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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 477 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 31 volume of the Bangladesh Agricultural University Research Progress in the form of proceedings of the workshop held on 29 & 30 May 2021. This volume contains 382 abstracts of on-going/completed research projects conducted in the fiscal year 2019–2020. 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 former Director of BAURES, 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. Abu Hadi Noor Ali Khan
Chief Editor
&
Director
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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, BAURS 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 382 research projects presented in the workshop held on 29 & 30 May 2021, where 158 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 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. Abu Hadi Noor Ali Khan, Director; Dr. Paresh Kumar Sarma, Senior Scientific Officer (SG); Mr. Md. Abul Hashem, Deputy Director; Mr. Md. Jabed Ali, Assistant Accounts Officer 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. Mohammad Mahfujul Haque
Executive Editor
&
Associate Director
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Bangladesh Agricultural University, Mymensingh, Bangladesh

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

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Abstract
Poultry sector is an integral part of supplying meat to the people's meals. Dexamethasone (DEX) is one of the most potent glucocorticoids used in man and animal. To the best of authors knowledge, the effects of high doses of dietary DEX on lipid metabolism in liver of broiler are remaining ambiguous. Therefore, the present research aimed to demonstrate the effects of glucocorticoid on the liver in broiler. The day old chicks (N=106) were randomly divided into four groups i.e. control and experimental groups (supplemented with DEX: E1-3mg/kg, E2-5mg/kg, and E3- 7mg/kg in commercial broiler type ration). Liver were collected from the broilers at 7, 14, 21 and 28 days of experiment. Then the tissues were stained with Hematoxylin and Eosin. Gross parameters i.e. color, weight, length and width were taken into consideration. The obtained gross data were analyzed using GraphPad Prism 8 software. In visual inspection, the liver was pale in color in case of treatment groups (E1, E2 and E3) at days 7, 14, 21 and 28 in comparison to the control group. Congestion and Hemorrhage were found in the liver of treated groups at day 7, 14 and 21. At 28, pinpoint multifocal hemorrhage was noticed throughout the liver in E3 group. Numerical decrease in the weight, length and width of liver indicates that DEX might causes apoptosis in liver. At day 14, numerous histopathological lesions i.e. fat accumulation, lymphocytic infiltrations, disoriented hepatic cords, widen sinusoidal space and degenerative changes with pyknotic nucleus were noticed in E2 and E3. In the DEX treated group, immunohistochemical expression of glucocorticoid receptor (GR) was seen in the central vein, cytoplasm and in the nuclei of hepatocytes. The present findings suggested that DEX alters the morphology of liver. It also suggested that exogenous glucocorticoid ameliorates the expression GR in the broiler liver.

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, we also described a simple technique for preserving the skeleton, stuffing or plastinates 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 using glue and wire. Finally, the skeleton was fixed on a wooden stand to be stored easily for animal structure 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 (horse, cow, goat, dog, cat, chicken turkey etc.), stuffed birds/animals (rabbit, cock, pigeon. duck etc.), and organs of animals were preserved. Implementation this technique for animal structure 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.

Reproductive Importance of Oviduct of Turkey Hen Especial Emphasis on Sperm-host Glands for Turkey Production in Bangladesh

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Abstract

Turkey bird is one of the famous and popular poultry species is reared primarily for meat production and one of the major sources of animal protein. With such importance of this species, the present study was designed to investigate the histo-morphology of the oviduct with especial emphasis on sperm-host glands of the turkey hen (Meleagris gallopavo) involving ten adult mature female turkeys. The present study highlights the distribution pattern of sperm-host glands (SHGs) in the oviduct of turkey hen that has a potential role in producing a fertile egg in poultry industries. The oviduct consists of the infundibulum, magnum, isthmus, uterus, and vagina which are the sole distributors for making nutrition enriched eggs. The tissue samples were collected from the uterovaginal junction (UVJ) and infundio-magnal junction, uterus, and vagina of the oviduct. The oviducts/uterine tubes were dissected and fixed in Bouin fluid and processed for histological sections under a light microscopic study. It was observed that the UVJ was lined by pseudostratified columnar epithelium with ciliated, non-ciliated cells, goblet cells, and basal cells. The sperm host glands extended into lamina propria of UVJ as an oval, rounded and straight tubules. The proximal part of the glandular neck was lined by pseudostratified columnar ciliated epithelium and distal part with non-ciliated columnar cells. The ciliated cells showed cilia and microvilli on the apical surface in the neck region, whereas the non-ciliated cells present in the distal part of SHGs had oval or elongated nuclei in their basal part and were studded with some of the microvilli in their luminal surface. These glands were surrounded by some of the smooth muscle cells and nerve fibers. The sperm-host glands may play a functional role in the storage and release of spermatozoa from the SHGs in response to oviposition or ovulation.

Methacarn as an Alternative to Formalin for Preservation of Tissues 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. In our study, we used alcohol-based fixative (methacarn) as a 10% formalin substitute for fixation and preservation of

tissues. Our gross study showed that alcohol-based fixative was faster in penetration of tissues than formalin. It fixed tissues (liver, spleen and brain) ideally as early as 8 hours of fixation whereas 24 hours for formalin. These results indicate better diffusion power of alcohol-based fixative in the tissues within shorter time. Microscopic examination of tissues stained with hematoxylin and eosin (H & E) revealed that methacarn preserved better histo-architectures than formalin. Our molecular analysis (total DNA and RNA yield with quality) showed that methacarn fixed tissues produced significantly ($P < 0.05$) higher quantity of genomic DNA and RNA than formalin with superior quality. These results are suggestive that methacarn could be a potential alternative to formalin for preservation of tissues in Bangladesh.

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.

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.

Immunophynotypic Analysis of Distribution of Non-parenchymal Cells in Liver of Normal Rats with Emphasis on Liver Macrophages

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Abstract

Liver is a major organ of the body. Liver consist of parenchymal hepatocytes and non-parenchymal cells. Non-parenchymal cells in the liver consist mainly of Kupffer cells, hepatic stellate cells and cholengiocytes. Hepatic macrophage is the principal non-parenchymal cells with crucial roles in the liver homeostasis and involved in the pathogenesis of liver injury. To establish baseline data, this study investigated immunohistochemically the distribution of hepatic macrophages in perivenular areas (PV), periportal areas (PP) and Glisson's sheath (GS) of adult rats. Liver tissues were collected from left lateral lobe of rats. CD163-positive macrophages appeared along sinusoid of PV and PP areas, indicating Kupffer cells. Numbers of Kupffer cells were significantly high in PP areas as compared with PV or GS areas. CD68-positive exudative macrophages was highly localized in PP and GS areas and comparatively low number in PV areas. The numbers of CD68-positive exudative macrophages was significantly high in PP as compared with PV. MHC class II-positive dentritic cells (activated macrophages) was localized mainly in GS and a very few in PV and PP areas of livers showing significantly high in GS areas as compared with PV or PP areas. Therefore, Kupffer cells and exudative macrophages were highly localized in PP areas and activated macrophages mainly localized in the GS of livers. Double immunofluorescence for CD163+ cells with CD68, or MHC class II showed that 92% CD68+ cells reacted simultaneously to CD163 in rat livers and only 14% of MHC class II+ cells showed a positive reaction to CD163. This study shows that heterogeneous macrophage populations localized in liver parenchyma and GS with cells specific pattern and may effectively contribute in rat hepatophysiology or hepatopathology.

Residual Effect of Toxic Chemicals (Pesticides) on the Immune System of Rabbits

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Abstract

Indiscriminately used pesticide has become a part of our food chain and having an adverse residual effect on biological systems of mammals. Therefore, present study were conducted to investigate the

toxicity of imidacloprid on immune system of adult male rabbits. To know the residual effect, fifteen adult rabbits were used. Feed exposed to pesticides (Imidacloprid, 0.5ml (100 mg)/L water) was given to rabbits without wash (designated as not washed feed rabbit, n=5) or after wash (designated as washed feed rabbit, n= 5) every alternative day in the morning for 15 days. Remaining rabbits (control, n=5) received standard diet (fresh vegetables, green grass and wheat bran). In blood serum analysis, the values of hepatic serum enzyme aspartate amino transferase (AST) and alanine transaminase (ALT) were significantly increased in both pesticide exposed not washed and washed feed rabbit in compared to control rabbit. Histologically, no lesions were observed in lymph node and spleen of control rabbits. Large number of secondary lymphatic nodules were seen in the lymph node of pesticide-exposed rabbits. In the spleen, large lymphocytic populations in the white pulp were seen, indicating infected or toxicity-based condition of spleen. Interestingly, lymphocytic population was increased in the secondary lymphoid organs like spleen and mucosa associated lymphoid tissue. Finally, it can be concluded that the present findings will provide a significant insight into the pathogenesis pesticide, particularly on immunotoxicity and it may cause immune failure or act as a co-factor for other diseases in birds and mammals.

Histomorphological and Biometric Architectures of Indigenously Plastinated Organs of Indigenous Goat

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Abstract
The histo-morphology and biometry of plastinated organs of goat were studied. The obtained samples were divided into two groups. One set of tissue was processed for paraffin embedding after formalin fixation. The other set was indigenously plastinated. The plastinates were embedded with paraffin without deplastination. Both the non plastinated and plastinated tissues were processed for routine staining. The tissues were examined under light microscope for histological architectures and quantitatively assessed the biometric parameters. The non plastinated and plastinated samples yielded mostly similar histological architectures. But plastinated liver showed alterations and artifacts with enlargement of central vein and hepatic sinusoidal space. Plastinated lung revealed enlarged alveolar sac. Lack of nuclear clarity was observed for all plastinated samples. The plastinated kidney revealed compactness of the cellular structures and shrinkage induced artifacts with clear renal corpuscles structure and obvious Bowman's capsule. The biometric measurements of central vein of liver, alveolar sac of lung, glomerulus and glomerular space of kidney of both plastinated and non plastinated tissue were also performed using calibrated stage micrometer. Comparison was done between the biometric data for both plastinated and non plastinated tissue. No significant difference was found in the obtained biometric data of liver and lung. Only a significant difference was observed between the width of glomerulus of non plastinated kidney and width of glomerulus of plastinated kidney. The morphological and biometric study of non plastinated and plastinated organs of goat can conclude that histological slides can be made from indigenously plastinated organs with well preserved histological architectures of the tissues with some rare exceptions. Plastination does not affect the biometric characteristics of the organs. In addition, the comparative morphologic and biometric study of plastinated and non plastinated organs of goat will be useful in education and research.

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Alterations on Morphology of Liver in Broiler Induced by Different Doses of Glucocorticoid, Dexamethasone

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Abstract
Poultry sector is an integral part of supplying meat to the people's meals and contributing country's economic growth in Bangladesh. Dexamethasone (a synthetic glucocorticoid) is one of the most potent glucocorticoids used in man and animal. To the best of authors knowledge there is no research has been done on the effects of dietary glucocorticoid on the lipid metabolism in liver of broiler chicken. However, the effects of high doses of dietary dexamethasone on lipid metabolism in liver of broiler are remaining ambiguous. Therefore, the present research aimed to demonstrate the effects of glucocorticoid on the morphology of liver in broiler. The day old chicks (N=106) were randomly divided into four groups i.e. control and experimental/ treated groups (supplemented with dexamethasone: E1-3mg/kg, E2-5mg/kg, and E3- 7mg/kg in commercial broiler type ration). Liver samples were collected from the broilers at 7, 14, 21 and 28 days of experiment. Then the tissues were stained with Hematoxylin and Eosin. Gross parameters i.e. color, weight, length and width were taken into consideration. The obtained gross data were analyzed using GraphPad Prism 8 software. In visual inspection, the liver was pale in color in case of treatment groups (E1, E2 and E3) at days 7, 14, 21 and 28 in comparison to the control group. Congestion and Hemorrhage were found in the liver of treated groups at day 7, 14 and 21. At 28, pinpoint multifocal hemorrhage was noticed throughout the liver in E3 group. Numerical decrease in the weight, length and width of liver indicates that DEX might causes apoptosis in liver. At day 14, numerous histopathological lesions i.e. fat accumulation, lymphocytic infiltrations, disoriented hepatic cords, widen sinusoidal space and degenerative changes with pyknotic nucleus were noticed in E2 and E3. These findings suggested that DEX alters the morphological architectures of liver in broiler.

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
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. Fifty 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.

Effects of Residue of Agricultural Pesticides on the Liver of Rabbits (*Oryctalagus cuniculus*)

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Abstract
Toxicity of pesticides for non-target organisms is of worldwide concern. Due to indiscriminate use of pesticides in agriculture, it have become a part of our food chain and having an adverse residual effect on vital organs of mammals. In the current study, to investigate the toxicity of low doses of top used pesticide, imidacloprid on the liver of adult rabbits (n=12). The exposure rabbits received imidacloprid (Bildor® 0.5 ml (100 mg)/L water)-contaminated feed for every alternative day in the morning up to two weeks (acute exposure) or up to three months (chronic exposure). Control rabbits received standard diet. After exposure, no sign appeared in acute case, interestingly, in chronic case, animals were loss their weight and nodules were appeared in the skin. In blood serum analysis showed that the hepatic enzymes aspartate aminotransferase (AST) and alanine aminotransferase (ALT) level were significantly increased in both pesticide-exposed rabbit compared to control rabbit. Histopathologic features of subcutaneous nodule under skin showed sparse inflammatory infiltrate involving septa of subcutaneous fat of chronic pesticide exposed rabbit. Liver showed coagulation necrosis in the parenchyma of the liver with massive infiltration of the inflammatory cells on the portal area in both acute and chronic pesticide exposed rabbit. Biliary hyperplasia was seen in the liver of chronic pesticide exposed rabbits. The findings of the present study suggest to control the pesticide use in field level and pesticide residues affect the body homeostasis and the individual may suffer from liver dysfunctions, which lead to biliary cancer.

Ubiquitous Use of Agricultural Pesticides and Its Impact on Public Health: An *In vivo* Study of Pesticide Exposure on the Vital Organs of Adult Male Rabbits (*Oryctalagus cuniculus*)

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Abstract
Pesticides are double edged weapon, widely used to protect the crops, vegetables and fruits in Bangladesh. Therefore, pesticides have become a part of our food chain and having an adverse residual effect on biological systems of mammals. Here, the present study is to investigate the present scenario of pesticides use, occupational exposure as well as to know the residual effects on body homeostasis

and histoarchitecture of vital organs of adult male rabbits. A surveillance study was conducted in six agro-based districts in Bangladesh and revealed that imidacloprid was top used pesticide among the study area. The knowledge and perception of the farmers towards pesticide usage are minimum. To know the residual effect, fifteen (15) adult male rabbits were used. Feed exposed to pesticides (Imidacloprid, Bildor® 0.5ml/L water) was given to rabbits without wash (designated as not washed feed rabbit, n=5) or after wash (designated as washed feed rabbit, n= 5) every alternative day in the morning for 15 days. Remaining rabbits (control, n=5) received standard diet. Histopathology of liver showed coagulation necrosis alone with marked inflammatory cells infiltration were seen in periportal area of pesticide-exposed rabbits. In lung, granulomatous inflammation with large number of inflammatory cells were observed in the peribronchial and perivascular area of pesticide-exposed rabbits. In testis, increased size of lumen with derangement and reduced number of spermatogenic cells in the seminiferous tubules in pesticide exposed rabbit compared to that of control rabbits. Significant level of abnormal morphology of spermatozoa in testes and epididymis were seen in pesticide-exposed rabbits. The results suggest that to control the pesticide use in field level and pesticide residues affect the body homeostasis and the individual may suffer from liver dysfunctions, respiratory problems as well as reproductive failure.

Prevalence and Characterization of Leptospira from Hospitalized Patients of Mymensingh City Corporation Areas

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Abstract

Leptospirosis is an important re-emerging zoonotic disease in tropical and subtropical regions of the world with various animal species acting as carriers. It is considered as an emerging global public health problem caused by different pathogenic species of Leptospira and is difficult to control in developing country like Bangladesh. The present project has designed to know the prevalence of Leptospirosis and also to characterize the etiological agents of Leptospirosis from suspected human patients of Mymensingh city corporation areas. For this, a total of 153 sera (102 from suspected patients and 51 from healthy cleaners) were collected from hospitalized patients of Mymensingh Medical College Hospital and healthy cleaners at Mymensingh City Corporation. All of the sera samples were exposed to Latex Agglutination test (LAT)/Rapid kit test for detection of Leptospira. Among 51 healthy cleaners, 8 (15.68%) were positive and 38 (37.25%) were positive for Leptospira from 102 hospitalized Leptospirosis suspected patients by Rapid kit test/LAT test. According to age group, commonest age group affected was >15-30 years (12/38), followed by >30-45 years (10/38). Out of 38 LAT positive cases 27 (71.05%) were male and 11 (28.95%) were female. Based on occupation, 12 (34.21%) were farmer followed by 09 (23.68%) were housewife and lowest number of cases were Businessmen 04 (10.53%). According to season, most of the positive cases were found in the month of August (23.68%) followed by 15.78% in the month of July, 10.52% in the month of June and it was lowest in the month of December with 2.63%. Results showed leptospiral infection was more common in rainy season. Leptospira were successfully isolated from blood samples of seropositive patients by culturing on EMJH media and detected by dark field microscopy. Isolates were also confirmed by PCR. Present finding of isolation of Leptospira is the first report in Bangladesh.

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Molecular Detection of β-Lactamase Producing Genes in *Salmonella* sp. Isolated From Layer in Selected Farms

Md. Rashedul Islam, Marzia Rahman, Md. Shafiqul Islam, Md. Tanvir, Rahman, Md. Bahanur Rahman and Mohammad Ferdousur Rahman Khan*

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Abstract

Introduction:

Antimicrobial resistance is a global problem that creating serious health hazards for poultry industry. *Salmonella* sp. produce an enzyme called β- lactamase which is a major factor that makes resistant to β-lactam antibiotics. The present study conducted with the aim to identify and molecular detection of β-lactamase producing genes in *Salmonella* sp. isolated from layer farms of Mymensingh and Kishoreganj districts of Bangladesh.

Methodology:

For this purpose a total of 70 cloacal swab samples were collected from 4 different layer farms. Then the samples were subjected to a series of conventional bacteriological examination, biochemical properties and antibiogram study followed by molecular characterization as well as detection of β-lactamase producing genes in *Salmonella* sp. isolated from layer farms.

Findings:

Out of 70 samples, 13(18%) were found positive for *Salmonella* sp. Farm wise detection of *Salmonella* sp. were 20%(4/20) and 25%(5/20) at Farm 1 and 2 in Mymensingh district 10%(2/20) and 20%(2/10) at Farm 3 and 4 in Kishoreganj district respectively. 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* isolates were sensitive to Amoxicillin, Ampicillin, Cefotaxime, Cefuroxime, Cephalexin and Cefoxitin respectively. PCR was performed for amplification of bla_{TEM} (793bp) and bla_{CMY} (562bp) genes which revealed that 38.46% *Salmonella* isolates were bla_{TEM} gene positive and 30.76% were bla_{CMY} gene positive respectively.

Conclusions:

Due to resistance against β-lactam antibiotic may lead to difficulties in treatment of Salmonellosis which is very alarming. Proper uses, rotation of antibiotics and continuous monitoring of sensitivity profile can control the emergence of resistant serovers of *Salmonella* sp. which may transmit from layer to human or poultry.

Development and Validation of Vaccine Candidates for the Control of Bacterial Mastitis in Dairy Cattle of Bangladesh

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Abstract

Mastitis is known as the most common and economically important disease in dairy industry throughout the world including Bangladesh. Mastitis is caused by an array of microorganisms among which bacteria plays a major role in onset of the clinical form of the disease. The present research was designed to isolate the bacterial pathogens for the development and validation of vaccine candidates to

control bacterial mastitis in dairy cattle of Bangladesh. To facilitate the isolation of diverse stains of the bacterial pathogens and selection of representative vaccine candidates this study was conducted in the established dairy zone and dairy industries or farms in Bangladesh. Milk samples were collected aseptically from apparently healthy cattle for the determination of subclinical mastitis and isolation of bacterial pathogens from clinical mastitis cases. The prevalence of subclinical mastitis was 46.4% according to this study. On the other hand samples collected from the clinical mastitis were subsequently cultured onto different selective media followed by isolation of pure colonies and sequencing of the 16S rRNA gene. The study revealed the presence of *Staphylococcus* spp. (58.8%), *Streptococcus* spp. (22%), *Enterococcus faecalis* (8.8%) and *E. coli* (27.9%) of the samples examined (n = 68). Among the *Streptococcus* spp., 20% *Strep. agalactiae*, 66.67% *Strep. uberis*, 6.67% *Strep. urianalis* and 6.67% *Strep. hyovaginalis* were confirmed by 16SrRNA gene sequence analysis. Although the aim of the study was to develop and validate vaccine candidate for the control of mastitis in cattle, we could not reach our goal due to some unavoidable circumstances including COVID-19. However, we are continuing the project and among the bacterial isolates further works were done on the virulence potential and antimicrobial sensitivity pattern of the *E. coli* isolates where all the *E. coli* isolates were found commensal but resistant against more than 4 classes of antibiotics.

Characterization of Bacteria Isolated from Hatching Eggs of Duck in Selected Mini Hatcheries of Kishoreganj District

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Abstract

Duck comprises about 16.52% (55.85 million) of the total poultry population (337.998 million), occupying second place next to chicken in the production of table eggs in the country. This study was conducted to isolate and characterize the bacteria from selected duck mini-hatcheries through cultural biochemical and molecular techniques and also to study their antibiogram profile. A total 150 samples were collected aseptically from Tarail and Itna upazila of kishoreganj district which includes egg surface soak, egg albumin, yolk sac, intestine and environmental samples. Primary growth was performed in LB broth followed by culture in different bacteriological media for the isolation of the bacteria and identification was done by staining, biochemical tests followed by molecular detection by PCR. Isolated organisms were then subjected to antibiotic sensitivity test using disk diffusion techniques using 10 commonly available antibiotics. It was found that out of 150 samples 89 were positive for *E. coli* (59%), 98 were positive for *Salmonella* spp. (65%), 91 for *Staphylococcus* spp. (61%) and 5 for *Clostridium* spp. (3%) From the Egg surface sample *Salmonella* spp. were recovered in highest number (77.79%) followed by *Staphylococcus* spp. (67.67%) and *E. coli* (67%). From the inner content of egg *Salmonella* spp. were recovered in highest number (57.5%) followed by *Staphylococcus* spp. (53.75%), *E. coli* (37.08%). From the Environmental sample *Staphylococcus* spp. were recovered in highest number (80%) followed by *E. coli* (60%) *Salmonella* spp. (4%). All the isolated organisms were sensitive to Gentamycin, Chloramphenicol and resistant to Ampicillin, Streptomycin. This study will help the farmers of the mini-hatcheries to take essential measures that will increase the hatchability and decrease the mortality of the duck chicks.

Bridging the Gap Between Exposures to Antimicrobial Resistance in the Environment and Impact to Human Health

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Abstract
Avian pathogenic *Escherichia coli* (APEC) causes significant economic losses in poultry industries. Here, we determined for the first time in Bangladesh, the prevalence of APEC-associated virulence genes in *E. coli* isolated from layer farms and their antibiotic resistance patterns. A total of 99 samples comprising internal organs, feces, and air were collected from 32 layer farms. Isolation was performed by culturing samples on eosin–methylene blue agar plates, while the molecular detection of APEC was performed by PCR, and antibiograms were performed by disk diffusion. Among the samples, 36 were positive for the APEC-associated virulence genes *fimC*, *iucD,* and *papC*. Out of 36 isolates, 7, 18, and 11 were positive, respectively, for three virulence genes (*papC*, *fimC*, and *iucD*), two virulence genes, and a single virulence gene. Although the detection of virulence genes was significantly higher in the internal organs, the air and feces were also positive. The antibiograms revealed that all the isolates (100%) were resistant to ampicillin and tetracycline; 97.2%, to chloramphenicol and erythromycin; 55.5%, to enrofloxacin; 50.0%, to norfloxacin and ciprofloxacin; 19.4%, to streptomycin; 11.1%, to colistin; and 8.33%, to gentamicin. Interestingly, all the isolates were multidrug-resistant (MDR). Spearman's rank correlation coefficient analysis revealed the strongest significant correlation between norfloxacin and ciprofloxacin resistance. This is the first study in Bangladesh describing the molecular detection of APEC in layer farms. Isolated APEC can now be used for detailed genetic characterization and assessing the impact on public health.

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.

Sero-monitoring and Detection of Circulating Leptospira Species in Dairy Cattle from Milk Producing Selected Areas of Bangladesh

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Abstract

Leptospirosis is considered to be worldwide zoonotic, emerging infectious disease and having global public health problem with high morbidity and mortality. Bovine leptospirosis is a cause of mastitis, abortion, stillbirth, or birth of weak calves. The objective of the present project was to conduct serological surveillance, isolation and molecular detection of circulation Leptospira species in dairy cattle of selected areas of Bangladesh. For this, bulk tank milk and milk/sera from individual animals was collected from different dairy farms such as Baghabarighat, Milk Vita, Bangladesh Agricultural University (BAU) dairy farm, Lal Teer dairy farm, Bhaluka, Bangladesh Border Guard dairy farm, Dhaka and Savar dairy farm, Dhaka and transported to the Laboratory of the Department of Microbiology and Hygiene, BAU, Mymensingh and screening test was performed using ELISA based Leptospira detection kit. Out of 376 milk samples, 23 samples (14 from bulk tank milk and 9 from individual milk) were found to be moderately positive for Leptospira in cattle. Out of 94 sera samples from cattle 8 were found to be positive for Leptospira. Leptospira was unable to isolate and identify from seropositive cattle but successfully isolated using cultural methods and detected by dark field microscopy and PCR from slaughter house samples of cattle. Present study revealed the serological existence of Leptospira in cattle of Bangladesh.

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.

Prevalence and Molecular Detection of Antimicrobial Resistance Genes in *Salmonella* spp Isolated from Layer Farms

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Abstract
Antimicrobial agents are used in human and veterinary medicine to treat bacterial diseases. Antibiotics are also used in food-producing animals like as poultry for therapeutic or as growth promoter at sub therapeutic dose which is responsible for emergence of antibiotic resistance bacteria contribute to treatment failure in human and animals. The present study was undertaken with the objectives to determine the prevalence of *Salmonella* in layer birds with their antibiotic resistant pattern. 100 samples were collected from 3 different layer farms and subjected to culture in selective media. Presumptive identification of *Salmonella* isolates was performed by culturing on selective media, Gram's staining and confirmed by PCR targeting the *invA* gene. Based on cultural characteristics and amplification of invA gene the prevalence was found 22% (22/100). The prevalence of Salmonella in farm A, B, and C were 12%, 36%, and 28% respectively. The prevalence of Salmonella in cloacal swab, feces, water, feed, and soil were 26.32%, 23.53%, 16.67%, 11.11%, and 14.28% respectively. After confirmation, all positive isolates were subjected to motility test and PCR to differentiate motile from nonmotile. Among the isolates motile Salmonella was 81.82% (18/22). The antimicrobial resistance pattern was determined by disc diffusion method and amplification of different resistance genes. Phenotypic and genotypic resistant pattern was different. On the basis of disc diffusion test the isolates were 18.18% resistant against florfenicol but 68.18% were intermediately resistant to florfenicol, 45.45% were resistant against ampicillin, 59% resistant against amoxicillin, 81.81% resistant for oxytetracycline, 68.18% resistant against stretomycin, 36.36% resistant against Nalidixic acid, 31.81% resistant against chloramphenicol, followed by 45.45% resistant against ciprofloxacin. Out of 22 isolates 22.72%, 63.63%, 95.45%, 77.27%, 36.36% and 54.54% were bearing *floR* , *blaTEM*, *tetA*, *aadA1*, *cat1*, *qnrA* genes respectively which were higher than the disc diffusion method. Of which 13.63% isolates exhibited resistant to 2 antibiotics, 36.36% to 3, 31.82% to 4 and 18.18% to 5 antibiotics. It can be concluded 100% isolates were found multidrug resistant which showed resistance to at least 2 antibiotics. This study demonstrated considerable prevalence and high antimicrobial resistant Salmonella in layer birds and their environmental samples which may act as potential threat for birds and foodborne Salmonellosis in human.

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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

In campylobacteriosis component (BAU), the study was aimed to isolate, identify and characterize *Campylobacter* species from different samples of dairy farms and human diarrhoeal samples. Similarly, in bovine tuberculosis component (icddr,b), the study was targeted to confirm the prevalence, herd and animal level risk of bovine tuberculosis along with isolation and identification and molecular characterization of *Mycobacterium* isolates from the farmed cattle and captive wild animal samples of selected dairy farms and zoological gardens. Cross-sectional surveys were conducted in two cattle dominated districts of Bangladesh. In campylobacteriosis component, samples were collected as cattle faeces, milk, faecal samples from diarrhoeal patients and blood samples from neurological patients were collected, and tested via cultured based techniques and molecular assays. In bovine tuberculosis part, single interdermal comparative tuberculin test was employed to estimate herd and animal level prevalence. Herd and animal level data were collected through using pretested semi-structured questionnaires and analyzed via univariable and multivariable logistic regression model. On the contrary, blood samples were collected from SICTT conducted cattle and tested by Bovigam® assay in a sandwich ELISA for evaluating the skin test results. Postmortem samples of different organs were collected from dead farmed cattle and zoo species and tested via smear microscopy, culture based methods and molecular assays. An overall prevalence of *Campylobacter* spp. was confirmed as 25.5% in dairy farms. However, the study confirmed the prevalence of *Campylobacter* in bull as 28.98% and human diarrhoeal patients as 28.62%. Different virulence and toxin genes were identified in *C. jejuni*, *C. coli* and *C. fetus* isolates. The overall herd and animal level prevalence of bTB were estimated to be 45.6 % and 11.3% respectively at >4 mm cut-off. The study has successfully applied Gamma interferon assay (Bovigam®) for the first time to detection of cattle TB in Bangladesh as parallel testing with the SICTT. The culture organism were further genotyped via Line Probe Assay and confirmed as *Mycobacterium africanum* (*M. orygis*). Of 209 sputum samples (cattle handers and butchers), 2 (two) were confirmed as *Mycobacterium tuberculosis* through genotyping. The studies confirmed the burden of zoonotic campylobacteriosis and tuberculosis in farmed cattle in the light of prevalence, risk factors, isolation, identification and characterization of organisms in two cattle dominant district of Bangladesh.

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 first 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 diarrhoeal patients, out of 170 stool samples, 62 samples were positive for *E. coli* non-O157:H7 and 40 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.

Isolation, Identification and Molecular Characterization of *Salmonella* Gallinarum from the Selected Layer Farms in Gazipur with Particular Focus on Antimicrobial Resistance

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Abstract
Salmonella is a one of the most significant microorganisms associated with diminished egg production in poultry. The objectives of this study were to estimate distribution, molecular traits and antibiogram of *Salmonella* Gallinarum isolated from small-scale commercial layer flocks of Bangladesh. A total of 765 samples including cloacal swabs (535), visceral organs (50) and droppings (180) from chicken of 12 layer flocks were collected. *Salmonella* Gallinarum was isolated and characterized employing culture-based method, followed by biochemical tests, sero-grouping, PCR assays and antibiogram. Confirmed via 16S rRNA gene based PCR as *Salmonella* spp., successively, *inv*A and *spv*C genes based PCR as the distribution of *Salmonella* Gallinarum was documented as 25.75% (197/765) in different samples. High genetic affinity of *inv*A and *spv*C genes, with an identity of 98.05-99.21% and 97.51-99.45%, respectively was observed for demonstrative strains under this study. Significantly, 66.5% (131/197) of *S.* Gallinarum strains were found to be resistant to 3-6 antimicrobial groups presented as multidrug resistant (MDR). The findings of this study are prospective to be used for formulating appropriate intervention measures to resist the wide incidences of MDR *Salmonella* Gallinarum in low biosecurity commercial layer flocks that will support to higher egg production envisaged for the poultry sector and to achieving food security and safety.

Isolation and Characterization of Turkey Astro and Corona Viruses Prevalent in Bangladesh

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Abstract
Turkey occupies an important position next to chicken, duck. Guinea fowl and quail in contributing the most evolving sector in Bangladesh. Turkey astro virus (TAstV) is a non-enveloped virus causes

gastroenteritis in turkeys of 3-4 weeks of age and Turkey coronavirus (TCoV) is an enveloped virus transmissible enteritis or blue comb disease in turkeys of all ages. The present study was conducted to isolate and identify astro and corona viruses from turkey prevalent in Bangladesh. A total of 180 samples comprising trachea, intestine and cloacal swabs from each bird were collected aseptically of which trachea and intestine from 45 dead birds and cloacal swab from 90 apparently healthy birds from six (6) commercial turkey farms of Narsingdi, Kishoreganj and Brahmanbaria districts. All the samples were processed and inoculated into 8 and 10 day-old embryonated hen egg through yolk sac and allantoic cavity routes for the isolation of astro and corona viruses, respectively. The allantoic fluid was collected from the dead and live embryos and tested for TAstV and TCoV by RT-PCR using virus specific primers. Seven (1.66%) out of 180 samples were found positive for corona virus only. None of the samples were positive for astro virus by RT-PCR. Findings of the present study clearly indicated that the corona virus is prevalent in commercial turkey in Bangladesh.

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.

