy efficient. Hence, there is a good scope to improve the extraction and processing technology of Agarwood and thus contributing to the foreign exchange earnings of Bangladesh. The project is proposed to improve the agar production process by minimizing heat loss during distillation, optimizing the fermentation process of agarwood before extraction and ensuring utilization of agarwood distillation wastes. As a part of its heat loss minimization activity, an agar-wood oil extraction plant has been set up in Halughat, Mymensingh considering the availability of the agarwood. The energy use efficiency of the plant at its current setup was assessed and about 27% heat loss was observed during operation and hence it was found inefficient. To make it efficient, the plant has been modified using insulation material to minimize fuel consumption. Fireproof aluminum foil/sheet has been used for insulation to minimize heat loss to the atmosphere. This replacement made the plant energy efficiency significantly.

Effect of Solvent on the Extraction of Polyphenols from Banana Peel

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Abstract

Fruit and vegetable wastes such as peels and seeds are the non-product flows of raw materials whose economic values are less than the cost of collection and recovery for reuse. As a result they are discarded as wastes. These wastes could be considered valuable by-products if there were appropriate technical means and if the value of the subsequent products were to exceed the cost of reprocessing. These wastes cannot be regarded as the wastes but become an additional valuable resource to augment existing natural materials. Recycling, reprocessing and eventual utilization of food processing residues offer potential of returning these byproducts to beneficial uses rather than their discharge to the environment which cause detrimental environmental effects. This study was carried out to investigate the chemical composition and biological activity of banana peel extracts; the efficiency of the different solvent systems: aqueous, 96 % methanol, 96% ethanol and 96% acetonitrile was used for extraction of phenolic and flavonoid compounds. Banana peel relative antioxidants potential by two assays DPPH and $ABTS^{\cdot+}$ inhibitor activities was evaluated. Analysis showed that methanolic extract (96%) had the highest content of total phenolic and flavonoid were 21.04 and 24.21 mg /g DW, respectively. Most of acetonitrile banana peel extracts (96%) was found to be highest antioxidant activity. HPLC suggested that main phenolic compounds was chyrsin, qurectein and catchin. These results clearly encourage the application of banana peel as a potent natural source of antioxidant and antimicrobial sources. However, micro-encapsulation and other study is going.

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Development of an Android app for BAU Alumni and Officers and Updating of ePM

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Abstract
Over the years, mobile has evolved from an over driven toy to hyper operative tool. Mobile devices have now become the focal point in IT business. With increasing advances in mobile technology, the intuitive interfaces and high-speed data access has made mobile computing a much better experience for users. Smartphones and smarter OS has seen the emergence of utility & productivity tools, games, data-editing apps and more. These app marketplaces have made easier for people to get any relevant information at their fingertips and stay connected to their work on-demand. 80% of the time spent on mobile devices is spent using apps, 20% in browser. This demonstrates that consumers indeed want the simplicity and focus that apps provide. Therefore, if organizations and industries are not investing in mobile applications to increase productivity among their workforce (or making their own software products mobile-friendly), they are going to fall behind. Bangladesh Government has also taken initiatives to implement the vision 2021 to build a digital Bangladesh. As part of this initiative, the ICT division of Bangladesh Government has funded the development of android mobile applications for all government organizations. These applications provide easier access to information and many more facilities. In this project, an android app has been developed to include the information of BAU alumni. A website has also been developed for the management of alumni by the administrators. Several programming languages and tools have been used to develop this project. For android app development, Java, XML and Android studio have been used. For website development, HTML, CSS, JavaScript and PHP have been used. For database development, MySQL DBMS has been used. Using this app and website, BAU alumni will be connected and get the benefits in socializing and improving their careers.

Development of a Sustainable IoT based Aquaponics System for Monitoring and Ensuring the Health of Plants and Fishes

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Abstract
Aquaponics is a promising field of agriculture to meet the growing demand of food for the population and producing fish and vegetables at the same time. It reduces both the wastage of water and the application of fertilizers. In this project, we have developed IoT based integrated system to make aquaponics more sustainable and suitable for the fishes and plants. This system will automatically monitor the water level of the fishes and fill up when necessary. It will also monitor the temperature of the water and keep it in a desired range by controlling fan and heater automatically. In this project, we have used various IoT devices such as Arduino microcontroller, Wi-Fi module, data logger, temperature sensor, ultrasonic sensor, and other devices. This project can be deployed by the aquaponics owners of Bangladesh to make their aquaponics more sustainable.

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Iot and Deep Learning Based Smart System Development for Poultry Environment Monitoring and Controlling, Bird Growth and Sell Time Prediction of Poultry Farms

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Abstract

Poultry means the birds that can be domesticated for producing mainly meat and eggs. This section contributes 1% of country's GDP and around 60 lakhs people are involved in this industry. But, the production of birds depends on many factors including environment, timely food supply, and addressing immediate emergency situations. Environment is important because it affects the respiratory, digestive and behavioral patterns of the birds. Timely and adequate food supply are also important for the proper growth and at the same time for reducing food wastage. Addressing immediate emergency situations may include fire accident, disease outbreak, theft, sudden death of birds etc. So, handling all these factors are extremely important for ensuring the growth and profit of the farms. Currently, these factors are monitored and controlled by human labor force which is expensive and time consuming. So, it would be extremely beneficial if an automated system can be developed which can be deployed by the owners to monitor and control the environment and ensure proper growth rate without the need of any labor and at a cheaper cost. For this reason, we aim to build a complete smart system for poultry farms. In this system, we will collect image, video and other data using IP cameras, and sensors (e.g. temperature, light, humidity, oxygen, carbon dioxide, etc.). All these data will be analyzed in the cloud server using deep learning and different predictions will be made based on the data. These predictions will include the growth rate, selling time, and profit calculation. An automated system will be also developed using internet of things (IoT) which will regulate the ceiling fans, exhaust fans, and lights to control the temperature, light, oxygen level, carbon dioxide level, and humidity. All these modules will work together to address all of the above challenges.

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Studies on the Causes of Gonadal Development in Small Size Hilsa: Assessment of the Factors Associated with the Early Gonadal Development of Hilsa

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Abstract

The reproductive cycle of Indian river shad, *Tenualosa ilisha* has included with the migration from Bay of Bengal to the upstream rivers where they reproduce. For successful reproduction, gonadal maturity has direct relation. Six different habitats of hilsa across Bangladesh were chosen for sample collection. For determining gonadal maturity and the peak breeding season the gonadosomatic index and ovarian histology were used. We have found apparently same GSI value frequency for all the six stocks where GSI value ranges from 4-12.4 respectfully. The large GSI value found in October (8.39 – 24.93), medium GSI value found in January (3.17-16.35), and small GSI value found in April (1.88-13.90). The highest GSI value was found in October and lowest GSI value was found in April. In the present study, some hilsa were found with matured ovary before reaching their usual age of sexual maturity. Except Kali river and Gaglajur haor, rest of the four stocks showed normal ovarian development pattern in respect to their size and age. The causes of these variations are not yet clearly understood, however; the nutrient availability, environmental variation, and gene-environment interaction might be attributable to the diversities displayed by the hilsa from different regions of Bangladesh.

Effects on Breeding and Larval Growth Performance of Minnow, Labeo Ariza in Response to Brood Stock Size Implicated for Quality Seed Production

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Abstract

This experiment was conducted to investigate the effect of size of brood stock on breeding performance, egg fertilization, and hatchability and fry survival rate of Labeo ariza in an intensive culture system, for a period of eight weeks. Larger brood stock size (180-290g) produced larger eggs and bigger fry while moderate brood stock size (70-130)g produced moderate eggs and moderate fry and small brood stock size (35-50g) produced smaller eggs and fry. The mean size of eggs produced and the size of brood stock was however not significantly different ($p > 0.05$). In addition, larger eggs resulted in larger fry. The survival rate of fry after starvation increased with increase in parent brood stock size. Best on this study it was recommended that for larger eggs and fry production, brood stock of Labeo ariza should be selected for use in fish hatchery operation in Bangladesh. There was no significant difference ($p> 0.05$) in the physiochemical parameters.

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Modeling Climate Change Impact on Agriculture and Developing Mitigation and Adaptation Strategies for Sustaining Agricultural Production in Bangladesh

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Abstract

Abstract: An experiment was conducted for assessing climate change impacts on growth and seed production of tilapia (*Oreochromis niloticus*) in traditional and control husbandry systems to develop mitigation strategies for sustainable hatchery operation. However, water quality parameters were varied such as water temperature (21-37.5^{0}C), water pH (7.3-11.5), dissolved oxygen (6.2-9.4), ammonia (0-0.5) and water transparency (8-35 cm) were recorded in the ponds of hatchery system. Regarding the assessment of plankton abundance, the Phytoplankton like Baciollairophyceae (1.5x10^5 cells/liter to 7.5x10^{5}cells/liter), Chlorophyceae (0.5x10^5 cells/liter to 3.5x10^5 cells/liter), Cyanophyceae (0.5x10^5 cells/liter to 3.5x10^5 cells/liter), Euglenophyceae (0.5x10^5 cells/liter to 1x10^{5}cells/liter), Rhodophyceae (0- 0.5x10^5 cells/liter), Xanthophyceae (0- 0.5x10^5 cells/liter) and Dianophyceae (0-0.5x10^5 cells/liter) including the presence of Zooplankton; Copepoda (0-300000 no/liter), Rotifera(0-350000 no/liter), Cladocera (0-300000 no/liter), Ostracods (0-50000 no/liter) and Protozoan (0-450000 no/liter) were recorded during the reporting period. Growth of fishes were observed monthly basis like % length gain average in T_1(male 2.05%, female 1.70%), T_2(male 5.21%, female 4.33%) and T_3(male 4.17%, female 3.97%) where % weight gain average in T_1(male 3.40%, female 5.08%), T_2(male 7.29%, female 5.72%) and T_3(male 5.59%, female 6.12%). Food conversion ratio (FCR) highest in T1(2.89) and lowest in T_2(2.19). Specific growth rate (SGR) (%/day) average highest in T_3(0.28%) and lowest in T_1(0.17%). Reproductive performance of tilapia were assessed during production of the year. Egg diameter varied from 1.5 to 3 mm in three treatments. Egg volume 0.25 – 0.98 mm^3. Egg color was observed; 91.16% blacking (grade-I), 7.73% brown(grade-II) and 1.11% light grey(grade-III). Sperm motility rate 40-65% was found using normal tap water. Sperm concentration/volume was found 26.24x10^6/ml to 90.40x10^6/ml. Sperm P^H 7.50 to 7.90. GSI value maximum4.38 in September and minimum 0.09 in February. Average level of Progestoren (male 0 ng/ml, female 0 ng/ml), Testosteron (male 6.36ng/ml, female 6.66ng/ml) and 17-β estrodial (male 312.16pg/ml, female 432.83pg/ml) were found in three ponds. Overall impact of climate change in fish hatcheries is great barrier against sustainable fish production. However, further detail study is needed about the impact of climate change on the fish hatcheries and overall in fisheries of Bangladesh.

Effects of Temperature on Embryonic and Larval Development of Bhagna, *Labeo ariza*

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Abstract

The influence of water temperature has been studied on embryonic and larval development of newly potential culture species *Labeo ariza* under laboratory condition. Fertilized eggs of *L. ariza* were

incubated at five different temperature conditions such as control, 26, 28, 30 and 32^0C. The embryonic development stages were completed within very short period of time at 32^0C but survival rate (13.53±8.82%) was very poor due to high mortality of larvae at this temperature. On the other hand, at 260C temperature duration of embryonic stages was delayed by 239.6 minutes from 32^0C. The hatching was started first in 320C (1020.5 minutes) then followed by 300C (1080.7 minutes), 280C (1140.1 minutes), control (1260.1 minutes) and 26^0C (1380.7 minutes). The percentages of hatching success of five respective temperatures (Control, 26, 28, and 32^0C) were 65.34±3.388%, 63.70±6.601%, 83.70±4.479%, 67.06±3.284% and 51.96±4.391%, respectively. The 28^0C temperature showed significantly highest hatching success among five incubation temperatures whereas 32^0C temperature showed significantly lowest hatching success. The exogenous feeding of larva started first after mouth opening and yolk sac resorption in 28^0C (64 hours) then followed by 30^0C (65 hours), control (68 hours), 32^0C (70 hours) and 26^0C (72 hours). The percentages of survival rate of larva in five respective temperatures were 83.63±4.373%, 72.23±6.002%, 91.93±1.637%, 73.96±4.662% and 13.53±8.82%, respectively. The 28^0C temperature resulted in the significantly highest (91.93±1.637%) survivability of larvae. The highest growth was found in larval rearing temperature of 28^0C and the lowest growth was found in temperature of 26^0C. The results suggested that 32^0C might be an acute temperature during embryonic and larval development of *L. ariza* species. The 26^0C temperature might also be an effective temperature due to longer embryonic period and shorter growth and development of larva. Therefore, the results of the current study suggested that 28^0C as a suitable temperature for best seed production and culture of *L. ariza* species. The findings of this study are applied in a commercial context for further improvement at the hatchery level.