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Molecular Detection and Characterization of Antibiotic Resistant Bacteria (ARB) from Goats and Finding Out the Link between Goat and Farmers Regarding ARB Existence and Spread

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Abstract
The present study was undertaken to determine the prevalence of common bacterial flora from goat farmers and apparently healthy goats and to determine antibiogram profile, and finally, to find out possible link between the goats and the farmers regarding prevalence and spread of ARBs. For this purpose, a total of 147 (38 from human and 109 from goats) samples were collected and were subjected to various cultural, biochemical and molecular examinations. Molecular detection of the isolated *Staphylococcus* spp. was carried out by the detection of 16s *rDNA* and *nuc* genes, *Salmonella* spp. by *inv*A gene, and *E. coli* by *mal*B and *stx*1 genes, using Polymerase Chain Reaction (PCR). Among the 128 PCR-positive isolates, 83 (56.5%) were *Staphylococcus* spp. (human: 28; goat: 55), 7 (4.8%) *Salmonella* spp. (human: 3; goat: 4), 35 (23.8%) *Escherichia coli* (human: 2; goat: 33), 3 (2%) *Proteus* spp. (human: 1; goat: 2). The antibacterial susceptibility test of PCR-confirmed isolates against 15 commonly used antibiotics revealed that antibiotic resistance pattern of the bacteria in human and goats for ampicillin (61.7% and 52.1%), Amoxicillin (50% and 32.9%), Azithromycin (26.5 and 21.3%), Cefradine (52.9% and 52.1%), Cefixime (85.3% and 84%), Ceftriaxone (5.9% and 5.3%), Ciprofloxacin (0% and 2.1%), Colistin (32.4% and 26.6%), Gentamicin (5.9% and 8.5%), Levofloxacin (2.9% and 6.3%), Moxifloxacin (0% and 4.3%), Oxacillin (71.4% and 70.9%), Penicillin-G (71.4% and 52.7%), Tetracycline (29.4% and 27.6%), and Vancomycin (25% and 14.5%). Multi-drug resistant (MDR) isolates of *Staphylococcus* spp., *E. coli*, *Salmonella* spp., and *Proteus* spp. were 56.63%, 54.29%, 57.14% and 100%, respectively. Using SPSS v.22, it was found that resistance pattern for human and goat column proportion did not differ significantly from each other at the .05 level. Thus this study revealed that there is a link between goat and farmers regarding antibiotic resistant bacteria existence and spread.

Therapeutic Potential of Bacteriophage for the Treatment of Colibacillosis in Broilers as Alternative to Antibiotics

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Abstract
Introduction: Now a day's emergence of antibiotic resistant bacteria are 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. In the present study bacteriophage against *E. coli* 0157 was isolated by an enrichment method from sewage water sample named as ECP-02.
Methodology: For the isolation of phage, sewage water samples were collected and mixed with respective bacteria followed by overnight incubation, centrifugation, filtration and presence of bacteriophage was observed by spot test. The bacteriophage in different samples was screened by spot test and lytic activity was observed by plaque assay. The isolated strong lytic bacteriophage was

partially characterized by determination of host range, ability to produce number of plaque with different host bacteria, pH stability at different pH solution, ability to adsorb to host bacteria at different time intervals and *in-vitro* antibacterial activity. A 50 day old broiler birds were divided into two groups A and B. The isolated bacteriophage was administered to birds of group A with feed @ 10^9 pfu/bird at each alternative day upto 4 weeks and group B were kept as control without bacteriophage. The body weight gain, FCR and *E. coli* load in cloacal swab were recorded.

Findings: The isolated bacteriophage showed wide host range among different *E coli* isolates and out of 14 isolates, 13 were lysed by the isolated phage. Efficiency of plating (EOP) was also found higher which ranges from 6.0 X 10^9 to 1.3 X 10^{12}. The bacteriophage was able to survive at wide range of pH solutions ranging from pH 2 to pH 9. This indicates that the isolated phage can be used orally for therapeutic purpose and will remain stable at gut pH of animal and poultry. More than 60% phages were adsorbed to their host bacteria after five minutes which indicates the phage was readily adsorb to the host. The bacteriophage showed very strong antibacterial activity when incubated with *E. coli* 0157 in NB for overnight which was measured by determination of OD value. The OD value of bacteriophage treated culture was found lower (OD600= 0.185) than the control one (OD600= 0.787). The mean body weight gain of group A and B at 28 days were 1406.67 gm and 1243.33 gm respectively. The FCR of group B (2.10) was higher than the group A which indicate feed conversion ratio is higher in bacteriophage group. The *E coli* load of control group (26.4 ± 2.580) was higher than the bacteriophage treated group (9.5 ± 2.236)

Conclusion: The characterization of the bacteriophage will be useful for establishing bacteriophage as an antibacterial agent to control bacteria against *E. coli* 0157 and for the treatment of colibacillosis in poultry. From this study it was found that bacteriophage reduce the number of *E. coli* in broiler, increase body weight and decrease feed consumption rate. Bacteriophage can be used for safe broiler production without use of antibiotic and emergence of antibiotic resistant bacteria.

Adhesion and Proliferation of Living Cell on Surface Functionalized with Glycine Nanostructures

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Abstract

This research presents the application of glycine amino acid for establishing firm cell-substrate interaction instead of expensive adhesion proteins, peptides and peptide derivatives. The glycine amino acid is chemically functionalized on the coverslip to achieve self-assembled nanostructure. Glycine self-assembly on NaCl treated coverslips is initiated with $SiONa^+$**:**COO^- linkage while their nanostructure is achieved with formation of glycine chain through NH_3^+**:**COO^- covalent linkage between the adjacent molecules. The functionalization steps are confirmed by FTIR investigation. The AFM and SEM investigations reveal that glycine growth initiats at 4H post-treatment while maximum growth appears after 8H-10H. Both the vertical and horizontal growth of nanostructures show dependence on functionalization periods. Various levels of glycine functionalized surface show different levels of Baby Hamster Kidney (BHK-21) cell adhesion and proliferation efficiency with maximum performance for 10H functionalized surface. The adhesion and proliferation performance of 10H glycine functionalized surface shows negligible difference when compared with Glycine-Aspartic Acid (RGD) functionalized surface. Finally, growth curves obtained from both glycine and RGD functionalized surface reveal exponential growth phage up to 48H followed by stationary phage between 48H-72H while death of many cells appears from 72H-96H. Thus, this research concluded that glycine functionalized surface is equally effective for cell adhesion and proliferation.

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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 seven 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 504 samples, 380 were positive for *E. coli*, 80 were positive for *Salmonella* spp. and 154 were positive for *S. aureus*. The *E. coli* isolates showed high phenotypic resistance to erythromycin (100%), ampicillin (97%), amoxicillin (97%), doxycycline (93%), tetracycline (87%), azithromycin (74%), ciprofloxacin (71%), nalidixic acid (71%). 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 (100%), ampicillin (99%), cephalexin (81%), erythromycin (77%), vancomycin (68%), doxycycline (66%) and tetracycline (64%). 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.

Prevalence of Multi Drug Resistant Pathogenic Strains of *Escherichia coli* Isolated from Children in Mymensingh District

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Abstract
Infectious diarrheal disease is the second leading cause of morbidity and mortality among children under 5 years of age in developing countries. Diarrheagenic *Escherichia coli* are associated with infantile diarrhea in the developing countries. The present study was conducted to determine the occurrence and antimicrobial resistance pattern of pathogenic and nonpathogenic strains of *E. coli* isolated from sick and apparently healthy children below 5 years. A total of 80 rectal swab samples were collected from children with and without diarrhea. *E. coli* were isolated and subjected to uniplex PCR to detect the genus using *mal*B gene and multiplex PCR to detect virulent strains like EPEC (*eae*A and *bfp*A), EIEC (*ial*) and EHEC (*stx* 1 and *stx* 2). All the pathogenic and nonpathogenic

isolates were subjected to antimicrobial sensitivity assay using 19 antibiotics by disc diffusion method. Seventy *E. coli* were isolated from the samples which produced metallic shin on EMB agar media and pink colony on MacConkey agar media. Some isolates were found to produce hemolysis on blood agar media. All the 70 isolates were positive for *mal*B gene (585 bp). *E. coli* isolation rate was higher (100%) between 2-4 years children compare to young (1-2 years). No virulent gene for EPEC (*eae*A and *bfp*A) and EIEC (*ial*) was detected in the isolates, but 15 were found to contain virulent genes (*stx* 1 and *stx* 2) of enterohemorrhagic (EHEC) *E. coli* with positive band of 606 bp and 374 bp, respectively with the isolation rate 18.75%. Gentamicin, amikacin and levofloxacin were found most effective against the *E. coli* isolates including virulent strains. Erythromycin and rifampicin were foound non effective and amoxycillin, ampicillin, azithromycin and cephalothin were found less effective againt *E. coli* isolated from <5 yrs old children. It might be concluded that prevalent of multidrug resistant *E. coli* strains in apparently healthy children can be a cause of treatment failure.

Assessing the Impact of Stocking Density on Welfare, Physiological Performances and Blood Biochemical Profile in Broiler Chickens

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Abstract

The study was conducted to know the effect of different stocking density rates on welfare, growth performance and hemato-biochemical parameters of broiler chickens. A total number of 106 broiler chicks (10 days old) were randomly divided into four groups (A, B, C and D) with different stocking density rates. The birds of group A were reared in floor space containing one bird per square foot area (SD1.0). The birds of groups B, C and D were reared in 1.5, 2.0 and 2.5 birds respectively per square foot area (SD1.5, SD2.0 and SD2.5). The birds were reared at 26-30^{0}C and the welfare parameters were recorded daily. The results showed that the birds of moderate density (SD2.0) and high-density groups (SD2.5) showed more increased panting breathing; wet feces adhered below the vent. There were a significant number of birds showing dirtiness of body and feathers. Few birds were experienced with footpad dermatitis, scratches and blister formation in the leg, especially in SD2.5. Litter of SD2.0 and SD2.5 were frequently getting moisture within a week of replacing dry fresh litters and higher ammonia concentrations were observed by bad-smelling. Body weights were significantly ($p<0.05$) decreased in birds reared in moderate (SD2.0) and high stocking densities (SD2.5). Broilers reared in SD1.0 and SD1.5 has a lowering effect on FCR. Greater stocking densities were found associated with significantly lower feed consumption. The present data indicated that birds housed in SD1.0 and SD1.5 is optimum space to have increased the body weight and improved FCR. Hematological parameters were not significantly differed among the groups. Serum lipid profile was also found non-significant among the groups. Serum alanine transaminase, aspartate transaminase and creatinine concentration didn't differ significantly. Overall, this work explores that higher stocking density rate has negative effects on welfare and growth performance in broiler chickens.

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Assessing Cellular and Humoral Immunity in Antibiotic free Broiler Chickens Fed Vitamin E and Natural Feed Additive

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Abstract
Natural feed additives are alternative choices of growth promoters in broiler industry due to public health concern of antibiotic resistance, their residual effects and food safety. The experiment was conducted to evaluate the effects of black cumin seeds (BCS) or their aqueous extracts and vitamin E supplementation on cell-mediated, humoral immune responses and physiological performances. A total of 160, day old Cobb 500 broiler chicks were used and they were reared for 42 days with timely vaccination without addition of antibiotic. At age of 10 days, chicks were randomly divided into four equal groups: A, B, C and D (n=40). The group A was considered as non-supplemented control. The group B, C and D were supplied aqueous extract of black cumin seed (BCS) through drinking water, intact black cumin seed through feed (BC2.0) and vitamin E (vit-E) through drinking water respectively. Results showed that the administration of black cumin seed in feed or their aqueous extracts in water to Newcastle disease vaccinated birds resulted in potentiation of chicken immune response to Newcastle disease vaccination as detected the the highest antibody titers against NDV and sheep RBC in birds of group B, C and vit-E group . Assessment of the cellular immune response by CBH test using PHA-P revealed significant skin increased in BCS and vit-E supplemented birds. However, the relative size of lymphoid organs was increased but not statistically significant. Broilers supplemented with BCS extract or intact seed in feed had significantly higher ($P<0.01$) live body weight, body weight gain and improved feed conversion ratio (FCR) The dietary BCS, their acqueous extracts and vit-E are effective to enhance the innate and specific immunity. Overall, this work strengthens the perspective use of black cumin seeds as immune stimulants as well as better growth performance in broilers.

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

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Abstract
We studied the effect Zink oxide and folic acid on reproductive performance in Bisphenol-A (BPA) treated male mice Swiss albino mice. A total of 35 male mice weight between 25-27 gm of 25-28 days old were used. The mice were randomly divided into 5 groups viz., A, B, C, D and E consisting of 7 mice in each group. Group A was served as vehicle control and will receive daily doses of the normal mice ration. The mice in Group B, C,D and E received daily doses of Bisphenol-A (BPA) 50 mg/kg, Bisphenol-A (BPA) 50 mg/kg and zinc sulfate 10 mg/k, Bisphenol-A (BPA) 50 mg/kg and folic acid 3mg/kg and Bisphenol-A (BPA) 50 mg/kg, zinc sulfate 10 mg/kg and folic acid 3mg/kg body weight. Both the zinc sulfate and folic acid will be given with water. The experiment was carried out for a period of 12 weeks. At 12th week, blood sample was collected and serum was separated for hormonal assays. At the same time, the mice were sacrificed and testes were collected for histological

examination. In male mice, the hormonal assay revealed that the level of testosterone and thyroxin decreased significantly after supplementation of BPA than the control ones ($P < 0.05$). But increased after supplementation Zink oxide and folic acid. Histomorphological examination revealed degeneration of seminiferous tubules fed with BPA that was improved by Zink oxide and folic acid treatment. Moreover, after BPA supplementation the sperm physiological parameters like Sperm motility, Sperm concentration was reduced that was corrected by Zink oxide and folic acid treatment. The study findings revealed the effects of micronutrients (Zinc) and vitamins (Folic acid) on reproductive health for reducing the adverse effect of endocrine disrupting chemicals (EDCs) on animal reproduction.

Effect of Vit-E and Black Seed Oil in Reproductive Performance in Male Mice

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Abstract

We studied the effect of vitamin E and black seed oil on reproductive performance of Swiss albino mice. A total of 40 male mice aged between 25-28 days with an average body weight of 27.4 ± 1 gram were used. The mice were randomly divided into 4 groups viz., A, B, C and D consisting of 10 mice in each group. Mice from the group A served as vehicle control and received normal mice ration whereas mice from the group B, C and D received black seed oil (0.5 mL/kg), vitamin E (200 mg/kg) and combination of black seed oil (0.5 mL/kg) and vitamin E (200 mg/kg), respectively daily in drinking water. At 16th week, blood sample was collected and serum was separate for hormonal assays. At the same time, the mice were sacrificed and testes were collected for histological examination. In male mice, the hormonal assay revealed that the level of testosterone and thyroxin increased significantly after supplementation of vitamin E and black seed oil than the control ones ($P < 0.05$). Histomorphological examination revealed an increased diameter ($P<0.05$) of seminiferous tubules in male mice fed with black seed oil and/or vitamin E. The study findings highlighted the promoting action of vitamin E and black seed oil on reproductive functions of mice and that can be a novel aid to treat infertility or reproductive disorders in animals and humans.

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.

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

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Abstract

We studied the effect Zink oxide and folic acid on reproductive performance in Bisphenol-A (BPA) treated male mice Swiss albino mice. A total of 35 male mice weight between 25-27 gm of 25-28 days old were used. The mice were randomly divided into 5 groups viz., A, B, C, D and E consisting of 7 mice in each group. Group A was served as vehicle control and will receive daily doses of the normal mice ration. The mice in Group B, C,D and E received daily doses of Bisphenol-A (BPA) 50 mg/kg, Bisphenol-A (BPA) 50 mg/kg and zinc sulfate 10 mg/k, Bisphenol-A (BPA) 50 mg/kg and folic acid 3mg/kg and Bisphenol-A (BPA) 50 mg/kg, zinc sulfate 10 mg/kg and folic acid 3mg/kg body weight. Both the zinc sulfate and folic acid will be given with water. The experiment was carried out for a period of 12 weeks. At 12th week, blood sample was collected and serum was separated for hormonal assays. At the same time, the mice were sacrificed and testes were collected for histological examination. In male mice, the hormonal assay revealed that the level of testosterone and thyroxin decreased significantly after supplementation of BPA than the control ones ($P < 0.05$). But increased after supplementation Zink oxide and folic acid. Histomorphological examination revealed degeneration of seminiferous tubules fed with BPA that was improved by Zink oxide and folic acid treatment. Moreover, after BPA supplementation the sperm physiological parameters like Sperm motility, Sperm concentration was reduced that was corrected by Zink oxide and folic acid treatment. The study findings revealed the effects of micronutrients (Zinc) and vitamins (Folic acid) on reproductive health for reducing the adverse effect of endocrine disrupting chemicals (EDCs) on animal reproduction.

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Alternative Antibiotic: Isolation, Identification and Structural Elucidation of Antibacterial Compounds from Turmeric (*Curcuma longa*)

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Abstract
Antibiotics are primarily used to treat human and animal infections. However, they are also used to promote the growth of livestock and poultry. The irrational use of antibiotics accounts for antibiotic residue in the food chain, the emergence of bacterial resistance, and therapeutic failure. Here, in collaboration with University of the Ryukyus, Okinawa, Japan, we search for antibacterial compounds from the well-known medicinal plant turmeric (Curcuma longa) through repeated fractionation with different solvents and high-performance liquid chromatography (HPLC). Structural identification of the compounds was conducted using 1H NMR, 13C NMR, and liquid chromatography-tandem mass spectrometry. We isolated three active compounds (curcumin, demethoxycurcumin and bisdemethoxycurcumin) from turmeric and studied their antibacterial potential against clinical isolates of two gram-positive (Streptococcus spp., Staphylococcus aureus) and one gram-negative bacteria (E. coli). Curcumin showed slight antibacterial effects against the clinical isolate of Streptococcus spp. but not on Staphylococcus aureus and E. coli at a concentration of 100 microgram/mL. However, demethoxycurcumin and bisdemethoxycurcumin did not show any significant effect against the tested bacteria at 100 microgram/mL. This study needs to be continued with different concentrations of the compounds to confirm their dose-dependent antibacterial effects.

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

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Abstract
Antimicrobials are used in humans and animal sectors to treat the diseases and improve livestock production. The increasing use of antimicrobials might result in deposition of residues in livestock food products and to develop resistance to these drugs by the microorganisms, therefore many diseases are becoming difficult to treat both in humans and animal. The research was undertaken to assess the status of antimicrobial residues in livestock food product and identification of resistance microorganism with their antibiogram in Mymensingh division of Bangladesh. Samples were collected randomly from livestock and poultry farms, and local markets of four upazillas of each district of Mymensingh division. Survey was conducted among 150 farmers, 20 veterinarian & 20 informal prescribers by questionnaire survey to assess the knowledge, attitude & practice regarding antimicrobial use and antimicrobial resistance. The statistical analyses of the data were performed by using SPSS software version 20. A total of 410 different types of samples (Feces, meat, milk, egg and feed) were collected from livestock and poultry to determine the antibiotic residue and antibiotic resistance. 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 poultry 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. 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 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%. After screening the samples by TLC, the concentration of residues was analyzed by HPLC. 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, amoxicillin, ampicillin, penicillin). Out of 30 poultry eggs sample the residual levels in one egg samples 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 residues (oxytetracycline 11 samples, doxycycline 3 samples and ciprofloxacin 2 samples). Among 295 samples, 438 isolates were suspected as *Escherichia coli*, *Salmonella* spp., *Staphylococcus aureus* and *Streptococcus* spp. of which 192, 40, 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.

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.

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

Drug residue and associated health hazard has become a burning question in the present era of Bangladesh. In our daily life, we use drugs in different forms either to control or prevent the diseases or even as household affairs. Therefore, use of drugs in our life is not a problem, and then the question arises, why drugs become enemy in our life? Simply, it is due to indiscriminate uses of drugs and the exposure of drug residues. A questionnaire based (details described in methodology) survey has been investigated in different poultry farms, retail sellers and poultry markets and spread out the public health hazards of indiscriminate use 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) were collected from different poultry farms, retail sellers and poultry markets. Randomly 100 livers, 100 thigh muscle and 100 breast muscle samples respectively were evaluated by TLC analysis. A very negligible number of samples were found positive for antibiotics residues. Out of 100 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 cephalexin; 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 of discriminate and indiscriminate uses of antibiotics is going on in poultry birds.

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Indiscriminate Use of Antibiotics in Poultry Industries and Presence of Antibiotics Residue in Edible Poultry Tissue and Products: A Need Based Research in Bangladesh

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Abstract

Majority of the people in Bangladesh are still not aware about the health hazards of antibiotic residues. In this perspective, a survey was undertaken at five different poultry farms in the Dinajpur district and one hundred liver, one hundred thigh muscle and one hundred breast muscle samples were collected from different farms & market places and evaluated by TLC method. A very negligible number of samples were found positive for antibiotics residues. Further investigation was done in indoor discriminate and indiscriminate use of antibiotics (ciprofloxacin and oxytetracycline) 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=6), discriminate antibiotic group (n=6) and indiscriminate antibiotic group (n=6) for each antibiotic. Discriminate antibiotic groups were treated with antibiotics (ciprofloxacin and oxytetracycline) for one week followed by withdrawal period of one week, whereas; indiscriminate antibiotics groups were treated with antibiotics (ciprofloxacin and oxytetracycline) for two weeks until the day of sacrifice. Liver, thigh muscle and breast muscle samples were collected and evaluated by TLC method. Control and discriminate antibiotics birds were found negative for any antibiotics residues. On the other hand, six liver samples, four thigh muscles and four breast muscles were found positive for ciprofloxacin and five liver samples, four thigh muscles and four breast muscles were found positive for oxytetracycline in indiscriminate groups. Therefore, poultry treated with antibiotics are required for specific withdrawal period until all residues are depleted to safe levels before human consumption. This research project provides idea that Bangladeshi poultry products are free of antibiotics residues in north area (Dinajpur District) of Bangladesh.

An Investigation of Chronic Exposure of Lead to the Pregnant Laboratory Animal and Its Effects on Their Offspring: Autism Investigation to the Laboratory Animal Model in Bangladesh

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Abstract

Lead poisoning is a continuing crisis impacting learning, neurological and behavioral development in children. This study investigated an important outcome from the environmental lead contamination which cause retardation of infant's brain development. A total of 30 Swiss albino mice of both sexes were used in this study and divide into three groups consisting 6 female and 4 male in each group. Two groups of mice were given lead treated drinking (30 ppm and 230 ppm respectively) and rat pellets ad libitum and the control mice were supplied normal drinking water and rat pellets ad libitum. At 20-21th days of pregnancy lead-induced female mouse gave birth to a litter of 5-6 pups; whereas, control mouse gave birth to 10-13 pups at a time. Both lead-induced and controlled offspring were found normal; however, some lead-induced offspring were found comparatively smaller than the control one.

Autism spectrum disorder behavioral diagnostic tools were used to explore the level of autism, if any. The anxiety assessment marble burying investigation did not reveal any significant differences among the group's mice. Three chambered social interaction analysis found no significant differences among the mice. Blood serum level of lead for controlled mice were found 0.333 μg/dL, whereas, 30 ppm and 230 ppm lead-induced born mice were found 3.833 μg /dL and 9.666 μg/dL, respectively. This study suggested that a genetic predisposition pair with exposure to environmental toxicants play important role in the causes of autism spectrum disorder. Lead is not the pivotal factor of autism development in new born offspring in mice

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

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Abstract

Many ethnopharmacological researches reported the traditional uses of turmeric in diabetes, inflammation, and wound healing. However, the specific active compounds responsible for those are not well documented. Here, we studied the anti-inflammatory and wound healing properties of pure compounds isolated from turmeric (Curcuma longa) namely; curcumin (1), demethoxycurcumin (2), bisdemethoxycurcumin (3), dihydrobisdemethoxycurcumin (4), cyclobisdemethoxycurcumin (5), 3-hydroxy-1,7-bis(4-hydroxyphenyl)-6-hepten-1,5-dione (6), 4-methyllene-5-hydroxybisabola-2,10-diene-9-one (7), 5-hydroxy-1,7-bis(4-hydroxy-3-methoxyphenyl)-1-hepten-3-one (8), bisabolone-9-one (9), turmeronol A (10), turmeronol B (11). Anti-inflammatory study was performed by in vitro egg albumin denaturation assay and in vivo Carrageenan-induced hind paw edema assay. Wound healing properties were evaluated in vivo in a full-thickness dermatic wound model in mice. Among these 11 compounds, compounds 1, 2, 6, 8 showed strong in vitro anti-inflammatory activity. Therefore, these compounds were chosen for in vivo anti-inflammatory and wound healing study. 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. A similar trend of results was also observed in wound healing assay. Mean days to heal completely were 7 days for compound 1 and 8-10 days for others. The wound was not completely healed until the end of the experiment (day 10) in the control group. In conclusion, turmeric could be a useful cost-effective alternative for inflammation and wound management.

Molecular Detection of Chikungunya Virus in Natural Populations of Mosquitoes in Mymensingh City: An Emerging Threat to Public Health

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Abstract

Chikungunya is a significant health problem in Bangladesh, causing serious illness including fever, joint pain, arthralgia, mental disorder and death. Prevalence of chikungunya is mainly limited to Dhaka or other large cities. Mymensingh is recently declared as divisional city and rapid urbanization is going to happen here. *Aedes* mosquitoes which are the vectors of chikungunya breeds mainly in urban areas,

but recently found extending their habitat throughout the country. One of the ways to assess the status of chikungunya is to detect the presence or absence of *virus* in vector mosquitoes. This study was designed to detect the chikungunya virus in vector mosquitoes in Mymensingh city. To do this, larval and adult mosquitoes were collected from Mymensingh city from January to June 2020. Larvae were collected from artificial and natural water lodging containers. Adult mosquitoes were collected from indoors in day time (from 8 am to 7 pm) from Mymensingh city using aspirator, mosquito spray and mosquito net. Larval and adult mosquitoes were identified with compound microscope to the species following the published keys. A total of 2185 mosquito larvae were collected from different artificial and natural water lodging containers of Mymensingh city. Among the collected larvae, 81.4% were *Aedes* and 18.6% were *Culex*. Two species of *Aedes* larvae were identified in which 58.1% were *Ae. aegypti* L. and 42.9% were *Ae. albopictus* Skuse. A total of 1262 adult mosquitoes were collected from Mymensingh city from January to June 2020 from indoor and outdoor of households. Three genera were identified from all collected mosquitoes in this study. Among three identified genera, 72% were *Culex,* 19.8% were *Aedes* and 8.2% were *Anopheles* mosquitoes. Two species of *Aedes* were identified, namely, *Aedes aegypti* L. and *Ae. albopictus* Skuse. Among them, *Aedes aegypti* were the most abundant species (65.3%) followed by *Ae. albopictus* (34.7%). Mosquito pools were made to test the presence of chikungunya virus. The procedure for pooling mosquitoes for chikungunya testing involves sorting samples by species. Reverse Transcriptase- Polymerase Chain Reaction (RT-PCR) was done for detection of chikungunya virus using published primers. All the pool samples were found negative in this study. This result might be an indicator of absence of chikungunya cases in Mymensingh for the particular period of time (January to June 2020). Further extensive study throughout the Mymensingh district is needed to clarify the original status of chikungunya in Mymensingh. However, the present study will contribute to develop a sustainable control program against chikungunya in Mymensingh, as well as in Bangladesh.

Epidemiology of Important Emerging Helminth Parasites in Backyard Chickens in Bnagladesh in Relation to Climate Change and Molecular Identification of Heterakis Gallinarum

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Abstract

Gastrointestinal helminth parasitism is a major hindrance of profitable poultry production especially for the scavenging backyard chickens in the tropics and subtropics during this study, the prevalence of the helminth parasites and the epidemiological factors in backyard chickens were investigated through faecal sample examination by post-mortem examination. A total of 300 faecal samples were examined by sedimentation technique and the results showed an overall 46.0% (138/300) infection with nematodes (Ascaridia galli, 92(30.67%), and Heterakis galliarum 41(13.67%)); cestodes (Raillietina spp., 86 (28.66%)); and trematodes (Echinostoma spp. 21 (7.0%)). Post mortem examination of 160 backyard chickens revealed an overall 60.0% (96/160) helminth infections. Through post mortem examination 5 nematode species viz. Ascaridia galli 72 (45.0%), Heterakis gallinarum 23(16.87%), Dispharynx (Acuaria) spiralis (7.5%), Acurioa hamulosa 9 (8.75%) and Capillaria spp. (6.88%); 3 cestode species of the genus Raillietina viz. Raillietina echinobothridia 53 (33.12%), R. tetragona 45(28.12%) and R. cesticillus 18 (11.25%) and 2 trematodes viz. Echinostoma revolutum 12 (7.5%) and Catatopis verrucosa 9 (5.63%) were detected. Almost similar prevalence was detected in male 47 (58.75%) and female chickens 49 (61.25%). The highest infection was detected in older chickens of > 6 months of age 51 (85%) followed by chickens of 3 months – 6 months of age 33 (66%) and the

lowest in birds of ≤ 3 months (24.0%). Almost similar prevalence of helminths was in winter 34(63.0%), summer 32 (59.3) and monsoon 30 (57.0%). These finding indicates that the sex does not have significant impacts on susceptibility of chickens to helminths. And seasons of the year does not impact on the development of the parasites in the environment as well as infection in backyard chickens. The ITS2 gene of the important caecal nematode, Heterakis gallinarum was expressed using the specific primer sets and an expected band of ~1020 bp was detected by agarose gel electrophoresis. Countrywide epidemiological study and immunogenic gene detection through genetic analyses are essentially needed to formulate low cost, safe and environment friendly control measures against the helminth parasites of chickens.

Tracheal Helminth Infection in Domestic Ducks: Eco-epidemiology and Anthelmintic Screening

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Abstract

The scavenging ducks prefers snails and small freshwater fishes which make them exposed to different trematodes including the tracheal flukes. The treacheal flukes cause respiratory distress and even may lead to death of the ducks. This pioneering research work was conducted to unveil the eco-epidemiology and determine the drug sensitivity of the tracheal flukes in ducks in ValukaUpazila, Mymensingh from November, 2019 to October, 2020. A total of 80ducks were slaughtered and their nasal passage, trachea, bronchioles and lungs were examined. Of the 80 ducks, 14 (17.5%) were found infected with tracheal fluke *Tracheophilus cymbius.* The parasite was found in nasal passage and trachea and the load ranged from 1- 5 parasites per infected duck. Significantly higher ($P< 0.05$) prevalence of infection was detected in ducks those scavenged in low lying areas (beels), canals and rivers (27.5%) than in the ducks reared in comparatively dry areas (7.5%). Higher prevalence of infection was detected in female ducks (23.33%) than in the males (14%). *T. cymbius* prevalence was higher in the ducks of >1 year of age (26.67%) than in ducks of >6 Months- 1 year. No infection was detected in ducks of ≤ 6 months. Seasonally, tracheal fluke infection was almost similar in monsoon (19.23%) and winter (20%). However, the lowest infection was found in summer (12.5%). The ducks with poor health condition were more infected (20%) than the apparently normal health conditioned ducks (13.33%). *In vitro* drug sensitivity tests of the tracheal flukes in RPMI medium at 37°C with 5% CO_2 and 95% RH to the commercially available different anthelmintics (20 µg/ml RPMI) were performed and calculation of the death time point after treatment showed that the tracheal flukes were most sensitive to oxyclozanide (3 ± 0.88 h) followed by praziquantel (10.5 ± 5.74 h), triclabendazole (21.5 ± 3.0 h), and nitroxynil (24.5 ± 4.12 h). The sensitivity of the parasites to albendazole was poor (81. ± 18 h) and ivermection could not kill the parasites even at 144 h post treatment. This study fairly suggests that the age, sex, season, health condition and scavenging places are the important risk factors of tracheal fluke infection in ducks. Among the anthelmintics, oxyclozanide may be the first choice of anthelmintic to treat the tracheal flukes in ducks.

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Avian Liver Flukes in Ducks in Some Selected Areas of Bangladesh: Epidemiology, Molecular Characterization and Anthelmintic Sensitivity

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Abstract
Parasitic diseases especially the snail and fish borne trematodal diseases are one of the major constraints of profitable duck rearing in the tropics and subtropics. Epidemiological investigation, molecular identification and anthelmintic sensitivity study of the duck liver flukes were conducted from July 2018 to June 2020. A total of 240 ducks were collected from Tarakanda Upazila (n= 128), Mymensingh and the haor area of Mohongonj (n = 112), Netrokona. Post mortem examination revealed that 104(43.33%) ducks were infected with avian liver flukes. Four species of duck liver flukes viz. *Amphimerus anatis* (29.17%), *Amphimerus ovalis* 11.67%), *Amphimerus lancea* (5.42%) and *Metorchis orientalis* (6.67%) were detected. Mixed infection was recorded in 7.92% ducks and the load of parasites varied from 1-22 parasites per infected liver. Significantly ($p<0.01$) higher prevalence of infections was detected in ducks of Mohongonj (55.36%) than that in Tarakanda (32.81%) and in the female ducks (54.67%) than in the males (24.44%). Among the age groups, the highest prevalence of infection was detected in ducks of ≥ 1 year (50.70%) followed by ducks of ≥ 6 months- 1 year of age (35.71%) and the lowest in ducks of < 6 months (14.29%). No duck below 5 months of age was found infected. Seasonal distribution showed that the highest prevalence was in summer (54.76%) followed by winter (44.36 %) and the lowest in monsoon (33.85%). Amplification of the *nad*1, *cox*1, 18S and 28S genes by using specific primers confirmed the *Amphimerus* and *Metrochis* species. *In vitro* anthelmintic sensitivity tests revealed that the *Amphimerus* spp. showed its highest sensitivity to the oxyclozanide followed by praziquental and nitroxynil. Studies on vectors (snails and fishes), development of risk models and anthelmintic therapy schedule are essentially needed to control the avian liver fluke infections in ducks.

PCR-based Identification of Schistosome Species Prevalent in Bangladesh Directly from Naturally Infected Vector Snails

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Abstract
Schistosomiasis, a neglected tropical disease (NTD) caused by blood flukes (schistosomes), which affects a wide variety of vertebrate hosts, including humans but at least one fresh water snail intermediate host is essential where they develop cercaraie, the infective stage for vertebrate hosts. A total of 20,394 snails of seven species such as *Lymnaea luteola*, *L. auricularia, Indoplanorbis exutus, Physa acuta, Vivipara vivipara , Brotia* spp. and *Thiara* spp. were collected and of them 538 (2.64%) snails of the species *P. acuta, V. vivipara, L. auricularia, L. luteola* and *I. exustus* were found infected. The highest infection was found in *L. luteola* (11.11%) followed by *L. auricularia* (5.3%) and the lowest in *I. exustus* (0.12%). Schistosome infection in snail was the highest in September followed by October and November but infection rate was least in the colder months such as January and February in Bangladesh. The study confirm that several fresh water snails such *as L. auricularia, L.*

luteola, *I. exustus, P. acuta* and *V. vivipara* acted as intermediate hosts of schistosome in Bangladesh, of which lymnaeid snails are the main intermediate host as. Size of the snails, seasons of the year and availability of the sunlight are the main factors that govern the prevalence of schistosome cercariae. Bigger snails and snails present in the sunny areas are more likely to carry schistosome cercariae. By employing PCR, we revealed that *Trichobilharzia* is prevalent in Bangladesh. And, using species-specific primer, we confirmed that human schistosomes were not prevalent in the study areas.

Prevalence and Molecular Identification of Hookworms Species from Dogs and Cats

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Abstract
Hookworms are voracious blood-sucking parasitic nematodes that live in the small intestines of most mammals such as dogs, cats, ruminants and humans. Canine hookworm infection is endemic in Southeast Asian countries. There is very limited research on canine hookworm infection in Bangladesh. Hence, the study was conducted to determine the prevalence of canine hookworm infection by fecal examination followed by morphometric identification and molecular identification of hookworm species. A total of 320 fecal samples were collected from Gauripur, Mymensingh Sadar and Tarakanda upzila. The samples were examined under microscope by simple flotation technique. Overall prevalence from fecal examination was 79.1% among which a higher prevalence was found in Gauripur 89.7% followed by 84.8% and 53.2%(42/79) at (95%CI 78.2-86.7) and P-value($P<0.001$) with p value defined as($P<0.005$). A total of 1200 adult hook worms were collected at necropsy from 74 dogs (male=35 and female=39) with females having high prevalence (65.4%) than in males (34.6%). On morphometric examination of (n=125) adult worms, the prevalence of *A. caninum* was 92.8% followed by 7.2% mixed infection of other hookworms species. One of the significant findings of this study is the morphometric identification of *A. ceylanicum* for the first time in Bangladesh along with *A. deodenale* and *A. brazilense* and *A. tubaeformae*. The genomic DNA was extracted from (n=85) adult worms amplified at 373 bp and 404bd respectively by using two set species specific primer for *A. caninum* and confirmed by PCR. The study confirmed the identification of *A. caninum* and *A. ceylanicum* by molecular methods for the first time in Bangladesh. The existance of *A. ceylanicum* in Bangladesh is revealed for the first time which can be reached adult in human. This study indicated that dogs as a public health risk to human hookworms infection. The morphometric identification of *A.ceylanicum* and *A.duodenale* indicates a higher level of zoonotic threat for human population.

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. FZTs are an emerging and rapidly growing concern in

developing and developed countries due to the expanding international trade in fishes and fish products, as well as human demographic diversity, especially mass refugee movement and global settlement, including in Bangladesh. A cross-sectional study was carried out to investigate the infection status of FZTs and explore the genetic diversity of FZT metacercariae (MC) from marketed freshwater fishes.A total of 16 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*), Pangas (*Pangasius pangasius*), singhi (*Heteropneustes fossilis*) and taki (*Channa punctata*) were collected and digested with pepsin to recover MC. Out of 16 species of fishes, all fish types were infected with FZTs, except grass carp. The overall prevalence of FZT 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., *Metorchis* spp. and *Metagonimas* spp. Importantly, yet today, we could not detect MC in grass carp.By employing PCR, we confirmed the presence of MC of opisthorchid flukes and our research is in progress to confirm other species.Taken together, our results suggest the frequent occurence of MC of FZTs in all fish types, indicating both the wild and cultured fishes carry the infection and people of the country are at risk.

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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Prevalence and Risk Factors of *Toxocara vitulorum* Infection in Buffalo and Cattle Calves in Coastal, Northeastern and Northwestern Regions of Bangladesh

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Abstract

Among the parasitic infections, *Toxocara vitulorum* is one of the most common and harmful parasites of buffalo calves in Bangladesh. A cross-sectional study was conducted to explore the prevalence and associated risk factors of *T. vitulorum* infection of buffalo and cattle calves in selected regions of Bangladesh. A total of 1751 faecal samples from buffalo calves were collected and examined using flotation followed by the McMaster technique for counting the eggs per gram of faeces (EPG) of *T. vitulorum.* The overall prevalence of *T. vitulorum* infection in buffalo calves was 22.96 %. Significantly ($p<0.001$) higher prevalence was found in the Barishal coastal area (35.73%) followed by Chattogram coastal area (29.24%), northeastern region (15.57%) and northwestern region (8.37%). Buffalo calves aged 1-3 months were heavily infected with *T. vitulorum* (51.77%) which was statistically different ($p<0.001$) compared to those >3-6 months (27.6%) and >6-12 months (6.56%). In cattle calves the overall prevalence of *T. vitulorum* infection was 14.9 % among 335 samples. Significantly ($p<0.01$) higher prevalence was found in the coastal region (19.4%) followed by northeastern region (10.0%). Cattle calves aged 1-3 months were heavily infected with *T. vitulorum* (22.2%) which was statistically significant ($p<0.001$). The larval bionomics of *T. vitulorum* of buffalo is related to observations on buffalo behavior and persistence of the eggs in soil and in wallows, contribute rapid embryonated eggs development. Some infective eggs persisted 3–4 cm deep for 18 months, finally dying during a prolonged hot, dry period. According to univariate analysis, coastal regions, rainy season, young age, gender, indigenous river type, buffalo calves in poor body condition and soft faeces were found significantly associated with *T. vitulorum* infections. Additionally, these were identified as the risk factors of *T. vitulorum* infection in calves by final logistic regression model. This study reveals that coastal region as the hotspot of *T. vitulorum* infection. Exploring the genetic diversity of *T. vitulorum* and anthelmintic resistance may help to reveal the host-parasite relationship in the future.

Collection and Isolation of Extracellular Vesicles Secreted *by Fasciola Gigantica*

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Abstract

Fasciola gigantica is the causative agent of liver fluke disease (fasciolosis) in domestic animals. and in human. 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. Special attention has been paid to the role of EVs in the establishment and progression of human diseases. Indeed, perturbing EV production to modulate their pathological effects is an attractive therapeutic option that has been successful in a number of diseases, including

cancer. Our study collected samples from various districts of the study area as planned for the 1st year of the project and successfully performed the culture of *F gigantica* parasites in incubator maintaining optmimun condition 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. The liver fluke parasite EVS will be available with the hope to gain new insight into the molecular information and proteomics. These findings would be helpful to recommend the immunogenic proteins and that may help in controlling the spread of liver fluke disease and also anthelmintic resistance in livestock of cattle. The obtained information from the study will contribute to the knowledge of the molecular immunology for subsequent vaccine development research in Bangladesh. Indeed, this project will have significant positive impact for designing the control strategies of liver fluke diseases in livestock to meet the challenges of 21st century in the field of Veterinary Parasitology.

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.

Investigation of *Eimeria* Oocyst Concentrations and Species Composition in Litter from Commercial Broiler Farms

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Abstract

Coccidiosis is one of the major economically important diseases of poultry industry worldwide. In Bangladesh, coccidiosis is one of the major threats for commercial poultry industry as well. Successful

control of chicken coccidiosis in Bangladesh mainly depends on the application of anticoccidial drugs (ACD) in a poultry house during grow-out. There are some reports on the occurrence of coccidiosis in broiler chickens in Bangladesh, but information on track changes in *Eimeria* oocysts levels and species composition in commercial broiler farms over time during ACD program is very scarce. The purpose of this study was to investigate the oocyst concentrations and species composition of *Eimeria* in litter from commercial broiler houses during ACD control programs. Litter samples were collected from a total of 22 different broiler farms during at least one complete grow-out cycle. Samples were collected at 0, 1, 2, 3 and 4 week (wk) of grow-out of the ACD cycle. We succeeded for isolation of *Eimeria* oocysts from the litter samples of 14 broiler farms and coccidian species were identified by previously described morphological characteristics using standard shape index method under microscopy. *Eimeria* oocyst concentration in litter was found to be reached in peak levels at 3–4 wk of grow-out cycle. However, sudden peak level of oocysts of *Eimeria* spp in 8 farms indicated to develop some drug resistance. Based on morphology of oocyst, *E. tenella, E. necatrix* and *E. acervulina* were generally found be to present in the most of the samples. Through internal transcribed spacer 1 (ITS1) based PCR, we identified the distribution of *Eimeria brunetti, E. acervulina, E. necatrix, E. maxima* and *E. tenella*, which might be potential clue in the control strategy of chicken coccidiosis for that respective zone.

Molecular Detection and Characterization of *Mecistocirrus Digitatus*, a Blood Feeding Nematode of 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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Exploring Anthelmintic Resistance and Molecular Analysis of Some Economically Important Gastrointestinal Nematode Parasites of Cattle in Bangladesh Status of Anthelmintic Resistance in Gastrointestinal Nematodes of Cattle

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Abstract
Present study was designed to survey the status of anthelmintic resistance in cattle by faecal egg count reduction test (FECRT), egg hatch assay and allele specific PCR (AS-PCR).Thirty animals with faecal egg counts of at least 200 eggs per gram (EPG) were identified from the farms, numbering individually, weighing and were allotted to four treatment (I-III) groups of ten animals each. Group I animals were treated with albendazole (7.5mg/kg body weight), Group II with with ivermectin (0.2 mg/kg body weight) and Group III animals remained untreated and served as control. Fecal samples were collected per rectum of each animal just prior to treatment (pre-treatment) and on 14 days post-treatment. The study found that anthelmintic resistance was present against albendazole and ivermectin in BAU dairy farm. Suspected resistance to albendazole and ivermectin was detected in Bigban dairy farm. Asha Agro farm showed resistance to ivermectin, but suspected resistance to albendazole. GI nematodes were susceptible to albendazole in Chan Miah dairy farm, but suspected resistance was detected against ivermectin. In egg hatch assay, ABZ resistance was detected in all the examined farms except Chan Miah dairy farm. The farms that were tested positive in egg hatch assay were also tested positive in Fecal Egg Count reduction Test. The EC_{50} value ranged from 0.087 to 0.176 µg ABZ/ml and the coefficient of determination (R^2) were all above 0.97. For AS-PCR, *H. contortus* were collected from cattle from different regions of Bangladesh. We analyzed 100 *H. contortus* DNA samples with an AS-PCR technique to detect BZ resistant allele. The frequency of resistance genotype (rr) ranged from 0% to 15% and allelic frequency of the mutation conferring resistance (r) ranged from 26% to 45%, and indicated that resistance to BZ were developed in nematodes of cattle collected from different topographic zones of Bangladesh. The obtained data from this study would be helpful to recommend the risk management by controlling the spread of anthelmintic resistance in cattle of Bangladesh.

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

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Abstract
Raillietina (Fuhrmann, 1920) is highly pathogenic cestode of domestic chicken throughout the world and also considered the most prevalent cestode recorded from the domestic fowl (*Gallus gallus domesticus*) in Bangladesh. The present study was conducted at Gouripur and Mymensingh sadar upazila of Mymensingh district from July, 2019 to March, 2020. A total of 211 chickens were collected to investigate the present status and parasitic burden of *Raillietina* species in domestic chicken using postmortem examination. 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, three species of *Raillietina* were identified including *R. echinobothrida* (38.9%, 95%CI: 32.3- 45.4%), *R. tetragona* (50.7%, 95% CI: 44.0-57.5%) and *Raillietina* sp. (34.1%, 95% CI: 27.7-40.5%). 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. The results obtained indicated high prevalence of *Raillietina* among domestic fowls. It is recommended to validate the species of *Raillietina* and also to find out the genetic diversity pattern of this parasite by using molecular tools. Thus help to formulate an effective control strategy against this parasite in domestic chickens.

Nodular Enteritis of Scavenging Chicken: Pathology and *In vitro* Standardization of Anthelmintics

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Abstract

Raillietina are the most prevalent and pathogenic cestode in the domestic fowl, *Gallus domesticus* throughout the world. For this, the present study was conducted to investigate the pathological condition caused by *Raillietina* in scavenging chicken using postmortem and histopathological examination and to assess the *in vitro* efficacy of anthelmintics such as albendazole (ABZ), mebendazole (MBZ), piperazine (PPZ) and ivermectin (IVM) at different concentration by maintaining a standardized culture technique. A total of twenty (20) native live fowls were collected from the local market of Mymensingh sadar to examine gross and histopathological changes in the intestine. The observed gross lesions were small nodular and pin point haemorrhage in the intestine in *Raillietina* infected chicken. In histopathology, the intestinal section of infected bird showed fusion of villi, desquamation and sloughing of lamina epithelia, haemorrhages, infiltration of inflammatory cells, and nodular aggregation of lymphoid follicle with encapsulation of fibrous connective tissue. To assess the *in vitro* efficacy of anthelmintics, three doses of each drug: 1 µg/ml, 10 µg/ml, and 100 µg/ml were used and examined 3hrs, 6hrs, 12hrs, 24hrs and 48hrs after treatment for motility in three independent trials. The results indicated that ABZ appears to be the generally most potent of the drugs, with quicker intoxication than MBZ, PPZ or IVM at almost all doses and more penetrant intoxication than all the other anthelmintics at the lowest two doses. In general, ABZ and MBZ show a well behaved dose–response curve (higher doses generally showing higher intoxication) with maximum intoxication at the highest doses at around 48 hrs. The dose response with PPZ and IVM were narrower, e.g., intoxication at100 µg/ml was markedly lower than might be predicted from the effects at other doses. So, the study revealed that albendazole is effective anthelmintic against *Raillietina* of chicken in compare to other studied drugs.

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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.

Molecular Characterization of Bangladeshi Isolates of Trichomonas Gallinae in Pigeon

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Abstract
Trichomoniasis, also known as canker, is one of the common infectious diseases of pigeons and squab caused by *Trichomonas gallinae.* Fundamental knowledge on the epidemiology, ecology and concurrent infections are prerequisite to establish more consistent development of control and for understanding of *T. gallinae* with respect to host adaptation. Therefore, the present research work was undertaken with the objectives to identify risk factors for the occurrence and severity of pigeon trichomoniasis and molecular characterization of Bangladesh isolates. A total of 90 pigeons and squabs were examined and data on age, sex, body weight were recorded and presence of *Trichomonas gallinae* was checked through microscopy of swab from oropharynx. Through post-mortem, gross lesions were investigated in the oral mucosa, crop, liver and lungs. *T. gallinae* were isolated and preserved with absolute alcohol. DNA samples were extracted and will be used for *T. gallinae* primer-

specific PCR. PCR products will undergo sequencing. Data will be analyzed to elucidate phylogenetic origin of *T. gallinae* isolates available in Bangladesh. From our study, until now 46.67% prevalence of pigeon trichomoniasis was recorded. Age and sex were found to have substantial role as the predisposing factors for trichomoniasis. In conclusion, this project will have significant positive impact for designing the control strategies of trichomoniasis to meet the challenges of sustainable development goal by promoting poultry production to alleviate protein deficiency from Bangladesh.

Evolutionary Analysis of *Peste des petits Ruminants'* Virus in Bangladesh During 2008-2017

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Abstract

Peste des petits ruminants virus (PPRV) infection is one of the major constrains of sustainable goat farming in Bangladesh. Since 1993, outbreaks of PPR are being continuously reported across the country. Our recent molecular phylogenetic analysis using partial F and N gene sequences of a limited number of samples showed that Bangladeshi PPRV isolates belonged to lineage IV but formed a separate sub-lineage along with recent isolates from Nepal, Bhutan and China (Rahman et al., 2016). However, full genome sequence analysis of Bangladeshi PPRV isolates is required to confirm the sub-lineage and to assess the evolutionary dynamics of the virus. This study describes the genetic diversity of three PPRV isolates from Bangladesh collected in 2008, 2015 and 2017 based on their complete genome sequence analysis. Two PPRV isolates from 2015 (BD10/2015) and 2017 (BD11/2017) were obtained from local field outbreaks and RNA was extracted from tissue homogenates of infected goats. The amplification of the full genome of PPRV was performed by 26 overlapping RT-PCR using custom designed primer sets. The amplified RT-PCR products were sequenced and sequence data were edited and assembled using Bioedit and MEGA 7 software and compared with other PPRV isolates from Bangladesh. The genome of all three field isolates of PPRV was 15948 nucleotide in length. Phylogenetic analysis using complete genomes and individual gene segments showed that all three PPRV isolates of Bangladesh belonged to lineage IV and were closely related to the viruses from Bangladesh, India, China, Tibet and Pakistan. The mean nucleotide divergence between the four lineages of PPRV varied from 9.7% to 14.8% based on their complete genome sequences. The highest divergence (14.8%) was found between lineage II and lineage IV. Bangladeshi PPRV isolates from 2015 (BD10/2015) and 2017 (BD11/2017) showed 1.7% and 2.3% divergence from isolate of 2008 (BD2/2008), respectively indicating that Bangladeshi PPRV are slowly evolving. Individual gene□based comparative analysis of nucleotide identity among strains of the four lineages showed that the M gene was the most conserved (7.1%-10.9%) whereas the H gene was the most divergent (9.6%-13.6%) one. Further phylogenetic analysis of global lineage IV PPRV strains showed that Bangladeshi three PPRV sequences clustered under clade 4.3. Nucleotide divergence analysis between four clades showed a mean divergence of 3.2% to 4.1%. Comparative residues analysis of complete genome showed several conserved motifs in the studied field isolates.

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.

Complete Genome Sequencing of Highly Pathogenic Avian Influenza Virus H5N1 from Recent Field Outbreaks

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Abstract
A total of five avian influenza suspected dead chickens were collected during a surveillance of respiratory diseases in commercial layer chickens in Bhaluka upazila of Mymensingh district and Sakhipur upazila of Tangail district during 2018-2019. The suspected flocks had 1100-1950 birds of different ages ranging from 27-87 weeks. Morbidity rate at the time of investigation was rather low (1.2%-6%), however, the case fatality rate was very high (57%-100%). Clinically, affected birds showed sudden death, depression, diarrhoea, cyanosis of comb and wattle, typical of highly pathogenic avian influenza. The gross lesions included congestion in comb and wattle, haemorrhages in muscles, congestion in lungs and trachea, cloudy air sacs, congestion in the liver, haemorrhages in the pancreas, caecal tonsils and proventriculus, enteritis, enlarged spleen and misshaped egg follicles. The RT-PCR technique subtyped the viruses as H5N1 highly pathogenic avian influenza (HPAI) virus. The viruses were propagated in chicken embryo and reconfirmed as H5N1 subtype by RT-PCR. The complete genome amplification and sequencing of all eight segments of the 5 HPAI viruses were performed. Phylogenetic analysis clustered the viruses under the reassortant H5N1 HA clade 2.3.2.1a (new) genotype together with HPAI viruses detected during surveillance in live bird markets and water bodies as well as outbreak in domestic poultry since 2015. Viruses of the reassortant genotype carried HA, NA and M genes of the circulating H5N1 viruses and PB2, PB1, PA, NS and NP genes of low

pathogenic avian influenza (LPAI) viruses. Our study revealed continuous circulation of the reassortant clade 2.3.2.1a viruses in domestic poultry in Bangladesh.

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 spp) in pediatric patient and to determine their antimicrobial resistance patterns 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) amd Mittis Salivarius Agar. The isolation and identification of the oral and periodontal diseases pathogens were performed based on morphology, cultural, staining and biochemical properties. The isolates were subjected to antimicrobial susceptibility test using 12 commonly used antiotics 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 spp. 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 spp. 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 spp. 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.

Effects of Acetaminophen (paracetamol) in Chickens with Emphasis on Hepatotoxicity

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Abstract
Drug induced liver injury is becoming a major concern in the globe. Acetaminophen (paracetamol) is extensively used in human medicine. In veterinary practice, paracetamol uses in poultry industry is drastically increased recently because of a safe alternative of ban diclofenac. However, reports of its toxicity in birds are very limited. Therefore, present study to investigate the histopathological alteration of liver following acute toxicity of acetaminophen. A total of 25 chickens were collected and randomly divided into control and acetaminophen-treated chicken (a single dose orally @2mg/kg body weight) and observed day 1 to 7. There was no clinical signs developed in acetaminophen-treated chickens. At necropsy, no gross lesions were seen in liver and other visceral organs of acetaminophen-treated chicken. Interestingly, the level of serum hepatic enzyme (alanine transaminase) was

significantly increased in acetaminophen-treated chicken compared to control chicken, indicating liver. Histopathological study revealed that hepatic lesions in centrilobular area and periportal areas including Glisson's sheath of liver in acetaminophen-treated chicken. Characteristically the hepatic lesions comprised of coagulation necrosis of hepatocytes and infiltration of mononuclear cells mainly lymphocytes and macrophages. The severity of necrosis and number of infiltrated inflammatory cells were found sharply higher on day 1 to 3 and gradually decreased up to day 7. In conclusion, it clear that, acetaminophen is detremental to liver homeostasis. Therefore, the present findings will provide a significant insight into the pathogenesis of liver injury of acetaminophen in chickens and may directly cause liver injury or act as a co-factor for other liver diseases.

Pathological and Molecular Studies on Avian Pathogenic *E. coli* Infection in Naturally Infected Chickens

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Abstract
E. coli infection is an important bacterial disease and a major constraints for poultry industry. This study was aim to find out the pathological changes and molecular detection of avian pathogenic *E. coli* (APEC) in naturally infected chickens. A total of 13 chickens, suspected for colibacillosis were examined for the clinical signs, gross lesions, histopathology and molecular detection by multiplex and real time-PCR. Major clinical signs, repiratory distress, inappetite, lethargy, whitish/ greenish diarrhea and leg paralysis were observed. At necropsy, internal organs were affected, particularly liver and lungs; and colisepticemia (69%), colienteritis (23%) and coligranuloma (8%) were diagnosed. Histopathologically, hepatitis is characterized by necrosis of hepatocytes mainly around the portal vein (periportal area), accompanied by infiltrates of mononuclear cells mainly macrophages, lymphocytes and hetrophils. Congestion, red hepatization and thromboemboli were seen in the lungs. Massive infiltration of heterophils were observed in heart, kidney and MALT. Multiplex-PCR was used for the detection of phoA gene of *E. coli* and invA gene of *Salmonella enteritica* and found 6 out of 13 samples positive for *E. coli* and only 1 sample have mixed infection with salmonella. Furthermore, real time-PCR also confirmed *E. coli* infection in 8 samples. No co-infection was seen by *Mycoplasma gallisepticum* and *Infectious laryngotracheitis virus*. As incidence and severity of colibacillosis have rapidly increased and possess a serious threat to poultry industry in Bangladesh, it is necessary to diagnose the disease rapidly and accurately, which will be helpful for the development of preventive strategy against *E. coli* infection.

Analysis of Sequential Pathological Changes and Innate Immune Responses in Chickens Experimentally Infected with Genotype XIII Newcastle Disease Virus

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Abstract
The sequential pathology and innate immune response of a genotype XIII Bangladeshi strain of Newcastle disease virus (NDV) was studied in 5-weeks old chickens. NDV-infected chickens showed

depression at 3 days pi (dpi) followed by dropped wings, paralysis and death starting at 4 dpi. Lungs of infected chickens showed hemorrhagic lesions starting at 24 hours pi (hpi) that was followed by pallor and slight contraction by 2 to 3 dpi and subsequently developed into severe hemorrhagic pneumonia with mononuclear cell infiltration. Hemorrhagic and necrotizing lesions were found in different visceral organs including proventriculus, intestine, gut-associated lymphoid tissues, liver and kidneys starting at 3 dpi that progressed rapidly. Severe lymphoid depletion was observed in the thymus, spleen and bursa of Fabricius starting at 1–3 dpi followed by hemorrhages, necrosis, inflammation and atrophy at 4–5 dpi. In the brain, mild neuronal lesions such as focal to diffuse encephalitis with encephalomalacia was observed at 2–3 dpi and moderate and diffuse meningoencephalitis with encephalomalacia at advanced stages. qPCR analysis of spleen tissues showed peak expression of Mx and PKR mRNA at 48 hpi, while IL-1β showed peak expression at 72 hpi and IL-6 at 96 hpi. In bursa, peak expression of Mx and PKR was observed at 48 hpi while IL-6 and IL-1β expressed peak at 96 hpi. Similar pattern of expression was observed in lungs, except IL-1β, which peaked early at 6 hpi. In caecal tonsils and thymus, highest expression of Mx and IL-6 was observed at 48 hpi and 72 hpi, respectively whereas PKR expression fluctuated but showed highest induction at 96 hpi in caecal tonsils and at 6 hpi in thymus. IL-1β expressed late at 96 hpi in caecal tonsils but not expressed at all in thymus.

Respiratory Co-infections of Commercial Layer Chickens of Bangladesh

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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 27 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 22 positive flocks, 10 (45%) showed single respiratory infections whereas 12 flocks (55%) showed mixed respiratory infections containing 2 to 3 pathogens. Among various pathogens, *Escherichia coli* was detected in 14 flocks (51.8%) followed by avian influenza in 11 (40.7%), *Mycoplasma gallisepticum* in 9 (33.3%) and infectious laryngotracheitis virus in 5 (18.5%) flocks. One case of Newcastle disease and *Avibacterium paragallinarum* was found. No IBV was detected in any of the tested samples. Next we amplified and sequenced the complete genome of five HPAI viruses collected from Mymensingh (Bhaluka) and Tangail (Sakhipur) districts during 2018 and 2019. Phylogenetic analysis based on full length gene sequences of HA gene placed all five 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 2.3.2.1aThe phylogenetic tree of NA and M gene sequences of all Bangladeshi H5N1 viruses broadly followed the topology of HA phylogenetic tree where all five isolates clustered under the new reassortant clade 2.3.2.1a viruses. Analysis of other internal genes showed that the five isolates of 2018 and 2019 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.

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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.

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.

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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Preparedness for the Control of PPR in Bangladesh

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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.

Identify Carrier, Transmission Cycle, Drug Toxicity and Drug Resistance Properties of Leishmaniasis (Kala-azar) in Bangladesh

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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.

Wild Animal's Tuberculosis (TB); A Hidden Source of Spreading Zoonotic TB

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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.

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Bulk Milk Somatic Cell Count in Dairy Herds at Baghabarighat Milk Shed Area of Bangladesh

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Abstract
Mastitis is one of the most devastating diseases in the dairy industry. Besides causing huge losses to milk production, the sub-clinically affected animals remain a continuous source of infection to other herd mates. Bulk milk somatic cell count (BMSCC) is a general indicator of the udder health in a herd and it is also considered as an indirect measure of milk quality.

Coregulatory Transcriptional Network of Innate Immune Response to *Escherichia coli* and *Staphylococcus aureus* Infection in of Bovine Mammary Epithelial Cells

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Abstract
Bovine mastitis, defined as inflammation of the mammary gland, is the most costly disease of dairy industry worldwide affecting both the quality and quantity of milk production. Escherichia coli and Staphylococcus aureus are among the most prevalent Gram-negative and Gram-positive bacterial pathogens, respectively, that cause intramammary infection in dairy cows. Bovine mammary epithelial (BME) cells stand at the frontline resisting intramammary infections, and thus, the severity of mastitis largely depends on the patterns of interactions between invading pathogens and the BME cells. The objective of the present study is to explore the key genes associated with the innate immune response of BME cells to mastitis through co-regulatory network analyses of publicly available transcriptome datasets. Lists of potential differentially expressed genes in BME cells at 3, 6, and 12 h post-infection were curated from published papers describing transcriptome profiles of BME cells based on microarray or next-generation sequencing. Curated gene lists with the uniform identifiers for E. coli and S. aureus were uploaded to the web portal of NetworkAnalyst (www.networkanalyst.ca) and InnateDB (www.innatedb.com) online tools for analyses with required modification of the default setup. The weighted protein-protein network analysis identified the 'Hub - potential network regulatory' gene including IL-1B, MMP2, MMP9, CXCL10, CCL2, CCL5, and IL-8 as potential regulatory genes. Gene-miRNA network identified potential microRNAs such as bta-mir-223, bta-mir-146a, bta-mir-146b, bta-mir-155, bta-mir-16b, bta-mir-15b, bta-mir-221, bta-mir-181a, and bta-mir-17-5p, which were predicted to be associated with posttranscriptional regulation of gene expression in BME cells. Transcription factor binding site analyses identified that Myc-Max, STAT5A, and NF-kappaB genes have transcriptional factors associated with gene expression regulation in BME after *E. coli* and *S. aureus* infection. We concluded that predicted genes from this study could be used as candidates for functional validation in order to elucidate the mechanism of intramammary immune responses to major mastitis-pathogens.

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Knowledge, Attitude and Practices of Veterinarians Regarding Lumpy Skin Disease 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, and the very first LSD outbreak in Bangladesh was reported in August 2019. The LSD has shown substantial economic impact causing decreased milk yield, abortion and infertility in cows, the reduced growth rate in beef cattle, and permanent damage to the skin of affected animals. 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. Thus, the experience, knowledge, attitude, and practices of veterinarians related to LSD in cattle would provide a better understanding and designing the prevention and control strategy. For this purpose, a country-wide, cross-sectional, online questionnaire survey will be conducted among the Government, non-government, and private veterinary practitioners to gather existing field-side knowledge on the predisposing factors, clinical manifestations, control measures, and management practices associated with LSD outbreak. The questionnaire has been sent via email or social media to the responders. The number of targeted responders is about 500 throughout the country. The inclusion criteria of responders are he/she should be the registered/licensed veterinarians who have been practicing in Bangladesh and gone through at least three LSD cases in cattle. The data from the responses will be filtered and analyzed with appropriate statistical tests. 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.

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 withdrawl 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.

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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*.

Molecular Diagnosis and Impact of Brucellosis on Human and Domestic Ruminant Populations 3. Economic Impact on Small Ruminants

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Abstract
According to the Food and Agriculture Organization (FAO), the World Health Organization (WHO) and the World Organization of Animal Health (OIE), brucellosis is considered to be the most widespread zoonosis throughout the world. 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 sacrolitis and hepato-splenomegaly are the most prominent. Brucellosis was first identified serologically in cattle in 1967 in Bangladesh and now it is endemic. However, the species designation of the prevalent *Brucella* is unknown and the impact of this disease in humans and animals has not been quantified in terms of economic and non-economic losses. In this study the sera from the blood of human and large (cattle and buffalo) and small (goat and sheep) ruminants have been tested by Rose Bengal Test (RBT) and rapid antibody test. A total of 250 sera from

human and 2593 small ruminants sera (746 sheep and 1847 goat) and 799 large ruminants sera (700 cattle and 99 buffalo) were collected along with their clinical signs and reproductive history from the different districts of Mymensingh division. The economic model to quantify the financial losses due to brucellosis were estimated in all upzilas of Mymensingh district only for goats and sheep.The prevalence rate of caprine and ovine brucellosis was estimated to be 1.6% whereas it was found to be 1.56% and 1.65 % in goats and sheep, respectively. Out of 799 serum samples from large ruminant, 45 serum samples reacted positive in the RBT and there were no positive among human sera and the prevalence of cattle, buffalo and human brucellosis were 5.42%, 7.07% and 0%, respectively. The RBT positive sera were re-tested by monoclonal based blocking ELISA (Enzyme Linked Immunosorbent Assay). ELISA positive sera were considered for DNA extraction and further confirmed by real time PCR for cattle and buffalo. Fourteen (9 cattle, 5 buffalo) sera were found to contain *Brucella* DNA by genus specific IS711 screening using quantitative real time PCR (qRT-PCR); and all the 15 qRT-PCR positive samples were found to contain specifically *Brucella abortus* DNA. Out of 38 RBT positive sera of cattle, 23.68%, out of 7 RBT positive buffalo sera, 71.43% were *B. abortus* positives. RBT positive dairy cattle were also screened by milk ring test (MRT) and positive samples were further confirmed by conventional polymerase chain reaction (PCR). Detection of an amplicon of 136 bp confirmed the presence of *Brucella abortus* DNA in milk samples with conventional PCR. Clinical signs related with brucellosis were abortion, retention of placenta and orchitis in ruminants. The result presented here indicate that *IS711* real time PCR assay is a specific and sensitive tool for detection of *Brucella* spp infection in cattle and buffalo. The total losses attributed to the disease was 48436400 taka (605455 US$) annually in the district whereas 46462900 taka (580786.25 US$) and 1973500 taka (24668.75 US$) in goat and sheep, respectively. The study concluded that *IS711* real time PCR assay is a specific and sensitive tool for detection of *Brucella* spp infection in animals and brucellosis silently constitutes economic loss to the economy of the country and the producers due to insufficient knowledge and inadequate diagnostic facilities, lack of awareness and an effective prevention and control strategy.

On-farm 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 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 district. 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 wet compared to dry season. The prevalence of SCM was not significant differences 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%) floor. Hair loss in the concrete and brick made floor was significantly higher ($P\leq0.01$) in comparison with soil floor. About 14.0 % cows had various forms of lameness. The highest percentage (64.52%) of the cow had BCS 2 and found 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% farmers believed that the 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 towards animal welfare.

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. 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.