Standardization of Sperm Cryopreservation Protocols of Indian Major Carps (*Catla Catla, Labeo Rohita And Cirrhinus Cirrhosus*) And Exotic Carps (*Hypophthalmichthys Molitrix*, *Hypophthalmichthys Nobilis* and *Ctenopharyngodon Idella*) and Production of Seeds Using Cryopreserved Sperm

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Abstract
The study was conducted to establish a cryogenic sperm bank of Rohu, Catla, Mrigal of Indian Major Carps (IMCs) and Silver, Bighead, and Grass carps to produce quality seeds and broods using cryopreserved sperm in selected public and private hatcheries. Quality broodstocks of IMCs were developed by rearing of Halda and Padma river-origin fish, and that of exotic carps was developed by rearing newly imported Silver, Bighead, Grass carps collected from government hatcheries. Sperm cryopreservation and breeding protocols of Rohu, Mrigal, Silver and Bighead were standardized and breeding was successfully done in seven public and private hatcheries in Mymensingh, Faridpur and Jashore regions using cryopreserved sperm. For development of suitable extender, activation of sperm motility was evaluated at different gradients of NaCl solutions. Highest motility and swimming duration of sperm of Rohu (96±1.0% and 37.5±0.8min), Mrigal (95±0% and 39.7±0.4min), Silver (97.5±2.5% and 29.6±0.5min) and Bighead (95±0% and 20.6±2.1min) were observed at 0.4 % NaCl solution. The toxicity of cryoprotectant (DMSO and methanol) to sperm was tested at their different concentrations (5%, 10% and 15%) and incubation time (5-40min) along with two extenders (Alsever's solution and egg-yolk citrate) and found that cryoprotectants at 5 and 10% concentrations produced better motility during 5 and 10min incubation. Alsever's solution plus 10% DMSO proved best combination showing 94.3±2.3% (equilibration motility) and 90.0±2.9% (post-thaw motility) of

sperm of Rohu. Best post-thaw motility of Rohu sperm was found at 10min equilibration time (93.33±1.7%, equilibration and 88.33±1.7%, post-thaw) and at 10°C/min cooling rate (96.0±1%, equilibration and 91.67±1.7%, post-thaw) during cryogenic freezing by Alsever's solution plus 10% DMSO at the dilution of 1:9 (milt : diluent). The fertilization and hatching rates were found as 26.4±8.4% and 20±5.7% in Rohu, 37±1.5% and 29±4.2% in Mrigal, 26±8.3% and 16.3±3.7% in Silver and 43±7% and 29.5±2.5% in Bighead with cryopreserved sperm during breeding trials in public and private hatcheries.

Captive Rearing, Induced Breeding and Cryogenic Sperm Banking of Critically Endangered Indigenous Mohashol *Tor Tor*

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Abstract
The growth performance of Mohashol, *Tor tor,* reared in two ponds, was studied by applying two formulated feeds containing 37.65% (T_1) and 44.02% (T_2) protein respectively. The initial weight of the fish was 2736±290.30g and 2781±258.12g, and the final weight was 4171.88±372.67g and 5078.63±345.06g, in T_1 and T_2 respectively. Feed containing higher protein in T_2 demonstrated a positive effect on growth and maturity as fish produced enough sperm. In both treatments, length-weight relationship of the fish was estimated as $W=0.04111L^{2.70}$ and $W=0.03848L^{2.72}$ and the R^2 values, 0.9789 and 0.9672 were highly significant ($P<0.01$). All the stocked fish survived in both treatments. Water temperature, pH and DO measured in two ponds found suitable for fish culture. For induced breeding trials with PGE, the females received two doses, 6 mg/kg body weight as first dose and 12 mg/kg body weight as second dose. The males received only one dose, 3 mg/kg body weight during the second injection of female. Similarly, another hormone, Ovaprim was applied with a single dose, 0.8 ml/kg body weight for female and 0.2 ml/kg body weight for male. In both cases, after 8-12h of final injection, the male broods released sufficient amount of milt and was easily collected in epppendorf tubes. The female broods were not ovulated and seemed that they were not fully matured at this stage. The sperm qualities i.e., motility, pH and concentration of fresh sperm were evaluated and found as 95-100%, 9.0 and $3.34x10^{10}$cells/ml respectively. The texture of milt was highly concentered and quite sticky. About 90% sperm showed forward movement and 10% showed Brownian movement. During cryopreservation, the equilibration motility of sperm was estimated as 90% and the post-thaw motility was observed as 73.3%. The cryopreserved sperm was stored in liquid nitrogen (-196^{o}C) dewar which is considered as cryogenic sperm bank.

Molecular Characterization of the Growth Hormone Gene and Selection of Fast Growing Stinging Catfish (*Heteropneustes Fossilis*, Bloch) By Marker Assisted Selection

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Abstract
Stinging catfish (*Heteropneustes fossilis*, Bloch) has recently become an important species in Bangladesh due to its popularity in aquaculture. Genetic improvement of this species may enhance its production that could be achieved through a marker assisted selection program. The aim of this study

was to detect polymorphisms in the growth hormone gene and to find out association between the polymorphisms with variation in growth in order to select fast growing fish by marker assisted selection. *H. fossilis* were reared in a pond for six months and 175 individuals were randomly collected for this study. Based on the size, the fish were divided into four fish groups such as large female, large male, small female and small male. A total of 60 individuals were selected from the four groups and used for molecular analysis. Genomic DNA was extracted and an approximately 500 bp fragment was amplified using primer sets designed from the published growth hormone gene sequences. The DNA sequences were edited and aligned for 485 bp which included Exon1(partial), Intron1, Exon2, Intron2 and Exon3 (partial). A total of 16 nucleotide polymorphisms were detected among which three single nucleotide polymorphisms (SNPs) were observed in two introns which were specific for the large and small fish groups. No size group-specific SNPs were detected in the exons and so no amino acid polymorphisms were found. SNPs in intron position may be associated with overall body weight. The values of genetic variability parameters including the number of polymorphic sites, mutations, nucleotide differences, singleton variable sites, parsimony informative sites and haplotype diversity were found to be higher in the small fish group compared to the large fish group. The comparative study of genetic variation possesses that polymorphism in growth hormone gene DNA found in this research may be directly associated with growth variation among the individuals. The polymorphisms, particularly the size group-specific SNPs that have been detected could be used to screen a large group of fish by genotyping and association analysis to facilitate identification of fast growing fish by marker assisted selection.

RNA Seq Analysis and Genome Annotation of Hilsa Shad (*Tenualosa ilisha*)

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Abstract

This purpose of the project is to develop genomic tools to address key knowledge gaps in hilsa biology for sustainable harvest through creating an assembly of hilsa transcriptome, annotation and characterization of genes comprising hilsa genome and identification of genes adaptive and sensitive to environmental changes. Pieces of liver, brain, and gonad were collected from live fish of the river Meghna and Padma and total RNA was extracted. The poly(A) mRNA was isolated and cDNA was synthesized using ProtoScript II Reverse Transcriptase. The libraries with different indices were multiplexed and loaded on an Illumina Novaseq instrument according to manufacturer's instructions (Illumina, San Diego, CA, USA). Sequencing was carried out using a 2x150 paired-end (PE) configuration. We have detected transcripts of 46,749 proteins in the liver tissue, 43, 282 in the female gonad, and 38, 586 in the brain tissue. From the transcriptomes, we have identified the transcript of 20 genes of seven gene families which are involved in osmoregulation through ion-balance. The gene families include: Aquaporins, Apolipoprotein a-iv, Solute carrier family, Serine threonine-protein kinase, Rho GTPase-activating protein, ATPase-activating protein, Mitogen-activated protein kinase. We have identified transcripts of four gene family namely metabotropic glutamate receptor, protocadherin, acetylneuraminate-beta-galactosamide-alpha-2,3-sialyltransferase 1-like (*ST3GAL1-like*), and Farnesyltransferase alpha-like (*FNTA1-like)* which are involve in migratory behavior. We have also identified genes of another important family which are involved in growth and omega-3/6 synthesis: Secreted protein acidic and cysteine rich (sparc), Forkhead box protein K1 (FoxK1), Smad family member 3-like (smad3),, Ubiquitin specific peptidase 38 (usp38), Carnitine O-octanoyltransferaselike (crot), Farnesyl pyrophosphate synthase-like (fdps),, Squalene epoxidase a (sqlea), Cytochrome P450-family 7-subfamily B-polypeptide 1-like (cyp7b1), Inositol monophosphatase 1-like (impa1), Glutathione

synthetase-like (gss). The RNASeq study has created an opportunity to identify important genes from *T. ilisha*.

Effects of Dietary Polyunsaturated Fatty Acids and Beta Glucan on Broodfish (*Labeo Rohita, Mystus Cavasius* and *Ompok Pabda*) Immunity and Fry Quality

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Abstract
The aim of this study is to evaluate the effects of PUFAs enriched squid extracted lipids on enhanced maturation, spawning and dietary beta glucan in enhancing immunity of *Mystus cavasius*, *Ompok pabda* and *Labeo rohita*. The *M. cavasius* and *O. pabda*, were collected from Brahmaputra river and stocked in the cisterns and ponds. The *L. rohita* was collected from beels of Netrokona district. Treated group was provided supplemental diet enriched with 1% squid extracted lipids as a source of PUFAs and 10% mushroom powder as a source of beta glucan, for four months (March-June) whereas controlled group was fed the same except PUFAs and beta glucan. Histomorphology of liver, serum calcium ion concentration, sperm viability and vitellogenin were used to clarify gonadal maturation and a spawning trial was conducted to spell out the reproductive performances. Blood cell count, antioxidant enzyme, lysozyme enzyme and IgM were measured using standard methodology to explain the immunomodulatory effects of beta glucan on *O. pabda, M. cavasius* and *L. rohita*. Treated group attained significantly higher (P<0.01) weight increment compared to the control group and significantly higher (P<0.05) length increment was also found for *O. pabda, M. cavasius* and *L. rohita*. In comparison with the control group, treated group exhibited an advanced gonadal maturation and higher reproductive performances in spawning trial. The fertilization rate, hatching rate and survival rate of offspring of *O. pabda*, *M. cavasius* and *L. rohita* were significantly higher in treated group compared to control group. During spawning season, lipid granules in the liver of treated fish were deposited abundantly, whereas less lipid granules in the liver of control group were deposited in *O. pabda*, *M. cavasius* and *L. rohita*. Serum Ca^{2+} and vitellogenin level in the treated female was significantly higher (P<0.05) compared to the controlled female of *L rohita*, *M. cavasius* and *O. pabda*. Viable sprems in treated group of *O. pabda*, *M. cavasius and L. rohita* were significantly higher (P<0.01) compared to control. The WBCs count in blood of *O. pabda, M. cavasius* and *L. rohita* which fed with beta glucan found significant increased (P<0.05) in number as compared with the control. The lysozyme activity in the presence of beta glucan supplement showed the significantly higher lysozyme in the seurm of *L. rohita*, *O. pabda* and *M. cavasius* compared to control groups. The IgM was increased significantly in beta-glucan group compared to the control group. The study suggests that supplementation of dietary PUFAs and beta glucan improve the spawning performances and immune status of *O. pabda, M. cavasius* and *L. rohita.*

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Effects of Soybean Meal in Diets Replace with Fishmeal on New Muscle Generation of Tilapia, *Oreochromis niloticus*

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Abstract
This study was designed to determine the effect of fishmeal (FM) replacement with soybean meal (SBM) in diet on the new muscle generation of tilapia (*Oreochromis niloticus*). Five diets were formulated where diet 1 (D_1) contained fishmeal as the primary protein source (SBM 0), and in other diets FM was substituted with graded levels of SBM to replace 25% (SBM 25), 50% (SBM 50), 75% (SBM 75) and 100% (SBM 100) of fishmeal naming as D_2, D_3, D_4, and D_5, respectively. Juvenile tilapia having initial weight and length of 6.60±0.13 g and 5.42±0.17 cm, respectively were randomly divided into five treatment groups each having 40 individual and fed to visual satiation for 180 days. Fish fed with D_1 and D_2 diets, had significantly higher number of muscle fiber compared to D_3, D_4, and D_5 diets (SBM 50, 75 and 100%). The diameter of muscle fiber (μm) was significantly changed with the increasing SBM in diet. These results observed more small muscle in D_1 and D_2 diets (SBM 0 and 25%) that means more new muscle was generated in D_1 and D_2 diets. High level of SBM showed the lowest density of muscle fiber.

Impacts of Freshwater Mussels on Aquatic Communities and Ecosystem

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Abstract
The mussels are known for bio-indicator for aquatic ecosystems. The objective of the work is to determine the waste water clearance, dye and heavy metals absorption by mussels. Mussels were released in the fertilized ponds and a control was maintained without mussels. Sacchi disc depth was measured weekly. Mussels were released in the cisterns to determine the absorption of waste products. In dye adsorption experiments, 5 ppm methyl blue (six plastic bowls) and 5 ppm methyl red (six plastic bowls) were added. Two mussels were placed in the dye containing water of plastic bowls for 7 days and control was maintained without mussels. Mussels and water were collected from the Bramaputra, Rupsa and Buriganga rivers for analyzing the heavy metals. For metal analysis, 0.2 g each of dried mussel flesh or water were weighed and placed in a Teflon reactor, and digestion was performed with nitric acid. Cu, Cr, Cd, Pb and Zn were determined by an inductively coupled plasma-mass spectrometer. The number of planktons were fish+mussel group<mussel group<fish group. It indicated that mussel consumed more plankton than fish. There were no nitrites, nitrate and ammonia in the cistern water of mussel group. Higher amount of nitrites and nitrate were found in the water of fish group, but comparatively lower amount of nitrites and nitrates were found in mussels+fish group. Mussels were absorbed methyl blue and methyl red significantly higher compared to the control group. Heavy metal in the mussels of the Buriganga river was higher than the mussel of the Brahmaputra and Rupsha rivers. The results suggested that mussels can consume plankton and absorb waste products, dye and heavy metals.

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Impact of Climate Change on the Fisheries Resources and Fishers' livelihood in the Lower Meghna River

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Abstract
Climate change is a contemporary global threat to the world especially for Bangladesh, because of its geographical location. The study was conducted to assess the effects of climate change on fisheries resources and livelihood of fishermen in the lower Meghna river. The data on fisheries resources was collected by using a well-developed questionnaire from the fishers and selected fish landing centers. The water quality parameters and primary productivity were measured by using appropriate apparatus and plankton nets. Sediment samples were collected by using Ekmandrege. Sixty fish species belonging to 13 orders and 29 families were documented in the Meghna river. Forty one and 24 genera of phytoplankton and zooplankton were identified in the lower Meghna river, respectively. Maximum number (3358 indi./m^2) of macrobenthos were found in Nereidae family where minimum (44 indi./m^2) in Echuiridae family. Rest were Capitellidae (310 indi./m^2), Syllidae (400 indi./m^2), Mysidae (177 indi./m^2), Lumbrinereidae (666 indi./m^2), Goniadidae (1021 indi./m^2) and unidentified (2858 indi./m^2) were recorded. Five macrobenthic groups (Taxa) were identified where number of Polychaeta (7819 indi./m^2) was highest in each month and Gatropoda (44 indi./m^2) was lowest. Others were Bivalvia (176 indi./m^2), Crustacea (664 indi./m^2) and Oligochaeta (619 indi./m^2). The average temperature, dissolved oxygen, pH and salinity were recorded as 27.5 ± 0.90°C, 6.37 ± 1.11 mg/L, 8.3 ± 0.59 and 1.10 ± 0.10 ppt, respectively. In the present study, it was found that most of the fishers were belonged to the age groups of 41 to 60 years (45%), represented by 75% muslim and joint family type (61%) was the predominant among the fishers. The results of the present study revealed that the fish species are decreasing day by day in the Meghna river despite abundance of plankton and macrobenthos.