Epidemiology and Antimicrobial Resistance of *Escherichia coli* in Broiler Chickens, Farmworkers, and Farm Sewage in Bangladesh

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Abstract

Antimicrobial resistance (AMR) has become an emerging threat worldwide, and developing countries like Bangladesh are considered to be at greater risk of disseminating the resistant bacteria between

human-animal interfaces. The present study was carried out to determine the prevalence and AMR profile of *E. coli* isolated from broiler chickens, the environment, and farmworkers. This study also aimed to identify the risk factors associated with the *E. coli* and multidrug-resistant *E. coli* infection in broiler chickens. In addition, the presence of carbapenem resistance gene (NDM-1) was assessed. A total of 150 samples (cloacal swabs = 50, farm sewage = 50, and hand washed water of farmworkers = 50) were collected from 50 commercial broiler farms and subjected to cultural and biochemical examination, and finally PCR assay for *E. coli* confirmation. Antimicrobial susceptibility test was performed with ten antibiotics by disk diffusion test. Carbapenem resistance gene (NDM-1) was detected by PCR. Risk factors were identified through multivariable logistic regression. The highest prevalence of *E. coli* was recorded in broiler chickens (86%) and the lowest in farmworkers (66%). *E. coli* infection in broiler chickens was significantly associated with flock size having >1500 birds, however, for MDR *E. coli* infection, winter season and absence of specific shoes for staff were the significant risk factors. High resistance of the *E. coli* isolates was observed to levofloxacin (81.6%), doxycycline (78.1%), cefotaxime (78.1%), and ciprofloxacin (70.2%). About 76% of the isolates demonstrated MDR. None of the isolates were positive for the NDM-1 gene. The high level and similar pattern of antibiotic resistance in *E. coli* isolates from broiler chickens, farmworkers, and sewage in poultry farms indicates that a very good possibility remains in spreading the antibiotic-resistant *E. coli* in such settings.

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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Differential Expression of Toll Like Receptors (TLRs) mRNA in Cerebral Coenuriasis in Goats

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Abstract
The research has been conducted to determine the differential expression of toll like receptors (TLRs) and serum biochemical changes in goats with cerebral coenuriasis. Pattern recognition receptors (PRRs) expressed by various immune cells and tissues have been shown to play a pivotal role in the recognition of pathogens by the host. The present study was carried out to find out differential expression of toll-like receptors (TLRs) 1-10 mRNA in goat peripheral blood mononuclear cells (PBMCs) and selected tissues including jejunum, lung, lymph node, skin, spleen and uterus using reverse transcriptase polymerase chain reaction (RT-PCR) in black Bengal goats with cerebral coenuriasis. Our results confirm earlier reports regarding the evolutionarily conserved nature of these receptors as successful amplification of the goat TLR mRNAs could be obtained with bovine TLR mRNA-specific primers. The partial sequences of the purified TLR PCR amplicons had 93.8–99.7% nucleotide identity with sheep TLR cDNA sequences available in the GenBank. Semi-quantification of the expression levels of the TLR mRNAs was done using densitometric analysis of band intensities. All the TLR mRNAs (1-10) were expressed in high amounts in the lymph node while spleen showed lower expression of TLR 6 and 10 mRNAs. PBMC and lung expressed all TLR mRNAs in high amounts except TLR 10 mRNA. In uterus and jejunum, lower expression of TLR 3, 4 and 10 mRNAs was seen. Skin had the lowest repertoire of TLR mRNA expression with lower or no expression of TLR 2, 3, 4, 8, 9 and 10 mRNAs. Another interesting observation was that tissues such as uterus, lung and skin that exhibited lower levels of TLR 2 had higher levels of TLR 6 mRNAs. Some important enzymes such as ALP, AST and glucose were increased significantly in affected goats. But values of total protein was decreased in the coenuriatic goats. Body electrolytes such as the concentration of Na+, K+ and Cl- were decreased in affected goats. Our findings suggest that the differential expression of TLRs strongly demonstrates the importance of the local immune response with little or no impact of the systemic innate immune response. Hence understanding of those local responses, particularly the role of TLRs, can contribute to developing different approaches to vaccination.
Keyword: Cerebral coenuriasis, TLRs, PBMC, goats

Physiological Responses of Murrah Buffalo (*Bubalus bubalis*) to Saline Water While Adapting in an Exotic Condition

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Abstract
The study was conducted to investigate the impacts of increased drinking water salinity on the physiological parameters of Murrah buffalo in Bangladesh. Twenty Murrah buffalo of both sexes with an average body weight of 331 kg and age ranged between 4 days to 11 years were randomly selected at Milkvita Buffalo Farm in Raipur, Luxmipur. Buffalos were classified as young (N =10) or adult (N =10) when younger or older than 2 years, respectively. Ten (10) ml of blood was collected from each buffalo. The supplied drinking water and feed samples were also collected. The blood parameters include glucose, alanine-aminotransferase (ALT), aspartate-aminotransferase (AST), creatinine, urea,

uric acid, magnesium, phosphorous, calcium, zinc, potassium, sodium, and chloride were analyzed. Different clinical manifestations of selected buffalos were also recorded. The sodium chloride concentration of supplied drinking water was found 2 ppt. The buffalos having skin lesions had higher serum concentrations of AST, creatinine, zinc, sodium, and chloride compared to other group. The significant age effects were found for serum concentrations of glucose ($p<0.05$), creatinine ($p<0.01$), uric acid ($p<0.001$), phosphorus ($p<0.05$), and potassium ($p<0.05$). No significant age and sex effects were found for AST, ALT, urea, magnesium, calcium, zinc, sodium and chloride. The serum concentration of creatinine was higher in female buffalos while uric acid concentrations in female buffaloes were lower than in male buffaloes. Thus indicating there is some effects on kidney function due to continuous ingestion of saline water. The measured blood parameters that remained within reference ranges indicate Murrah buffalo's remarkable capacities to adapt to saline water with minimal damage to liver and kidney functions. The differences between different age and sex of animal among the study groups underline that adult female buffalos suffer from more skin diseases and attempt to adapt to an exotic condition by altering their liver and kidney functions.

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

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Abstract

The research was undertaken to investigate the impacts of increased drinking water salinity on heamato-biochemical parameters of Black Bengal goats in Bangladesh 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 and riverine areas of Bangladesh. In order to account age effects, all goats were categorized as young (less than 2 years) and adults (older than 2 years). All goats were divided into 2 groups. In group 1, higher saline water (12 ppt) and lower saline water (1 ppt) in group 2 were continuously drunk by goats. Blood parameters of all selected goats were measured. Serum creatinine, uric acid, urea, potassium, sodium, and chloride were significantly higher ($P<0.05$) in group 1 compared with group 2, although serum phosphorous was significantly lower ($P < 0.05$) in group 1 compared with group 2. Between the two groups, there was no significant difference in serum aspartate aminotransferase (AST), alanine aminotransferase (ALT), glucose, magnesium, and calcium. AST and magnesium differed significantly ($P< 0.05$) between young and adult goats in group 1. In group 2, however, there was no significant difference in all serum electrolytes except glucose and urea when comparing two age groups. Glucose and urea levels were slightly higher ($P<0.05$) in young goats. In groups 1 and 2, male goats had significantly higher ($P<0.05$) serum potassium and urea levels than female goats. All other blood electrolytes did not vary between male and female goats in both groups. All measured blood parameters of our study remained within reference ranges, suggesting that Black Bengal goats of the coastal areas have the ability to withstand saltwater without health impairment and to adapt to higher salinity by changing kidney functions.

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Haematological and Biochemical Changes of Ovine Blood During Prolonged Storage for Transfusion

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Abstract
Haematobiochemical changes of sheep blood were investigated during preservation and storage with Citrate Phosphate Dextrose Adenine-1 (CPDA-1) and Acid Citrate Dextrose (ACD) for transfusion. Sixteen healthy sheep were selected and divided into two equal groups: group X (n=8) and group Y (n=8). Fifty ml of blood was collected from each animal and preserved with CPDA-1 in group X and ACD in group Y under 4°C in refrigerator for 28 days. Haematological changes viz., total erythrocyte count (TEC), total leukocyte count (TLC), haemoglobin (Hb), packed cell volume (PCV), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH) and mean corpuscular hemoglobin concentration (MCHC); and biochemical changes viz., total protein (TP) and pH were evaluated immediately after blood collection and thereafter on day-1, day-3, day-7, day-14, day-21 and day-28 for both groups. In ACD preserved blood; TEC, TLC, Hb and PCV decreased significantly ($P<0.01$) from day-14 onward, whereas in CPDA-1 preserved blood, these parameters decreased significantly ($P<0.01$) from day-21 onward. Blood preserved in ACD showed significant changes ($P<0.01$) in MCV, MCH and MCHC respectively from day-7, day-14 and day-21 onward, whereas blood preserved in CPDA-1 showed no significant changes in the same parameters throughout the experiment. In both groups, no significant changes were noticed in TP values but significant changes ($P<0.01$) were observed in pH with the progression of storage period. These findings elicited that both ACD and CPDA-1 exerted certain haemato-biochemical changes in stored sheep blood, however, CPDA-1 was more efficient than ACD in terms of maintaining proper levels of TEC, TLC, Hb, PCV, MCV, MCH and MCHC during preservation and storage of sheep blood for transfusion.

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

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Abstract
The objectives of the study were to determine the parental admixture of genome and their performances in crossbred Friesian cattle in selected population bred by AI in Bangladesh. A total of 1100 phenotypically looked crossbred Friesian cows from public and private commercial farms and 25 crossbred Friesian bulls routinely used for AI by Central Cattle Breeding and Dairy Farm (CCBDF), Savar, Dhaka, Bangladesh were selected. Phenotypic data on productive and reproductive performances were collected from all selected cows at 1-2 month intervals using a questionnaire. Single blood samples (~5 ml) from each selected cow and 25 bulls were collected for DNA extraction. Extracted DNA samples were stored at -20°C or -80°C until analysis for admixture in laboratory of IAEA using 60K SNP. Collection of production and reproduction performance related data have been going on from 1100 crossbred Friesian cows. Blood samples from 1049 crossbred cows and 25 breeding bulls have been collected and genomic DNA was extracted. Of these, the first set of 398 samples were subjected to two step quality control using nanodrop spectrophotometry and picogreen assay. Additionally, purebred Friesian (*Bos taurus*) and Bangladeshi local (*Bos indicus*) cattle were

included in the study to establish reference genotypes for admixture analysis. The samples were subsequently genotyped using Axiom bovine (BovMDv3) 60K array. The array consisted of 63655 probe sets targeting 63648 single nucleotide polymorphic markers located in different bovine chromosomes including that of sex chromosomes. The preliminary upstream analysis was conducted with the following sample quality control parameters: DQC> 0.82, SNP QC call rate >93%, average call rate for passing samples ≥ 98.5 and percent passing samples ≥ 95. The results revealed 382 samples passed DQC threshold, of which 372 passed SNP QC and other parameters. The genotype data were successfully extracted for a total of 48908 SNP markers out of 63648 markers available in the array (76.841%). The number of successful SNPs obtained in the crossbred cattle was slightly lower as compared to taurine cattle (~80-85%). However, it is understandable as the SNP discovery panel used to identify SNPs on the array predominantly consisted of commercial taurine cattle. Among the 48908 SNPs, 40637 (63.846%) were classified as Poly High Resolution SNPs that had all three genotypes (homozygotes for both alleles and heterozygotes), 3935 (6.182%) as No Minor Homozygous SNPs (homozygous genotypes missing for minor allele) and 4336 (6.812%) as Mono High Resolution SNPs (monomorphic markers). SNP genotype data for each marker locus and each animal was extracted along with information on chromosome number, strand, dbSNP ID, flanking region sequence, reference allele and associated gene. Genomic analysis of the second set of 676 samples is currently underway, after which further downstream bioinformatics analysis will be conducted to estimate genetic admixture and level of taurine inheritance in Bangladeshi crossbred cattle. The results of genomic analysis will be utilized to establish the genetic composition of crossbred cattle in Bangladesh under field conditions. The crossbred cattle will be classified into different genetic groups based on the levels of taurine introgression. The performance data will be compiled to generate phenotypes related to milk production for evaluation of different crossbred genetic groups and identify the optimal genotype that perform efficiently under the small holder dairy production system prevailing in Bangladesh. The study will also help in establishing a National Gene bank of phenotype recorded cattle that can serve as a reference population for implementing genomic selection programs in future.

Bovine Blood Bank for Treatment of Critically Ill Animals

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Abstract

This study was conducted to strengthen blood banking and institute transfusion therapy to the critically ill cattle brought and registered for treatment at the Veterinary Teaching Hospital (VTH), and also to some clinically sick animals at the farmer level. A total of 35 transfusions were performed to 30 anaemic animals. Single transfusion was performed in 20 animals and 5 animals received repeat transfusion of whole blood. Twenty five sick animals received transfusion from the donors of our blood bank and 10 animals in a farm were transfused fresh blood collected from the same farm. Before each transfusion, the donor and recipient blood profile was assessed. The blood parameters assessed included total erythrocyte count (TEC), total leucocyte count (TLC), haemoglobin (Hb), packed cell volume (PCV), and total serum protein (TP). A posttransfusion upgradation of the haematological parameters (TEC, Hb and PCV) and TP was noticed in the recipient animals. Blood banking can be of great importance to store and supply blood at the time of need to treat critically ill animals when life is threatened without such restoration.

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Developing Salinity Tolerant Rice Cultivar Through Transformation of Plasma-membrane and Tonoplast Na^+/H^+ Antiporter Genes

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Abstract
Salinity stress is one of the most deleterious abiotic stresses causing significant crop yield losses in many countries across the world. In Bangladesh, out of 2.85 million hectares of the coastal and offshore areas about 0.83 million hectares are arable lands, which is affected by varying degrees of salinity. Crop production, especially rice, in the area is severely affected by salinity stress. Development of salinity tolerant rice cultivar is an utmost necessity in the country to sustain rice production in the area and, thus, to attain self-sufficiency in rice production in the country. A plasmamebrane Na^+/H^+ antiporter (OsSOS1) and a tonoplast Na^+/H^+ antiporter (OsNHX1 & OsNHX2) in rice are shown to play a substantial role in conferring salinity tolerance by compartmentalizing Na^+ into the apoplast and vacuole, respectively. In addition, members of the high affinity K^+ transporter (HKT) family, such as *OsHKT1;5 (OsHKT8)* mediates Na^+ exclusion from leaves via Na^+ removal from the xylem sap in rice and, thus, play a very significant role in salinity tolerance. In this study, we have cloned OsNHX1, OsNHX2, OsSOS1 and OsHKT8 from the most salinity tolerant rice cultivar Pokkali. The salinity induced cDNA was prepared from Pokkali, the coding regions of *OsNHX1, OsNHX2,OsSOS1* and *OsHKT8* genes were amplified and cloned into the entry vector pDONOR221 using BP Clonase through Gateway Cloning Technology. The entry clones were transformed into *E. coli (*DH5*α)* by Heat-shock method and transformed colonies were confirmed by the colony PCR. The gene constructs were cloned into plant expression/destination vector pB2WG7 containing cauliflower mosaic virus 35S promoter by using LR Clonase and mobilized into *Agrobacterium tumefaciens* strain GV3101. Several putative transgenic rice lines were obtained by *Agrobacterium* harbouring *OsNHX2* gene from the rice genotype IR64, of which three transgenic lines viz., OE1, OE2 and OE3 were confirmed by genomic PCR.

Effect of Phosphorus, Boron and Potassium on the Growth and Yield of French Bean

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Abstract
The experiment was conducted at the Agronomy Field Laboratory of the Department of Agronomy, Bangladesh Agricultural University, Mymensingh to study the effect of phosphorus, boron and Potassium on the growth and yield of French bean during July 2018 to June 2020. BARI Jharsheem-3 was used as the experimental crop. The experiments was comprised of three factors involving phosphorus *viz.* 15, 20, 25, 35 kg P ha^{-1}; boron *viz.* 0, 0.5, 1.0,1.5 kg B ha^{-1} and Potassium viz. 0 ,20, 30, 40 Kg K ha^{-1}. TSP, Borax and Muriate of Potash were used as source of phosphorus, boron and potassium respectively. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. The results exhibited that growth and yield contributing characteristics were significantly influenced by the phosphorus, boron and potassium applications. In case of interaction of phosphorus and boron, the highest number of pods per plant (5.18), pod length (14.35 cm), number of seeds pod^{-1} (4.84), and 1000-seed weight (427.19 g), seed yield (1.86 t ha^{-1}), stover

yield (2.05 t ha^{-1}), biological yield(3.91 t ha^{-1}) and harvest index (47.57 %) were recorded under P level at 25 kg ha^{-1} and B level at1.5 kg ha^{-1}. On the other hand, In the interaction effect of phosphorus and potassium, the highest number of pods $plant^{-1}$ (5.18), pod length (13.40 cm), number of seeds pod^{-1} (4.30), weight of 1000-seed (430.53 g), seed yield (1.40 t ha^{-1}), stover yield (1.60 t ha^{-1}), biological yield (3.00 t ha^{-1}) and harvest index (46.66%) were recorded from P @ 25 kg ha^{-1} and K @ 40 kg ha^{-1}.However, from the study it can be concluded that application of P @ 25 kg ha^{-1} along with 1.5 kg B ha^{-1} or K @ 40 kg ha^{-1} was the most suitable combination for better yield of French bean.

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

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Abstract
Wide genetic variability exists in the current genetic resources for resistance to heat stress. This potential could be explored to screen rice germplasms with heat tolerance for developing current well-adapted varieties for future warmer climates. Considering the fact a study was undertaken to screen out heat tolerant boro rice varieties where 25 boro rice varieties (3 local, 17 high yielding and 5 hybrid rice) were grown with three distinct sowing date (16 January, 30 January and 16 February). Experiment was carried out following split plot design by assigning sowing date in the main plot and variety in the sub-plot. Data on phenology, yield, yield contributing characters and grain morphology were recorded. Days to maturity were reduced at late sown condition. BRRI hybrid dhan-5, BRRI dhan29, BRRI dhan84, Hira dhan-2 and Bina dhan-6 showed consistent grain yield irrespective of planting dates. This result will help the breeder to develop heat tolerant rice variety.

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 herbicide 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.

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

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Abstract

Dry direct seeded system does not require standing water but water stress at any growth stages may affect yield. 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 (10 February and 01 March 2020) and five 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) and no irrigation). Experiment 2 comprised four irrigation levels (25% FC (3 irrigation), 1 week 25% FC (2 irrigation)), 2 week 25% FC (1 irrigation), and no irrigation) and six rice varieties (BRRI dhan28 (V_1), BRRI dhan58 (V_2), BRRI dhan67 (V_3), BRRI dhan88 (V_4), Binadhan-14 (V_5) and Binadhan-19 (V_6). Both the experiments used split-plot design with three replications. Data on different growth and yield parameters of rice were recorded and analysis was done by Statistics 10 software. The result revealed that rice yield reduced significantly due to delayed sowing and irrigation. The crop sown on 10 February gave the highest yield for irrigation during this period. Among six rice varieties, Binadhan-19 gave the highest yield when irrigation was given within a week after 25% FC soil moisture. The present study concludes that highest yield of dry direct seeded boro rice can be obtained for early February sowing and irrigation at within a week of attaining 25% field capacity moisture level.

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*.

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), rrecommended 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.

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

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Abstract
Roots are crucial for nutrient and water acquisition and can be targeted to enhance plant productivity under a broad range of growing conditions. Root growth is an important component of the adaptation of rice to drought-prone environments, and the size of the root system varies substantially between the different ecotypes of rice. Therefore, a study was conducted at pot condition in the net house of Agronomy Department, BAU, Mymensingh during December 2019 to May 2020 for screening out best rice cultivars to have the maximum rooting ability for higher yield. The another objective is to find out the variation in root system architecture and yield among different cultivars of *boro* rice in respect of irrigation condition, level of potassium and level of nitrogen. Thirteen rice varieties viz. BRRI dhan29, BRRI dhan58, BRRI dhan67, BRRI dhan81, BRRI dhan86, Binadhan-8, Binadhan-10, Dhanigold, Hira, SL8H, Tepiboro, Rataboro and Lakhai were included in the study. The experiment was laid out following CRD design with three replications. Results revealed that the variety Binadhan-10 produced the highest root number (250.67), root length (976.17 cm), root volume (1.52 ml), root porosity (51.05 %), LAI (4.43), total dry matter (30.93 g) and crop growth rate (11.63 gm^{-2} day^{-1}) followed by hybrid Hira. Similarly the highest grain yield (26.26 g pot-1) and straw yield (26.58 g pot^{-1}) was obtained from Binadhan-10. The local varieties have the lower root number, root length, root volume, root porosity, LAI, total dry matter and crop growth rate. Based on results, it can be concluded that Binadhan-10 and hybrid Hira can be cultivated effectively used for rice cultivation.

Pre and Post Emergence Herbicidal Activity of Aqueous Extract of Grass Pea and Lentil in Rice

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Abstract
Crop residues extract applied in the experiments suppressed weed growth and inhibition at satisfactory level. Two experiments were conducted to evaluate the effect of extract of crop residues on weed suppression and crop performance of *boro* rice. In first experiment, treatments consist of BRRI dhan58, BRRI dhan81, BRRI dhan88 and application of aqueous extract of grass pea (5)- no extracts (Control); aqueous extract of grass pea as pre-emergence at 3 days after transplanting, aqueous extract of grass pea as post emergence at 10 days after transplanting, aqueous extract of grass pea as post emergence at 10 days after transplanting+ one hand weeding at 30 DAT and three hand weeding as farmers practices. Second experiment also consists of variety (3)- BRRI dhan58, BRRI dhan81, BRRI dhan88 and application of aqueous extract of lentil (5)- no extracts (Control); aqueous extract of lentil as pre emergence at 3 days after transplanting, aqueous extract of lentil as post emergence at 10 days after transplanting, aqueous extract of lentil as post emergence at 10 days after transplanting+ one hand weeding at 30 DAT and three hand weeding as farmers practices. Among the treatments used in both of the experiments, three hand weeding was the most effective followed by combined use of crop residues. It was noticed that broadleaf weed species were more susceptible to crop residues than grass weed species. In this respect, the highest growth inhibitions (100.00%) in experiment-1 experiment-2 were

observed in controlling Panikachu *(Monochoria vaginalis)*. The results indicated that the highest grain yield (6.04 t ha^{-1} and 6.02 t/ha) in experiment-1 and experiment-2 were observed in three hand weeding along with variety BRRI dhan58 followed aqueous extract of grasspea and lentil as post emergence at 10 days after transplanting+ one hand weeding at 30 DAT with BRRI dhan58.

Screening of Locally Available Herbicides for their Efficacy and Phytotoxicity in Different Boro Rice Production Systems

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Abstract
Weed management is a great challenge for crop production. Despite some undesirable side-effects no viable alternative is presently available to shift the chemical dependence for weed management in rice. Migration of labour away from agriculture to industries or other countries for employment further aggravated this reliance. However, efficacy, cost-effectiveness and application time 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. Hence, before recommending any herbicide, information regarding efficacy, cost effectiveness, and phytotoxicity to crops need to be considered for sustainable weed management. In this backdrop, three experiments were carried out at the Agronomy Field Laboratory of Bangladesh Agricultural University to find out the effective herbicide(s) for weed management and their phytotoxicity to crops under three boro rice production systems *viz.*, puddled transplanted rice (PTR), non- puddled transplanted rice (NPTR) and dry direct seeded rice (DDSR). The experiments comprised 22 herbicidal weed management practices along with season long weedy, weed free and farmers' practices. The experiments were conducted under randomized complete block design with three replications. The results showed that the herbicide performance in terms of weed suppression varied significantly depending on the type of rice cultivation. More interestingly the herbicide performance varied depending on the manufacturer and/or marketing company rather their chemical groups. The weed composition and diversity were also varied among the production systems. No phytotoxicity to rice plant was observed for the herbicides in any of the experimental conditions. The final conclusion may be made based on the efficacy and economics after second year (on going) and third year (farmer's field) experiments considering different doses of the selected herbicides.

Comparative Role of Allelopathy and Weed Competitiveness of Major Cereals of Bangladesh in Suppressing Weeds

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Abstract
Manual weed control is the best and sustainable, while herbicidal control is more effective and rapid option for weed management. But due to migration of agricultural labors from agriculture to industry or foreign countries for employment; adverse effect of herbicides on human health and environment, development of herbicide resistant weed biotypes motivates the researcher to think their alternatives. In this backdrop, weed competitive crop cultivars may play a vital role. Therefore, four field experiments were designed to evaluate the weed competitiveness of selected boro & aman rice, wheat and maize cultivars of Bangladesh. In addition, a pot experiment was conducted to quantify the comparative role

of allelopathy and competition for suppressing the weeds. A total of 70 rice (28 boro & 42 aman rice), 18 wheat and 12 maize varieties were grown under season-long weedy and weed-free conditions. Plots with no crop were also maintained to observe the natural growth of weed in absence of crop. The field experiments were laid out in a randomized complete block design, while pot experiment in completely randomized design with three replications. Results showed that all cultivars varied widely in their yield performances and weed competitiveness. Among the 28 boro rice cultivars, the hybrid Heera 6 was the most productive (8.3 t ha^{-1}), as well as the most weed competitive (relative yield loss *i.e.* RYL 23.7%). The hybrid Dhani Gold (6.3 t ha^{-1}, RYL 46%) was the most productive but BU dhan1 (3.5 t ha^{-1}, RYL 4.0%) was the most weed competitive among 42 aman cultivars. Among the 18 wheat varieties, the BARI Gom32 (4.98 t ha^{-1}, RYL 28%) was the most productive, but BARI Gom 33 (3.93 t ha^{-1}, RYL 5%) was the most weed competitive cultivar. While, Mohabir (9.43 t ha^{-1}, RYL 91.7%) was the most productive, but BARI hybrid maize 12 (7.92 t ha^{-1}, RYL 42%) was the most weed competitive variety among 12 maize cultivars. Because of the lower RYL, BU dhan1 was used in pot experiment to quantify the role of allelopathy and species competition in suppressing weed and more than 40% weed growth suppression due to allelopathy was observed. Based on the results it is clear that cereal cultivars of Bangladesh differ among themselves for their weed suppressive ability, and allelopathy is one of the important factors for their weed suppression.

Seed Priming Mediated Enhancement in Cold Tolerance and Weed Competitiveness of Boro Rice

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Abstract

Seed priming is an approach which results in higher germination, better seedling growth, higher survivability and increased yield under stress conditions. Boro rice is very often enjoys cold wave during sowing and/or after transplanting and competition from weeds resulting poor seed emergence rate & seedling growth, low survival rate and reduced yield. Therefore, the objective of this study was to evaluate the efficacy of different seed priming techniques to increase weed competitiveness, seed emergence, seedling growth, survivability, and yield of both transplanted and direct seeded Boro rice under cold stress. The priming agents (of different concentrations) tried included NaCl, KCl, $CaCl_2$, $CuSO_4$, $ZnSO_4$, Na_2MoO_4 and PEG. A positive impact of seed priming on seed emergence rate, seedling growth & vigor and survivability was evident from both laboratory and pot experiments. Seed priming with NaCl/$CaCl_2$ was found the best for higher & faster seed emergence with vigorous seedling growth. In transplanted Boro rice, seed priming enhanced rice growth and yield up to 15%. But no significant effect of seed priming on weed suppression was recorded. Primed seeds performed better than non-primed seeds under low temperature condition to some extent. Priming with 20000 ppm NaCl/$CaCl_2$ emerged as the best approach for enhancing transplanted Boro rice yield. Under direct seeded condition, plant growth and yield parameters were positively influenced due to seed priming resulting yield enhancement up to 18% compared to no priming in Boro rice. But, seed priming failed to enhance the weed competitiveness of rice resulting similar weed growth for primed and control treatments. Seed priming with 20000 ppm KCl/$CaCl_2$ may be practiced for enhancing yield of Boro rice under dry direct seeded condition. In conclusion, seed priming can be explored as a tool for increased growth and yield of both transplanted and direct seeded Boro rice under low temperature.

Salt Stress Mitigation in Wheat by Arbuscular Mycorrhizal Fungi

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Abstract
Introduction: Arbuscular mycorrhizal fungi (AMF) enables the plant with increased antioxidant capabilities to scavenge the reactive oxygen species (ROS) developed within the tissues of stressed plants. In addition, when AMF inoculated plant is grown in soil/media with high nutrient/metal contents (polluted, saline soil, etc), AMF reduces the uptake of the metal/nutrient by chelating in its root tissue, and therefore it can improve the national status of the plant in addition to reducing stress. **Methodology:** A pot experiment was conducted at the net house of Department of Agronomy in Bangladesh Agricultural University to evaluate the effect of AMF inoculation on growth, yield and nutritional status of two wheat varieties (BARI Gom-25 and BARI Gom-30). The experiment consisted of four levels of salinity (0, 4, 8 and 12 dS/m) and two levels of AMF inoculation (AMF-inoculated and non-inoculated). The experiment was laid out a 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. **Findings**: It was found that though AMF inoculation didn't significantly affect the growth parameters of wheat (leaf number, number of leaves/plant and leaf greenness), it had significant effect on number of filled grains/panicle and grain yield. Concentrations of reactive oxygen species (MDA) and anti-oxidants (CAT, APX and POD) in leaf tissue suggested that inoculation of AMF in wheat in saline condition could alleviate the oxidative stress. **Conclusion:** The results of this research conclude that AMF inocula can be used to improve wheat yield and quality under saline condition. Further research should be conducted on the screening of naturally occurring AMF species found in saline condition and their effect on wheat yield and quality.

Impact of Organic Amendment on Carbon Sequestration in Soils of Two Different Land Uses

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Abstract
Soil organic carbon (OC) is the largest terrestrial C stock and soils' capacity to preserve OC varies with many factors including land use and organic matter (OM) management. This study aimed to assess the effect of OM amendments on C sequestration of soils under diverse land uses. This was a pot experiment under net house conditions and composed of two OM amendments: rice straw (RS) and poultry manure (PM); four application rates of OM: 0 (control), 25, 50 and 150 g dry weight/pot; two placement methods of OM amendments: surface application and incorporation; and three land uses: cultivated: - (i) rice-rice and (ii) rice-wheat, and (iii) uncultivated: - grassland. After 4 months of incubation, soil samples were collected and fractionated into particulate (>53µm, labile) and mineral associated (<53µm, stable) OMs. Bulk soil samples (before and after incubation) and soil fractions were analyzed for OC and nitrogen (N), and C sequestration percentage was calculated. Among land uses, rice-rice system stored higher amounts of OC than rice-wheat and grassland. This may be related to OC – mineral association mechanism, since the mineral associated OM fraction was the highest in

rice-rice system among the land uses. Application of PM led to a significant increase in OC content than RS which was attributed to the narrower C: N ratio of PM, that resulted higher decomposability of OM than RS. Application of manure showed higher C sequestration potential than RS application which was corresponding to the higher distribution of OC in the mineral associated fractions than labile portion. Use of higher organic amendments always did not enhance OC content and decreased C sequestration percentage in the soils. Because the microbial activity most likely did not match with the higher amount of OM, and resulted increased distribution of OC in the partially decomposed labile fractions compared to the mineral associated OM. In general, incorporation of OM resulted higher OC in all cases than surface placement. Therefore, C sequestration potential was higher in PM than RS following incorporation method, and in cropland soil than uncultivated soil. The findings revealed the necessity of paying more attention to the selection of the type, rate and placement method of organic amendments for enhancing C sequestration in soil and sustainable agriculture.

Suitability Assessment of Some Hilly Black Rice Cultivars in Plain Land Ecosystem

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Abstract

To assess the suitability of hilly black rice cultivation in plain land ecosystem, two experiments were conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh. The first experiment was completed during the period from April 2018 to March 2019 and the second experiment was done from November 2019 to May 2020. In the first experiment morphological, phenological and yield contributing and yield characters of the cultivars were identified. Three varieties named Knognang ene, Gelong ni and Gelong se with 12 date of transplanting (1st day of every months of the year) were used as experimental treatments. It was found that Gelong se produced tallest plant (115.25 cm), highest number of effective tillers (1071) per hill, number of grains per panicle (123.46), weight of 1000-grain (30.82) and grain yield (4.00 t/ha). Considering the date of transplanting it was found that highest number of effective tiller (13.72) was produced when the seedlings were transplanted on January 01. The same transplanting date also gave maxium number of grains (130.3) per panicle, highest grain yield (4.0 t/ha) and highest straw yield (7.66 t/ha). Days required to express different phenological characters were significantly differed among the rice cultivars and transplanting date. After transplanting, the cultivar Kongnang ene required minimum number of days (42.17) to panicle initiation (PI), 62.50 days to flowering and 95.67 days to harvesting. Considering transplanting date, minimum days (44.67) required to PI when transplanted on May 01, but 66.67 days required to flowering and 100 days required to harvesting when transplanted on April 01. However, longest period viz. 53 days to PI, 75 days to flowering and 112.0 days to harvesting was required when transplanted on December 01. Based on the performance of first experiment two cultivars (Kongnam ene and Gelong ni) with 9 transplanting date at boro season were considered for the second experiment. It has been found that all the crop characters, yield contributing characters and yield except non-effective tillers, panicle length and sterile spikelets panicle^{-1} were significantly varied between the cultivars and among the date of transplanting. Highest number of effective tillers hill^{-1} (10.10) was observed when the cultivars Gelong ni was transplanted in 10 January, which was statistically similar with the transplanting at 01 January. Maximum grain yield (4.23 tha^{-1}) and straw yield (6.29 tha^{-1}) was found when Gelong was transplanted in 10 January. Therefore, it can be concluded that for plainland ecosystem the black rice cultivars Gelong ni can be cultivated in boro season (10 January) to get maximum yield compared to other black rice cultivars.

Impact of Irrigation and Nutrient Management on the Yield Performance and Nutritional Quality of Faba Bean (*Vicia faba* L.)

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Abstract
A field experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University to assess the influence of irrigation and nutrient management on the yield and quality of faba bean. The experiment consisted of four levels of irrigation viz. rainfed (no irrigation), one irrigation at the early-branching stage, one irrigation at the pod formation stage, two irrigations at early branching and pod formation stages and four nutrient managements viz. 0-0-0-0, 5-20-20-5, 10-40-40-10, 15-60-60-15 kg of N-P_2O_5-K_2O-S ha^{-1}, respectively. The experiment was laid out in a split-plot design assigning irrigation in the main plot and nutrient management in subplot with three replications. The highest number of nodules $plant^{-1}$ (58.67), shoot dry weight $plant^{-1}$ (1.20 g), number of total pods $plant^{-1}$ (59.19), seed yield (1.49 t ha^{-1}) and crude protein (31.55%) were found in two irrigations at early branching and pod formation stages while the lowest values of these parameters were recorded in rainfed condition (no irrigation). In case of nutrient management, the highest number of nodules $plant^{-1}$ (60.00), shoot dry weight $plant^{-1}$ (1.28 g), number of total pods $plant^{-1}$ (60.66), seed yield (1.70 t ha^{-1}) and crude protein (32.70%) were obtained when fertilized with 10-40-40-10 kg of N-P_2O_5-K_2O-S ha^{-1}, respectively while the lowest values of these parameters were recorded in control nutrient management (0-0-0-0 kg of N-P_2O_5-K_2O-S ha^{-1}, respectively). In case of interaction, the highest number of nodules $plant^{-1}$ (65.33), shoot dry weight $plant^{-1}$ (1.477 g), number of total pods $plant^{-1}$ (63.34), seed yield (1.99 t ha^{-1}) and crude protein (34.20%) were recorded in two irrigations at early branching and pod formation stages fertilized with 10-40-40-10 kg of N-P_2O_5-K_2O-S ha^{-1}, respectively. Therefore, application of two irrigations at early branching and pod formation stages fertilized with 10-40-40-10 kg of N-P_2O_5-K_2O-S ha^{-1}, respectively seems to be promising technique for faba bean cultivation.

Impact of Foliar Application of Boron on Crown Rot Incidence, Growth, Yield and Juice Quality of Tropical Sugarbeet

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Abstract
The experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh to find out the effect of foliar application of boron on the growth, yield and quality of tropical sugarbeet. The experiment consisted of foliar application of boron at four concentrations viz. 0, 50, 100 and 150 ppm and three frequencies of application time viz. once at 40 days after emergence (DAE), twice at 40 and 65 DAE and thrice at 40, 65 and 90 DAE. The experiment was laid out in a randomized complete block design with three replications. The SPAD value increased in advancement of time and reached maximum (55.99) at 90 DAS with 150 ppm boron applied thrice at 40, 65 and 90 DAE and thereafter declined. Crown rot infestation suppressed properly using 100 ppm or 150 ppm boron applied twice at 40, 65 and 90 DAE. The highest beet length (28.92 cm) was obtained in 150 ppm boron applied twice at 40 and 65 DAE while the highest beet girth (36.25 cm), beet yield (104 t ha^{-1}) and shoot yield (6.40 t ha^{-1}) were recorded in plants grown in 150 ppm boron with foliar

application thrice at 40, 65 and 90 DAE whereas the lowest values were recorded in control treatment. The highest brix percentage (16.33%) was recorded in 100 ppm boron applied thrice at 40, 65 and 90 DAE which was at par with 150 ppm boron applied thrice, twice and once while the highest purity (75.53 %) was recorded in 150 ppm boron applied thrice at 40, 65 and 90 DAE. Therefore, it can be concluded that 150 ppm boron with foliar application thrice at 40, 65 and 90 DAE appears as the promising combination for maximizing the beet yield and juice quality of 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 cultivars may differ because of differences in growth duration and N dynamics in the soil. Therefore, a two year study was conducted with two experiments (pot and field) to evaluate yield and nitrogen use efficiency in modern wheat cultivars. During first year, ten wheat varieties viz. BARI GOM 24, BARI GOM 25, BARI GOM 26, BARI GOM 27, BARI GOM 28, BARI GOM 29, BARI GOM 30, BARI GOM 31, BARI GOM 32, BARI GOM 33 and four levels of nitrogen viz. i) 0 nitrogen, ii) 45 kg N ha^{-1}, iii) 90 kg N ha^{-1}, iv) 135 kg N ha^{-1} were included in the study. Results revealed that the variety BARI GOM 32 produced the highest plant height (97 cm) and leaf area index (1.07). BARI GOM 32 produced grain yield (4.53 t ha-1), straw yield (6.58 t ha^{-1}) and

nitrogen use efficiency (35.63) at 90 kg N ha^{-1}. During second year, four wheat cultivars BARI GOM 28, BARI GOM 30, BARI GOM 31, BARI GOM 32 with five nitrogen management systems (Control, 90 kg N ha^{-1} from Prilled Urea (PU), 57 kg N ha^{-1} from PU + 3 t ha^{-1} Poultry manure, 62 kg N ha^{-1} from PU + 5 t ha^{-1} Cowdung and 29 kg N ha^{-1} from PU + 4 t ha^{-1} vermi compost) were incorporated in the study. BARI GOM 32 produced maximum grain yield (4.38 t ha^{-1}) along with 57 kg N ha^{-1} from PU + 3 t ha^{-1} Poultry manure. The highest grain yield and nitrogen use efficiency was obtained from the variety BARI GOM 32 with an application of 90 kg N ha^{-1} during first year and with 57 kg N ha^{-1} from PU + 3 t ha^{-1} Poultry manure during second year.

Responses of Zinc Fertilizer and Irrigation on the Performance of Wheat

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Abstract
Wheat is one of the crops most sensitive to Zn deficiency. Two field experiments were carried out during November 2019 to March 2020 to find out yield performance of wheat as influenced by Zn application and irrigation. The first experiment comprised of four variety viz. BARI Gom-26, BARI Gom-27 and BARI Gom-28 and four Zn level e.g. Control, 4 kg ha^{-1} Zn, 8 kg ha^{-1} Zn and foliar spray of 5 kg ha^{-1} ZnSO4 at 25 and 50 days after sowing. The second experiment consists of irrigation viz. regular irrigation: irrigation at crown root initiation stage, booting stage and grain filling stage; skipping one irrigation at crown root initiation stage; skipping one irrigation at booting stage; skipping one irrigation at grain filling stage and Zn treatments consists of control, 0.02%, 0.04% and 0.06% foliar application of Zn. The highest number of effective tillers $hill^{-1}$ (4.57), grain yield (5.20 t ha^{-1}) and straw yield (7.27 t ha^{-1}) were obtained from the interaction of BARI Gom-28 and Zn application @ 8 kg ha^{-1}. The second experimental result showed that there were significant differences in grain yield and straw yield due to the application of irrigation and Zn fertilizers; although some of the yield attributes were not found significant. Interaction effect of irrigation and Zn rates on yield and most of the yield attributes were found significant. The highest grain yield (5.50 t/ha) and straw yield (6.93t/ha) were found from the treatment combination of regular irrigation + of 0.04% Zn. It may be conclude from the results of the study that, BARI Gom-28 with treatment Zn application @ 8 kg ha^{-1}can be used for successful cultivation of wheat. In case of irrigation and foliar application of Zn, regular irrigation with 0.04% Zn can be effectively used for wheat cultivation.

Phytotoxicity Assessment of *Rumex maritimus*: An Alternative Sustainable Weed Management Approach in Rice Field

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Abstract
The experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh to study the phytotoxic effects of the extracts and residues of *Rumex maritimus* on weed management and the yield performance of rice. In first (pot) experiment, chaffed residues of *R. maritimus* were extracted with water (1:20, w/v) to prepare five treatment concentrations *viz.*, 0% (control), 25%, 50%, 75%, and 100%. The second (field) experiment consisted of two rice cultivars i.e.

BRRI dhan58 and BRRI dhan74 and five *R. maritimus* residues treatment *viz.,* 0, 1.0, 2.0, 3.0 t ha^{-1} and farmers practice. Six weed species such as chapra, mutha, nakful, shama, biskatali and joina belonging to four families were identified in pot at control. But with the increased of the extract of *R. maritimus* the weed species gradually inhibited. At 100% concentration, mutha, nakful, shama, biskatali and joina were completely inhibited except chapra. Weed population and weed dry weight were also significantly affected by different concentrations of *R. maritimus* extracts. In field experiment, four weed species such as panikachu, shama, shusni and chesra belonging to four families infested the rice cultivars. Weed density and weed dry weight were significantly affected by the cultivar and residues. In field experiment, the maximum weed growth was noticed with no residues and the minimum was found when residues applied @ 3 t ha^{-1}. The grain yield as well as the yield contributing characters produced by BRRI dhan74 was the highest among the studied varieties. The highest reduction of grain yield was obtained in no residue treatment. Results of this study indicate that *R. maritimus* residues showed potentiality to inhibit weed growth and it has a significant effect on the yield of rice.

Allelopathy of *Eleocharis atropurpurea* (RETZ.) and *Fimbristylis dichotoma* (L.) in *Aman* Rice

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Abstract
The researcher, recently, has been emphasized on the biological weed control approach in replacement of synthetic herbicides. In Bangladesh, though the farmers mostly used synthetic herbicides to control their rice fields weeds, but it produces negative impacts on both human and environment. Others methods of weed control are also not feasible and cost-effective to use in controlling weeds. In this regard, the use of plant residues could be an alternative, biological option to control weed. In this phenomenon, we evaluated the combined effect of the residues of *E. atropurpurea* and *F. dichotoma* on weed management and crop performance of *aman* rice. The experiment comprised of three cultivars i.e. BRRI dhan34, Nizershail and Kalozira and four combined residues of *E. atropurpurea* and *F. dichotoma viz.,* 0, 1.0, 2.0, 3.0 t ha^{-1} with farmers practice treatment. The weed density and weed population were found varied under both treatments. The highest weed density was found in no residue treatment and the lowest was found in farmers practice. The highest shama dry weight was found in Nizershail and the lowest chesra dry weight was obtained in BRRI dhan34. Shama weed dry weight was found highest for the variety of BRRI dhan34 and Nizershail with control treatment. On the other hand, shusni shak dry weight was found lowest for BRRI dhan34 variety with farmers practice. Kalozira had the highest grain yield (4.44 t ha^{-1}) while BRRI dhan34 produced lowest grain yield (3.94 t ha^{-1}). Kalozira with 3 t ha^{-1} residues produced the highest grain and straw yield. The lowest grain and straw yield resulted from BRRI dhan34 variety under no residue treatment. From the results, it may be said that, combined application of the residues of *E. atropuroure*a and *F. dichotoma* could be a potential source of weed management for sustainable rice production.

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, two pot experiments were conducted at the net-house of Department of Soil Science, Bangladesh Agricultural University (BAU) 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 pot 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 no significant effect ($p>0.05$) on the yield and yield contributing characters of rice. In case of maize, significant differences ($p<0.05$) were observed due to different rates of lime and phosphate fertilizer. Lime @1 t/ha and P @ 200% of the recommended dose produced significantly higher grain yield (143.71 g/pot) compared to other treatment combinations except T_{10} (142.53 g/pot) and T_{12} (138.10 g/pot). It can be concluded that combination of lime and P fertilizer could effectively reduce Al toxicity in maize and increase the crop yield.

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.

Methane Emissions from Rice-rice Cropping Pattern under Fertilizer Management and Planting Method

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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 with following rice varieties in rice-rice pattern: T. Aman (BRRI dhan 71)-Boro (BRRI dhan 81). 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. Methane flux was measured during the entire rice-growing season to get the cumulative CH_4 emissions using static closed chamber method. Salient outcomes include: from Aman season it is clear that

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), cow dung (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, AWD and SRI systems other than DSR. 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. Combining evidence from both rice season results concluded that organic manure application could be potential trade-off between rice productivity and CH_4 emissions. For policy decisions, government should consider long-term manure incorporation field trials with fertilizers to enhance the mitigation of CH_4 emissions without any yield loss.

Enriching Beneficial Indigenous Soil Microorganisms Through Integrated Plant Nutrient Management and Assessing Their Effects on Soil Fertility and Sustainable Rice Production

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Abstract

A research project was undertaken for a period of two years from July 2018 to June 2020 with the objectives of enriching beneficial indigenous microorganisms in soil and assessing their effects on improving soil fertility and increasing rice yield. In order to fulfill the objectives of the project a field experiment was also conducted in the second year at the Soil Science Field Laboratory of Bangladesh Agricultural University, Mymensingh during T.aman season of 2019 with the application of organic and inorganic fertilizer. Cotton seed oilcake and mustard oilcake are excellent and high quality organic manures enriched with essential nutrient elements and were used in this experiment through IPNS as a source of nitrogen. BRRI dhan49 was used as test crop. The experiment was laid out in a Randomized Complete Block Design (RCBD) with seven treatment combinations and four replications. The treatment combinations include T_1: control, T_2: 100% Recommended Fertilizer Dose (RFD), T_3: 50% RFD, T_4: 50% nitrogen (N) from RFD + 50% N from cotton seed oilcake, T_5: 50% N from RFD + 50% N from mustard oilcake, T_6: 50% N from RFD + 25% N from cotton seed oilcake + 25% N from mustard oilcake, T_7: 50% N from cotton seed oilcake + 50% N from mustard oilcake. Cotton seed oilcake and mustard oilcake were applied before 7 days of transplantation. The grain and straw yields as well as yield components, nutrient uptake and soil fertility were significantly influenced due to different treatments. The highest grain and straw yields of 5.04 and 5.98 t ha^{-1} respectively were recorded in treatment T_2 (100% RFD) which were statistically identical to those recorded in treatments T_5 and T_6 having integration of cotton seed oilcake and mustard oilcake. Soil fertility was also improved significantly but further works on enrichment of beneficial indigenous microorganisms in soil are necessary for having clear and conclusive results due to application of organic and inorganic fertilizers in an integrated way.

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.

Laboratory and Field Efficacy of Botanicals, Chemicals Pesticides and Entomopathogenic Fungus for the Management of Spider Mites

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Abstract

Tetranychus urticae Koch (Acari: Tetranychidae) is one of the most polyphagous herbivorous arthropods, feeding on different plants in field and greenhouse. A laboratory and field study were conducted to determine the field efficacy of botanicals, chemicals pesticides and entomopathogenic fungus for the management of *T. urticae*. We examined different chemicals, i.e., abamectin, bifenthrin, bifenazate, etoxazole, hexythiazox and Spinosad; botanical, i.e., neem oil, and entomopathogenic fungus, i.e., *Beauveria bassiana*. All chemicals were found to be effective against adult female except etoxazole. On the contrary, all chemicals were effective against eggs of *T. urticae*, as the LC_{50} values were lower than the recommended concentration. The neem oil and *B. bassiana* was also effective to control both stages on *T. urticae*. In synergism test, 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. All chemical pesticides, neem oil and *B. bassiana* were applied in the bean plant in field condition and found to be effective except etoxazole to reduce the pest population. Neem oil (5%) and *B. bassiana* were also effective to reduce the spider mite number in field condition. The efficacy of *B. bassiana* was also verified on mites infesting bean plants with a concentration of 1×10^8 conidia/ml. In double spray treatment where applications were made 2 times on days 2 and 12 after mite infestation, the adult population of *T. urticae* were reduced to lowest in number. With a single spray on day 2, the adult population was also greatly reduced, but increased rapidly after day 12. These results suggest that 1×10^8 conidia/ml was the most effective dose and that two applications, at a 10-day interval provided good control of *T. urticae*.

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.

Management of Capsicum Mite, Polyphagotarsonemus Latus Using Bio-Rational Approaches

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Abstract
Insect pest causes the loss of capsicum yield in Bangladesh in every year highly. Off different insect pest, capsicum mite is one of the most serious insect of capsicum. Yield can be increased by controlling mite using bio-rational management approaches. With a view to know the efficacy of some bio-rationals on leaf mite of capsicum, the research experiment was conducted in the experimental field and laboratory of the Department of Entomology, Bangladesh Agricultural University (BAU), Mymensingh during 01 July, 2019 to June, 2020. A survey was conducted in three capsicum growing areas (Mymensingh, Bogura and Rangpur) for collecting information about farmers' knowledge and perception on the management of capsicum mite. Two botanicals and a commonly used detergent with same doses (0.5, 0.1, 5.0%) viz. Neem leaf extract, Mahogany seed extract and detergent (Surf excel) solution ; Three microbial derivatives with same doses (0.25, 0.5, 1.0ml/L) namely Tracer 45SC

(Spinisad 45SC), Ambush 1.8EC (Abamectin 1.8EC), Imidagold 20SC (Imidacloprid 20SL) and two insect growth regulators with same doses (0.25, 0.5 & 1.0ml/L) i.e. Award 40SC (Buprofezin 40SC), Heron 5EC (Lufeneuron 5EC) were used experimental treatments in this study. Survey report showed about 97% of farmers is used insecticides for controlling mite in capsicum field which was not appropriate insecticides as well as doses. The farmers also report that about 66.73% in plant infestation occurred and caused maximum yield loss (45.76%). The experimental study revealed that all botanicals, microbial derivatives and insect growth regulators showed significantly higher efficacy on the mortality of mite in laboratory and reduce plant infestation caused by capsicum mite at the field condition compared to untreated control. Among the botanicals, Neem leaf extract @ 5.0% was the best for controlling mite both condition than other treatments as well as all doses and returned maximum yield (6.12kg/10plant). The ranged of efficacy (highest to lowest) between botanicals were: Neem leaf extract>Detergent solution>Mahogany seed extract. On the other hand, Ambush 1.8EC@ 1.0ml/L showed the highest performance against capsicum mite than other microbial derivatives as well as all doses where returned maximum yield (7.15kg/10plant). The ranged of efficacy (highest to lowest) between microbial derivatives were: Ambush 1.8EC>Tracer 45SC>Imidagold 20SC. Furthermore, among insect growth regulators and simultaneously all doses, the highest efficacy was observed in Award 40SC@1.0ml/L both laboratory and field condition and returned the highest yield (5.77 kg/10plant). The ranged of efficacy (highest to lowest) between insect growth regulators were: Award 40SC>Heron 5EC. Therefore, it can be concluded that the capsicum grower can use Neem leaf extract@ 5.0% as botanical, Ambush 1.8EC@ 1.0ml/L as microbial derivatives and Award 40SC@ 1.0ml/L as insect growth regulator for management of capsicum mite under field condition to get return higher yield.

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.

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.

Abundance and Management of Citrus Leaf Miner, *Phyllocnistis citrella* Stainton Using New Generation Insecticides

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Abstract

Abundance of citrus leaf miner, *Phyllocnistis citrella* Stainton and the efficacy of some new generation insecticides against the infestation of this pest was evaluated in the Horticulture Field Laboratory, Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh during July 2019 to April 2020. The experiment consisted of 9 treatments viz. T_1=Neem oil (2ml/l), T_2=Furadan 5G (2g/L), T_3=Agromethrin10EC (2ml/l), T_4= Decis 2.5EC (2ml/l), T_5= Spinosad 45SC (2ml/l), T_6= Abamectin (2ml/l), T_7= Thiamethoxam 25WG (2g/l), T_8= Imidachloprid 17.8SL (2ml/l), T_9=Control. .The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. The abundance of citrus leaf miner was estimated based on the cumulative mean number of larva per five flushes and the percentage leaf infestation at different months. In July to August and again in December to January the abundance was less. But the abundance was higher in September to November. Based on this abundance management practices might be dome in the citrus orchard. The effectiveness of selected new generation insecticides was evaluated based on different parameters viz. the percentage of leaf infestation, mine length (cm), and mean no. of larva per five flushes. All the treatments significantly reduced the no. of larva per five flushes, mine length and percentage leaf infestation compared to control treatment. Among the treatments Furadan 5G showed the best performance against the infestation of citrus leaf miner. The efficacy showed by Furadan was followed by Agromethrin 10EC and Neem oil. In some cases Spinosad and Abamectin also showed good efficacy against the citrus leaf miner infestation. Therefore, it might be concluded that Neem oil, Spinosad and Abamectin might be incorporated as components of IPM for the sustainable management of citrus leaf miner in the field.

Effect of NPK-based Fertilizers, Weather Parameters and Bio- and Reduced Risk Insecticides on the Incidence of Sucking Insect Complex on Okra

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Abstract

Sucking insect complex *viz*. jassid, white fly, aphid and thrips are the major threat for vegetable production in Bangladesh. In recent years, this infestation level became severe due to changes of climatic scenario especially sudden rainfall, changes of temperature and humidity. Moreover, injudicious application of N-P-K based fertilizers has triggered the infestation level. All the experiments were conducted in the Entomology Field Laboratory, Bangladesh Agricultural University, Mymensingh during the period from February to June, 2019. In the present study, effect of different weather parameters, NPK based fertilizers and different bio- and reduced risk insecticides were evaluated against sucking insect complex on okra. It has been clearly found that there has a positive relationship between high incidence of sucking insects and rainfall, temperature and humidity. Sudden rainfall in the first week of April (about 23 mm) as well as high humidity and moderate temperature highly induced high incidence of sucking insects. In case of fertilizer experiment, 30% extra K in addition with recommended level of NPK significantly reduced pest incidence and increased 25% more yield over control. On the other hand, 30% extra P and recommended level of NPK increased 14.5% of okra yield over control. Among bio- and reduced risk insecticides, Kotan 50 WG (Pymetrozine) and Sniper 10 SC (Fenopropathrin + Fenvalerate) showed the best efficacy where about 42% yield was increased over control. Capture 75 WDG (Imidacloprid + Emamectin Benzoate), Ravjum 14.5 SC (Indoxacarb) and Antario (Bt + Abamectin) showed moderate efficacy. The botanical, Biotrin 0.5% (Matrine) showed the least efficacy.

Efficacy of Some New Generation Insecticides Alone or in Combination with Different Non-chemical Methods Against Cucurbit Fruit Fly in Bitter Gourd

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Abstract
In the present study, the efficacy of some new generation insecticides alone or in combination with different non-chemical methods was evaluated against cucurbit fruit fly (CFF)during the kharif season, 2019-2020 at Entomology field laboratory, BAU. Different non-chemical methods *viz.* field sanitation, hand picking, fruit bagging and bait traps were evaluated. Moreover, six new generation insecticides like Pyrifen 10.8EC, Libsen 45 SC, Lumectin 10 WDG, Intrepid 10 SC, Ravjum 10 SC and Manik 20 SP were evaluated. Data were collected on different parameters *viz.* percent fruit infestation, marketable or healthy fruit yield (t/ha) and abundances of beneficial arthropods per experimental plot. Among the new generation insecticides, Intrepid 10 SC @ 1.0 ml/L (17.33% infested bitter gourd; 12.01 t/ha yield) and Ravjum 14.5 SC @ 1.5 ml/L (20.51% infested bitter gourd; 11.19 t/ha yield) were found highly effective against CFF where others showed moderate efficacy compared to control. Lumectin 10 WDG provided the lowest efficacy against CFF infestation. Expectedly, efficacy was further increased when these new generation insecticides were applied in combination with different non-chemical methods. Results showed that the highest marketable (14.01% infested bitter gourd; 13.85 t/ha) was recorded from T_1 (Intrepid 10 SC @ 1.0 ml/L + field sanitation + hand picking+ fruit bagging+ bait trap) that was closely followed by the rest of the treatments. The highest fruit infestation (48.75%), highest infested fruits yield (4.12 t/ha) and the lowest marketable yield was (4.52 t/ha) recorded from untreated control plots.

Incidence of Major Sucking Pests Complex of Chilli and Their Management Using Different IPM-Modules

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Abstract
Abundances of different sucking insects like aphids, whiteflies and jassids were recorded on chilli plants at different time of the study period. Seedlings were transplanted on 3rd week of November, 2019 in experimental plots and data collections were started on 20 December, 2019 that was continued till 1st week of April. Incidence was fluctuated based on plant age as well as different time of the months**.** Among different sucking insects aphid populations were found higher that was followed by whiteflies and jassids respectively in the whole study period. Insect infestations were first recorded in the 3rd week of December, reached to the peak level by the end of February and reached to the minimum level by the end of March. Maximum 23-24 aphids, 10-11 whiteflies and 5-6 jassids per leaf was counted in the last week of February. In addition, some IPM modules were tested against sucking insect pests where each of the module consists of multiple components. Among the tested IPM-modules, the module-1 (Yellow sticky trap + Libsen 45 SC @ 0.5 ml/L water + Ambush 1.8 EC @ 1.5 ml/L) showed the best efficacy in reducing sucking pest complex, curled leaf and increases of yield of green chilli (t/ha). This result was followed by module-2 (Soapy water spray at 1 day interval +

Ravjum 14.5 SC @ 1.0 ml/L + Impale 200 SL @ 0.5 ml/L), module-3 (Yellow sticky trap + Soapy water spray at 1 day interval + Intrepid 10 SC @ 1.0 ml/), module-4-7 respectively.

Relative Efficacy of Chitin Synthesis Inhibitor, Juvenile Hormone Analogue and Some New Generation Acaricides Against Red Spider Mite, *Tetranychus urticae* (Koch.) on Marigold

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Abstract
In the present study, efficacy of chitin synthesis inhibitor (Heron 5 EC), juvenile hormone analogue (Pyrifen 10.8 EC) and some new generation acaricides (Oberon 240 SC, Mite Scavenger 10 EC and Omite 57 EC) were evaluated against red spider mite, *Tetranychus urticae* (Koch.) on marigold under laboratory condition. Experiments were conducted in the laboratory, Department of Entomology, Bangladesh Agricultural University, Mymensingh from the period of August 2018 to February 2019. All the selected molecules had two concentrations and sprayed directly on the marigold plants. Data were collected on abundances of mite populations per leaf, percent reductions of curled or infested leaf, formation of webs or silk ball (cm^2) and number of fresh or marketable flowers per plant. Mite populations were counted at 1, 3, 7 and 10 days after given each spray, curled leaves and webs were counted at 10 DAS after given 3rd spray. Marketable flowers were counted when flowers were attained the perfect size for selling. Among five molecules, Omite 57 EC @ 1.5 ml/L performed the best efficacy considering all parameters studied which was followed by 1.0 ml/L of water. This result was closely followed by Oberon 240 SC, Mite Scavenger 10 EC and Heron 5 EC respectively. Pyrifen 10.8 EC was found to be ineffective compared to untreated control.

Field Evaluation of Different Non-chemical Methods and Biorational Pesticides Against Major Insect Pests of Cucurbitaceous Vegetables on Bitter Gourd

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Abstract
In the present study, effect of different non-chemical methods alone or in combined way as well as some biorational insecticides were evaluated against cucurbit fruit fly, red pumpkin beetle and epilachna beetle in field condition in kharif season, 2018-2019 at Entomology field laboratory, BAU to compare the infestation level as well as yield of bitter gourd. Different non-chemical methods *viz.* deep ploughing, field sanitation, hand picking, fruit bagging, bait trap and sticky traps were evaluated. Moreover, five biorational insecticides like Pyrifen 10.8EC, Baicau 0.5%, Libsen 45 SC, Lumectin 10 WDG and *Bacillus thuringiensis* were evaluated. Data were collected on different parameters *viz.* percent fruit infestation, marketable or healthy fruit yield (t/ha), abundances of red pumpkin beetle and epilachna beetle etc. In case of non-chemical approach, the treatment field sanitation + hand picking + bait trap + fruit bagging + sticky trap (T_7) was found superior to minimize fly incidence and thereby reduction of fruit infestation (12.23%). This was closely followed by bait trap + fruit bagging + sticky trap (T_6) (14.45%) and deep floughing + field sanitation + hand picking + fruit bagging (T_4) (15.53%) respectively. On the other hand, the highest yield was recorded from T_7 (9.12 t/ha). This result was closely followed by T_6 (8.75 t/ha), T_4 (8.12 t/ha) and T_5 (7.75 t/ha) respectively. Other treatments also potentially reduced infestation level. Among the tested biorational insecticides, 8.73% infested fruits were found when plants were treated with Libsen 45 SC @ 0.5 ml/L that was closely followed by

Lumectin or Pyrifen (12-17%). *Bacillus thuringiensis* had moderate effect on fruit infestation level. Baicau (Biotrin 0.5%) was found to be very ineffective against fruit fly infestation. Abundances of red pumpkin beetle and epilachna beetles/5 leaf were significantly reduced compared to control when plants were treated with Libsen 45 SC @ 0.5 ml/L that was followed by Lumectin and Pyrifen respectively. *Bacillus thuringiensis* was found moderately effective while Baicau was found very less effective against red pumpkin beetle or epilachna beetle.

Incidence, Population Dynamics and Bio-efficacy of Some New Generation Insecticides Against Major Insect Pests of Soybean

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Abstract
Soybean is an important oil crop that is severely infested by different sucking and leaf-eating insects. In the present study, incidence and population dynamics of different sucking and chewing insects were observed for the whole cropping season of soybean. Moreover, some new generation insecticides like Ravjum 14.5 SC, Lumectin 10 WDG, Intrepid 10 SC and Sniper 10 SC were evaluated against major insects of soybean. All the experiments were conducted in rabi season, 2018-2019 at Entomology field laboratory, BAU. A total of 12 insect pests were identified in soybean field from different orders and among them jassids, white fly, aphid, cutworm and soybean leaf rollers incidence were major. Among the sucking insects, the incidence of jassids, white fly and aphids were started from 2nd week of January, reached to the peak level in the month of February and then gradually declined. On the other hand, the incidence of leaf eating insects like soybean leaf roller, leaf beetle, grasshopper etc were started from mid of January, reached to the peak level by mid February to mid March and then declined gradually. Among the tested insecticides, Ravjum 14.5 SC @ 1.5 ml/L showed the best efficacy where 90% jassids populations were reduced over control that was followed by Lumectin 10 WDG @ 1.0 ml (85.01%). Similar trend of efficacy was found in controlling white fly and aphids. On the other hand, about 94% reductions of rolled leaves over control were found when plants were treated with Ravjum 14.5 SC @ 1.5 ml/L that was followed by Lumectin 10 WDG, Sniper 10 SC and Intrepid 10 SC respectively. Among the insecticides, Ravjum 14.5 SC @ 1.5 ml/L treated plots produced the highest yield (2.34 t/ha) that was followed by Lumectin 10 WDG, Sniper 10 SC and Intrepid 10 SC respectively. Minimum yield (1.41t/ha) was recorded from untreated control plot.

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
Recent invasion of the invasive pest, Fall Armyworm (Spodoptera frugiperda) (J.E. Smith) (Lepidoptera: Noctuidae) in Bangladesh threatening its food security. 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 of the pest insect is the prime requirement to develop appropriate and effective management techniques. Use of DNA barcoding 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.

Genetic Diversity of Some Indigenous Entomopathogenic Fungi (EPF) Isolated from Bangladesh

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Abstract

Entomopathogenic fungi (EPF) are those species of fungi that specifically infect and often kill insects and other arthropods and therefore, possessing have great potential as biological control agents against many insect pests of agricultural importance. *The Beauveria bassiana, Metarhizium anisopliae, Aspergillus* are the commonly used EPFs in insect pest management around the world. In this study, an attempt was taken to determine the genetic variations of the native EPFs from Bangladesh. Therefore, soil samples were collected from several districts of Bangladesh and fungal strains were isolated by using the selective medium (Oatmeal Agar,0.6g/L CTAB,0.5g/L Chloramphenicol, 0.1g/L Ampicillin). The isolated fungi were then identified using morphological and molecular methods. Entomopathogenic fungi have been isolated comprising *Beauveria bassiana, Aspergillus flavus, Aspergillus tamarii, Trichoderma asperellum* and *Fusarium* sp. For molecular characterization, ITS region was amplified by PCR using ITS1 and ITS4 primers and about 600bp of PCR band was amplified. NCBI blast search has confirmed the identity of 17 *Beauveria bassiana,* two *Aspergillus flavus*, two *Aspergillus tamarii*, one *Trichoderma asperellum* and one Fusarium sp. fungal species. Based on the ITS DNA sequence, the phylogenetic tree was constructed and it was found that there is considerable genetic diversity is present among the fungal species. Further analysis using RAPD-PCR for determining the genetic variation is under investigation.

Molecular Characterization of the Native Beauveria and Metarhizium Strains of Bangladesh and Their Virulence Against Sucker Insect Pests of vegetables

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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.

Molecular Characterization for Salt and Drought Tolerance of Vegetables Grown in Bangladesh

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Abstract

Salt tolerance of three varieties from each of popular vegetables, namely Cabbage, Broccoli and Spinach were evaluated in pot soil under nethouse conditions in the horticulture farm of BAU. The varieties used in the experiment were Atlas-70, Supreme, & Magic-65 of Cabbage; BARI Brokoli-1, Early you, Green Carpet of Broccoli and BARI Palong shak-1, Ankita and Evan of Spinach. The plants were treated under salt stress levels of 0 ,4, 6 and 8 ds/m. Plant height, number of leaves, leaf length, leaf width, fresh weight of leaves, dry weight of leaves, curd length, curd diameter, root length, root diameter, fresh weight and dry weight of roots were recorded. The varieties of all three vegetable crops displayed differential responses to salt stress levels. In almost all cases, all varieties had significantly higher values for all characters at no salt stress (0 ds/m) level, and the lowest at 8 ds/m. However, in some cases the performance of the varieties at 4 ds/m and in some other cases at 6 ds/m were statistically similar to that at 0 ds/m. All the varieties produced the highest yield at 0ds/m and lowest at 8ds/m. Some varieties performed statistically similar for yield at both 0ds/m and 4ds/m. Samples of young leaves of promising varieties were collected and processed for RNA extraction and Rt-PCR The analysis of the experimental results indicated that repetition of the experiment with a greater number of varieties and higher salt stress levels can be performed.