Generation of Saline Tolerant Tilapia: A Need Based Study for the Coastal Zone of Bangladesh

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Abstract
Identification of the genes for salt tolerance to study the level of prolactin and transferrin gene polymorphisms in F1 generation of (*O. niloticus* (♀) × *O. mossumbicus* (♂)) hybrid was conducted through five microsatellite loci named Prl (L-K), Prl (S-K), Prl-MS01, TFA and TFB. Genomic DNA was isolated from 20 fish (10 male and 10 female) samples. The microsatellite markers were amplified by polymerase chain reaction, separated on polyacrylamide gel electrophoresis and visualized by ethidium bromide staining. All five loci were found to be polymorphic in this hybrid population. Locus Prl (L-K) had the highest numbers (six) of alleles while the locus Prl (S-K) and Prl-MS01 had the least number (four) of alleles. In locus Prl (L-K) six alleles (from 236bp to 281bp) were found, where all the alleles were present in male whereas three alleles (236bp, 246bp and 271bp) were absent in female. All alleles were present in Prl (S-K) locus which ranged from 507 to 531bp. On the contrary, among 4 alleles from 256bp to 288bp in Prl-MS01 locus, the male hybrid population showed two absent alleles (256bp and 288bp) while the female showed no absent allele. The other two microsatellite loci, TFA and TFB in F1 generation were analyzed in this study were also found to be

polymorphic. A total of five alleles were found in both TFA (from 300bp to 380bp) and TFB locus (from 177bp to 215bp). No alleles were absent in female hybrid for TFA and TFB. But in case of male 300bp was absent at TFA locus whereas 177 and 195bp were absent at TFB. The average observed heterozygosity (H_o) value in male hybrids (0.380) was lower than that in female (0.400) populations. In locus Prl (L-K) in both male and female hybrid, the F_{IS} values were positive indicating deficient in heterozygosity. While in rest of the loci the F_{IS} values were found indicating excess of heterozygosity which might occur due to the presence of over-dominant selection or the occurrence of outbreeding or Wahlund effect. The test for fit to Hardy-Weinberg expectation revealed that both male and female hybrid population were found to be deviated from Hardy-Weinberg expectations in 8 out of 10 tests. The deviation from Hardy-Weinberg Equilibrium at locus Prl (S-K) in male hybrid population and at two of loci Prl (S-K) and Prl-MS01 were high ($p<0.0001$). The deviation from Hardy-Weinberg expectation at locus Prl-MS01 ($p<0.01$) and TFA ($p<0.05$) in male hybrid population was relatively low compared to that in female hybrid population at locus Prl-MS01 ($p<0.001$) and TFA ($p<0.01$).

Effects of an Application of Synbiotics on Growth, Persistence and Immune Responses in a Commonly Cultured Catfish, *Heteropneustes fossilis*

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Abstract

This experiment investigated the effects of dietary synbiotics on growth performance, survival, immune responses and to assess the efficiency of synbiotic on hematological changes in the stinging catfish (*Heteropneustes fossilis*). A total of 180 *H. fossilis* with average initial weight 5.7±0.61 gm and average length of 9.7±0.58 cm were randomly stocked and after acclimatization fishes were fed with different synbiotic concentrations like 0% (T1), 0.3% (T2), and (0.7%) T3 (8.3×10^6) cfu/ml as well as the control group (C) was fed normal diet without any addition of synbiotic. All treatments were fed twice a day at the rate of 3% body weight for 60 days. The results showed that synbiotic could significantly enhance growth parameters (weight gain, specific growth rate, daily weight gain, survival etc.) ($P < 0.05$) but did not exhibit any effect on percentage weight gain, length gain ($P > 0.05$) compared with the control. Hemoglobin level was highest in T3 (7%) synbiotic suspension compared with control. Overall studies, the best result were founded in T3 (7%) synbiotic suspension. The incorporation of Synbiotic diets improved growth performance and survival, so synbiotic could be recommended for farmers practicing catfish culture in particular *H. fossilis* for successful grow out culture.

Effects of Synbiotics on Growth, Persistence and Immune Responses in Stinging Catfish (*heteropneustes fossilis*)

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Abstract

Synbiotics are a combinational supplementation of probiotics with prebiotics to improve the health status and productivity of the host animal. Our study investigated the effects of dietary synbiotic (a group of probiotics at a dose of 8.3×10^7 CFU/ml with a mixture of prebiotics) supplementations on

growth performance, body indices, and hematological and biochemical parameters in *Heteropneustes fossilis*. A total of 180 *H. fossilis* fries with an average initial weight of 5.7±0.61 gm and an average length of 9.7±0.58 cm was randomly stocked into three groups T1 (control; no synbiotic), T2 (3%) 8.3×10^7 CFU/ml and T3 (7%) 8.3×10^7 CFU/ml groups. Fishes were fed twice a day at the rate of 3% body weight for 60 days, while T2 (3% synbiotic) and T3 (7% synbiotic) received synbiotic supplementations (3% and 7% of basal feed, respectively) once in a 15-day interval throughout the feeding trial. At the end of the study, it was observed that synbiotic supplemented groups showed significant increment in five growth parameters, weight gain (WG), length gain (LG), percent weight gain (PWG), daily weight gain (DWG), and specific growth rate (SGR) gain compared to the control. Besides, among three body indices (hepatosomatic index (HSI), viscerosomatic index (VSI), and carcass yield (CY)), VSI and CY were significantly affected by the synbiotic supplement in the feed of stinging catfish. Furthermore, the blood hemoglobin was significantly higher in T3 (7%) compared to control, while blood glucose level was unaffected. Some parameters were not changed significantly after 15 or 30 days of treatment with the synbiotic, but after 60 days, their differences with the control became significant, which indicates a substantial effect of culture period on these parameters. Therefore, it could be concluded that this synbiotic can potentially change the growth and health status of stinging catfish, and the results will be more prominent if the fish is treated with the synbiotic for a longer period.

Fish Biodiversity Study and Suggested Conservation Measures in the Transboundary River – Someshwari

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Abstract

The River Someshwari is a major transboundary river in Netrakona District of Bangladesh. In past, the river was full of many important fishes, but now, is now under great danger regarding habitat and species biodiversity. Many fishes are threatened and many have already become extinct. To date, however, no comprehensive research is conducted to study the fish biodiversity of the river. A comprehensive study (2019-21) was conducted in the river Someshwari with a broad objective of helping stakeholders to understand current biodiversity status of the river, causes of biodiversity loss and potential conservation measures. A total 61 finfishes have been observed over the study period. The number of fish gradually decreased from sampling month 1 to 4 but again increased in the sampling month 5 and 9. Fish diversity decreased compared to previous years. Two key factors responsible for gradual disappearance of fish are – sand/stone excavation and coal picking from the riverbed. Water abstraction in upstream and set up of roads, fencing etc. across river are detrimental for fish. Species and ecosystem biodiversity is in the dire state, gradually decreasing over the years and needs immediate actions for conservation - restoring habitats, regulate fishing intensity, control gear type and fish size and setting up fish sanctuary. Well-planned dredging in main river channel is needed. Coal, stone and sand excavation must be stopped. Setting up of 2-3 permanent fish sanctuaries in the strategic locations will have immense benefit in conserving the fish diversity. All people including fishers should be made aware on importance of this important river in respect to food, nutrition and livelihood. Transboundary river management approach between Bangladesh and Indian govt. should be immediately initiated to sustainably manage the river Someshwari.

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Detection of Microplastics from Some Aquaculture Farms Located in Mymensingh District

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Abstract
Due to persistency and potential toxicity, microplastics (MPs, <5 mm) threaten public and environmental health. Thus, understanding the ecological occurrence of MPs is crucial, but research on MPs in Bangladesh has yet in its infancy. To facilitate the understanding of the occurrence and existence of MPs, we investigated fish flesh, commercial fish feed, and rearing water from commercially important catfish farms (n=10) in the Mymensingh aquaculture zone, Bangladesh. The density separation method to extract and light microscopic technique to analyze the MPs were employed. A total of 191 MPs particles were recorded, 134 found in rearing water ranging from 8-53 μm, 45 found in fish feed ranging from 10-88 μm, and 12 found in fish flesh ranging from 7-15 μm. Fiber type MPs were the most frequent contributing of 77% in water, 62% in fish feed, and 5% in fish flesh, following fragments and films. Coloured MPs particles such as black, blue, brown, translucent, and mixed were identified. The highest abundance of MPs was found in the fish feed (6 particles gm^{-1}), compared to fish flesh or water. The ingestion of microplastics by fish feed are concerning for aquaculture production globally. Therefore, this study provides a crucial baseline for future studies of MPs ingestion through fish feed and other routes that could be a threat to public health via the food chain.

Development of Health Management Strategy Against Bacterial Diseases in the Aquafarms of Bangladesh

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Abstract
Studies were conducted to evaluate the effects of probiotic supplementations on growth, rearing water quality, hematology, intestinal morphology, and gut bacterial load of Nile tilapia, *Oreochromis niloticus*. Fifteen ponds were used for 5 treatments with 3 replications, and 400 fingerlings per pond were fed for 90 days with pre-starter feed twice a day at 5-8% of body weight. First treatment (T1) was supplemented with the soil probiotic Super PS/ week, T2 was designed to add gut probiotic Zymetin with feed, T3 contained half of the recommended doses of soil, gut, and water probiotics pH FIXER, T4 was planned to supplement with pH FIXER/ week, and no probiotic was used in T5 (control). Growth parameters (net weight gain, weight gain (%) and specific growth rate (%), SGR), survival, feed utilization (feed conversion ratio, FCR and feed conversion efficiency, FCE); water quality (dissolved oxygen, DO), free ammonia, temperature, alkalinity and pH), hematological parameters (RBC, WBC, hemoglobin, glucose, mean corpuscular hemoglobin, MCH), gut bacterial load and intestinal histomorphology (villi length, and enterocyte height) were analyzed fortnightly by sacrificing 3 fish/ treatment. Significant improvements in water qualities, growth performance, feed utilization, hematological parameters, intestinal microbial load and morphology were found with probiotic supplemented treatments than the control group where supplementation of gut probiotic (T2) and combination of soil, gut and water probiotics (T3) significantly augmented growth performance and feed utilization with improved gut microbiota and intestinal morphology. Hence, the findings

recommended the probiotic supplementation as an effective health management approach for tilapia aquaculture.

Investigation of Emerging Diseases in Fish Hatcheries

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Abstract
Fish hatchery plays an important role in sustainable aquaculture development of Bangladesh through uninterrupted supply of fish seeds. The present study was carried out to examine the nature and extent of diseases in fish hatcheries, to assess their biosecurity status and to develop protocol for better health management. The study focused in 50 fish hatcheries in Mymensingh district producing seeds of different species on commercial basis. Data was collected through combination of different survey techniques including questionnaire interview and participatory rural appraisal tools. The questionnaire focused mainly on general information on hatchery operation, water sources, sources and management aspect of fry, brood and feed, health and disease issues, status of biosecurity, use of disinfectant, disease treatment, hatchery hygiene, movement of equipment, protection of vector, quarantine, removal of dead animal, training of hatchery personnel and record keeping. It was found that the hatcheries produced seeds of tilapia, Indian major carps and other carps, gulsa, pabda, Thai koi, Thai pangas, Vietnamese koi, Vietnamese pangas, Vietnamese snakehead and some other species of fish. Generally, the hatchery production activities took place during late February and continued up to September. Peak season of production was found during April to May. A number of diseases were noticed in brood fish which included argulosis, epizootic ulcerative syndrome or EUS, gill rot, dropsy and nutritional diseases. Diseases were more frequent in winter season and after striping when the fish became weak. The major problems of fish eggs and hatchlings were fungal infection in fertilized eggs, white spot inside the yolk sac, loss of slime, spinal deformities, enlarge head and stomach, blindness and sudden spawn mortality. A number of treatments were reported for health management and disease treatment. Liming was the most common treatment followed by application of salt, potassium permanganate, antibiotics, pesticides and insecticides. The bioiosecurity status of hatcheries was not that satisfactory. This study also identified problems of hatcheries in fish health management and recommended for improvement.

Promoting Prudent Pharmaceutical Usage in Bangladesh Aquaculture: Pharmaceutical Misuse in Bangladesh Aquaculture-Understanding the Role of Information Exchange

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Abstract
While aquaculture was prophesied to meet protein demands in a sustainable manner, pharmaceutical misuse in aquaculture became high and expected to rise. Bangladesh is undergoing massive intensification in traditional to enterprise-based culture system but it lacks institutional infrastructure and policy to ensure prudent use of pharmaceuticals in aquaculture practice. With the aim of examining the role of different actors involved in aquaculture backward chain, in this study, we mapped the pharmaceutical value chain to identify the potential actors through a scoping interview

with 30 respondents; sought to better understand the relationships through focus group discussion (90 participants); and finally unrevealed the context and drivers of pharmaceutical usage through an in-depth interview with 100 respondents in Mymensingh. Value chain map referred company agents and farm shop owners as the most active players, while administrative and organizational roles remained faint in desiring, choosing, and accessing pharmaceuticals. Farms were found misusing pharmaceuticals qualitatively and/or quantitatively, irrespective of their knowledge and skills. Interest-influence analysis revealed that farmers expedited more influence but owned less interest than shop owners, however, company agents sited at the top for both regarding which, when, and how farmers used pharmaceuticals. Farmers were aware that they were provided the least independent advice by shop owners and company agents whereas fellow farmers are considered highly trustworthy, influential and legitimate in terms of advice. Private sectors (shop owners and company agents) are influential but not considered trustworthy or legitimate as governing bodies. This suggests that a community champion scheme, to work with influential members of the community, could be an effective tool to improve knowledge of prudent pharmaceutical use in aquaculture.

Harnessing Machine Learning to Estimate Aquaculture Production and Value Chain Performance in Bangladesh: Harnessing Machine Learning Techniques for Mapping Aquaculture Waterbodies in Bangladesh

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Abstract

Aquaculture in Bangladesh has grown dramatically in an unplanned manner in the past few decades, becoming a major contributor to the rural economy in many parts of the country. National systems for the collection of statistics have been unable to keep pace with these rapid changes, and more accurate, up to date information is needed to inform policymakers. Using Sentinel-2 top of atmosphere reflectance data within Google Earth Engine, we proposed six different strategies for improving fishpond detection as the existing techniques seem unreliable. These techniques include: (i) identification of the best time period for image collection, (ii) testing the buffer size for threshold optimization, (iii) determining the best combination of image reducer and water-identifying indices, (iv) introduction of a convolution filter to enhance edge-detection, (v) evaluating the impact of ground truthing data on machine learning algorithm training, and (vi) identifying the best machine learning classifier. Each enhancement builds on the previous one to develop a comprehensive improvement strategy called the enhanced method for fishpond detection. We compared the results of each improvement strategy to known ground truthing fishponds as the metric of success. For machine learning classifiers, we compared the precision, recall, and F1 score to determine the quality of results. Among four machine learning methods studied here, the classification and regression trees performed the best with a precision of 0.738, recall of 0.827, and F1 score of 0.780. Overall, the proposed strategies enhanced fishpond area detection in all districts within the study area.

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Risk-Based Pedigree-Analysis for Regulation of Prophylactic Aquaculture Health Products and Improved Smallholder Health Management in Bangladesh: Role of Dgda in Regulation of Aquaculture Drugs in Bangladesh

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Abstract
Although prophylactic health products (PHPs) are routinely framed as a response to the problem of imprudent antibiotic use in aquaculture, screening of commercial PHPs marketed to shrimp farmers in Bangladesh revealed a range of problems associated with poorly regulated products in the market. Focusing on emergent markets for PHPs in intensifying aquaculture sectors, the quality assessment tool for PHPs is under development to fit specific needs of the user-partners in order to support the target beneficiary group particularly aquaculture pharmaceutical traders and small-scale farmers. The PEDIGREE project aims to: (i) increase local industry and regulator awareness of these risks and improve regulatory policy by strategically targeting the Department of Fisheries 'National Fish Health Management Strategy of Bangladesh' ii) support implementation of national (DGDA - Directorate General of Drug Administration) drugs regulatory process; (iii) support implementation of a risk-based sampling approach to safety and quality assurance; and (iv) support adoption of the tool within a national farmer advisory helpline service operated by our NGO partners. This study focuses the role of DGDA in regulation of aquaculture drugs in Bangladesh to provide necessary inputs to develop the PHPs assessment tool. Intensive literature review on the drugs policy and activities of DGDA shows that the stake of DoF in the DGDA particularly in different committees is very limited though several committees are functioning where DoF has a lot to contribute. It was found that DGDA lacks comprehensive information base of aquaculture drugs in Bangladesh. DGDA registers all the drugs in the category of human and livestock in their web-bade information base but not for aquaculture. However, it has developed National Drug Policy 2016 where Aquaculture Medicinal Products (AMPs) have been addressed. Accordingly, DoF has developed guidelines for the control of AMPs. In the broader term of 'Aquaculture Drugs' of DGDA, prophylactic health products (PHPs) have to included and they should have the category in the registration process. The registration process of PHPs has to be easy based on the risk assessment tool.

Potential of Jute Leaf Meal-based Fish Feed on the Growth and Survival of Thai Sharpunti (*Barbodes gonionotus*, Bleeker) in Hapa System

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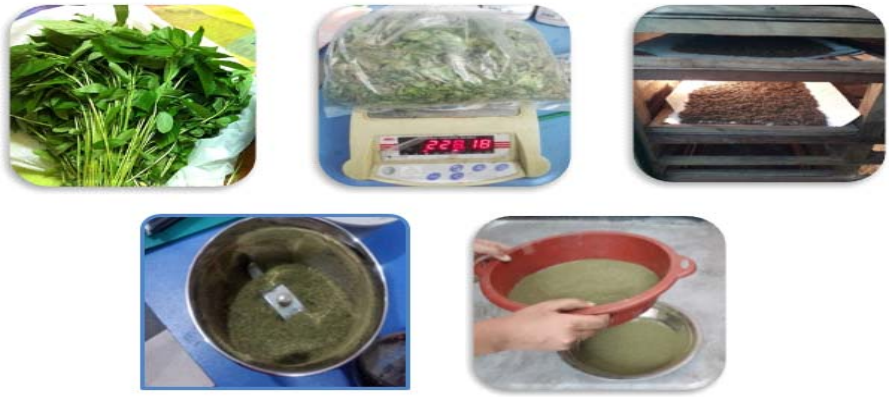
Abstract
Finding an alternative non-conventional protein and nutrient-rich plant-based fish feed ingredients, which can meet the nutritional demand and make the fish culture viable without any impairment of fish health, is an emergent issue for the current world. The present study was conducted to perceive the effectiveness of Jute leaf meal (*Corchorus olitorius*) as a replacement for soybean meal in the Thai silver barb diet. Soybean meal was substituted with jute leaf meal (JLM) at 10, 30, and 50% having

total inclusion of 2.5, 7.5 and 12.5%, respectively in the diet and control having no (0%) inclusion of jute leaf meal and represented as T_{10}, T_{30}, T_{50} and T_0, respectively. The treatments were randomly allocated in 12 hapas installed in 3 parallel 2 decimal ponds with 3 replication each. The fish growth performance, feed utilization, fish production and survival rate, hematological parameters were measured, and after completion of the experiment, low pH (pH-5) stress test was performed after the completion of the experiment. Final weight, weight gain, percent weight gain (PWG), specific growth rate (SGR), feed conversion ratio (FCR) and feed conversion efficiency (FCE) were showed statistically significant ($p<0.05$) while only protein efficiency ratio (PER) did not show any significant difference ($p<0.05$) among the treatments. The yield of fish was significantly highest in T_{10} with 1273.03 kg/ha while the lowest production was in T_{30} with 1032.32 kg/ha. Moreover, the highest (96.29±3.21) survival rate was recorded in T_{50} and the lowest (87.04±3.21) with T_0 and T_2 treatments. The Red blood cell (RBC), Hemoglobin (Hb) and mean corpuscular hemoglobin (MCH) were gradually decreased with the increase of jute leaf meal in the diet. However, the white blood cell (WBC) showed the opposite trend. Moreover, the low pH stress test showed the highest tolerance in T_{50} treatment, while the least tolerance was observed in the control (T_0) means jute leaf meal had positive impact on the fish physiological process. From the above results it is clearly reveal that the jute leaf meal has direct impact on the fish biomass in the present study. Therefore, it is proved that the jute leaf meal can be a potential fish feed ingredient with low cost but not compromising fish production in future.



Development of Black Soldier Fly Larvae Production Techniques Using Household Wastes and its Potential in Low-Cost Aqua Feed Production

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Abstract

An experiment was carried out to assess the use of rotten banana, mixed cereal brans, jack fruit waste, and mixed vegetable wastes, as substrates to produce Black Soldier Fly (BSF) larvae, and to determine its advantages in aquaculture and keeping our environment pollution-free. The experiment was conducted in three stages, 1st with 20g wastes and 20 newly hatched larvae with an initial length of 15.8±0.8485 mm and weight 0.0285±0.00071 g for a week and 2nd experiment was with 200g wastes and 50 larvae of length 14.5±0.707 mm and weight 0.0327±0.00042g and the 3rd

and final experiment was 14.2 g of newly hatched larvae and one kg of rotten banana, mixed brans, and mixed household wastes each. There were 2 replicates of each treatment in a completely randomized design. The substrates were ground with a blender and kept in a plastic coffee cup in 1st experiment and in a plastic lunch box in 2nd and 3rd experiments. All the experiments were done in a well-ventilated room. The wastes turned over every day and at the end of the study, the larvae were separated, counted, and cleaned before weighted. The results showed that there was no significant difference (P>0.01) among the initial length and weight of BSF larvae in all the treatments, whereas the highest percent weight gain of BSF larvae was 292.9204±0.4438 g in mixed cereal brans in 1st experiment and the lowest was with rotten banana 186.2685±24.47007 g. By contrast, the highest percent length gain of BSF larvae (74.07407±35.35534 mm) was observed in mixed vegetable waste and the lowest with the Jack fruit waste (52.54237±8.452771 mm). A similar trend of weight gain of BSF larvae (244.4444±4.1914g) was found with the mixed cereal brans and the lowest with the rotten banana in 2nd trial. However, a higher percent length gain (79.48718±17.39855mm) was achieved with mixed vegetable waste rather than mixed cereal brans. Moreover, the highest survival rate was found with cereal brans (65%) and the lowest by rotten banana (25%) in 1st trial and the survival of larvae in 2nd trial was 42, 87, 17, and 79% with rotten banana, mixed cereal brans, jack fruit waste, and mixed vegetable waste, respectively. Finally, the larvae consumed the highest percent of kitchen wastes (61.985%) followed by mixed cereal brans (60.396%), and rotten banana (57.703%) in the 3rd experiment. Therefore, it can be concluded that household waste recycle is possible through BSF larvae and can get protein-rich fish feed ingredients and agricultural fertilizer as well address the environmental pollution problem in the country from the process.

Effect of Silica Nanoparticles on the Growth and Production of Two Exotic Fishes: Tilapia, *Oreochromis niloticus* and Thai Koi, *Anabas testudineus*

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Abstract

The use of nanotechnology in food production systems is being investigated globally, though there is limited research on its effect on fish nutrition. Therefore, this study aimed to identify the effects of silica nanoparticles (NPs) on the nutrition and physiology of tilapia, *Oreochromis niloticus*. Four isonitrogenous diets (300 g/kg crude protein) with NPs (0, 1, 2, and 3 mg/kg diet) were fed to fish (6.52 ± 0.20 g) in a recirculatory aquaculture system for 56 days. Throughout the study period, the effects of silica NP on survival rate, blood cell count, hemoglobin (Hb) level, condition factor (CF), and final product composition (except lipid content) were insignificant. However, growth performance and feed efficiency increased with an increasing level of silica NP, up to 2 mg/kg, and then decreased. This increase was due to the highest apparent protein digestibility and dry matter digestibility when fish were fed silica NP at 2 mg/kg. However, fish at the early stage showed better performance in all dietary groups than in later. Blood glucose (BG) content and histology of the kidney revealed that fish were stressed when a 3 mg/kg silica NP was used and they adapted through excessive excretion *via* expanded glomeruli. Though no significant effect on villi length was observed, silica NP increased the surface area widening the villi of the gut along with the number of goblet cells in the intestine significantly, when supplemented at a level of 2 mg/kg. The bioaccumulation of silica shows that incorporating silica NP in the fish feed will not compromise human health safety upon consumption.

Although silica NP at 1 mg/kg and 3 mg/kg yielded some improvements to growth and final product quality, a 2 mg/kg silica NP generated the best results in all measured parameters.

Effect of Silica Nanoparticle on the Growth Performance and Survival of Pabda, *Ompok pabda*

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Abstract
Nanoparticle hold promises to favor growth performance, feed utilization, physiological condition, and carcass quality of aquaculture species, however, evaluation of silica nanoparticle on Pabda, *Ompok pabda* remains unpacked yet. Hence, with the aim of studying the effects of silica NP on nutrition and physiology of *Ompok pabda*, an 8-week experiment was designed to carry out in Wet Laboratory, Bangladesh Agricultural University. Magnetically activated silica NP at different levels (0, 1, 2, 3 mg/kg diet) were incorporated into 30% proteinous diet. Fishes of 2.16 (±0.20) gm were assigned randomly to the triplicate tanks maintaining for each treatment in glass aquaria of 40 L capacity and fed with their respective diets at satiation level. Results demonstrated that the effects of silica NP on length gain, survival, dry matter digestibility, RBC count, hemoglobin level, condition factor and final product composition (protein, lipid, ash, and crude fibre) were found insignificant ($p>0.05$). However, growth parameters (weight gain, specific growth rate, daily growth coefficient) and feed efficiency (FCR, PER) increased in a dose dependent manner. The advancement in the growth performance was gained because of highest apparent protein digestibility (APD) with strong significance ($p<0.001$) took place when fishes were fed with silica NP at 2 and 3 mg/kg diet. However, in dietary groups treated with lower concentration (1 mg/kg) of silica NP showed insignificantly ($p=0.76$) higher digestibility than control. Blood glucose data and RBC increased significantly ($p<0.05$) when fish were challenged with silica NP at 3 mg/kg, suggesting that fish got stressed at concentration higher than 2 mg/kg. Bioaccumulation study of silica interprets that incorporation of silica NP in fish feed will not compromise human health safety upon consumption. Conclusively, incorporation of silica at 1 mg/kg and 3 mg/kg diet though exposed some improvement in growth, 2 mg/kg silica NP is obviously best performer in regards of all indicators.

Effects of High Temperature on Growth and Reproduction of Nile Tilapia *Oreochromis niloticus*

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Abstract
Increased water temperature up-regulates the oxygen consumption, metabolic rates and alters the physiological processes. In this study, we identified the critical thermal maxima (CTmax) at both hypoxia and normoxia states in the Nile tilapia, *Oreochromis niloticus*. The effects of elevated water temperature on growth and hemato-biochemical parameters were studied after acclimatized to three temperatures (31°C, 34°C and 37°C) for 60 days. Additionally, erythrocytic cellular abnormalities (ECA) and erythrocytic nuclear abnormalities (ENA) tests were assayed using peripheral erythrocytes after exposure to the three temperatures. Fish were sacrificed on days 7, 15, 30 and 60 of exposure. CTmax was 41.25^{o}C at hypoxia and 44.50^{o}C at normoxia states. Lowered amount of hemoglobin (Hb)

and red blood cell (RBC) was observed at the CTmax at hypoxia states compared to the normoxia condition. In contrast, higher values of white blood cell (WBC) and blood glucose level were noticed at the CTmax in hypoxia condition. Consequently, higher frequencies of micronucleus, cellular and nuclear abnormalities of erythrocytes were observed at the CTmax in hypoxia condition. Growth performances viz., weight gain, % weight gain, specific growth rate (SGR) showed decreasing tendency at 34°C but significantly declined at 37°C compared to 31°C. The abundance of Hb and RBCs significantly decreased in response to temperature increases, while WBCs displayed the opposite response. At days 7 and 15, blood glucose levels significantly increased in response to the temperature increase, while at days 30 and 60 glucose declined. Frequencies of ECA and ENA were significantly enhanced at the highest temperature throughout the experimental period. These results suggest that, high temperature tolerance and subsequent physiology is significantly affected by the oxygen supply in Nile tilapia. As the climate vulnerability is intensifying day by day, this data will be helpful in successful management practice for aquatic environment having low oxygen content and in the intensive aquaculture practice in a changing world.