Sustainable and Quality Production of Cherry Tomato Through Vertical Farming

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Abstract
Cherry tomatoes are taste-bud delight, delicious and nutritious food that becomes more nourishing, healthy and appealing to consumers. The experiment was conducted at the Horticulture Farm and Postgraduate Laboratory of the Department of Horticulture, Bangladesh Agricultural University, Mymensingh during the period from September 2019 to March 2020 to assess the effects of variety and organic manures on growth, yield and quality of cherry tomato. It was plotted in Randomized Complete Block Design with three replications. The treatments were in a factorial arrangement of 2 × 8, with 2 varieties of cherry tomato viz. V_1: Binatomato-10 and V_2: BARI Tomato-11 (Jhumka) and 8 different organic manures viz. T_0: Control, T_1: Cowdung @ 3 kg/m^2, T_2: Mustard oil cake (MOC) @ 0.6 kg/m^2, T_3: Poultry manure@ 3 kg/m^2, T_4: Cow dung + MOC @ (3+0.6) kg/m^2, T_5: Cowdung + Poultry manure @ (3+3) kg/m^2, T_6: MOC + Poultry manure @ (0.6+3) kg/m^2, T_7: Cowdung + MOC + Poultry manure @ (3+0.6+3) kg/m^2. All the parameters under study showed significant variation between cherry tomato varieties and organic manures. Binatomato-10 revealed the highest growth, yield and quality characters except plant height and number of leaves per plant compared to BARI Tomato-11 (Jhumka). BARI Tomato-11 (Jhumka) accompanying the combined application of cowdung + MOC + poultry manure (V_2T_7) gave the highest plant height (127.75 cm) and number of leaves per plant (51.25). Binatomato-10 together with combined application of cowdung + MOC + poultry manure (V_1T_7) produced the highest number of fruits per plant (502.33), individual fruit weight (12.50 g), fruit length (4.23 cm) and breadth (3.22 cm), yield (89.07 t/ha), and total soluble solids (TSS) content (10.40%). Therefore, Binatomato-10 together with combined application of cowdung + MOC + poultry manure was found to be better in respect of growth, yield and quality of cherry tomato.

Optimization of Growth, Yield and Quality of Strawberry Through Verticulture in Poly-tunnel

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Abstract
Application of organic manures is an ecofriendly and safe crop production techniques. Planting of strawberry in polybag could be a cheaper way of verticultural production and overcome the land deficit problems. The experiment was conducted at the Landscaping Section of the Department of Horticulture, Bangladesh Agricultural University, Mymensingh during the period from October 2019 to April 2020 to evaluate the efficiency of using different organic manures on growth, yield and quality of strawberry through various planting media under poly-tunnel. The two factor experiment was laid out in Split Plot Design with three replications and comprised two planting media viz. M_1= planting in soil and M_2=planting in polybag, and eight different organic manures viz. T_0 = Control (no manures), T_1 = Cowdung @ 500 g/plant, T_2 = Mustard oil cake (MOC) @ 100 g/plant, T_3 = Poultry manure @ 250 g/ plant, T_4 = Cowdung +MOC @ (250+100) g/plant, T_5 = Cowdung + Poultry manure @

(250+250) g/plant, T_6 = MOC + Poultry manure @ (100+250) g/plant, T_7 = Cowdung + MOC + Poultry manure @ (250+100+250) g/plant. Significant variations were observed due to planting media and organic manures on all the parameters studied. Highest fruit length (3.43 cm), fruit breadth (2.54 cm), fruit weight per plant (213.88 g), fruit yield (12.80 t/ha) and TSS (7.44%) were recorded from planting of strawberry plants in polybag media in compare to soil. In case of organic manures superior data of fruit length (4.27), fruit breadth (3.21), fruit weight per plant (272.50 g), fruit yield (16.35 t/ha) and TSS (8.10%) were found from cowdung + MOC + poultry manure @ (250+100+250) g/plant. Therefore, combined application of different organic manures along with polybag media under poly-tunnel was found to be better and more efficient for growth, yield and quality of strawberry compared to other treatments.

Induction of Flowering, Fruit Setting and Production of Seedless Fruit in Watermelon

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Abstract

The experiment was conducted at the Horticulture Farm of the Bangladesh Agricultural University, Mymensingh during the period from October, 2018 to May, 2019 to evaluate the effect of plant growth regulators (PGRs) on flowering, fruit setting and seedless fruit in watermelon. The experiment consisted of two factors, such as factor (A): four different doses IAA *viz*., 0, 100, 150, 200 ppm and factor (B): four different doses GA_3 *viz*., 0, 100, 150, 200 ppm. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. The result of the study revealed that application of PGRs induced earlier flowering, higher percentage of fruit set and seedless fruit in watermelon. In addition, PGRs also significant influenced on the other parameters studied e.g., vine length at different DAT and at final harvest (cm), number of branches per plant, leaf length (cm), leaf breadth (cm), minimum days to first flowering, number of male and female flowers plant^{-1}, male and female flower ratio, fruit length (cm), fruit diameter (cm), rind thickness (cm), TSS content (ºBrix), number of seeds per fruit, fruit set (%), weight of individual fruit (kg), number of fruit per plot and fruit yield ha^{-1} (ton) of watermelon. The vine length at 30 DAT, 60 DAT and at final harvest, number of branches plant^{-1}, leaf length (cm), leaf breadth (cm), number of female flowers plant^{-1}, fruit length (cm), fruit diameter (cm), rind thickness (cm), TSS content (^{o}Brix), fruit set (%), weight of individual fruit (kg), number of fruit per plot and fruit yield ha^{-1} (ton) fruits was found maximum but the days to first flowering, number of seeds per fruit, male and female flower ratio was found minimum from the plant treated with 200 ppm of IAA and 200 ppm GA_3, respectively. For combined effect of IAA and GA_3, the highest vine length at 30 DAT, 60 DAT and harvesting time, leaf length (cm), leaf breadth (cm), number of male and female flowers plant^{-1}, fruit length (cm), fruit diameter (cm), rind thickness (cm), TSS content (^{o}Brix), fruit set (%), weight of individual fruit (kg), number of fruit per plot and fruit yield ha^{-1} (ton) were found maximum from the treatment combination of 200 ppm IAA and 200 ppm GA_3. The minimum days (28.96) were required for first flowering, minimum male and female flower ratio (2.24) and lowest numbers of normal seeds per fruit (248) were found from the treatment combination of 200 ppm IAA and 200 ppm GA_3.

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Morpho-molecular Characterization of Some Mango Germplasms of Chapainawabganj District

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Abstract
In this study, morphological and molecular characters of mango germplasm were assessed by using six simple sequence repeat (SSR) markers. Thirty mango germplasm were selected and their leaf, panicle, fruit and stone samples were collected to study their morphological and molecular traits respectively. In-situ characterization and evaluation of fruit samples revealed phenotypic variations among mango germplasm. In the present study wide variability was observed among these 30 mango germplasm. Two types of leaf shape, two types of leaf margin and one type of leaf tip were observed in 30 mango germplasm. Light green to dark green color of mature leaves were recorded among the 30 mango germplasm. The longest leaf was recorded in the germplasm Lokhonvog. Maximum leaf breadth was recorded in the germplasm Kachmithi. Gopalvog had the highest (92.33%) and Langra had the lowest (67.33%) of male flowers per panicle. Langra showed maximum (32.67%) of bisexual flowers per panicle. The color of the panicle was observed light green to light green with red patches. Kalua had the maximum initial fruit set per panicle (35.00). The germplasm, Fazli was the longest fruit having maximum fruit weight with highest pulp/peel ratio (9.83) among the germplasm. The highest breadth was observed in Nora. Two types of fruit shape and three types of color were observed among mango germplasm. The ripe mango contained highest TSS in the germplasm Bombai (20.00%). Maximum stone weight was recorded in Fazli whereas the minimum in Nora. Polymerase chain reaction (PCR) amplification of the DNA isolated from 30 mango germplasm with 6 SSR primers were used. The allele size detected ranged from 121 to 223 bp. SSRs gave moderate values of polymorphic information content (PIC) range of 0.6499 to 0.9311. We obtained moderate degree of genetic diversity, highest level of genetic diversity value (0.9343) in loci MIGA179 and the lowest level of genetic diversity value (0.6643) was observed in loci MIGA253 with a mean diversity of 0.8703. The dendrogram generated from the unweighted pair group arithmetic average (UPGMA) cluster analysis broadly placed 30 mango cultivars into eight major clusters. The cluster size varied from 2 to 6 and cluster VII was the largest cluster comprising of 6 cultivars. The tendency of clustering among mango cultivars revealed that they have strong affinity towards further breeding programme.

Studies on Genetic Variability, Character Association and Yield Performance of Some Sweet Pepper *(Capsicum annuum* L.) Germplasm

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Abstract
An experiment was conducted at Horticulture farm, Department of Horticulture, Bangladesh Agricultural University, Mymensingh during the period from October, 2018 to April, 2019. Studies on field performance, character association and genetic diversity of sweet pepper accessions were carried out using morphological traits. Analysis of variance for different characters showed high degree of variation among the 30 accessions. The accession CA 24 showed the best performance in respect of

yield per plant (941.34gm). The highest average fruit weight (113.75gm) was recorded in CA 27. Regarding the fruit per plant, CA 18 produced the maximum number of fruits per plant (15.74). In all the traits genotypic coefficient of variation was smaller than phenotypic coefficient of variation. High heritability with genotypic and phenotypic coefficient of variation was observed for plant height, width of plant, breadth of leaf, number of flower per inflorescence, fruit length, fruit breadth, pedicel length, pedicel thickness, individual fruit weight, number of fruit per plant, fruit yield per plant, dry weight, number of seeds per plant and weight of 1000 seeds indicating additive gene effects of these traits. Correlation coefficient study indicated that yield per plant had highly significant positive correlation with fruit length and fruit weight at genotypic and phenotypic level. Both genotypic and phenotypic path coefficient analysis showed that average number of fruit per plant had maximum direct effect on yield per plant. On the basis of D^2 analysis, 30 accessions were grouped into 6 clusters. No relationship was found between genetic diversity and geographical distribution of the accessions. The maximum inter-cluster distance (694.61) was observed between cluster IV and VI and minimum (58.24) between cluster II and IV. The highest intra-cluster distance was recorded in cluster V (246.24). Above accession could be utilized in hybridization programme for *Capsicum annuum* crop improvement.

Screening of High Yielding Antioxidant Rich Colored Sweet Potato Genotypes

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Abstract
Tuberous roots as well as leaves of colored sweet potato is a vital source of vitamins, minerals and antioxidant for human body. This experiment was conducted at the Horticulture Farm, Bangladesh Agricultural University, Mymensingh during July 2018 to June 2020 in order to select high yielding antioxidant rich colored sweet potato genotypes. Eight exotic colored sweet potato genotypes including a BARI released variety were used as a check for this experiment. The study was carried out in randomized block design with three replicates. In two-year study, plant growth and yield performance were evaluated during July 2018-June 2019 and nutritional study was accomplished during July 2019 to June 2020. Results showed that the maximum plant height (116.90 cm) obtained from G4 (CK variety) which was statically similar with G1 (115.91 cm) and G8 (104.27cm). Genotype G6 produced highest branches (4.07) while G8 gave the lowest branches (2.53). Leaf chlorophyll index was highest in G2 (34.51) which was similar with G1 (34.49) and G7 (34.42). Anthocyanin and total sugar contents in roots was higher than leaves while β-Carotene content was higher in leaves than roots and it was statistically different among the genotypes. It was observed that most of the exotic genotypes (except G2, G3) produced almost equal number of storage root tubers (3.49 - 4.17) which was statistically similar with CK variety (4.12). The longest length of storage root tubers (21.63 cm) was obtained from G6 which yielded the maximum fresh weight (754.40 gm/plant). In comparison to dry matter content all the exotic genotypes gave the highest dry matter (21.11-35.16%) compared to CK variety. In terms of tuberous root yield G6 produced the maximum storage root tubers (48.80 t/ha) followed by CK (38.07 t/ha) and the lowest yield obtained from G2 (2.03 t/ha). From nutritional analysis, it was noticed that except starch content all other nutrients (Ash, crude fibre, crude protein, N free extract, fat) and mineral contents (Ca, Mg, P, K) were higher in leaves than tuberous roots. From the results of this study it was observed that four exotic colored sweet potato genotypes (G1, G3, G6 and G8) exhibited superior performance in respect of yield and nutritional quality.

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Selection of Drought Stress Tolerant Potato (*Solanum tuberosum* L.) Varieties in Bangladesh

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Abstract
Drought is one of the most damaging abiotic stress seriously affecting the productivity of modern agriculture. Screening of drought stress tolerant crop species is time demanding issue in Bangladesh. This project was carried out to evaluate drought stress responses of ten potato genotypes during November 2019 to March 2020 at the Horticulture Farm, Bangladesh Agricultural University, Mymensingh. The two-factor experiment was comprised with two levels of drought stress *viz.,* T_1: Well-watered (Control), T_2: Soil drying and ten potato genotypes namely G1: BARI Alu-8, G2: BARI Alu-53, G3: BARI Alu-63, G4: ACC 10063, G5: ACC 10097, G6: Local-1 (Jam Alu)), G7: Local-2 (Changta Alu), G8: Local-3 (Lal Pakri), G9: Local-4 (Challisha) and G10: Local-5 (Sadagota Alu). Pot experiment was laid out following Randomized Complete Block Design with three replications. Results showed that drought stress significantly influenced on plant growth and tuber yield contributing traits of potato genotypes. It was observed that plant height, leaf length, fresh weight, dry weight, percent relative water content in leaves (%RWC), leaf area, tuber length, diameter, fresh weight of tuber significantly decreased due to application of soil drying treatment. At the same time Leaf chlorophyll index (LChl), Leaf flavonoid index (LFlav), Leaf anthocyanin index (LAntho), % dry matter contents in leaves, tuber number, tuber dry matter contents increased due to imposition of drought stress. The combine effect of drought stress and potato genotypes was significant on plant growth and tuber yield traits. It was found that the lowest reduction in leaf area obtained from T2G8 followed by T2G6 and T2G4, these results indicated that local genotypes G8, G6 and exotic genotype G4 (AC10063) can withstand in the dry condition. The local genotype G9 maintained smaller leaf area with higher chlorophyll index as well as leaf dry matter content and number of tuber per plant impacted during water limit condition. The findings of this study indicated that the genotype G4, G6, G8 and G9 can be able to grow under water limit condition.

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.

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

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Abstract

The majority of human populations in developing countries rely on traditional medicines but the practice of traditional medicine is not the same across the world. The loss of habitats and overharvesting has threatened the availability of medicinal plants. Considering the importance of medicinal plants of Bangladesh, the study was undertaken to explore, identify and collection of fruits/seeds/plants species which contains medicinal value from the selected area and natural forests; and develop propagation techniques for multiplication and *ex situ* conservation at BAU-GPC, Bangladesh Agricultural University, Mymensingh. The investigation was on traditional medicinal plants used by the communities living at Natore, Tangail, Jamalpur, Mymensingh and Sherpur districts in Bangladesh. Field visits were done for identification and collection of medicinal plants in these areas. Saplings /seeds/seedlings of 48 different medicinal plant species were collected from the above locations and planted at BAU-GPC during the period from July, 2019 to June, 2020. Collected and planted medicinal plants were Yellow Berried Nightshade (*Solanum surattense*), Ceylon Irishwood (*Mesua nagassarium*), Cannonball tree (*Couroupita guianensis*), Costus (*Couroupita guianensis*), Indian birthwort (*Aristolochia indica*), Agnimantha (*Premma integrifolia*), European plum (*Prunus domestica*), Governor's plum (*Flacourtia indica*), Allamanda (*Allamanda catharica*), Chenille plant (*Acalypha hispida*), Choi jhal (*Piper chaba*), Purging croton (*Croton tiglium*), Heliotrope (*Heliotropium indicum*), Wood apple (*Aegle marmelos*), Bilimbi (*Averrhoa bilimbi*), Pirangichekka (*Smilax prolifera*), emblic myrobalan (*Phyllanthus emblica*), Siz (*Euphorbia prostrata*), Sebesten plum (*Cordia dichotoma*), Indian bdellium-tree (*Commiphora wightii*), Litsea (*Litsea monopetala*), Midnight horror plant (*Oroxylum indicum*), Blue Plumbago (*Plumbago capensin*), Coffea (*Coffea arabica*), Lipstick tree (*Bixa orellana*), Annual mugwort (*Artemisia annua*), Salparni (*Desmodium gangeticum*), Country mallow (*Sida cordifolia*), Ashoth (*Ficus religiosa*), Banyan Fig (*Ficus benghalensis*), Indian Mallow (*Abutilon indicum*), Ivy gourd (*Coccinia grandis*), Gonga Sagor, Plantain (*Plantago lanceolata*), Chondal, Sugar Apples (*Annona squamosa*), Jabuti kaba (*Plinia cauliflora*), Cherry (*Prunus avium*), Elephant apple (*Limonia acidissima*), Spanish cherry (*Mimusops elengi*), Kalo nirbish, Sada nirbish, Star Gooseberry (*Phyllunthus acidus*) and Pandan (*Pandanus odoratissimus*. Multiplications of some medicinal plants like *Terminalia chebula*, *Terminalia bellirica*, *Terminalia arjuna, Vitex negundo, Justicia adhatoda Withania somnifera*, *Codariocalyx motorius*, *Ocimum tenuiflorum*, *Cissus quadrangularis*, *Bryophyllum pinnatum*, *Gynura procumbens*, and *Aloe barbadensis* were done. About 800 seedlings and saplings of medicinal plants were produced at BAU-

GPC. Morphological characterization of 40 medicinal plants were done. A demonstration plot at Natore with 36 different species of medicinal plants was also developed. Day long training was conducted at BAU-GPC on 17/06/2020 with 30 participants of male and female from Mymensingh District. More than 150 seedlings/saplings of different medicinal plants like *Aloe barbadensis, Terminalia chebula*, *Terminalia bellirica*, *Justicia adhatoda, Vitex negundo, Andrographis paniculata, Bryophyllum pinnatum, Ocimum tenuifloru etc.* were distributed among the participants.

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
Postharvest losses of horticultural crops are very high. As per FAO estimates, roughly one-third of the global food produced, are lost every year, and losses of fruits and vegetables, are the highest (45%) amongst the food groups. Therefore, SDG 12.3.1 called for halving food loss by 50% by 2030. The present research attempted to reduce postharvest loss and extend shelf life of climacteric fruits through adoption of environmentally-friendly modified atmosphere packaging (MAP). This is an on-going project, and the 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, a number of experiments were carried with completely randomized designs. Parameters investigated included physiological weight loss, ripening rates (colour and firmness), total soluble solids, disease incidence, disease severity, nutritional properties, and shelf life. Preliminary results suggested that LDPE (low density polyethylene) bags of 50µ thickness outperformed the thin LDPE (25µ) and the PP (polypropylene) bags irrespective of thickness in reducing weight loss, disease incidence and severity, and in extending shelf life of bananas. At the 12^{th} day after storage, the LDPE bag of 50µ 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 (cv. Amritasagar), and the fruits held in 50µ 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).The above results have commercial implications, especially in long-distance transportation, medium to long term storage, and export for profitable production and marketing of perishable horticultural commodities.

Standardization of Modified Atmosphere Packaging For Shelf Life Extension of Guava Varieties of Bangladesh Without Deteriorating Quality and Safety

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Abstract
Horticultural produce are highly prone to postharvest losses and quality deterioration. Globally, one-third of food produced, are lost after harvest, and fruits and vegetables have been reported to have the

highest level of such loss. Hence, the SDG recognizes reduction of food loss and waste by 50% by the year 2030. The present study attempted to minimize postharvest losses of guava using non-chemical, safe and environmentally-friendly modified atmosphere packaging (MAP). There remains paucity of data and information on suitable packaging materials and appropriate thickness of MAP for shelf life extension of guava without compromising quality and safety. The objectives were to standardize type and thickness of MAP to prolong shelf life and maintain quality of guava. To achieve the objectives, number experiments were carried out following completely randomized designs at the laboratory of the Department of Horticulture, BAU. Parameters investigated included physiological weight loss, ripening rates (colour and firmness), total soluble solids (TSS), disease incidence, disease severity, nutritional properties, and shelf life. Three different types of MAP (PP- Polypropylene, LDPE- Low density polyethylene and HDPE- High density polyethylene) were tested on guava (cv. Swarupkathi and BAU-5) with or without perforation. The unperforated, PP bags of 50 thickness exerted the best result in terms of arresting shrinkage, maintaining firm texture and freshness, minimizing disease severity and extending shelf life of guava (cvs. Swarupkathi and BAU-5) followed by unperforated LDPE. The HDPE performed the least amongst the treatments. The longest shelf life of 9 days after harvest was observed in guavas held in unperforated 50 PP bag. In conclusion, PP (polypropylene) bags of 50 thickness may be recommended for wrapping guavas during postharvest handling and marketing in order to minimize loss and maintaining quality attributes including freshness, firm texture, adequate taste and quality.

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.

Keywords: Potato, Biofortification, Zinc, Soil, Foliar

Soil and Foliar Application of Zinc Fertilizer on Growth, Yield and Zinc Uptake in Tomato

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Abstract
About one-third people in the world suffer from Zn deficiency. Two experiments were performed to assess the biofortification of Zn through soil and foliar application in tomato and improvement of crop yield. The variety under test was "Roma VF". The source of Zn was $ZnSO_4.7H_2O$. Both experiments were laid out in a randomized complete block design (RCBD) with three replications. Plant growth and yield components were found significantly influenced. The fruit samples from each plot were analyzed for Zn concentrations. In the first experiment, treatment T_4 (applied twice: 8 kg/ha) produced the highest yield (23.15 ton/ha) whereas the Zn control treatment (T_1) produced the lowest yield (7.4 ton/ha). Zinc concentration in tomato were found the range from 20.31 to 76.21 ppm. The highest concentration of zinc was found from T_7 (applied thrice: 16 kg/ha). Although, applied two (T_4) and three (T_5) equal splitted zinc in soil gave 53 to 54 ppm Zn in tomato. In the second experiment, treatment T_6 where double of full dose was applied twice (16 kg Zn/ha) produced the highest fruit yield (15.6t ha^{-1}) which was statistically similar with the yield obtained with T_4 (13.53 t/ha) and T_5 (15.21 t/ha) treatment. Foliar Zn application significantly increased Zn concentration of tomato; Zn concentration varied from 21.17 to 56.23 ppm. The highest uptake of Zn accumulation (56.23 ppm) in tomato were found from T_4 (full dose applied twice: 8 kg/ha). Considering the yield and nutrient uptake; in case of zinc application in soil, T_4 (applied twice: 8 kg/ha) can be the recommended. On the other hand, twice foliar application of zinc (T_4: 4 kg Zn/ha) can be recommended for consistence of higher yield of tomato and dietary uptake of zinc from tomato.

Nitrogen Use Efficiency in Rice under Continuous Flooding and Alternate Wetting and Drying Conditions

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Abstract
Nitrogen is the major essential plant nutrient, leading to the contribution of the increment of rice production. Deep placement of USG in rice field can increase the efficiency of applied nitrogen by improving absorption to a certain extent. AWD irrigation is useful strategy to reduce the excess use of water and increase crop yield. This research project was undertaken to study the improvement of NUE in rice cultivation under continuous flooding and AWD conditions. A field experiment was conducted at farmer's field of Sadar Upazilla, Mymensingh with two water managements *viz.* continuous flooding and AWD, and seven nitrogenous treatments consisting of PU and USG *viz.* T_1: Control (no PU or USG); T_2: PU at 7 DAT+27 DAT+47 DAT (216) kg ha^{-1}; T_3: PU at 10 DAT+30 DAT+50 DAT (216) kg ha^{-1}; T_4: PU at 15 DAT+35 DAT+55DAT (216) kg ha^{-1}; T_5: USG at transplanting (216) kg ha^{-1}; T_6: USG at 7 DAT (216) kg ha^{-1}; and T_7: USG at 10 DAT (216) kg ha^{-1}. There was considerable difference in growth and yield between continuous flooding and AWD. Application of PU and USG remarkably increased grain and straw yields of rice under both continuous flooding and AWD. Among PU treatments, T_3 treatment (10 DAT+30 DAT+50 DAT) produced the highest yield of rice. On the other hand, USG at 7 DAT produced the highest yield of rice and NUE among nitrogenous treatments.

Continuous flooding and AWD increased N uptake and NUE but no considerable differences were observed between them. However, the performance of USG was superior in aspect of rice yield and NUE compared to PU under both continuous flooding and AWD conditions. It can be concluded that application of USG might be profitable for rice cultivation under both continuous flooding and AWD conditions through increasing yield and NUE.

Biocontrol of Wheat Blast Disease Using Endophytic *Pseudomonas* and *Bacillus* Bacteria

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Abstract
This experiment was performed to isolate and identify promosing bacteria which could potentially act as plant growth promoting bacteria (PGBR) from wheat phylloplane and rhizosphere that antagonistic to *Magnaporthy oryzae* pv. *Triticum* (MoT). Wheat phylloplane and rhizosphereic bacteria were isolated from the plant surface (leaf and stem) of wheat as well as from the root region of wheat plant, respectively. The antagonistic performance of these isolated bacteria was observed in vitro condition by dual culture triangular method. The bacterial isolates worked well against MoT were identified by measuring their inhibition area. Plant growth promoting activities of these beneficial bacteria was observed with the production of Indole Acetic Acid (IAA) and phosphate solubilization assay. The growth promotion of plant was assessed by the determination of root length, shoot length and vigor index. Thirty bacterial isolates were identified as antagonistic to MoT out of 110 bacterial isolates by dual culture triangular method. The maximum growth inhibition (91.56%) of MoT was recorded in plate inoculated with bacterial isolate BDM-42 while the minimum growth inhibition (60.41%) was recorded in BDM-27. The moderate growth inhibition was recorded in BDM-4, BDM-6, BDM-8, BDM-9, BDM-18, BDM-20, BDM-22, BDM-33, BDM-26 and BDM-2. The bacterial isolates were identified BDM-14, BDM-21, BDM-36, B M-56, BDM-58, BDM-62, BDM-63 as *Bacillus* sp and more than 20 isolates as *Pseudomonas* spp based on colony morphology and colony colour. Four antagonistic bacterial isolates produce IAA, 11 bacterial isolates were found able to show phosphate solubilizing capability. The study indicates that these bacterial isolates have the potential to enhance plant growth and suppress MoT causing blast of wheat.

Developing Sustainable Disease Management Strategies for Safe Vegetable Production in Bangladesh

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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.

Formulated *Pseudomonas* and *Bacillus* Reduced Application Frequency of Chemical Fungicide in Controlling Late Blight of Potato

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Abstract

Late blight caused by *Phytophthora infestans* limits production of potato in cool weather worldwide. *Phytophthora infestans* (Mont.) De Bary, is an oomycete which is well known for its explosive development when environmental conditions are favourable. In Bangladesh farmer's are rely mostly on chemical fungicides to control this disease. In this study field efficacies of four potential formulated plant growth promoting bacterial strains viz. BDISO02PanR (*Pseudomonas fluorescens*), BDISO042ThaR (*Pseudomonas putida*), BDISO44JoyR (*Bacillus subtilis*) and BDISO61JamR (*Bacillus subtilis*) were evaluated against late blight of potato. Significant effects of these formulated bacterial bioagents were observed at 60 days after planting (DAP). The maximum (40.20%) reduction of late blight severity was observed when potato plants were sprayed with *Pseudomonas fluorescens* [T_2] followed by *Pseudomonas putida* [T_3], *Bacillus subtilis* [T_4] and *Bacillus subtilis* [T_5] among the bioagents tested. However, the late blight severity was reduced by these formulated biaogents ranged by 84.04 to 88.41% if chemical fungicide was sprayed for four times which was 45-50% higher as compared with only bioagents application. To test the economic feasibility of using bacterial bioagents, BCR were determined for each treatment. The results showed that foliar application of chemical fungicide yielded the highest BCR (1.91) indicated that an investment of Tk. 1.00 may lead to a profit up to Tk. 0.91. Treatments include foliar spray of only bioagents viz. *Pseudomonas* and *Bacillus* spp. lead to loss of Tk. 0.62 to 0.66 over the investment of Tk. 1.00. However, foliar spray of these bioagents plus four sprays of chemical fungicide may lead to a profit of Tk. 0.32 to 0.39 over the investment of Tk. 1.00. These results collectively indicate that application of proper forecasting model and suitable bacterial bioagents can reduce the frequencies of fungicide application by 50% in controlling late blight of potato.

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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.

Formulation and Field Application of Novel Plant Growth Promoting Bacteria and Fungi in Controlling Bacterial Blight of Rice

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Abstract

Bacterial Blight (BB) caused by*Xanthomona soryzae* pv. *oryzae* (*Xoo*) considered as a most destructive disease of rice. Control measures for BB include cultural, chemical, biological and host resistance. However,none of the control methods found effective due to dynamic changes of pathogen population and severity of regional outbreak.To develop environment-friendly sustainable management approach against BB of rice, 63plant growth promoting (PGP) antagonistic bacteria were identified from rice phylloplane and rhizosphere against *Xoo* during 2018 and 2019.Assessment of PGP determinants revealed that 32 bacteria enhance growth of rice plants significantly. Efficacy test of 16 formulated bacteria identified in boro seasons (2018 and 2019) revealed 40.83 to 62.20% reduction of lesion

length caused by *Xoo* under net house and 41.46 to 70.16% under field condition in boro seasons 2018 and 2019. Remarkable 13.33 to 29.94% yield increases of rice were observed by these bacteria.However, efficacy test of 16 formulated bacteria showed 31.65 to 69.99% reduction of lesion length caused by *Xoo* under net house and 47.44 to 60.38% reduction under field condition in aman seasons 2018 and 2019. Significant yield increases (12.25 to 27.03%) were also observed by these bacteria. Four PGP fungi antagonistic to *Xoo* were identified from rice rhizosphere in boro seasons 2018 and 2019. Growth promotion assessment of rice plants showed that all these *Trichoderma* species promoted the growth significantly. Efficacy test revealed that these *Trichoderma* species reduced 45.77 to 61.76% lesion length caused by *Xoo* under net house and 40.14 to 49.12% under field condition. Significant (17.03 to 23.94%) yield increases were observed by these *Trichoderma* species. Therefore, patenting, formulation and commercialization of these potential *Pseudomonas* spp., *Bacillus* spp. and *Trichoderma* species will ensure step forward strategies for increasing rice yield through sustainable management of BB.

Identification of Potential Bacterial and Fungal Bioagents in Controlling Potato Late Blight Pathogen, *Phytophthora infestans*

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Abstract

Late blight of potato caused by an oomycete, *Phytophthora infestans* (Mont.) De Barylimits the production of potato worldwide. Late blight management has been heavily based on fungicide application and in many areas fungicide applications have increased over the last decade due to the introduction of new and more aggressive genotypes of the pathogen. Innovative and effective control measures are needed if fungicide use is to be reduced or, eliminated in the case of organic production.A total of 200 bacterial isolates were isolated from potato phyllosphere and 150 bacterial isolates were isolated from potato rhizospheric soil samples collected from 15 potato growing areas during 2017 to 2018. Out of these bacterial isolates, 35 bacterial isolates from potato phyllosphere and 30 bacterial isolates from potato rhizosphere were identified as antagonist against *P. infestans*. Among these 65 bacterial isolates, 27 were identified by sequencing of 16SrDNA gene. Out of these 27, eleven antagonistic bacterial isolates showed 78-98% sequence identity with the corresponding nucleotide sequences of 16SrDNA gene of different *Pseudomonas* strains reported in National Center for Biotechnology Information (NCBI) and were identified as different spp. of *Pseudomonas.* Nine antagonistic bacterial isolates showed 83-98% sequence identity with the corresponding nucleotide sequences of 16SrDNA gene of *Bacillus subtilis*strains reported in NCBI and were identified as *Bacillus subtilis*. In addition, seven antagonistic bacterial isolates were identified as *Stenotrophomonas maltophilia* by sequencing of 16SrDNA gene. Two fungal strains viz. *Trichoderma paraviridicens* and *T. erinaceum* were identified as potential antagonist against *P. infestans* that were identified previously from rice rhizosphere in our Laboratory.Therefore, it can be concluded that patenting, formulation and commercialization of these potential bacteria and fungi antagonistic to *P. infestans* would be a great option for organic management of late blight of potato.

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Genetic Diversity Analysis of Rice Blast Pathogen for Developing Sustainable Management

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Abstract
To find out the genetic diversity of rice blast pathogens in Bangladesh and devising sustainable bio-management was the prime consideration of the project started from 2017. In doing this infected rice samples from 29 regions under various Agro-Ecological Zones revealed no significant variation in conidial size and shape. Here, we report that the races of *M. oryzae* in Bangladesh belongs to 4 major clade in the phylogenetic tree indicating distinct genetic variation/distance which may one of the reasons of disease severity of blast at different levels. We isolated and identified potential antagonistic bacterial strains from rhizopheric zones of rice plants. All the isolated *Bacillus subtilis* and *Pseudomonas fluorescens* have been assigned to NCBI GenBank accession (MN256387, MN256388, MN256389, MN256390, MN256391, MN256392, MN256393, MN256394, MN256395, MN256396, MN256397, MN256398, MN256399, MN256400, MN256401, MN2563402 and MN252542, MN252543, MN252544, MN252545, MN252546, MN252547) which confirm the authentic molecular identification of the bio-agents and first time recorded accessions in NCBI GenBank from Bangladesh of its kind. Phylogenetic study also revealed their diversity. Some of the bio-agents showed complete growth suppression of *M. oryzae* in the laboratory may be the potential candidates for commercial bio-pesticide production. Both antagonistic *B. subtilis* and Fluorescent Pseudomonads (*P. fluorescens* and *P. putida*) were formulated in talc, bentonite, palm oil and coconut oil and assessed for its shelf-value. Growth parameters, yield parameters, incidence and severity of blast of rice significantly influenced at different growth stages of rice by formulated bio-agents application. Moreover, yield contributing parameters were increased significantly giving the highest benefit cost ratio (BCR) compared to untreated control. Field evaluation of boron and zinc fertilizer solution spray on the foliage can suppress blast disease incidence and can significantly increase growth and yield parameters. We also report that foliar application of three elicitors *viz.* salicylic acid, benzoic acid and chitosan can mediate induction of resistance to reduce blast disease incidence. The outcome of the research project can be sustained through Private-Public collaboration especially for commercialization of the *Bacillus* and Pesudomonad bio-agents to reach the terminal levels of farmers.