Study the Effects of Probiotics on Growth and Reproduction of Selected Farmed Fishes in Bangladesh

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Abstract

Over the last decades, aquaculture has expanded, diversified, intensified and technologically advanced in Bangladesh. Chemicals are indeed an essential ingredient to successful aquaculture, which has been used in various forms for centuries. Hence, during the reporting period we surveyed to know the extent of use of probiotics in aquaculture of Bangladesh. Based on the survey, most commonly used 2 commercial and 1 locally developed probiotics were selected and characterized, and tested their efficiency in growth performance of rohu and Nile tilapia in aquaria. Data was collected from 200 individual respondents of commercial fish farms located at Mymensingh, Rajshahi, Jashore and Cumilla (50 from each) regions. A total number of 88 different probiotics products from 36 companies are using in the aquaculture of Bangladesh. The purpose of use of probiotics is not clear for the farm owners in most cases. However, when they faced any problem, several representatives of different companies provide suggestions to use their different probiotics products. Most of the farm owners responded that they used probiotics to get higher production through promote growth of fish. A considerable number of farm owners responded that probiotics reduced mortality as well as reduced gas from the aquaculture ponds. Although, the use of commercial probiotics are varies from region to region, the Pond Care and Safegut, product of SK+F are mostly used in aquaculture as per perception of 32% and 21% respondents, respectively. Three probiotics were slected and we started to characterize in the microbiology laboratory. Probiotic yeast enhanced growth performance of rohu and Nile tilapia in aquarium. Locally developed putative probiotics showed better performance compared to commercial probiotics in terms of growth studies of rohu and Nile tilapia in aquarium.

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Breedibg Biology of Punti, *Puntius* sp. in the Rajdhala Beel, Purbadhala, Netrakona

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Abstract
The Rajdhala reservoir (locally known as *beel*) at Purbadhala, Netrakona, with an area of 53 ha (24º70' and 25º80' N and 90º29' and 90º48' E) is an important beel of the country with its rich ichthyofauna playing an important role in the production of fish and livelihood of the adjacent fishermen community. The aquatic environmental condition and reprpoductive biology of punti, *Puntius* sp. in the beel were studied. The primary goal of this study was to determine the breeding season of punti by observing the species' gonadosomatic index (GSI), fecundity, and gonadal histology. The highest value of GSI was 14.43 ± 2.40 found in the month of May. The highest fecundity (5323 ± 765.27) was also recorded in the month of May. Histology of the ovary showed the presence of early and late perinucleolar stage of oocytes during March indicating immature oocyte. The data revealed that the spawning season of punti in the beel starts from March and continue up to July with a peak during April and May. Environmental prameters of the beel like temperature, rainfall were found as influencing factors for the reproductive parameters of punti in the Rajdhala reservoir.

Environmental Changes, Natural Productivity and Their Impacts on the Biology of Bele, *Glossogobius Giuris* in Rajdhala Beel, Purbadhala, Netrakona

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Abstract
The Rajdhala beel at Purbadhala, Netrakona is an important beel with its rich ichthyofauna. The beel is managed by the beel management Committee (BMC) following Community Based Fisheries Management (CBFM) policy. This system improved the social management of the beel. Among the different small species of fishes in the beel, bele, *Glossogobius giuris* is a self-recruiting species. In recent years the catch of bele has drastically reduced. The environmental changes, natural productivity and their impacts on the biology of bele in the beel were studied. The beel was found heavily vegetated with submerged aquatic weed *Vallisneria* and floating macrophyte, water hyacinth, *Eichhornia crassipes*. These weeds along with other causal factors might have caused oxygen deficient situation in the beel especially during midnight and late night, and that could have impaired the physiology of aquatic animals including fishes in the beel with mortality of dissolved oxygen sensitive fishes. The natural productivity (the abundance of plankton) was not found satisfactory. Moreover, noxious blue-green algal dominance was observed. The fish bele, *G. giuris* was found carnivorous and with cannibalistic behaviour. The gut content dominated by crustaceans, zooplankton and insects. The breeding season of the fish is found prolonged from February to June with peak in March. The fecundity varied from 7,500 to 35,200 depending on the size of the mature female fish. The production of the beel can be substantially improved through implementation of some measures including maintenance of good/proper environmental condition, rational stocking of fishes, fishing restriction during breeding season, avoiding fine meshed fishing gear during post spawning season etc.

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Mass Culture of a Green Alga *Chlorococcum* sp. and its Utilization in Aquaculture

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Abstract
As the use of dietary *Chlorococcum* sp. in fish feed can be a good solution which is supposed to be used as a complementary dietary ingredient of feed for fish, shrimp and poultry, and increasingly as a protein and vitamin supplement to aqua feeds, some experiments were done to see the effects of different culture media, light intensity and pH on the growth of *Chlorococcum* sp. Cultures were found to be reached a maximum cell density of 32.5×10^5 cells ml^{-1} on day 12 at Bold Basal Medium which was significantly higher than Kosaric Madium. A maximum cell density (49.3×10^5) of this species was found at 120 µEm $^{-2}$ s^{-1} with the cell density of 49.3×10^5 cells/ml. Growth rate was also rapid at 160 µE m–2 s–1 and was significantly higher than the growth at 80 µEm $^{-2}$ s^{-1}. At 20 µEm–2 s–1, cells grew very slowly with a long lag phase, and both the division rate and the final cell density were found to be very low. Cell morphology was not influenced markedly by the range of light intensities tested. This species grew at pH from 6.5 to 8.0, with the optimum 7.0 to 7.5. In all cultures, there was a clear decrease in growth rate at lower pH (6.5). Although a significantly lower growth rate was found at pH 6.5, cultures at this pH reached stationary phase later and the maximum cell density was not much different. In the present study, we could do culture *Chlorococcum* sp. very successfully and we hope, this findings will be very helpful in rearing zooplankton and fish larvae that will ultimately help the development of aquaculture and fisheries in Bangladesh.

Influence of pH and Light Intensity on the Growth and Morphology of a Green Alga, *Monoraphidium littorale*

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Abstract
The effects of pH and light intensity on growth and morphology of *Monoraphidium littorale* were investigated. The growth and morphology of *M. littorale is strongly* affected by different light intensities and pH's. Four light intensities; 10, 30, 50 and 70 µmol $m^{-2}s^{-1}$ were tested among them highest cell density (7.46×10^5 cells/ml) was observed on the 10th day after inoculation at 70 µmol $m^{-2}s^{-1}$ and lowest cell density (4.35×10^5 cells/ml) was observed on the 10th day after inoculation at 10 µmol $m^{-2}s^{-1}$. Similarly rapid morphological changes are also observed at 70 µmol $m^{-2}s^{-1}$ and slower morphological changes observed at 10 µmol $m^{-2}s^{-1}$. Six pH levels; pH 6.5, 7.0, 7.5, 8.0, 8.5 and 9.0 were examined among them highest cell density (5.97×10^5 cells/ml) was observed on the 12th day after inoculation at pH 8.0 and alkaline pH (8.0-9.0) showed comparatively better growth rate than acidic pH (6.5-7.5). pH 6.5-7.5 didn't show a decline in the number of cells during the 18th days of the culture period. Best morphological changes were observed in alkaline pH (8.0-9.0) than acidic pH (6.5-7.5) within 70th days of culture period. In both cases at logarithmic phase, 100% cells were spindle, then at early stationary phase (20th & 30th day) *M. littorale* started to change their shape spindle to oval then oval to spherical and finally at late stationary phase (60th & 70th day) 90-100% cells turned into oval and spherical at 70 µmol $m^{-2}s^{-1}$ and at pH 8.0-9.0. For both experiments the temperature was above 27^{o}C and below 33^{o}C. Meanwhile, life cycle of *M. littorale* was also observed

where, it showed two types of life cycle; □) spindle to spindle □) spindle to spherical, depending on their nutrient availability in the culture media.

Mass Culture of Astaxanthin Producing Green Alga, *Haematococcus pluvialis*

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Abstract
The green alga, *Haematococcus pluvialis* was collected from natural water and then isolated in the laboratory. The algal cells were cultured in different concentrations of digested rotten potato (inexpensive media) for finding out the best and inexpensive media for mass culture of this valuable species. *H. pluvialis* showed better growth in KM (Kosaric Medium) in comparison with BBM (Bold Basal Medium). Growth of this microalga was found to be significantly varied in different concentrations (25%, 50% and 75%) of the digested rotten tomato media. Highest growth was observed in KM ($5.18\times10^5\pm575$ cells/ml) followed by $1.71\times10^5\pm401$ cells/ml in 75% digested rotten tomato supernatant with lower cell numbers in 50% ($1.26\times10^5\pm445$ cells/ml) and in 25% ($43.8\times10^4\pm821$ cells/ml) digested rotten tomato supernatant. Among the different concentrations growth of *H. pluvialis* was significantly higher ($p<0.05$) in the 75% digested rotten tomato supernatant with a mean daily division rate 0.37 d^{-1} than in other concentrations (25% and 50%). As the presence and combination of nutrients in 75% digested rotten tomato supernatant is suitable for optimal growth of *H. pluvialis*, 75% concentration of digested rotten tomato supernatant can be used as a low cost culture media instead of the expensive chemical media for the mass culture of *H. pluvialis* However, before going to outdoor or commercial culture of this species, several laboratory culture trials are needed using different media in different environmental conditions.

Influence of Environmental Factors on the Occurrence and Abundance of *Microcystis* and *Anabaena* in Aquaculture Ponds

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Abstract
In Bangladesh, freshwater aquaculture ponds have a great contribution in national fish production. But unfortunately, noxious cyanobacteria mainly *Microcystis* and *Anabaena* are the most common genera that create serious adverse effect in pond water, causing water pollution through heavy bloom and severe economic losses to aquaculture/fisheries. Recently, bloom forming toxic *Microcystis* and *Anabaena* produce toxins directly or after death through autolysis which cause massive fish fatality and less production from aquaculture sector in Bangladesh. To identify the occurrence of *Microcystis* and *Anabaena* and the physicochemical parameters e.g., water temperature, DO, pH, alkalinity, nitrate-nitrogen (NO_3-N) and phosphate-phosphorus (PO_4-P) influencing the abundance of them, a study in three aquaculture ponds was performed over a period of six months from March 2021 to August 2021. Out of 31 phytoplankton genera identified, 12 to Chlorophyceae, 9 belong to Cyanophyceae, 7 to Bacillariophyceae and 3 to Euglenophyceae. Cyanophyceae was ranked as the first in respect to abundance in all ponds. The abundance of Cyanophyceae was dominated by *Anabaena*, *Microcystis*, *Osillatoria* and *Aphanothece*. During the study period, *Microcystis* found in large quantities in mid-

May with the cell density of 1117×10^3 cells/l and *Anabaena* in mid-June with the cell density of 306×10^3 cells/l in pond 1. Contrariwise in pond 2, *Microcystis* existed in large number in mid-March with the cell density of 5957×10^3cells/l and *Anabaena* in mid-May with the cell density of 220×10^3 cells/l. Besides in pond 3, *Microcystis* and *Anabaena* was the most dominant genera with the highest cell density of 10400×10^3cells/l and 87×10^3 cells/l in mid-April. Significant variation was observed in water temperature, dissolved oxygen, pH, alkalinity, nitrate-nitrogen (NO_3-N) and phosphate-phosphorus (PO_4-P) throughout the study period. From the evidence, it is revealed that the occurrence and abundance of *Microcystis* and *Anabaena* are comprehensively influenced by physicochemical parameters of water bodies as well as decrease the sustainable production from aquaculture ponds.

First Record of *Trichodesmium erythraeum* Winter Bloom in the Bay of Bengal, Bangladesh

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Abstract

Plankton samples were collected monthly from upstream and downstream of the Bakkhali River Estuary and Maheshkhali Channel, Bay of Bengal, Cox's Bazar, Bangladesh. In total 96 species of phytoplankton were identified of which 65 belong to Bacillariophyceae, 23 belong to Dinophyceae, 4 to Chlorophyceae and 4 to Cyanophyceae. Bacillariophyceae was found to be the most dominant group with large number of species in the study period. Among Bacillariophytes, the different species in order of abundance were *Chaetoceros curvisetus, Pseudo-nitzschia delicatissima, P. pseudodelicatissima, P. seriata, Asterionellopsis glacialis, Biddulphia sinensis, B. aurita, Coscinodiscus wailesii, Thalassionema* and *Rhizosolenia alata.* Dinophyceae ranked second among all phytoplankton groups in respect of both abundance and number of species. Among the dinophytes, the different species in order of abundance were *Ceratium furca, C. tripos, C. fusus, Dinophysis caudata, Prorocentrum micans* and *Gonyaulax polygramma.* The present study was alluded to declare the first record of *Trichodesmium erythraeum* dense bloom in winter along the Bay of Bengal, Bangladesh adjoining Bakkhali River Estuary and Maheshkhali Channel. The brownish to light pinkish bloom appeared in mid-winter (January 2021), and it was investigated on alternate days up to spring (March 2021) when the bloom disappeared abruptly. Heavy blooms of *T. erythraeum* as "puffs", "tufts" and "asymmetrical" colonies revealed the highest concentration ($91.47 \pm 52.94 \times10^3$ colonies/L) in late-winter (February 2021) at Bakkhali River Estuary. The present bloom was associated with temperatures not exceeding 24°C exhibiting an unusual report on a worldwide basis, especially in the case of the largest Bay of Bengal. In this study, several other influential environmental parameters for potential bloom formation have also proposed a view about the Bay of Bengal, Bangladesh region in order to effectively manage or detain algal blooms.

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Occurrence, Assessment and Management of Japanese Threadfin Bream *Nemipterus japonicus* in the Bay of Bengal

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Abstract
Stock assessment and management of Japanese threadfin bream, *Nemipterus japonicusus*, a commercially important fish species in the Bay of Bengal was studied. Standard length (SL) of male and female ranged from 8.5 to 22 and 8 to 21.4 cm, and body weight (BW) from 17.09 to 276.65 and 14.71 to 300.69 g respectively. Bhattacharya plot decomposed 4 age-groups on pooled length frequency histogram of male, female and unsexed individuals separately. Three common growth models, i.e., von Bertalanffy, Gompertz and Robertson in terms of length were fitted for male, female and unsexed populations separately. Since statistics nullified differences between SLs of male and female, and their growth curves (t-test and F-test; $p>0.05$), therefore, present study adopted the growth modelling of unsexed population. Growth was best described by the von Bertalanffy for the species based on χ^2 values as goodness of fit index among three models, and the equation was as $SL_t = 25.17 [1- \exp \{-0.637 (t + 0.014)\}]$, where t is age in year. The relationship of pooled data of SL and BW was $BW = 0.035SL^{2.92}$, and the von Bertalanffy equation in terms of BW was fitted as $BWt = 431.34 [1- \exp \{-0.646 (t +0.03)\}]^3$. The study obtained growth performance 2.61, and the approximate longevity was 4.71 years. The length and age of the youngest female were 10.5 cm SL and 0.83 years, while the mean length and age at sexual maturity were 14.82 cm SL and 1.38 years. Japanese threadfin bream recruited when they were 9.4 cm SL and 0.82 years age to the adult stock in the Bay of Bengal. Employing length based catch curve and based on reduction of individuals in a cohort to near zero over the life span, natural and fishing mortalities were 0.98 and 2.27 per year respectively, while the exploitation rate was 0.66 during the year of study. The maximum yield per recruit was 41.3 g at fishing mortality of 1.2 per year, and the biomass analyses, however, estimated that *N. japonicus* attained 50.4 kg relatively at the age of 1.62 years if 1000 individuals recruited to the parent stock in the Bay of Bengal. Finally, the study suggested a format of management guide incorporating the present findings.

Stock Assessment and Conservation of Hilsa Shad *Tenualosa ilisha* in the Bay of Bengal

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Abstract
The research preliminarily assessed age and growth of hilsa shad, *Tenualosa ilisha* of the Bay of Bengal. Conventional models were used to estimate age and growth parameters using data of 100 specimens collected from the artisanal hilsa fisheries based at Gangamotir char, Kolapara upazilla, Patuakhai district in Bangladesh. The total length of sampled individuals ranged from 24.2 to 45.4 cm, and the body weight from 176.22 to 1450.4 g. Bhattacharya method incorporated into FISAT routine decomposed length frequency data into 5 component normal distributions. The growth equations provided by three models were as $TL_t = 57.22 [1- \exp \{-0.168 (t + 2.632)\}]$ for von Bertalanffy model; $TL_t = 44.06 \exp [-\exp \{-0.445 (t + 0.411)\}]$ for Gompertz model; and $TL_t = 56.32 / [1 + \exp \{-0.213 (t - 1.393)\}]$ for Robertson model respectively, where TL_t is total length (cm) at age t (years). Growth

was best explained by von Bertalanffy growth equation based on χ^2 values as goodness of fit index among three models. The study obtained growth performance 2.74, and the approximate longevity was 17.91 years. The relationship between total length and body weight was $BW = 0.0096TL^{3.079}$. The von Bertalanffy growth curve fitted with weight-at-age data constructed the equation as $BW_t = 2481.5\ [1\text{-}\exp\ \{-0.166\ (t\ +0.191)\}]^3$. Length frequency distribution of pooled data showed 5 pseudo cohorts revealing 5 age groups, and since the mean TL of youngest age group was considered length at recruitment, therefore, the length and age at recruitment were 27.11 cm and 3.50 years to its adult stock in the Bay of Bengal.

Population Dynamics of Ticto Barb *Pethia ticto* and Recommendations for its Stock Management in Bangladesh

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Abstract
The ticto barb *Pethia ticto* (Hamilton, 1822), locally known as tit punti is one of important small indigenous fish species and belongs to the Family Cyprinidae under the Order Cypriniformes. This small fish is esteemed as a quality food containing substantial amount of protein, fat, carbohydrate, calcium, iron, zinc and vitamin A. The species is valuable food resource crucial in preventing malnutrition, and vitamin and mineral deficiencies particularly for the rural poor. The present research work was proposed to determine age and growth, recruitment pattern, spawning period, frequency of spawning, length of spawning season and fecundity, and both natural and fishing mortality with a management suggestion to conserve the stock of this valuable fish species using fish samples to be collected from the river Old Brahmaputra for a period of one year. Data collection is being continued and would be end up in December 2021. A total of 600 specimens from 6-month samples were collected by June 2021. Among the total number of fish 306 were male and 294 were female. Sex ration between male and female did not deviate from parity (χ^2 test, $p > 0.05$). The standard length of male ranged from 2.6 to 6.9 cm, and the body weight ranged from 0.54 to 12.33 g. The standard length of female ranged from 2.8 to 6.9 cm, and the body weight ranged from 0.74 to 9.52 g. The required analyses to address the objectives of the research project are in progress.

Growth, Survival and Gonadal Development of *Lamellidens marginalis* at Different Oxygen Concentrations

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Abstract
Lamellidens marginalis, a bivalve mussel, and commonly known as freshwater pearl mussels, is a popular species to produce pearl in freshwater culture systems. On the other hand, low dissolved oxygen (DO) often creates oxidative stress to aquatic organisms capable of reducing metabolic activities; thus reduces nutrient supply, growth and hampers gonadal development. The objective of this present study was to assess growth, survival and gonadal gonadal development of *L. marginalis* exposed to different oxygen concentrations. Adult *L. marginalis* were reared in aquaria under no addition air supply (T_0, control), one (T_1), two (T_2), three (T_3) or four (T_4) air tone aerators per

aquarium supplying DO. DO concentrations were measured at every fifteen-day interval and were recorded to be 0.82±0.05, 1.61±0.06, 3.31±0.07, 5.34±0.04, 5.42±0.06 and 5.44±0.06 mg/L on day- 15, -30, -45, -60, -75 and -90, respectively for T_0. For T_1, T_2, T_3, T_4 DO concentrations were recorded between 7.01±0.40 to 7.93±0.02 mg/L during 90-days of rearing. In case of T_0, DO concentrations were <2 mg/L for first 30 days indicating hypoxia, followed by normoxia from day-45. In case of T_1, T_2, T_3 and T_4 DO concentrations were >2 mg/L for entire of the rearing period indicating normoxia. On day-15, -30, -45, -60, -75 and -90, DO concentrations (T_1, T_2, T_3, T_4) were significantly higher than T_0; but there were no significant differences among T_1, T_2, T_3 and T_4. Data collected from 260 specimens were used to determine the instantaneous and relative growth rates with initial and final values including shell size (length, width) and total weight. ANOVA analysis detected significant increases ($P < 0.05$) for the relationship between the shell length, width and total weight of pearl mussels at all months. Instantaneous growth rates (% of weight, length and width) were higher (0.04, 0.02 and 0.02) in T_3 and T_4 compared to T_1 and T_2 (0.03, 0.02 and 0.02). Relative growth rates (% of weight, length and width) were highest in T_4 (11.94,6.96 and 5.7) and lowest in T_1 (10.49, 5.5 and 4.72). Again, survival rate (%) was also highest in T_4 (73.33) and lowest in T_1 (66.67); in T_0, all mussels died after 20 days. Visceral masses of *L. marginalis* were collected every 30-day interval for histological analyses and preserved in 10% formalin for fixation. In day-30 histo-sections, oocytes in T_0 were found to be smaller in size, with developing acini and no previtellogenic oocytes were recorded; whereas in T_1, T_2, T_3 and T_4 previtellogenic oocytes and larger acini were evident. In day-60 histo-sections, oocytes (T_1, T_2, T_3 and T_4) were observed to be vitellogenic, with few under-developed oocytes. In day-90 histo-sections, oocytes started to detach from the acini walls, as well as some already started to migrate to germinal duct in case of T_1, T_2, T_3 and T_4. This indicates that ovaries in T_1, T_2, T_3 and T_4 become ripe and were ready to spawn between day-60 and -90. In day-30, secondary spermatocytes were observed in testicular acini in case of T_0, whereas more developed and dense spermatids were evident in T_1, T_2, T_3 and T_4. These results indicate that testes were in late development stages in T_0 and ripe in T_1, T_2, T_3 and T_4. The above results are indicative of the fact that hypoxia (T_0) retarded development of ovary and testes, and on the contrary, relatively faster gonadal developments were observed in normoxia (T_1, T_2, T_3 and T_4 where DO ranges from 7.93±0.02 to 7.01±0.40 mg/L). Findings of the present research confirm the fact that hypoxic conditions of waters are capable of retarding growth and survival of individuals and development of reproductive organs of *L. marginalis.*

Investigations of Microplastics Pollution in the River Karnaphuli and from some Coastal-marine Fishes of the Upper Bay of Bengal off Bangladesh Coast

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Abstract

Microplastics are prevalent pollutants, present in almost all environmental compartments. In the present study, we investigated microplastics pollutions in a coastal river - Karnaphuli and from four species of coastal-marine fishes (*Escualosa thoracata, Mystus gulio, Tenualosa ilisha* and *Trichiurus lepturus*). Occurrences of microplastics particles in surface water was highest in the downiest-stream site (222500/km^2) compared to upstream sites of the River Karnaphuli. In the river, fibers and

fragments were the most abundant microplastics compared to other types. In case of river sediments, higher (178/kg) numbers of microplastic particles were observed in downstream sites compared to upstream sites (23/kg). Predominance of filamentous- and irregular-shaped and black and purple coloured microplastics were recorded from both surface water and bottom sediments. Microplastics were also identified and quantified from some coastal-marine fish species. Small pelagic fish *E. thoracata* had the highest number of microplastics (550/kg) compared to *M. gulio* (200/kg), *T. ilisha* (30/kg) and *T. lepturus* (20/kg). Fibers were the most common type of microplastics identified from coastal-marine fish, followed by fragments and particles. Considerable variations of color (Black > Blue > Green > Red > Purple > Translucent) and shape (Filament > Irregular > Angular > Round) of microplastics were recorded from fishes.

Histopathological Alterations in Internal Organs of Banded Gourami Exposed to Sub-lethal Concentrations of Thiamethoxam

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Abstract

Agro-pesticides enter aquatic ecosystems through surface runoff, spray drift and ground water leaching and may cause detrimental effects to many non-target aquatic organisms including fish. Thiamethoxam (THM) is a widely used neonicotinoid insecticide in Bangladesh but the toxic effects of this insecticide is not yet studied well for aquatic organisms. The present experiment was conducted to explicate the toxic effects of THM insecticide on the haematology and histopathology of a freshwater fish banded gourami (*Tricogaster fasciata*). Fishes were exposed to different concentrations (75, 125, 175, 225, 275 mg/L) of THM to determine 96-hour median lethal concentration (LC50). The 96-h LC50 of THM on *T. fasciata* was determined 161.065 mg/L. After LC50 determination, fishes were exposed (90-days) to six sub-lethal concentrations (0, 9.375, 18.75, 37.5, 75 and 150 mg/L) of THM in triplicated and examined using histological protocols. In ovary, histopathological alterations detected were adhesion (AD), interfollicular space (IFS), degeneration of ovigerous lamellae (DOL), necrosis (NE), degenerated perinucleolar oocyte (DPNO), and cytoplasmic retraction (CR); while empty lumen (EL), damaged of sertoli cell (DSC), irregular shape of seminiferous tubule (ISST), and breakage of seminiferous tubule (BST) were detected in testes. Histopathological alterations in liver observed were autolysis, necrosis, vaculation, fatty change (FC), and acute cellular swelling (ACS). In kidney, necrosis, cellular degradation of tissue (CD), acute cellular swelling (ACS) and irregular renal corpuscle (IRT) were observed as histo-alterations. Clubbing, reduction of gill filaments, telangiectasia of gill lamellae, haemorrhage and damage of gill raker were observed as histo-alterations in gills.

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Environmental Monitoring of Agro-Pesticide Residues in a Freshwater Floodplain Habitat of Bangladesh

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Abstract

Organochlorine (OC) pesticides have already been banned in Bangladesh due to their high level of toxicity, persistence, and ability to bioaccumulate and biomagnify in both terrestrial and aquatic food chains. After OC-ban, agriculture sector of this country has shifted towards use of organophosphate (OP), neonicotinoid (NNI) and other groups of pesticides. In this study, the levels of these pesticide residues were investigated in surface water and bottom sediment and their bioaccumulations were studied in fish and mussel sampled from a typical freshwater floodplain *Beel* habitat located close to agricultural practices. *Dalia Beel* located in Gouripur sub-district of Mymensingh district, Bangladesh was chosen for this study since a number of channels connected to crop fields are drained to this *Beel*. Again, the *Beel* drains to the Old Brahmaputra River during monsoon. Extractions of pesticides from the samples were done using QuEChERS technique and tested using GC-MS. Two pesticides, namely acetamiprid (NNI) and dimethoate (OP) were detected in water and sediment samples and acetamiprid was detected in mussel samples of the *Beel*. Acetamiprid in the surface water ranged from n.d. (not detected) to 2.89 ppb, in sediments from n.d to 37.30 ppb and in mussel from n.d to 0.81 ppb. On the other hand, dimethoate in surface waters ranged from n.d to 1.32 ppb, and in sediments from n.d to 17.9 ppb. Different fish species were also analyzed but it was difficult to identify residual concentrations. Detection of two NNI and OP pesticides in water, sediment and mussel samples of the *Beel* indicate that there are chances of bioaccumulation of agro-pesticides in aquatic animals, particularly those that are resident.

Freshwater Filter-Feeding Bivalve *Lamellidens marginalis* Uptakes Microplastics if they are Available in Water Column

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Abstract

Freshwater pearl mussel *Lamellidens marginalis* is a bivalve species widely distributed in freshwater habitats of Bangladesh. It is a filter feeder that consumes phytoplankton suspended in the water column. Because of uncontrolled use and dumping of plastics by humans, microplastics are now ubiquitous in distribution including freshwater habitats. Since filter-feeding bivalves filter a large volume of water, they are predominantly vulnerable to microplastics. In this study, *L. marginalis* was exposed to two types of microplastics (fragments and fibers) in glass aquaria. Entire soft tissue samples of exposed mussels were sampled for microplastics ingestion studies both using digestion and histological investigations. For digestion studies, collected soft tissues were digested, filtered, and finally observed under a microscope for presence of microplastics. Results showed that the average numbers of microplastics ingested were 4.25 per mussel and the size of microplastics ranged from 60.65 to 1248.53 µm. Furthermore, soft tissues of mussel (n=12) were fixed and processed using

routine histology protocols and studied for ingested plastics. The histological studies identified both fragments and fibers adhered to the soft body tissues of exposed mussels. This study, performed using two protocols, suggests that freshwater pearl mussel uptakes microplastics if they are available in water column.