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
Occurrence of *Stemphylium* blight of both garlic and onion in Bangladesh is common and causes enormous losses due to ubiquitous nature of the pathogen. The present study was undertaken to examine the morphological variation of *Stemphylium botryosum* isolated from infected onion and garlic plants. Forty six diseased plant samples of garlic and onion were collected from different locations of Rangpur, Dinajpur, Gazipur, Mymensingh, Bogura, Nilphamari, Gaibandha, Gopalganj, Shariatpur, Magura, Narayanganj, Lalmonirhat, Naogaon, Rajshahi, Faridpur and Natore. Associated

pathogen was isolated by tissue planting method in potato dextrose agar medium and subsequent purification was done by hyphal tip culture preserved in -20° C. Morphological characters varied greatly among the isolates showing variation in colony growth, texture, colony elevation and colony color in PDA medium. Radial mycelial growth also showed variation among the isolates where in general it takes 11 days to cover the whole petridishes. Isolates OBSS-33, ORPB-4 and ONSK-35 showed faster growth in PDA medium.Variation in shape and color of the fungus is evident. In most cases the conidia are oblong and deep brown in color. Both size of the conidia and septation vary among the isolates of the fungi. The length of conidia ranges from 199.00 to 344.00 µm while breadth ranges from 129.24 to 200.23 µm. The findings of this study reveal that *Stemphylium botryosum* has great variation in morphological characters which may also vary in cultural characters and pathogenicity.

Isolation and Characterization of Parthenium Pathogen to Develop Bioherbicide for Effective and Eco-friendly Control of Parthenium Weed

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Abstract

Parthenium is an invasive and obnoxious weed in Bangladesh which is spreading alarmingly all over the country. The present research was undertaken to isolate and identify the pathogens of Parthenium from naturally infected plants and to validate the toxins isolated from potential microorganisms which might affect the growth and development of Parthenium. Microorganisms associated with naturally infected Parthenium was isolated following tissue planting technique on moistened blotter paper and potato dextrose agar (PDA) medium. Infected plant tissue on blotter paper and PDA medium were incubated in room temperature followed by 12/12 darkness/NUV light. Isolated fungi were identified under microscope while bacteria were streaked on nutrient agar (NA) medium for further multiplication and identified by observing morphological characters. Pathogenicity of the isolated microorganisms was confirmed by artificial inoculation following detached leaf method. Out of nine fungi and four bacterial isolates two fungi and one bacterium developed infection at 7 DAI and cause complete rotting of the detached leaves. These selected microorganisms were further inoculated to the whole plants in the pots. Comparatively slow development of infection was recorded in case of in vivo study. One fungus and one bacteria showed potential infection (90.00 %) after 14 DAI indicated that more intensive research works should be carried out to have any precise conclusion.

Morpho-molecular and Pathogenic Diversity Analyses of *Fusarium* spp. for Developing Sustainable Management of Bakanae Disease of Rice

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Abstract

Bakanae disease of rice caused by a ubiquitous pathogen (*Fusarium* spp.) can cause major damage of rice especially at the low lying areas of Bangladesh. Diseased samples of Bakanae of rice were collected from 55 locations under different Agro-Ecological Zones of Bangladesh to examine the

morphological, pathological and molecular variation of its causal organism (*Fusarium* spp.) in order to develop suitable integrated management.Isolates showed distinct variation in colony color, structures and radial mycelial growth. The pigmentation mostly includes white, whitish, whitish-yellow, yellow, yellowish-white and yellowish and the type of mycelium or the consistencies were sparse, compact, floccose and wooly. The average mycelial growth ranges from 5.45 to 8.76 cm at 7 DAI. Both micro- and macro-conidia varied in their size in different isolates. Isolates FM10 showed the highest shoot length, more chlorotic leaves and minimum germination percentages. A number of chemicals *viz*. Nativo[Tebuconazole 50%+ Trifloxystrobin 25% w/w WG (75 WG)], Blastin (Tricyclazole 75% WP), Tabia [Penconazole(10%) + Difenoconazole(20%)] and Unisaaf[Mancozeb (63%) + Carbendazim (12%)] showed complete *in-vitro*growth suppression of *Fusarium* spp. Among the biological agents *Achromobacter* spp., *Bacillus subtilis* (BdBs 21), *Trichoderma* spp. and *Pseudomonas fluorescens* (BdPf 7) showed 73.54%, 71.61%, 69.84% and 58.64% *in-vitro* growth suppression of *Fusarium* spp.over control respectively. Moreover, chemical pesticide Nativo[Tebuconazole 50% + Trifloxystrobin 25% w/w WG (75 WG)] showed the highest compatibility with *Achoromobacter* spp. and *Trichoderma* spp. Therefore, a combination of chemical fungicide Nativo and *Achromobacter* spp. may result in reducing the incidence and severity of bakanae disease of rice.

Management of Wheat Blast: A Holistic Approach with Emphasis on Early Stage Detection for Forecasting

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Abstract

Since its first appearance on 23rd February 2016, wheat blast continued to spread to wheat growing areas of Bangladesh. It's a big threat to wheat cultivation in Bangladesh. Research strategies for developing effective GAP including developing resistant variety to face this threat is in progress. Infected seeds either proceeded to death or produced both healthy and diseased seedlings, all produced spikes with blast symptoms. These experimental results prove Magnaporthe oryzae Triticum (MoT) remains in the seeds and transmits through plant body to spike i.e. it is seed transmitted. Anatomical and molecular analyses confirmed the movement of MoT through the ground tissues to the rachis of wheat plants. Detection of the presence of MoT at 30, 40, 45, 50, 55- and 60-days age of wheat plants under natural field condition indicates MoT is seed-borne and seed transmitted and it is randomly distributed in the field as it goes with the seeds when planted. Early stage forecasting of wheat blast is possible. Cocktail of fungicides sprayed as both preventive and curative measures for two times starting from booting stage before symptoms appearance reduced blast incidence by 97%. The approach is cost-effective with BCR 1.45. Soil amendments and foliar spray of Si, Se, B and Zn were effective in reducing wheat blast incidence and severity by 50%. The approach is economic and eco-friendly. Barley is proved to be an effective alternative host of MoT. MoT stays in wheat stubbles in the field as its continued presence through March (after harvest) to January (next season) is detected. Destruction of wheat stubbles is recommended. 20 M4/ M5 families were selected with no blast symptoms, will be sown in farmer's field for yield trial and disease reaction.

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Role of Micronutrients on Growth and Yield of *Bangi* (*Cucumis melo* L.) in Charland Agriculture

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Abstract
Bangi, an important short duration summer fruit crop, is rich in vitamins and minerals, facilitated to protect from hidden hunger. To expedite the growth and fruit yield attributes of Bangi through micronutrient application for the Charland Agriculture, the experiment was conducted at the farmer's (Charland) field in two locations *viz*. Sadar and Belkuchi Upazilas of Sirajgong district. The crop was cultivated following farmer's management practices in mada(s)/pits (spacing 3.5 m row-row X 3.5 m plant-plant) in RCBD design with 3 replications. Two fertilizer doses – i. control (farmers practice; cow dung + NPK) and ii. improved practice (farmers practice + micronutrients), were used as experimental treatments. The application of micro-nutrients enhanced plant length and other growth descriptors and fruit yield as well; however, locations did not affect on the studied descriptors except the number of secondary branches plant^{-1} and leaf characters. The plant length varied from 148.6 cm to 321.7 cm, the fruit yield (number) plant^{-1} almost quadrupled and size more than double due to improved practice (with micronutrients) resulting 4–5 times increased the farmer's profit compared to conventional (farmers) practices. Further research on the effect of micronutrients on nutritional quality enhancement (Biofortification) and self-life is suggested for better understanding and nutritional quality improvement processes of Bangi through nutrient management.

Effect of Cultural Practices and Retting Methods on High Value Flax Fibre Production

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Abstract
An experiment was conducted to observe the effect of cultural practices and retting methods on flax genotypes under (farmer's) field condition at Shoreartol, Alamnagar, Rangpur during October to March in 2019-20. Three sowing dates, viz. 1st November, 16th November and 1st December, in main plot and four flax genotypes, viz. BARI Tishi-1, BD-10708, Canada and China, in subplot were allocated based on their performances tested in the previous two years (2017 – 2019) experiments. Individual plot size maintained was 3.0 m × 1.5 m (10 lines) with continuous sowing. Each subplot was made sub-sub plot and plants were harvested three times viz. pre-flowering stage, 50% flowering stage and post-flowering stage. From each harvest, fibres were extracted following ribbon retting method (of Jute) and dew retting method. Among the planting time and varieties, BARI Tishi-1 performed better (longest plant) in both 16th November and 1st December sowing with recommended fertilizer dose. The fibre separation by dew retting method is not promising (/feasible) for Bangladesh due to scarcity of space. In wet retting method, the largest amount of fibre was extracted from Canada (22.05 g m–2) at 16th November planting and harvesting at 50% flowering stage followed by BARI Tishi-1 (20.30 g m–2) in similar condition. The lowest was weighted both in BARI Tishi-1 and BD-10708 (1.01 g m–2) in combination with 1st November sowing and pre-flowering cut. The fibre quality parameters could not be performed at the scheduled time due to COVID-19 pandemic situation and hope to be completed soon.

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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 (1st year) and 56 genotypes were selected for the phenotypic and spectral reflectance index (SRI) evaluation in the field (2nd 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.

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.

Impact of Drought Stress on Cambial Growth of Tropical Diffuse Porous Hardwood *Samanea saman* During Hot Summer in Bangladesh

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Abstract
The seasonal changes in the activity of cambium in relation with the precipitation pattern in some tropical hardwood trees grown in Bangladesh were investigated. Variation occurred in the daily or monthly precipitation pattern all-year-round. The frequent precipitation provides the favorable condition with available water on the soil for cambial growth in tropical trees. Water stress can affect cambial growth, directly, through the effects on cambial cells and their derivatives. Therefore, an experiment was conducted during hot summer, where severe drought is a common problem. With application of high irrigation water for a certain period, cambial growth was initiated and continued on the stems of *Samanea saman* seedlings during hot-summer. By contrast, when low irrigation water was applied, cambial growth was not initiated during-hot summer. The inability of cambium to initiate cell division in response to lack of water might be the result of an adaptive change or may be a secondary effect of physiological changes in the whole plant during hot-summer. From this study, it is 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 in *Samanea saman* seedlings grown in Bangladesh. There were clear changes in the respective localizations and levels of starch from cambial dormancy to the start of xylem differentiation between irrigated and drought stressed stems. In drought stressed stems, the levels and number of starch fell from cambial reactivation to the start of xylem differentiation. There was a significant decrease in the relative area occupied by starch granules in the cambium from cambial reactivation to the start of xylem differentiation in drought stressed stems.

Microscopic Investigation of Wood Formation: Focusing Artificial Application of Water in *Tectona grandis* in Bangladesh

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Abstract
The availability of water on the soil is an important regulating factor for determining the cambial growth in trees. Water stress can affect cambial growth, directly, through the effects on cambial cells and their derivatives or indirectly, through an effect on photosynthesis and plant hormone production. To evaluate the hypothesis that cambial growth is regulated by the precipitation during dry season in tropical and sub-tropical trees, an experiment was conducted during hot summer, where severe drought is a common problem. With application of high irrigation water for a certain period, cambial growth was initiated and continued on the stems of *Tectona grandis* seedlings during hot-summer. By contrast, when low irrigation water was applied, cambial growth was not initiated during-hot summer. The inability of cambium to initiate cell division in response to lack of water might be the result of an adaptive change or may be a secondary effect of physiological changes in the whole plant during hot-

summer. From this study, it is 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 in *Tectona grandis* seedlings grown in Bangladesh.

Regulation of Wood Formation in Srees 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 on adaptive researches and extension works many farmers don't utilize the technologies that released over the years; hence sustainability of research outcomes may be poor. Some adaptation gaps may exist between research institutes, policy makers, extension works and rural communities, and ultimate target for getting expected production against climate shocks couldn't reach up to the mark. Recently huge loss in *Boro* harvest is noticed in *Haor* areas due to early flash flood; therefore, the present study was undertaken to investigate whether any adaptation gap to save production against aberrant weather exist. Data are collected through stakeholder consultation from respective officials especially DAE personnel, and focus group discussion and questionnaire survey from *Haor* farmers. Most of the farmers are advised to cultivate BRRI Dhan28 variety in the *Boro*

season. However, to get higher yield many farmers cultivate with BRRI Dhan29 variety whose life span (160 days) is twenty days longer than the BRRI Dhan28. As a result the said crop is often subjected to early flash flood. *Haor* farmers use the rice seed from the local market, thus the varietal purity is getting lost day by day which is associated with poor yield. Most of the farmers believe that cool injury that affects rice is the main barrier for advancing *Boro* season, and submergence tolerant rice may tackle the flood incidence to some extent especially in *Aman* season. 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 flood or flash flood.

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

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Abstract
Sunflower (*Helianthus annuus*) is cultivated in the coastal region of Bangladesh due to its saline tolerant ability. Farmers of saline-prone areas will be more benefitted if they cultivate sunflower genotypes with higher tolerance to salt. Therefore, a keen evaluation is of prime importance to screen suitable genotypes of sunflower which can tolerate higher degree of salinity. The experiment was conducted in the Plant Ecology Laboratory of the Department of Crop Botany, BAU. After performing germination and related tests, seedling growth behavior was evaluated. More than thirty sunflower genotypes were collected for evaluation. Nacl solutions with 0 (distilled water), 100, 150, 250 and 300 mM concentrations were used. Standard research protocol and techniques were followed. Seed germination was conducted in petridishes in dark and kept the growing plantlets a week for observation. Data were collected on plumule and radical lengths and corresponding dry weights, and calculated these to find standardized root and shoot reductions (SRR and SSR), seedling vigour index (SVI), salt tolerant index (STI) etc. Among the genotypes tested the sunflower cultivar Hysun-33 performed better with said parameters in higher salt concentration.

Physiological and Biochemical Response of Tomato to Combined and Individual Heat and Drought Stress

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Abstract
Global agriculture is facing challenges under dramatic global climate changes. Tomato is a popular vegetable crop and its production is limiting due to simultaneous heat and drought stress in Bangladesh. A two factorial pot experiment following CRD with three replications was conducted in the Department of Crop Botany, Bangladesh Agricultural University, Mymensingh to investigate the physiological and biochemical responses in tomato plants to individual and combined heat and drought stress. The two experimental factors were i) Tomato cultivars (BARI Tomato-8, BARI Tomato-16 and BARI Tomato-18) and ii) Stress treatments (control, heat, drought and heat + drought). The plants of three tomato cultivars were exposed to heat (38/25°C day/night for 3-4 d), drought (350 mbar) and a combination of heat and drought at seedling and flowering stages. Shoot biomass, relative greenness/SPAD, maximum photochemical efficiency of PSII (F_v/F_m), photosynthetic and transpiration rate, leaf chlorophyll and carotenoids contents and fruit weight were significantly

declined by the stress treatments in all tomato cultivars compared to control. The catalase and ascorbate peroxidase enzymes activities were significantly increased in plants grown under stress treatments compared to the plants grown in control. The tolerance of cultivars in response to individual and combined heat and drought stress varied significantly. The percent reduction (over control) values in photosynthetic rate in BARI Tomato-8, BARI Tomato-16 and BARI Tomato-18 were 47, 36 and 41%, respectively due to combined stress. The percent increased (over control) values of catalase activities under combined stress in BARI Tomato-8, BARI Tomato-16 and BARI Tomato-18 were 53, 63 and 54%, respectively. The cultivar BARI Tomato-16 showed better stress tolerance based on the studied parameters and could be recommended for cultivation in the simultaneous heat and drought prone areas of Bangladesh with further investigation.

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.

Drought and First Phase of Salt Stress: Response to Physio-Biochemical Parameters of Maize Genotypes

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Abstract
Salt and drought stresses are being quite similar considered as two major constraints in maize production. Drought and salt sensitive BARI hybrid maize-7 was compared in a hydroponic culture

with two drought resistant genotypes, namely BARI hybrid maize-12 and BARI hybrid maize-13 against drought and salt stresses to observe differential responses of salt and drought stresses on some morphological, physiological, and biochemical attributes. Control, salt stress (100 mM NaCl) and drought stress (equiosmotic PEG-6000) were simulated to each of the tested three maize genotypes in a completely randomized design having four replicates. Salt stress declined shoot fresh weight by 28.2, 35.8 and 42.2%, whereas drought stress reduced the same by 22.6, 18.1 and 32.4% in BARI hybrid maize-7, BARI hybrid maize-12 and BARI hybrid maize-13, respectively. In BARI hybrid maize-7, photosynthetic rate, stomatal conductance, and transpiration rate declined by 23.1, 56.7 and 55.3% under salt-stress and 46.7, 66.67, 63.3% under drought, respectively, compared to the control. However, drought-resistant genotypes BARI hybrid maize-12 and BARI hybrid maize-13 were found unaffected under both salt and drought stresses. Salt stress augmented phenolics content by 95.1 and 86.6%, whereas drought stress increased the same by 111.7 and 137.8% in the shoot of drought resistant genotypes BARI hybrid maize-12 and BARI hybrid maize-13, respectively. Also, salt stress augmented DPPH scavenging activity of plant extract by declining IC_{50} value by 27.7, 3.8 and 1.7%, whereas drought stress decreased the same by 26.2, 19.1 and 30.5% in the growing leaves of BARI hybrid maize-7, BARI hybrid maize-12 and BARI hybrid maize-13, respectively. This research unveiled some physio-biochemical bases of drought resistance in BARI hybrid maize-12 and BARI hybrid maize-13.

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.

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Utilization of Biological Nitrification Inhibition (BNI) Function for Increasing Nitrogen Use Efficiency in Cereal Production Systems

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Abstract
The indiscriminate use of nitrogenous fertilizers in agricultural systems has generated a negative impact on the environment since around 70% of these fertilizers are lost due to nitrification and associated processes. Regulation of nitrification could be a key strategy to improve N-recovery and agronomic nitrogen use efficiency of crops. The studies were made with the emphasis to screen sorghum germplasms based on biological nitrification inhibitors and to evaluate biological nitrification inhibition (BNI) function released from sorghum for enhancing nitrogen use efficiency in rice cropping system as well as to assess the effect of BNI on N_2O gas emission from rice field for the mitigation of global warming. To accomplish these purposes, five experiments were conducted in the Field Laboratory, Plant Physiology Laboratory, Department of Crop Botany, Bangladesh Agricultural University, Mymensingh. Firstly, twenty-one genotypes were grown hydroponically and collected root exudates were analyzed by High Performance Liquid Chromatography. Among the screened genotypes Hybrid Sorgho showed the best BNI potential based on methyle 3-(4-hydroxyphenyle) propionate (MHPP). To validate the BNI potential sorghum genotypes, two genotypes (BNI- Hybrid Sorgo and non BNI- BD 717) were grown in field at different N levels as well as their yield potential, grain and soil N status were evaluated. Results revealed that grain yield, % N in grain and soil increased with increasing supply of urea but BNI potential genotypes showed significant increase upto 90 kg ha^{-1} due to nitrification inhibitors secreted from its root. In pot and field experiment, sorghum was grown as preceding crop of rice to exploit BNI function of sorghum on yield and yield attributes as well as nitrogen use efficiency of rice. The results showed that the novel natural nitrification inhibitors from sorghum enhance the nitrogen use efficiency by improving yield and yield contributing characters of rice. The results also revealed that urea applied with biological nitrification inhibitors showed 11.59% and 6.08% more apparent recovery efficiency than urea added alone in pot and field respectively, and maintained statistically similar grain yield of rice. Finally, an experiment was set to evaluate the impact of BNI on N_2O emission from rice. It was evident from the study that the application of nitrification inhibitors released from sorghum was found to reduce N_2O emission effectively. The inhibition of total N_2O emission was 42.71% with nitrification inhibitors compared to urea applied lone. It can be concluded that sorghum has the potential to increase nitrogen use efficiency and to mitigate N_2O emission from rice effectively. Therefore, sorghum can be cultivated in a rice-sorghum-rice rotation system for effective utilization of nitrogenous fertilizer that ultimately lessens the total demand for nitrogenous fertilizer.

Phytochemical Analysis of Medicinal Plant Parts 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. Medicinal plants contain many essential components, bioactive compounds. The most important of these bioactive compounds are alkaloids, flavonoids, tannins and phenolic

compounds. The main target of the study was to analyze presence or absence of alkaloids, saponins, terpinoids, tannin, flavonoids and phenolics as well as evaluate the phytochemical constituents as total alkaloid, flavonoids, phenolics, tannin, chlorophyll a, chlorophyll b, chlorophyll (a+b) and total carotenoids. Six different samples from four selected plants Bohera (*Terminalia bellirica,* Family: Combretaceae), Noni phol (*Morinda citrifolia,* Family: Rubiaceae), Choijal (*Piper chaba,* Family: Piperaceae) and Pathor kuchi (*Bryophyllum pinnatum,* Family: Crassulaceae) were collected from The Botanical garden of Bangladesh Agricultural University. In first experiment the samples were analyzed for qualitative test and in second experiment the samples were evaluated quantitatively. The result of qualitative analyses of samples shows that higher amount of Alkaloids were found in all samples where saponins absent in *Piper chaba* (stem and leaf), Terpinoids was found in all the samples except *Bryophyllum pinnatum* and other phytochemicals like Tannin, Flavanoids, Phenolics were also found in all samples. In quantitative analysis highest percent of alkaloid content (1.27 g/100 g sample) was found in the sample of *Terminalia bellirica* leaf and other phytochemical like total flavonoid, total soluble phenoilcs and tannin were also found in *Morinda citrifolia* (3.1g/100 g sample), *Morinda citrifolia* (3.60 mg GAE/g extract) and *Morinda citrifolia* (2.97 mg GAE/g extract) respectively. The samples were also evaluated for the phytochemical pigments. The highest chlorophyll a, chlorophyll b and chlorophyll (a+ b) contents were detected in *Morinda citrifolia* (Leaf) which was (1.01 mg/g FW), (0.573 mg/g FW) and (1.583mg/g FW) respectively. The highest amount of carotenoids (0.013 mg/g FW) was detected in *Terminalia beleirica* (leaf). Further investigation of these active ingredients is needed to exploit the pharmacological properties of these potential medicinal plants through isolation, identification, characterization, purification, separation, crystallization and elucidation the structure of the bioactive compounds.

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.
Keywords: Salinity, yield attributes, biochemical parameters, tolerance

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 ʻbon chaltaʼ (*Dillenia pentagyna*), ʻbilati gabʼ (*Diospyros discolor*), ʻdephalʼ (*Garcinia xanthochymus*), ʻchina cherryʼ (*Muntingia calabura*), ʻdumurʼ (*Ficus racemosa*), ʻkaramchaʼ (*Carissa carandas*) and ʻbilimbiʼ (*Averrhoa bilimbi*) collected from Botanical Garden, Bangladesh Agricultural University. Results revealed that percent dry matter content ranged from 5.38 (ʼbilimbiʼ) to 19.71 (ʻchina cherryʼ). For proximate composition, crude protein was higher in ʻbilati gabʼ (25.9%), crude fibre and ash was higher in ʻdumurʼ (19.58 and 9.09%, respectively), and crude fat was maximum in ʼkaramchaʼʼ (24.42%). Thus, the species, ʻbilati gabʼ, ʻkaramchaʼ, ʻchina cherryʼ 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 (ʻdumurʼ at post-PM) to 315.045 (ʻbilati gabʼ at pre-PM) mg GAE /100 g FW, flavonoids ranged from 48.36 (ʻdumurʼ at post-PM) to 652.22 (ʻdephalʼ 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 gabʼ at PM) to 30.30 (ʻdumurʼ at post-PM) mg mL^{-1} fruit extract. Thus, according to species, ʻbilati gabʼ, ʻdephalʼ and ʻchina cherryʼ 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.

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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Drought and Methyl Jasmonate Mediated Enhancement of Bioactive Compounds and Antioxidants in *Andrographis paniculata* Medicinal Herb

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Abstract
Application of methyl jasmonate (MeJA) and mild drought stress are considered to increase the bioactive compounds and antioxidants in medicinal plants. A two factorial pot experiment was conducted in the Department of Crop Botany, Bangladesh Agricultural University, Mymensingh to investigate the exogenous application of methyl jasmonate and mild drought stress on the enhancement of bioactive compounds and antioxidants in *Andrographis paniculata* (Kalomegh) medicinal plant. The two experimental factors were i) MeJA dose (0 and 50 µM) and ii) two water regimes (control with 100% FC and mild drought with 80% field capacity). The MeJA was applied in three times as foliar spray at 30, 45 and 60 days after establishment period. Data regarding leaf area, plant biomass and leaf greenness (SPAD) were recorded in younger and older leaves after foliar spray of MeJA and mild drought treatment. Mild drought and exogenous application of MeJA significantly enhanced the leaf greenness in both younger and older leaves. The leaf area and shoot dry mass significantly increased by the exogenous application of MeJA. The maximum SPAD value, leaf area and shoot dry mass were observed in drought + MeJA treatment (68, 60.84 cm^2 and 2.72 g $plant^{-1}$ in older leaves and 68.5 and 35.06 cm^2 in younger leaves, respectively). All the parameters were higher in younger leaves in comparison to older leaves. The leaf samples for pigments, antioxidants and bioactive compounds were collected and stored. Due to COVID-19 pandemic, the unavailability of lab research for longer period, the stored samples were expired, and biochemical analysis could not be done. In conclusion, exogenous MeJA treatment increased the leaf greenness, leaf area and shoot dry mass in all leaf stages of kalomegh plant but these values were higher in younger leaves in comparison to older leaves.

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.

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Genetic Dissection of Soybean Genotypes for Resistance Against *Soybean Yellow Mosaic Virus*

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Abstract
Experiments were conducted with 26 selected soybean genotypes for their screening against Yellow mosaic virus disease based on field performance, viral assays and SSR marker linked to *Rsv1-h* gene. Diverse soybean genotype collection and its subsequent experimentations were performed in the GPB-farm laboratory and in Molecular laboratory of Bangladesh Agricultural University, Mymensingh during the period October 2017 to December 2019. Morphological data were recorded at field maturity to study field performance and genetic analyses of the selected materials. Soybean genotype Davis had shown the highest (76.73 cm) plant height, maximum number of branches (5.76) and highest number of pods plant^{-1} (47.63). The genotype Bragg was recorded having the least number of days to 50% flowering (51 days) and minimum days required to maturity (98.55 days). The maximum pod length (3.93 cm) was observed in DES-10 and maximum number of seeds pod^{-1} (2.90) was produced by the genotype G-2261.The genotype Mina Hai showed the highest seed weight (14.19 g) and highest seed yield (1211.10 kg ha^{-1}). In this study, among all the traits 100 seed weight (g) exhibited highest estimates of phenotypic co-efficient of variation (PCV) and genotypic co-efficient of variation (GCV) (32.40% and 31.86% respectively). The highest heritability was recorded for 100 seed weight (96.70) and the highest value of genetic advance was found in yield (447.76).The highest value in genetic advance as per cent of mean was found for the traits 100 seed weight (64.53%). Pod length and 100 seed weight had highly significant positive correlation with yield plant^{-1}**.** Based on Nei's (1972) genetic distance using Unweighted Pair Group Method of Arithmetic Means (UPGMA), Cluster II was from different origins and showed highest genetic distance (30.00), also isolated in the grouping. On the other hand, Cluster III was from same origin and showed the lowest genetic distance (2.00) contained same morphological characters such as days to flowering, plant height, pod length, number of seeds pod^{-1}. Net house assay upon sap inoculation facilitated determining the trend of AUDPC (Area Under Disease Progress Curve) under controlled condition. TBIA (Tissue Blot Immunoassay) was carried out using rabbit antiserum for SYMV that did not conflict with non target virus. No mismatch of TBIA was noticed with AUDPC or molecular assay. Younger leaves were collected from these infected plants and were used as source materials for molecular analyses. Three sets of SSR marker were used to detect the presence of gene(s) responsible for *Soybean yellow mosaic virus* resistance. BARCSOYSSR_13_1115, BARCSOYSSR_13_1119 & BARCSOYSSR_13_1173 primer sets were used for the confirmation of the desired genes in all 26 genotypes. The result indicated that the genotypes Mina Hai, G-2261,PB-1 and GC-83005-9 showed the presence of *Rsv1-h* gene which is reported to be indispensible for resistance against *Symv* capable of producing higher yield as compared to those of other genotypes tested. The four soybean genotypes having *Rsv1-h* gene might be mosaic virus resistant and could be used as source material for future advanced breeding purpose.

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Cucumber Mosaic Virus Resistance in Local Cucumber Genotypes for Vegetable Safety and Nutritional Security

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Abstract

Cucumber *(Cucumis sativus*), a nutritious vegetable is infected by a number of diseases and among them Cucumber mosaic virus disease takes a heavy toll infecting the plant at all stages of its growth reducing an unexpected yield loss causes vegetable shortage and malnutrition in Bangladesh. In this project, twenty six genotypes were collected from Bangladesh Agricultural Research Institute and different districts of Bangladesh for evaluating cucumber mosaic virus resistance, genetic potentiality, yield and yield contributing characters. For agronomic and molecular assays, cucumber genotypes along with the standard check were planted following RCBD with three replications at BAU-GPB farm. Net house assay upon white fly mediated inoculation facilitated determining the trend of AUDPC (Area Under Disease Progress Curve) under controlled condition. TBIA (Tissue Blot Immunoassay) was carried out using rabbit antiserum for CMV that did not conflict with non target virus. No mismatch of TBIA was noticed with AUDPC or molecular assay. Younger leaves were collected from these infected plants and were used as source materials for virus specific molecular analyses. Three sets of SSR marker were used to detect the presence of gene(s) responsible for *Cucumber mosaic virus* resistance. Affy4, IBP160 & cmvAFLP primer sets were used for preliminary assessment of those genotypes against cucumber mosaic virus. Among all, the genotypes Cu5, Cu10 and Cu15 gave the higher mean values of individual fruit weight, number of fruit per vine and also gave the higher yield and minimum viral infection as compared to the check variety Sosha5. On the other hand, the rest 23 genotypes gave moderate to poor performances in respect of yield and related traits. All the marker sets detected the absence of the responsive gene in most of the genotypes while detected the presence of the resistant gene in the genotypes Cu5, Cu10 and Cu15. Therefore, the genotypes Cu5, Cu10 and Cu15 were recommended as resistant to *Cucumber mosaic virus* having high yielding genetic potentiality.

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 etc. 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). A series of relevant experiments were carried out with the broad objective of development of potential corn varieties for resistance against major viruses through field assay, pathogenic tests and molecular marker aided

breeding. Maize plants were inoculated with viruses and symptoms were scored at 7, 10 and 14 dpi (days post inoculation) to calculate infection per cent which was adjusted after performing Tissue blot immunoassay (TBIA) and Area Under Disease Progress Curve (AUDPC). The field assay and crossing with the potential parental genotypes for obtaining maize hybrids were done accordingly. 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. The disease severity and the marker test indicated that BHM-7, BHM-15, V-92, Uttaran and Duranta carried *Wsm1/ Wsm2/ Wsm3* genes, but according to pathological test, functional resistance was observed for only BHM-7, V-92 and Uttaran on the basis of infection percentage and AUDPC score. BHM-7 (BARI Hybrid Maize 7), BHM-15, BHM-13, BHM-12 were noticed as the best one for showing resistance against MDMV/MCDV/SrMV and possibly carrying *Wsm* gene(s) need extensive assays.

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 indeed is a great barrier of crop production while salinity areas are expanding in Bangladesh and reducing the cultivable land. To increase oilseed production in saline soils, a useful tactic could be developing salinity tolerant mustard varieties. This study screened five promising advanced breeding lines of mustard along with a check variety (BARI Sarisha-14) for salinity tolerance. Two experiments were conducted to fulfil the study objectives. First experiment was conducted in lab condition with 6 rapeseed-mustard genotypes along with three salinity doses (control, 50 and 100 mM). The second experiment was conducted for morpho-biochemical evaluation and genetic analyses at the field laboratory of the Department of Genetics and Plant Breeding. The second experiment was executed following a split plot design (RCBD) with six genotypes (BD-6950, BAU shorisha-3), BD-7104, BD-10115, JUN-536, BJDH-12 and BARI Sarisha-14) and five salinity doses (control, 6, 8, 10 and 12 dSm^{-1}). A total of 16 morphological characters and five biochemical characters were studied in the experiment. Significant variations were accounted for the genotypes and treatments for all characters studied. A significant and positive correlation was found among seed yield $plant^{-1}$ and 1000-seed weight, number of seeds $siliquae^{-1}$, length of siliqua, total number of siliqua, length of primary branches. Genetic analyses revealed that some morphological and biochemical traits could be suitable indicators of salinity tolerance. All morphological characters except the number of secondary branches and length of siliqua showed high heritability (62% to 98%) which indicated that these characters can be selected for further improvement. Biochemical analysis showed high activity of APX, CAT and POD in genotype BD-7104 along with contrasting results for MDA H_2O_2 compared to the check variety BARI Sarisha-14. Principal component analysis revealed that days to first flowering and days to maturity were contrasting with other variables for salinity stress tolerance in genotypes BD-7104 (BAU shorisha-2) and BD-10115 (BAU shorisha-1) under 8 and 10 dSm^{-1} salinity levels. The genotype BD-7104 followed by BD-10115 and BD-6950 were the suitable salt tolerant genotypesunder salinity stress. Three varieties have been released from this project- BD-10115 (BAU shorisha-1), BD-7104 (BAU shorisha-2) and BD-6950 (BAU shorisha-3). Further research would be more useful for QTL mapping of salt tolerant traits and developing of new, improved and climate smart salt tolerant variety of oilseed *Brassica*.