Stock Assessment and Management of Tengra Catfish *Mystus tengara* in Bangladesh

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Abstract

The study was designed to work on stock assessment and management of tengara catfish *Mystus tengara* in Bangladesh. The tengara catfish is a freshwater bagridae, locally known as bajari tengra, widely distributed in slow and shallow waters of rivers of plains and estuaries, canals, streams, beels, ponds and inundated fields in Bangladesh. The study has been proposed to describe population parameters and maximum sustainable yield of *M. tengara*, which lead to develop management strategies for its numerous stocks across Bangladesh. The tengara catfish, *Mystus tengara* (Hamilton, 1822) is a small indigenous fish species collected monthly from January to June 2021 (where 100 fish samples were collected in each month; total 600 individuals were collected) from Dingaputa haor located at Mohanganj upazila of Netrokona district in Bangladesh. Length-weight data were recorded, and gonad was extracted from all fish to determine sex ratio, gonadosomatic index, fecundity, spawning season and spawning frequency. Among samples of six months, the standard length and total length of male ranged from 3.1 to 5.6 cm and from 4.2 to 6.9 cm, respectively, and the standard length and total length of female ranged from 3.2 to 6.2 cm and from 4.2 to 7.6 cm respectively. Collection of samples at regular monthly intervals from adult stock will be made for next six months (July-December 2021) to determine the timing of growth, recruitment, mortality and stock assessment. The present findings will be used as input data for fisheries management of this valuable species in the Dingaputa haor and adjacent aquatic ecosystems in Bangladesh.

Quantitative and Qualitative Changes in Bacteria During Live Fish Transportation

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Abstract

This study was conducted to assess the changes in bacterial number and types, and different water quality parameters during live transportation of two selected fishes, Pangasius catfish, Pangas (*Pangasianodon hypophthalmus*), and Climbing perch, Koi (*Anabas testudineus*). The correlations between bacterial viable count and water quality parameters were also evaluated in different supply channels. The channels were from Mymensingh to Dhaka, Faridpur, and Sylhet for Pangas; and from Mymensingh to Dhaka, Sylhet, and Rajshahi for Koi. Subsamples were collected at 2 hours intervals during transportation and the water temperature, dissolved oxygen (DO), pH, and ammonia concentration were measured. For bacteriological assessment, the viable counts of bacteria were

estimated using plate count agar, and the presence of *Salmonella* and *E. coli* was detected after isolation using selective media, and confirmation through DNA-based molecular techniques. The water temperatures were around 30°C and the pH was within the optimum range for fishes in all the channels. Marked fluctuations were observed in DO and ammonia concentration; the DO levels decreased while ammonia concentrations increased at the end of the supply periods. The viable counts of bacteria were gradually increased depending on the distance and duration of the supply channels, and the initial and final average counts were 0.103×10^5 cfu/ml and 3.50×10^5 cfu/ml for Pangas, and 0.063×10^5 cfu/ml and 4.43×10^5 cfu/ml for Koi, respectively. In the case of Pangas, about 2% isolates were confirmed as *Salmonella* spp. and 87% as *E. coli* positive; while in the case of Koi, the values were about 19% and 73% for *Salmonella* spp. and *E. coli*, respectively. The overall findings showed a general reduction in water quality (decreased DO level and increased ammonia concentration), resulting in bacterial regrowth. Thus the viable counts of bacteria were negatively correlated with the DO level and positively with the ammonia concentration of the transporting water. Results also showed an incidence of fish foodborne pathogenic bacteria like *Salmonella* spp. and *E. coli* in the transport water and a gradual increase in their numbers with the periods of transportation.

Production, Consumers' Likeliness and Profitability of Different Value-added Ready-to-Eat Products from Kachki (*Corica soborna*) and Mola (*Amblypharyngodon mola*)

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Abstract

Among different small indigenous species (SIS) of Bangladesh, Kachki (*Corica soborna*) and Mola (*Amblypharyngodon mola*) bear prime importance in terms of availability and popularity. These fishes have high nutritive values, they are rich in proteins, vitamins, and minerals. However, the majority of the people, especially children do not like eating small fish for the presence of fishbone. Thus, processing of these small fishes into a wide variety of value-added ready-to-eat products can be a great option that will increase demand as well as ensure nutrient supply, especially to the young groups. This study was conducted with the aim to produce a variety of value-added ready-to-eat products from Kachki and Mola fish and to assess their proximate composition, quality, consumers' likeliness, and cost-benefit. Raw fishes were collected, sorted and dun dried in a ring tunnel dryer. The dried fishes were used to produce different types of products. Dried Kachki was used to produce 6 products under two broad categories, 3 products (P1, P2, P3) under category I (crispy-spicy products), and 3 products (P4, P5, P6) under category II (crunchy-sweet products); while dried Mola was used to producing another 2 products (P7, P8) under the category II. Within category-I (crispy-spicy products), dip fried fish were added at 10%, 20%, and 30% rate with commercially available chanachur base to produce least amount fish added chanachur (LFC, P1), medium amount fish added chanachur (MFC, P2), and highest amount fish added chanachur (HFC, P3), respectively. In category-II, broiled and groundfish were cooked/ mixed with roasted peanuts and/ or sesame seed and sugarcane brown sugar block (gur) to produce fish peanut bar (FPB, P4, and P7), fish sesame bar (FSB, P5, and P8), and fish peanut-sesame bar (FPSB, P6). All these raw materials and finished products were analyzed for their proximate compositions (moisture, protein, lipid, ash, fiber). The quality and likeliness of the prepared products were evaluated through sensory assessment considering defect points (DP), and 9 scale hedonic scores given by the panelists/ respondents, respectively. The cost-benefit was analyzed considering the production costs and price ready to pay by the respondents. In the case of the products of category-I, reasonably the highest amount of protein was found in P3 (22.14%), while the lowest in P1 (17.54%). The highest amount of lipid was found in P1 (29.76%), and the lowest in P3 (26.13%).

The amount of fiber was almost similar in all the three products of category-I, which was about 2%. On the other hand, among the products of Category-II, the highest amount of protein was found in P4 (15.07%), and the lowest in P8 (12.85%). While the highest amount of lipid was found in P4 (18.57%), and the lowest in P8 (9.53%). In category II, the amount of fiber was also similar, about 2.5%. Quality assessment through sensory evaluation by the panelist/ respondents showed that except for P3 and P4, all the products were excellent and highly acceptable (grade A). Likeliness analyses through a 9-point hedonic scale indicated that among all the products, the likeliness scores of P1, P5, and P6 were equal, 7.6. However, the average likeliness scores were between 7-8, indicating the products were liked moderately to very much. Preliminary cost-benefit analyses showed that the production costs of per kg of products were Taka 277, 314, 351, 149, 165, 157, 416.66, and 427.61, for P1, P2, P3, p4, P5, P6, P7, and P8, respectively. However, benefits for Category-II (crunchy & sweet) products were reasonably higher, which were Taka 491, 635, and 483 for products P4, P5, and P6. Thus, among all the products, P5 was found very potential for further consideration based on gross benefit. Finally, it can be concluded that the studied small indigenous fish species (Kachki and Mola) can be used to produce ready-to-eat, nutritious, and excellent quality products having higher likeliness at a relatively profitable cost.

Assessment of Post-Harvest Fish Losses, Critical Loss Points and Actions and Fishery Wastes and Offal Management in the Capture Fishery Value Chain

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Abstract

Reduction in post-harvest fish losses (PHFLs) can make a major contribution to satisfy the growing demand without making additional efforts to increase fish production. A study was conducted to assess the PHFL status in inland and marine capture fisheries in selected locations of Bangladesh, identify the critical loss points in post-harvest process, hot-spots for fish spoilage in inland capture and marine fisheries and assess control zones for achieving zero post-harvest lost zones in the country. In addition, the existing status of fishery offal wastes production and management in the major metropolitan cities and processing zones were also assessed. For PHFL, a number of FAO recommended methods viz., Informal Loss Assessment Method (IFLAM such as focus group discussion, FGD; Key Informant Interviews, KIIs), Load Tracking (LT) and Questionnaire Loss Assessment Method (QLAM were applied. A total of 60 FGDs and 1,363 questionnaire interviews were conducted with different stakeholders for PHFL in selected locations of Bangladesh. Quantitative losses for inland capture fisheries using IFLAM, QLAM and LT were estimated to be 7.75, 6.86, 5.90 and 7.16%; 6.81, 5.97, 5.83 and 6.43%; 6.88, 6.28, 5.08 and 5.56% at the fishermen, *Aratdar*, *Paiker* and retailer level respectively with a total average loss of 27.7%, 25.0% and 23.8% respectively. On the other hand, PHFL for the coastal and marine fishermen, *Aratdar*, *Paiker*, retailer and traditional processors were estimated to be 9.40, 6.90, 4.50, 6.20 and 4.20%; 8.65, 6.85, 3.18, 4.62 and 4.14%; 8.00, 5.01, 3.88, 5.16 and 3.95% respectively. Existing status of fishery offal waste were assessed through visual observation (IFLAM), FGDs (IFLAM), questionnaire interviews (QLAM). A total of 40 FGDs and 1,157 questionnaire interviews were conducted with different stakeholders for fishery offal waste assessment in selected locations of Bangladesh. Visual observation and FGDs revealed that substantial amount of fishery offal wastes were generated in these points, mostly in the retail markets. These wastes were not in use in any form, and thus mostly dumped / discarded. The highest amount of fishery offal wastes were generated in the retails markets through dressing and cutting of the fishes that was

estimated to be 4.89 to 6.75 lac MT / Year (average 5.82 lac MT / Year). These wastes largely remained unutilized with 83.33% dumped in the dustbin and 16.67% managed by city corporation. The total volume of fishery offal waste generated was 6.95 lac MT per annum. The proximate and nutritional composition (Vitamin A, D, amino acid profile and fatty acid profile) of seven different fishery offal types (Hilsa shad, mixed carp, Pangasius catfish, Pangasius catfish liver, small fish, *Bagda* and *Galda*) were assessed and found to contain substantial amout of different valuable nutrients. The highest protein content was found in Pangasius catfish offal (about 16%) and the lowest in Bagda offal (about 7%). Among the essential amino acids, arginine was most abundant in hilsa offal waste (27945.2± 259.94 mg/ 100g). Pangasius catfish offal was found as the richest sources of saturated (about 2.50±0.03%), monounsaturated (about 2.45±0.21%), and polyunsaturated (about 0.73±0.051%) fatty acids. A substantial amount of vitamin-A (1570.3±36.2 µg/100 g) was found in the offal from small fishes. On the other hand, all the offals were found to contain Vitamin-D, ranges from a minimum 15.2±2.21 µg/100g in Pangasius catfish offal to a maximum 35.4±1.71 µg/100g in hilsa offal. It is concluded that post-harvest fish loss occurs at each stakeholder level due to various reasons. Post-harvest fish loss was comparatively higher in marine capture fisheries than inland capture fisheries. The study result on fish offal/ shrimp, prawn waste showed that, a huge amount of fish offal, shrimp waste are being produced in different markets, processing yards/ processing industries. This fishery offal wastes have huge potentiality to produce usable items as suggested. Proper management and utilization strategies and policy support should be put into place to convert these wastes into valuable and usable resources.

Smoked Hilsha (*Tenualosa ilisha*): Assessment of Nutritional Quality and Shelf Life Study Under Various Storage Conditions

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Abstract

Preservation of hilsha (*Tenualosa ilisha*) by smoking is comparatively a new trend or new kind of study in this country. Development of smoked hilsha and study of its quality parameters has a great potential. Therefore, the present study was designed to investigate the shelf life and different quality aspects of smoked hilsa (*Tenualosa ilisha*) at room (28 to 32°C) and refrigeration (5 to 8°C) temperature. At the same time, study was also carried out to study the effect of brine concentration, effect of local spices and the effect of the smoke source on the quality aspects of smoked hilsha (*Tenualosa ilisha*) stored at room (28 to 32°C) and refrigeration (5 to 8°C) temperature in different packing condition. The experiments were done in the Laboratories of Department of Fisheries Technology, Bangladesh agricultural University. Among the four parts of the experiment the first part of the experiment is completed and the other three parts are in progress. To carry out the first experiment hilsha fish (*Tenualisa ilisha*) was smoked using the locally prepared smoking kiln in the Laboratory of Fish Processing. The smoked hilsha was then stored at room (28 to 32°C) and refrigeration (5 to 8°C) temperature in non-sealed, sealed and vacuum sealed packets. Sensory, biochemical and microbiological changes of smoked hilsha during storage were determined. At room temperature the percent moisture, protein and lipid content of the product decreased gradually from 56.40 ± 1.34 to 49.86 ± 1.53, 21.02 ± 0.78 to 17.76 ± 0.66 and 14.15 ± 0.63 to 10.43 ± 0.53, respectively within 12 hours of storage period in sealed packets with but the ash content increased from 4.19 ± 0.18 to 5.97 ± 0.19 . At refrigeration temperature also the percent moisture, protein and lipid content decreased with the lapse of time. On the other hand, percent ash content increased slowly at refrigeration. pH value of the product both at room and refrigeration temperature decreased very slowly throughout the storage period (pH value decreased from 6.54± 0.02 to 4.67 ± 0.01, 4.62 ± 0.02

and 4,69 ± 0.10 in non-sealed, sealed and vacuum sealed packets within 21, 27, 40 days respectively at refrigeration temperature) . The TVB-N value and peroxide value also increased with lapse of storage period but the peroxide value increased more rapidly (peroxide value increased from 21.06 to 57.32 meq/kg in sealed packet within 12 hours at room temperature storage). The microbial load also increased rapidly at room temperature whereas the growth of microbes was slower at refrigeration temperature (bacterial load increased from 2.1×10^4 to 4.4×10^5 and 6.6×10^5 within 40 days in sealed and vacuum sealed packets respectively at refrigeration temperature). Therefore, the study revealed that at room temperature the smoked hilsha cannot be stored for longer period, in fact not more than 12 hours in sealed packet and 15 hours in vacuum sealed packet. On the other hand at refrigeration temperature smoked fish may remain in good condition until 17, 27 and 40 days in non-sealed, sealed and vacuum sealed packets, respectively.

Present Status of Traditional Fermented Fish Product Shidhil of Northern Region in Bangladesh and Development of Improved Shidhil

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Abstract

A survey was conducted to collect information on present status of *Shidhil* in Rangpur, Kurigram and Nilphamari districts. Studies were also carried out on the improvement of production method of *Shidhil* and comparison on quality parameters of traditional and improved *Shidhil* under different storage conditions. For the production of *Shidhil* in laboratory using improved techniques, Punti (*Puntius ticto*), Mola (*Amblypharyngodon mola*), Kachki (*Corica soborna*) and Taro (Colocasia esculenta) were used as raw materials. After 120 days of storage condition moisture content of Traditional *Shidhil* collected from Rangpur, Kurigram and Nilphamari districts were in the ranges of 32.60±0.95% to 36.87±0.87%, 17.78±0.99% to 26.31±1.65% and 24.92±0.71% to 34.26±0.32% respectively at room temperature (28±2ºC) whereas at refrigeration temperature (5±0.5ºC) the values ranged from 32.60±0.95% to 36.07±0.82%, 17.78±0.99% to 21.60±1.09% and 24.92±0.71% to 28.17±0.73% respectively. For these samples protein content were in the ranges of 25.49±1.25% to 20.97±2.11%, 42.75±0.58% to 32.68±1.04% and 33.56±0.83% to 24.78±0.44% respectively at room temperature and at refrigeration temperature the values ranged from 25.49±1.25% to 23.17±0.87%, 42.75±0.58% to 38.76±0.82% and 33.56±0.83% to 29.32±0.92% respectively. Lipid content of these samples ranged from 9.63±1.49% to 7.05±1.49%, 15.28±0.37% to 8.19±1.21% and 11.30% to 5.70% respectively at room temperature and at refrigeration temperature the values ranged from 9.63±1.49% to 8.07±0.42%, 15.28±0.37% to 13.67±0.55% and 11.30±0.61% to 10.42±0.58% respectively. TVB-N values were in the ranges of 16.30±0.20 to 32.23±0.71, 9.67±1.24 to 39.89±0.55 and 16.13±0.92 to 40.24±0.56 (mg/100g) respectively at room temperature and at refrigeration temperature the values ranged from 16.30±0.20 to 30.37±0.54, 9.67±1.24 to 27.80±0.42 and 16.13±0.92 to 32.39±0.43 respectively of the Traditional *Shidhil* samples. On the other hand, after 120 days of storage moisture content of Improved Punti, Kachki, Mola and Mixed *Shidhil* were in the ranges of 14.52±0.34% to 22.79±0.68%, 23.84±0.74% to 29.54±1.05%, 18.27±0.49% to 19.95±0.82% and 22.59±0.82% to 26.10±1.65% respectively at room temperature whereas at refrigeration temperature it ranged from 14.52±0.34% to 21.32±0.16%, 23.84±0.74% to 27.90±0.81%, 18.27±0.49% to 22.33±0.25% and 22.59±0.82% to 26.67±0.56% respectively. Protein content of these samples ranged from 41.07±0.58% to 35.10±0.41%, 43.95±0.56% to 39.67±0.34%, 44.25±0.92% to 37.29±0.21% and 39.18±0.98% to 33.24±0.92% respectively at room temperature and at refrigeration temperature these values ranged

from 41.07±0.23% to 35.62±0.05%, 43.95±0.56% to 38.69±0.16%, 44.25±0.92% to 39.21±0.60% and 39.18±0.98% to 35.17±0.17% respectively. The lipid content ranged from 28.90±0.58% to 21.48±0.88%, 19.89±0.68% to 12.29±0.72%, 24.25±0.38% to 20.31±0.51% and 24.52±0.64% to 19.32±0.42% in the samples respectively at room temperature whereas at refrigeration temperature values ranged from 28.90±0.58% to 26.13±0.38%, 19.89±0.68% to 17.92±0.53%, 24.25±0.38 to 22.90±0.51% and 24.52±0.64% to 23.30±0.31% respectively. TVB-N values ranged from 3.24±0.76 to 31.51±0.47, 3.57±0.24 to 35.14±0.17, 2.75±0.08 to 31.82±1.24 and 5.22±0.15 to 35.10±0.30 (mg/100g) respectively in Improved *Shidhil* samples at room temperature and at refrigeration temperature values found to be in the ranges of 3.24±0.76 to 21.53±0.53, 3.57±0.24 to 22.17±0.86, 2.75±0.08 to 20.25±0.32 and 5.22±0.15 to 23.67±0.39 (mg/100g) respectively. The study showed that traditionally produced *Shidhil*s had high moisture content, less protein content, less lipid content, high ash content and high TVB-N value compared to Improved *Shidhil*s. Among the two storage temperatures refrigeration temperature (5±0.5ºC) resulted *Shidhil* of better quality than stored at room temperature (28±2ºC) during 120 days of storage in zipper polythene packets.

Utilization of Pangas (Pangasianodon Hypophthalmus) Fish and Fish Industrial Waste: Development of Value Added Fish Products and Quality Assessment of the Products for Human Consumption

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Abstract

The present study was carried out in order to utilize pangas fish (*Pangasianodon hypophthalmus*) waste and development of different fish products for human consumption. Fish gelatin was developed successfully from the pangas waste skin using different extraction procedure. Extraction procedures were carried out with hot water and diluted acid. Results showed that the yield of pangasius gelatin was 20.32% which is higher than other reported gelatin from other fish. The highest yield was obtained when extraction was done with citric acid at 70°C for 4 hours and with acetic acid the yield was 16.03%. Color of gelatin produced by acetic acid at 70°C for 6 hours was more transparent than produced by citric acid. Highest gel strength was found 301g extracted by acetic acid at 60°C for 6 hours indicating the physical properties of pangas skin gelatin is comparable with that of commercial gelatin. The study was also conducted to prepare fish noodles (pasta type with 30%, 40% and 50% fish mince) and fish chips (with 20%, 30% and 40% fish mince) using pangas-waste mince along with other ingredients to assess its quality and shelf-life. The noodles with 50% pangas-waste mince had highest level of moisture content and had higher levels of protein, fat and calories (per 100 g) and fish chips having 40% pangas waste mince was the most preferable one. Results of both studies indicated that, popular snack item like fish noodles and chips prepared with pangas waste mince might contribute to the health benefit to the consumers.

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Development of Value Added Products (Cutlet, Sausage, Flaks and Papad) from Pangas (*Pangasianodon hypophthalmus*) Fish, Observation on Shelf-life of the Products under Various Storage Condition and Consumer's Preference to the Products

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Abstract
In Bangladesh, a wide variety of fishes are available Among them Pangas is the most common, popular and cheapest. While the harvest of this fish is abundant it's price goes down which can be minimized by preparing different value added products like- Cutlet, Sausage, Flaks and Papad. Initially these mince based products were prepared in different inclusion level (Cutlet with 30%, 40% and 50%; Sausage with 40%, 60% and 80%; Flake with 30%, 40% and 50%; Papad with 10%, 15% and 20% fish mince) along with other ingredients and a panel test (panels were formed on the basis of educational level, age, income of the panelists) was arranged. Cutlet prepared with 40%, Sausage with 80%, Flake with 50% and Papad with 20% fish muscle was liked by the panelists. On the basis of panelists choice all the samples were prepared further and stored under various temperature and packing conditions. Chemical analysis of the samples showed that- even at refrigeration temperature (5 to 8°C) the rate of increase in the values of total volatile base nitrogen and peroxide values were found higher for cutlet stored in non-sealed pack than the cutlet stored in sealed pack (on 0 day TVB-N and PV were 2.54 and 2.46 which increased to 14.32 and 8.27 in non-sealed pack and 12.87 and 7.78 in sealed pack on 12 days of storage). For preparation of sausage one step heating results better quality gel than two step heating and for storage of sausage refrigeration temperature provides gel of higher gel strength (Breaking force in gram obtained 468.85 after 24 hours of storage at refrigeration temperature and 354.68 at frozen temperature). The proximate composition of fish flakes varied between the ranges 9.24 to 10.45 (% moisture content), 20.24 to 18.75 (% ash content) 24.56 to 21.22 (% protein content) and 3.67 to 1.90 (%lipid content) indication the possibility of longer storage of fish flake in sealed pack at room temperature. The initial values of % moisture, % protein, % lipid and % ash content were 9.8, 26.09, 2.43 and 7.2. After storage of 30 days at room temperature (28 to 32°C) these values were found 11.21, 29.98, 2.59 and 9.76 respectively in sealed pack and 10.98, 28.77, 2.49 and 9.56 in vacuum sealed pack indicating that among different packs vacuums sealed pack might be better option for longer storage of fish papad. The developed value added products with pangas muscle were well accepted by consumers and these products can be stored for longer period applying different storage techniques for market availability.

Antibiotic Resistance Profile and Molecular Characterization of Pathogenic Bacteria Emerging in Aquaculture Farms of Bangladesh

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Abstract
Introduction: In Bangladesh, there prevails a situation where indiscriminate and/or increased use of antibiotics in aquaculture farms is going on. With the intensification of aquaculture (i.e. expansion of monoculture, increased stocking densities, use of artificial feeds) for several species of carp, tilapia and catfish farming, antibiotics are administered at sub-therapeutic levels for growth promotion, improved

FCE and disease prevention (Hong et al. 2013). This has superficially prevented viral, bacterial and fungal infections, but wastewater discharge into the surrounding aquatic ecosystems has potential damaging impact on the structure and functioning of the ecosystems, and contribute to the development of resistant strains of bacteria (Burridge et al. 2010). The common pathogenic bacteria reported in aquaculture in Bangladesh including *Aeromonas*, *Vibrio*, *Staphlylococcus* and *Pseudomonas* in Nile tilapia, Thai pangus, *Galda* and *Bagda* have already become antibiotic resistant to some extent. Since the particular problem facing in Bangladesh differs from those in other geographical regions, a systematic study was conducted to enumerate antibiotic-resistant bacteria contamination in fish and shrimp farms of Bangladesh.

Methodology: Sampling locations were chosen to ensure representation of culture area for Nile tilapia (*Oreochromis niloticus*), Thai pangus (*Pangasianodon hypophthalmus*) from Mymensingh; catla (*Gibelion catla*), ruhu (*Labeo rohita*) from Rajshahi and bagda (*Penaeus monodon*), galda (*Macrobrachium rosenbergii*) from Khulna districts. During the 1st year, three pond clusters consisting of 10 ponds from each selected upazila were sampled for 10 diseased fish, and their gill and intestine were subjected to bacteria isolation. Then they were plated on tryptic soy agar, nutrient agar and blood agar following international guidelines for animal welfare (OIE, 2000). The relevant metadata including physico-chemical parameters (e.g. water temperature, DO, ammonia, nitrate, phosphate, hardness etc.) as well as geographic location using GPS receiver were recorded. Culture-based methods for bacteria identification were performed that included Gram reaction, Oxidase test, Motility, Oxidation and fermentation test, O/129 sensitivity test. Further biochemical and molecular-based characterization targeting 16S *rRNA* housekeeping gene is being carried out to identify up to the species level.

Results: During the 1st year, bacterial colonies grown in pure culture in the laboratory were stocked in agar slant for future use. They were also subjected to identification, and several species including *Salmonella* and *Escherichia* were identified based on their biochemical characteristics. Their identification will be confirmed using molecular based method such as PCR and sequencing of 16S *rRNA* gene.

Conclusion: Additional works for bacterial identification isolated from diseased fish is required which include use of molecular-based 16S *rRNA* sequencing method. The stock culture bacteria will be subjected to antibiotic-susceptibility testing and finally the results will be used to identify linkage between phenotypic and genotypic antimicrobial susceptibility and virulence gene(s) of pathogenic bacteria isolated from commercial fish and shrimp farms of Bangladesh.

Development of PCR-based Method to Detect Mycotoxigenic Fungi in Fish and Shrimp Feed to Ensure Food Safety

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Abstract

Introduction: Mycotoxin is a toxic secondary metabolite produced by fungus, and is capable of causing diseases and death in both humans and other animals. Studies showed that 62.5% of the human food commodities including lentils, wheat flour, dates, groundnuts and poultry feeds in Dhaka, Chattogram and Sirajganj districts were contaminated with high levels of aflatoxin (Roy et al. 2013) that were above the US maximum regulatory levels, indicating morbidity and high risk of exposure to this fatal toxin. With the inclusion of plant-based ingredients such as maize, wheat, rice flour, sorghum, nuts in aquaculture, the potential for mycotoxin poisoning in fish has increased accordingly. In addition, humid condition in rainy season and abusive conditions of fish feeds including high contamination level, temperature, storage period and nature of substrate influencing the production of

mycotoxins (Nafeesa et al. 2006), there is ever increasing possibilities of mycotoxin contamination in aquacultured fish species of Bangladesh. Therefore, there is an urgent need for rapid assessment of these contaminants and identification of the main toxicogenic fungal species in fish feeds to develop control strategies for ensuring food safety.

Methodology: Fish feed samples were collected from 2 warehouses in Trishal and Phulpur upazila, Mymensingh district. Temperature, relative humidity and moisture content of the feed samples were recorded and the collected samples were kept in sterile plastic bags and transported to the laboratory and stored at 4°C until analysis. Then DNA sample was extracted by lysis of 20 g of feed sample as described by Ye et al. 2000. During the 1st year, a total of 6 pair of primers were designed using the aligned gene bank database sequences viz., *Tri6*, *Tri7* and *Tri13* for *Fusarium* sp. and *avfA*, *aflR1* and *nor1* genes for *Aspergillus* spp. for the specific detection of mycotoxin encoding genes using PCR. After the withdrawal of COVID-19 restriction, research work was started.

Results: During the 1st year, 18 DNA samples were extracted from 18 fish feed samples collected from Trishal and Phulpur upazila. They are now being tested for detection of aflatoxin producing gene(s) using PCR.

Conclusion: After completion of the research, it is expected that molecular methods for isolation of mycotoxigenic fungi will be established and it will improve decisions about storage life of the product and for the need of specific mycotoxin analysis.