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Proposition for Best Climate Smart Rice Varieties to Farmers Through an Effective Supply Chain for Ensuring Sustainable Agriculture

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Abstract
Rice is the main staple food in Bangladesh, consequently the major instrument to attain food security. Among the factors to get higher production, supply of quality seeds and cultivation of demand and location suitable varieties are the major concern. To address the factors, a total of 300 farmers comprising 100 each from three upazila *viz.* Sadar, Haluaghat and Gouripur of Mymensingh district were selected. Among the 300 farmers, 50 were female. Each farmer were delivered with 5 kg of seed of BAU Dhan-3, BRRI Dhan51, BRRI Dhan52, BRRI Dhan56, BRRI Dhan71, and Binadhan-11 & Binadhan-12 in Aman season and BRRI Dhan67 & Binadhan-10 in Boro season. Monitoring of all the activities related to quality seed production was done. Field days were conducted in every upazila in growing season. Participation of female farmers was ensured in all the activities. From the field performances of the supplied varieties farmers has chosen suitable rice varieties for aman and boro season. From the supplied seeds, farmers produced their own stock of seeds to grow in the next season, which will be supplied to their neighbouring farmers, and subsequently, to others among the villages. They will be able to keep the seeds for their own use and can sell the quality seeds to other farmers. In totality the project will be able to supply climate smart seeds to the farmers of all the three selected upazilla of Mymensingh district. Eventually the generated technology will also be available to other farm families of the country and thereby about 15 million farm families will be benefited.

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.

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Development of Drought Stress Tolerant Rice to Ensure Food Security of Bangladesh

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Abstract

Yield stability under drought stress condition is one of the major selection criteria for developing drought tolerant rice mutants conferring higher yield. An experiment was conducted during the period of July-December 2020 at three locations (Magura, Rangpur and Mymensingh) of Bangladesh to study the stability for yield and yield attributing traits under drought stress in selected ten rice mutants (M5 generation) developed from Binadhan-17, Nerica-4 and Galon through gamma irradiation including parents and checks. 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, these mutants can be used as stable lines adapted to drought stress in terms of yield for developing high yielding drought tolerant rice variety.

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.

Characterization of Rice Genotypes in Relation to Salt Tolerance Using Morphological, Biochemical and Molecular Analyses

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Abstract

Salinity is a major problem for rice production in the coastal regions of Bangladesh. This problem can be mitigated by developing salinity tolerance, high yielding rice genotypes. In our research, sixty local rice genotypes were collected from different coastal regions of Bangladesh. Peters Professional nutrient solution was used for hydroponic screening of the collected genotypes at seedling stage. The salinity treatments of 0 dSm-1, 08 dSm-1, 10 dSm-1, 13 dSm-1 and 15 dSm-1 were imposed. Based on morpho-physiological clustering and standard evaluation system (SES) scoring developed by IRRI, thirty genotypes showed different levels of salinity tolerance ability. Khoiramota, Pokkali, Jotai, Benapole, Ranisalute, Panbota, Vojon showed tolerance to 13 dSm-1 and Rajashail, Gotalia, Blockkhira, Mouthamota, Lalmatha, Holdegotal-2, Bohorimota, Morichshail, Hatibejor exhibited tolerance to 15 dSm-1. These 16 genotypes were further screened at reproductive stage including Binadhan-10 and Kalojira as tolerant and susceptible genotypes, respectively. Experiment was set using perforated pots filled with soil and 25 days old seedlings, placed in trays by using normal water. Before 7 days of booting, the same salt treatments were imposed for 14 days, and thereafter-normal water was kept in the trays until harvesting. Twelve genotypes were selected for biochemical analysis based on morphological and yield-attributing traits. The tolerant genotypes were characterized by the lower content of H2O2 and Malondialdehyde. Furthermore, five primers linked to Saltol QTLs were used for the molecular characterization of the selected genotypes. Based on SES scoring, morpho-physiological, biochemical, and molecular characterization; Rajashail, Gotalia, Bohorimota and Hatibejor exhibited tolerance level at 15 dSm-1. Whereas, Pokkali, Jotai, Benapole, Vojon, Morichshail survived at 13 dSm-1; Khoiramota, Mouthamota, Ranisalute, Panbota, Lalmatha at 10 dSm-1, and Blockkhira, Holdegotal-2 at 8 dSm-1. Rice variety tolerant to 15 dSm-1 might not been reported or released to date which could be used as an outstanding materials for future rice breeding.

SSR Marker Based Molecular Screening of Blast Resistance Genes in Rice

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Abstract

Rice blast caused by *Magnaporthe oryzae* is one of the most devastating disease causing major yield losses in every year worldwide. It had been proved that using resistant rice varieties would be the most

effective way to control this disease. Molecular screening and allelic diversity of major rice blast resistance genes were determined in forty-eight (48) genotypes of rice germplasms of Bangladesh with ten (10) previously synthesized gene based SSR (Single Sequence Repeats) markers [RM 541, RM 224, RM21, RM527, RM 208, RM 247,RM 72, RM 259, RM 246 & RM 206]. The genetic frequencies of ten (10) major blast resistance genes (*Pi-9, Pi-1, Pi-5(t), Piz-5, Pi-b, Pi-b, Pi-ta, Pi-33, Pi27(t), Pitp(t) and Pi-k^h*) were ranged from 4% to 93%. The blast resistance gene *Pi-k^h* was widely distributed (93%) among the selected genotypes. Out of forty-eight (48) genotypes, forty-five (45) genotypes occupied at least five (5) positive fragments of expected product size. Nine (9) genotypes had maximum eight (8) blast resistance genes and only one had minimum two (2) blast resistance genes. Allelic diversity was also found among the rice genotypes for different blast resistance genes. Among the SSR markers used, RM224, RM72 & RM206 can be used to screen blast resistant genotypes as showing distinct band in resistant and susceptible genotypes. Additionally, isolation of blast isolates from neck blast infected rice samples were also performed which showed that, blast isolates were successfully grown on the water agar, PDA (potato Dextrose Agar) and oat-meal agar medium and the conidia were also confirmed under microscope.

Genetic Analysis of Yield, Its Attributing and Fruit Quality Traits in Tomato

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Abstract

The tomato (*Lycopersicon esculentum* Mill.) fruit is one of the most popular as well as important commodities in the world. The present study was conducted to evaluate the genetic variability for yield, its attributing and biochemical traits using thirty eight (38) tomato genotypes. A wide range of variation was observed among the characters studied which have a great interest for tomato breeders. High to moderate heritability (60-90%) coupled with high genetic advance was observed for number of bunches/plant, total chlorophyll content, pollen fertility, titratable acidity (TA), soluble solid, ascorbic acid (Vit-C), lycopene and beta-carotene content, for those traits, phenotypic influence was negligible, indicating further improvement is possible using breeding approaches for those traits. Yield per plant was found highly significant and positively correlated with number of flower/bunch, fruit size and fruit weight. Beta-carotene content showed positive and significant correlation with soluble solid content in red fruit, titratable acidity and lycopene content; pH of fruit juice showed negative and significant correlation with titratable acidity. Principal component analysis (PCA) for biochemical traits showed that the first six principal components having eigen value more than one of the considered traits accounted for about 80% of the total variation, where only 45% variation was accounted for the first three components. Based on the mean performance, genotypes Tm-131 and WOP-10 for yield and ascorbic acid content; Puli-25, VI005584 and Tm-2 for total soluble solids; VI-063607, VI-0337183 for lycopene and beta-carotene content may be considered as superior genotypes, which can be used as potential genetic resources for the development of nutritional rich high yielding tomato variety.

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Phenotypic and Genetic Variability and Genetic Divergence in Lentil (Lens Culinaris Medik.) Germplasm

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Abstract
Lentil is a leguminous crop which plays important role in both human health and agriculture. Lack of genotypic and phenotypic variability limits the scope of breeding for developing high yielding lentil varieties. In order to know the genotypic and phenotypic variability and diversity in lentil, a research was carried out with 30 lentil genotypes following a randomized complete block design using three replications. Highly significant variability was found for all of the traits among the genotypes under study. The genotype ILL 4127 showed superior in performance whereas ILL 2894 showed poor in performance. The environment had great impact on the genotypes as the PCV (phenotypic coefficient of variation) was greater than the GCV (genotypic coefficient of variation). High PCV coupled with high GCV, heritability, genetic advance and genetic advance in percentage of mean was found for number of pods plant-1 and number of seeds plant-1. Thirty genotypes were divided into 5 clusters where cluster I and cluster V had the maximum inter-cluster distance, specifying the existence of wider genetic diversity among the genotypes of these clusters. Hence, suitable transgressive segregants might be found from crosses between genotypes of those clusters. Genetic diversity at molecular level was found 0.861 to 1.112 which indicated the existence of genetic variation within the studied genotypes. Microsatellite profiling revealed that SSR19 was the highly informative and detectable polymorphic marker followed by SSR48, SSR156, SSR33, SSR13 and SSR130. The results showed the consistency both in molecular and morphological clustering. The genotypes ILL 2894, ILL 3823, ILL 2764, ILL 3201, BM 680, ILL 2083, ILL 5103, ILL 4355, ILL 4707 and ILL 5844 were found as stable considering genetic variability and diversity under study. Therefore, these genotypes might be used as suitable breeding materials for developing advanced lentil varieties.

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.

Germplasm Enhancement and Genetic Purity for Biotic Resistance and Short Duration in Rapeseed and Mustard

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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 this research, new rapeseed-mustard genotypes were collected from domestic and international institutions to enhance germplasm collection. Further, genetic and multivariate analyses were conducted for 19 morphological characters of 48 rapeseed and mustard genotypes. Evaluation of oil content and fatty acid profiles were done for ten selected rapeseed and mustard genotypes. Significant genotypic variations were observed for all morphological characters except 1000 seeds weight. Days to 50% flowering, plant height, total number of siliqua per plant, number of seeds per siliqua, length of siliqua and days to maturity exhibited high broad sense heritability along with high genetic advance. Length of primary branches, number of primary branches, number of secondary branches, total number of siliqua per plant, number of siliqua per main axis and number of siliqua per primary branches had a significant and positive correlation with yield per plant. According to principal component analysis and cluster analysis, BARI Sarisha-9, BD-110455, BD-7113, BD-6954 and BD-6953 were the earliest genotypes and BD-10112, M-395 and M-119-5 were comparatively high yielding genotypes. The genotypes BD-6953, BD-6954, BD-10455, BD-10112 and BD-7113 had comparatively lower erucic acid and saturated fatty acid profiles that are regarded as better edible oil characteristics. This study also screened 248 oilseed *Brassica* genotypes under field condition to assess their *Alternaria* blight resistance. The selected genotypes and associated traits could be utilized for developing short duration, high yielding and edible quality rapeseed-mustard varieties.

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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.

Screening Wheat Genotypes for Drought Tolerance Based on Root Traits

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Abstract
Wheat is an important cereal crop in Bangladesh. Currently this crop is suffering from a recurrent abiotic stress, drought at the reproductive stage. A little attention has so far been paid towards mitigation and preparedness of droughts due to its complexity. Polyethylene glycol (PEG) treated hydroponic conditions create negative osmotic potential which is comparable to moisture deficit stress. The main objective of this study was to investigate the effects of PEG 6000 induced low osmotic stress on morphological traits, root and root hair morphology of 22 wheat varieties. Two experiments were conducted to measure the detailed developmental pattern of both seminal and adventitious roots of hydroponically grown wheat plants under two different level of PEG-6000: 0% and 10%. Median values of leaf injury scores after fifteen days of 10% PEG treatment at the vegetative stage indicated that treated leaves from first youngest leaf to the fifth oldest leaf were injured significantly compared to control (0% PEG). PEG stress significantly reduced percent germination, plant height, number of live leaves and chlorophyll content of the leaves. Measurements related to seminal root development was carried out at 15 days after PEG treatment. PEG stress significantly increased total number of roots per plant; main axis length and diameter; length, diameter and density of both first and second order laterals. Density of root hair at main, first order laterals and second order laterals were increased significantly under 10% PEG treatment compared to control. Biochemical analyses were conducted with two tolerant and two susceptible varieties based on root response to osmotic stress. Principal component analysis revealed response of root traits of tolerant wheat varieties under osmotic stress. Correlation study revealed the significant relationships among root, root hair and biochemical traits. BARI Gom 24 found to have better performance in root capacity development along with root hairs for drought tolerance followed by BARI Gom 25, BARI Gom 32 might be considered as drought tolerant variety whereas Kalaysona followed by Sonora-64 found to poor performing against drought stress. Evolved information of this research could be exploited for developing drought tolerant cultivars of wheat.

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 Strengthening of Haor Farmers in Resource Management for their Livelihood Improvement

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Abstract

The main objectives of the study were to determine the extent of need for capacity development of haor farmers in managing their resources for their livelihoods improvement and to identify the training needs and provide training to the respondents. The study was conducted in Niklee (Kishoregonj) and Mohangonj (Netrokona) Upazila. Two hundred haor farmers were interviewed (100 from each upazila) through personal interview using a structured questionnaire. Need for capacity development of haor farmers in managing their resources for their livelihoods improvement was the focus variable. A four-point rating scale was used to measure the focus variable while four options were "high", "medium", "low" and "no" need and the corresponding scores were 3, 2, 1 and 0, respectively. Both descriptive and inferential statistics were used to analyze the collected data. The finding indicates that most of the haor farmers had the highest extent of need for capacity development but none of them were belong to low extent of need for the same. Besides, Majority of the respondents had low to medium participation in the activities of resource management. Twenty three training needs identified and eight capacity building training were organized with 200 farmers in both sites. Seven factors named named age, farming experiences organizational participation, extension media contact; coping ability, food security and knowledge were identified as influential variables for the same. Lack of training and lack of good governance, sudden flood were the top problems in rank order. Concern authorities especially Department of Agricultural Extension (DAE), Department of Fisheries (DoF) and Department of Livestock Services (DLS) should take initiatives for instance frequent training, non-formal education, arraigning motivational tour, providing credit, inputs, transport, and market facilities etc. to fulfill the identified needs.

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Training Needs Identification and Capacity Building of Farmers on Organic Vegetable Cultivation: An Empirical Study

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Abstract
Rice farming is currently a non-profitable enterprise for farmers due to an increase in the cost of production compare to the stagnation of rice yield. Organic farming is considered as a production system that maintains soil health, ecosystems, and human health which aims at social, environmental and economic sustainability. The objectives of the project were: identify training needs of farmers regarding organic vegetable cultivation (OVC); ii. build capacity of farmers on OVC; iii. explore the factors that may influence upon capacity building of farmers; and iv. identify the constraints faced by the farmers about OVC. A total of 200 vegetable growers from four villages of Islampur and Karimganj upazila under Jamalpur and Karimgonj Kishoregonj districts were considered as the population of the project. Data were collected using semi-structured interview schedule through face-to-face interview and focus group discussions to get information about farmers' training needs of OVC. The majority (78%) of the vegetable growers confessed the excessive use of agrochemicals especially pesticides while an overwhelming majority (92%) of them were reported with very high need of training concerning 'judicious use of pesticides'for vegetables cultivation. 'Appropriate ways of land preparation' and 'right quantity of fertilizer applications' were reported by a significant proportion (81%) of growers. For building capacity, a total of 8 training programs were conducted involving 200 vegetable growers in study areas. 'Level of education', 'extension contact' and 'use of ICTs' had very strong influence upon capacity building of vegetable growers while, "lack of availability organic fertilizers", "low yield", and "chemical fertilizers and pesticides are more easily available" were identified as the major constraints regarding OVC. From FGD, it was reported that though the level of awareness about organic farming was low, both farmers and consumers were aware of the toxic effect of chemical fertilizers and pesticides.

Identification of Training Need and Capacity Building of Farmers on Organic Vegetable Cultivation: An Empirical Study

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Abstract
The study attempted to identify training needs and build capacity of farmers regarding organic vegetable cultivation. Due to an increase in the cost of production compared to the stagnation of rice yield, rice farming is currently a non-profitable enterprise for farmers. Organic farmingis considered as a production system that maintains soil health, ecosystems, and human health which aims at social, environmental and economic sustainability and animal welfare by minimizing the use of external resources, maximizing the use of locally-derived renewable resources.The major objectives of the project are: identify the training need of farmers regarding organic vegetable cultivation; ii. build capacity of farmers on organic vegetable cultivation; iii. explore the personal and socio-demographic factors that may influence upon capacity building of farmers; iv. identify the constraints faced by the farmers in relation to organic vegetable cultivation. A total of 200 vegetable growers from four villages under Islampur upazila under Jamalpur district and Karimgonj upazila under Kishoregonj dictrict were

considered as the population of the study with whom the project activities are conducted. Data were collected using semi-structured interview schedule through face-to-face interview and focus group discussions to get information about farmers' training needs of vegetable cultivation using organic technique. The majority (78%) of the vegetable growers confessed the excessive use of agrochemicals especially pesticides for vegetables cultivation. In addition, an overwhelming majority (92%) of them were reported with very high need of training concerning 'judicious use of pesticides'for vegetables cultivation. The aspects such as 'appropriate ways of land preparation' and 'right quantity of fertilizer applications' were reported by a significant proportion (81%) of growers. For building capacity, 8 training programs so far been conducted involving 200 vegetable growers in study areas. The factors such as 'level of education', 'extension contact' and 'use of ICTs' had very strong influence upon capacity building of vegetable growers. Among the constraints, "lack of availability organic fertilizers", "though the quality of vegetable produced organically is better, the total production is lower than modern farming", and high yielding seeds, chemical fertilizers and pesticides are more easily available" were identified as the major constraints regarding organic vegetable cultivation. From FGD, it was reported that though the level of awareness about organic farming was low, both farmers and consumers were aware of the toxic effect of chemical fertilizers and pesticides.

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.

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.

Arsenic in the Food Chain: Problems and Perspectives of Local Farming Communities in India and Bangladesh

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Abstract

For the survey, 200 participants were selected from two arsenic affected districts (Faridpur and Chandpur) covering three Upazilas (sub-districts) such as Faridpur Sadar and Bhanga Upazila and Chandpur Sadar Upazila (from now on referred to as BD dataset). Surveys were conducted during May-July 2019 in WB and August-September 2019 in BD. High levels of arsenic in drinking water and food materials continue to pose a global health challenge. Over 127 million people alone in Bangladesh (BD) and West Bengal (WB) state of India are exposed to elevated levels of arsenic in drinking water. Despite decades of research and outreach, arsenic awareness in communities continue to be low. Specifically, very few studies reported arsenic awareness among low-income farming

communities. A comprehensive approach to assess arsenic awareness is a key step in identifying research and development priorities so that appropriate stakeholder engagement may be designed to tackle arsenic menace. In this study, we developed a comprehensive arsenic awareness index (CAAI) and identified key awareness drivers (KADs) of arsenic to help evaluate farmers' preferences in dealing with arsenic in the environment. The CAAI and KADs were developed using a questionnaire survey in conjunction with ten machine learning (ML) models coupled with a hybrid feature selection approach. Two questionnaire surveys comprising of 73 questions covering health, water and community, and food were conducted in arsenic-affected areas of WB and BD. Comparison of CAAIs showed that the BD farmers were generally more arsenic-aware (CAAI = 7.7) than WB farmers (CAAI = 6.8). Interestingly, the reverse was true for the awareness linked to arsenic in the food chain. Application of hybrid feature selection identified 15 KADs, which included factors related to stakeholder interventions and cropping practices instead of commonly perceived factors such as age, gender and income. Among ML algorithms, classification and regression trees and single C5.0 tree could estimate CAAIs with an average accuracy of 84%. Both communities agreed on policy changes on water testing and clean water supply. The CAAI and KADs combination revealed a contrasting arsenic awareness between the two farming communities, albeit their cultural similarities. Specifically, our study shows the need for increasing awareness of risks through the food chain in BD, whereas awareness campaigns should be strengthened to raise overall awareness in WB possibly through media channels as deemed effective in BD.

Zinc and Iron Enrichment in Lentil-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.

Effects of Sulphur and Zinc on the Physiological and Biochemical Parameters and Seed Yield of Chickpea

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Abstract
An experiment was carried out at Bangladesh Agricultural University Farm, Mymensingh during *rabi* season from November, 2019 to March, 2020 to study the effects of different levels of S and Zn from gypsum and zinc sulphate fertilizers on the physiological and biochemical parameters, seed yield, S and Zn contents of chickpea cv. BARI Chola-5. It was a two factor experiment where 3 levels each of S (0, 15 and 30 kg ha^{-1}) and Zn (0, 1 and 2 kg ha^{-1}) were used following RCBD with three replications. Both the levels of S and Zn significantly influenced the yield contributing characters, grain and stover yield of chickpea. The highest plant height, number of branches, pods and seed $plant^{-1}$, total leaf area, seed and stover yield, total sugar, protein, S and Zn contents were obtained from 30 kg S ha^{-1} but the highest 100 seed weight and total chlorophyll content were found @ S_{15} treatment. Zinc application @ 2 kg ha^{-1} gave the tallest plant, highest 100 seed weight, seed and stover yield, total leaf area, protein, S and Zn content. On the other hand, branch, pod and seed number $plant^{-1}$ were maximum when Zn was applied @ 1 kg ha^{-1}. The interaction effects of different rates of S and Zn also showed significant influence on different parameters of chickpea. The highest yield attributes, grain and stover yield were obtained from the combine treatment of S and Zn @ 30 and 1 kg ha^{-1}, respectively. But the highest leaf area, total chlorophyll content and total sugar content, protein, S and Zn contents were obtained from their highest additions. Considering yield attributes, grain yield, physiological and biochemical parameters, it can be suggested that S @ 30 kg ha^{-1} from calcium sulphate and Zn @ 2 kg ha^{-1} from zinc sulphate can be used for increasing yield and obtaining high quality chickpea.

Nutritional, Medicinal and Cosmetic Compounds of Aloe vera as Influenced by Integrated Application of Inorganic Fertilizers and Organic 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 ares 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 cow dung (CD) 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 cow dung (CD) @ 40 t ha^{-1}. Eight treatment combinations

were used following RCBD with three replications. Integrated applications of IF and CD exerted significant influence on all plant and soil parameters. The highest plant height (48.20 cm), leaf number (20), leaf area (333 cm^2 $plant^{-1}$), number of suckers (11.33 $plant^{-1}$) and leaf biomass yield (22.67 kg $plot^{-1}$) were obtained when 75% CD was applied along with 25% IF. The macronutrients (N, P, K, and S) of the leaves were highest @ $IF_{85}CD_{15}$ treatment but other nutrients (Ca, Mg, Fe, Mn, Zn, Na, and Cu) were highest @ $IF_{10}CD_{90}$ treatment. The chlorophyll concentration (3.41 mg g^{-1} of fresh weight of leaf), total phenolic compounds (29.35 mg QE $100g^{-1}$ FW), aloin concentrations (494 mg kg^{-1}) and total flavonoid content (22.61 g QE 100 gdw^{-1}) of the leaves were highest when 100% CD was applied. Integrated application of IF and CD significantly improved soil fertility. The organic matter content of the soil increased with the increase of CD. All the macronutrients (N, P, K, S, Ca, and Mg) and micronutrients (Zn and B) of the post-harvest soil were highest with 100% CD treatment. Farmers may be advised to apply 25% IF and 75% CD for producing higher yield and better quality *A. vera* maintaining soil fertility.

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.

Assessment of Major Biochemical and Mineral Constituents in Commonly Consumed Jujube Varieties of Bangladesh

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Abstract

A study was conducted to determine major biochemical and mineral constituents in commonly consumed jujube varieties of Bangladesh. A total of 15 varieties of matured jujube fruits were collected

from the local markets and area of Mymensingh, and analyzed for this study. The study results revealed that all studied physical properties were lower in local/deshi sour varieties of jujube, and *BAU Kul* contained the maximum amount of flesh (edible part of fruits) along with flesh and seed ratio. Among the biochemical properties- titratable acidity, vitamin-C, chlorophyll-a, chlorophyll-b, total sugar and reducing sugar content varied from 0.178-2.769%, 33.28-98.63 mg/100 g flesh, 0.0019-0.0174 mg/g tissue, 0.0007-0.0148 mg/g tissue, 2.50-9.83% and 0.135-4.15%, respectively. The study results revealed that local varieties contained comparatively higher vitamin-C and lower total sugar content. Among the mineral elements, the content of Ca, Mg, Na, K, P and Su in jujube varieties ranged from 0.040-0.233%, 0.071-0.164%, 0.054-0.189%, 0.490-2.602%, 0.062-0.234% and 0.079-0.359%, respectively. The study results concluded that biochemical and mineral contents in jujube fruits changed with the varieties, which would allow breeders to improve the quality of cultivars.

Heavy Metal Accumulation and Health Risk Assessment in Vegetables Irrigated with River Water Polluted Through Industrial Effluent

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Abstract

An experiment was conducted at the laboratory of the Department of Agricultural Chemistry, Bangladesh Agricultural University, Mymensingh to determine the possible health risk by heavy metal through consuming vegetables grown in Khiru river bed of Bhaluka upazilla, Mymensingh. In November 2019, a total of 30 river water and mustard vegetable samples were collected from Khiru river bed of Bhaluka upazilla of Mymensingh district following the sampling techniques. The plant extract were prepared by wet oxidation method using di-acid mixture. Metallic constituents like Ca, Mg, K, Na, Fe, Mn, Zn, Cu, Cd, Cr and Pb were determined following standard methods. The estimated daily intake (EDI) of heavy metals was determined based on both the metal levels in crops and the amount of consumption of the respective food crop. The health risks to local inhabitants associated with the intake of Cd, Cu, Ni, Co, Pb, Zn and Cr through the consumptions of wastewater-irrigated mustard are established based on Target Hazard Quotients (THQs). The THQ is a ratio of determined dose of a pollutant to a reference dose level. If the ratio is less than 1, the exposed population is unlikely to experience obvious adverse effects. The daily metals intakes (DMI) were estimated and compared with the upper tolerable daily intakes (UTIL) for metals. It was revealed from the study that all the heavy metals in mustard vegetables were lower than upper tolerable intake level. However, Zn, Pb and Cr content in mustard vegetable samples exceeded oral reference doses (RfD). The THQ values of Zn for female is 1.50, which implies that the exposed population is in a level of concern interval. Combined target hazard quotient (CTHQ) of heavy metals in mustard vegetable samples for male and female is 1.46 and 2.29, respectively. Consumers of mustard vegetables grown in Khiru river bed of Bhaluka area are in a level of concern interval for health risk of heavy metal. Necessary action should be taken to minimize the health risk through reducing pollution of the river.

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Management of Wheat Blast with Synthetic Silicate Supplements and Fungicides

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Abstract
Wheat (*Triticum aestivum* L.) is considered the second most important cereal crop because of its easier cultivation, higher nutrient content and ecological suitability in Bangladesh. The first occurrence of wheat blast disease in Bangladesh in February 2016 was the biggest shock for wheat cultivation. A pot experiment was conducted to evaluate the effectiveness of three fungicides of different groups along with potassium silicate and ash of rice husk in managing wheat blast. The experiment was conducted at BINA Headquarters Farm, Mymensingh, during the winter season of 2019-2020. A completely randomized design was followed with three replication. The fungicides viz. Nativo 75WP (Tebuconazole 50%+ Trifloxystrobin 25%), Filia 525 SE (Propiconazole 12.5%+ Tricyclazole 40%), and Trooper 75WP (Tricyclazole 75%) were tested. The treatments were T0 = Control; T1 = Nativo; T2 = Filia ; T3 = Trooper; T4 = Nativo + Si; T5 = Filia + Si; T6 = Trooper + Si; T7 = Nativo + Ash; T8 = Filia + Ash; and T9 = Trooper + Ash. Total twenty five seeds of BARI Gom-26, a susceptible wheat variety, were sown in each pot on November 30, 2019, and at five days after seedling emergence, each pot was thinned to fifteen seedlings. The recommended dose of fertilizers were used and irrigation was done as and when necessary. The inoculum of blast (*Magnaporthe oryzae*) was collected from blast hotspot of Meherpur district and inoculated on the plant canopy. The fungicides were sprayed twice; first one at 50 and second one at 60 Zadok growth stage. Percent disease severity was scored as percent infected spike and percent disease area on spike based on 0-100 scale. Data on grain yield and 1000 grain weight per pot were recorded. All of these fungicides were found effective in controlling the disease as compared to control. Among them, Nativo 75WG along with potassium silicate spray was found very effective in controlling wheat blast with least disease incidence (6.76%) and severity (3.11%). In contrast, Trooper without silicon spray showed the highest percentage of disease incidence and severity (33.03% and 19.61%), next to control (93.75% and 100%). The highest WTS (Weight of 1000 seeds) of 51.1 g was obtained from Nativo 75WG, and potassium silicate spray followed by Trooper without silicon spray.

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.

Detection and Management of Mycotoxin Contamination in Poultry Feeds and Products

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Abstract

Mycotoxin contamination in poultry feeds is one of the most serious emerging threats for the poultry industry and food safety in Bangladesh. To detect the presence of mycotoxinogenic fungi population in poultry feeds, feed samples were collected from Mymensingh, Gazipur and Chattogram district. The Average moisture content in collected poultry feed samples was 8%. 20% samples were found without contaminations. 50% samples contaminated with 3 to 5 isolates. However, higher moisture contents were not always related to higher fungal contamination. One third of contaminated sample tested have total aflatoxin above the maximum allowable level. The antifungal activity of some natural feed additives against selected fungal isolates revealed that 2-5% turmeric and 0.5% Bixa food colour have promising antifungal activity for mycotoxin management in poultry feeds. The findings of this research will help the policy makers to take initiatives to monitor these commodities periodically and evolve policies to discourage the marketing of mycotoxin-contaminated feeds.

Proximate and Mineral Composition of Bt and Respective non-Bt Brinjal (Solanum Melongena L) Cultivars in Bangladesh

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Abstract

Brinjal (Solanum melongena L.) is a very popular vegetable in Bangladesh. Brinjal Fruit and Shoot Borer (Leucinodes orbonalis) is a serious pest of brinjal causing 50 to 70% damage and require 25 to 80 sprays of harmful and expensive insecticides to control. Bt brinjal is a trangenic brinjal expressing crystal protein gene (Cry1Ac) from Bacillus thuringiensis bacteria to fight against Brinjal Fruit and

Shoot Borer. Bt brinjal is cultivated by the Bangladeshi farmers for the last five years with varying degree of adoption and success. To study the nutritional quality of Bangladeshi Bt brinjal cultivars comparing with their respective non-Bt varieties, pot experiment with similar cultural practices was conducted in the net house of the Department of Agricultural Chemistry, Bangladesh Agricultural University, Mymensingh. Seeds of four Bt brinjal cultivars viz. BARI Bt Brinjal 1 (Uttara), BARI Bt Brinjal 2 (Kajla), BARI Bt Brinjal 3 (Nayantara) and BARI Bt Brinjal 4 (ISD006) and their respective non-Bt brinjal cultivars viz. BARI Brinjal 1 (Uttara), BARI Brinjal 4 (Kajla), BARI Brinjal 5 (Nayantara) and BARI Brinjal 6, respectively were collected from Bangladesh Agricultural Research Institute, Gazipur. The proximate compositions (% moisture, % crude fiber, % crude protein, % crude fat, % ash and % carbohydrates) and mineral compositions (N, P, K, Ca, Mg, S, Fe, Zn, Cu and Mn) of brinjal fruit samples were analyzed from Bt and respective non-Bt brinjal cultivars growing in pot experiment. Proximate compositions and mineral nutrient contents were significantly varied with the genotypes. However, no significant difference was found among the Bt and respective non-Bt cultivar. These variation among the genotypes suggested that different brinjal genotypes are different in nutritional composition. However, no variation among Bt and respective non-Bt brinjal cultivars suggesting the expression of Bt gene in genetically modified Bt brinjal is not hampering the nutritional composition.

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.

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Jackfruit Seed Flour Supplementation Attenuates High Sugar Diet-induced Hyperphagia and Hyperglycemia in Mice

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Abstract

The prevalence of obesity and other metabolic syndromes are 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 jackfruit seed flour supplementation on the development of metabolic syndromes. Three diet paradigms were selected for this experiment- Normal diet (control), 20% sucrose (HSD) and 20% sucrose & 20% jackfruit seed flour (HSD+JSF). The food intake, body weight, blood glucose, organ weight, and blood lipid profile were measured and the feeding experiment was continued for a period of 8 weeks. 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 group at the 6th to 8th week of the treatment. The body weight gain in HSD+JSF mice was statistically insignificant with the control group but significant with the HSD group. Jackfruit seed flour supplementation significantly attenuated HSD-induced hyperglycemia. However, no significant difference was found in total cholesterol, triglycerides, HDL- cholesterol, and LDL- cholesterol in the blood. An increased dose of JSF may have a beneficial effect on blood lipid profiles that need to be tested. Overall, jackfruit seed consumption could play a crucial role in the management of metabolic disorders caused by high sugar diets.

Cassava Fiber Supplementation Improves Glucose Tolerance and Counteracts the High Sugar Diet-induced Metabolic Disorders

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Abstract

Metabolic syndrome is a burgeoning global problem that has increased in urban populations of developing countries. The worldwide prevalence of metabolic diseases is on the rise. According to some epidemiological studies, metabolic syndromes like diabetes and obesity are highly prevalent in Bangladesh and have increased dramatically in the last few decades. Consumption of various sugary foods is preferred by both traditional and modern societies which have been reported to accelerate the development of diabetes and obesity. Diets that are rich in dietary fiber are reported to have substantial health benefits. The remarkable beneficial effects of a fiber-rich diet are prevention of obesity, improved glucose levels, and control of blood lipid profiles. Root or tuber crops like cassava are good sources of dietary fiber. Therefore, we designed this experiment to measure the potentiality of cassava

fiber (CF) in modulating physiological parameters that are related to metabolic syndromes. Swiss Albino male mice were fed with a diet containing 25% cassava fiber (CF) in supplementation with or without 25% sucrose for a period of 24 days. Cassava fiber supplementation gradually reduced food intake in comparison to the high sugar diet (HSD) group. No significant difference was observed in daily water intake among the groups during the experiment. Supplementation of CF decreases body weight as compared with the HSD group. Cassava fiber improved the glucose tolerance and the area under the curve was significantly decreased in comparison to HSD-fed mice. However, no significant difference was found in serum cholesterol, triglycerides, and HDL-cholesterol among the groups. But, the LDL-cholesterol was significantly lower in comparison to other groups. Therefore, we concluded that cassava fiber could effectively sustain a normoglycemic state as well as body weight and food intake against the development of diabetes and obesity caused by HSD.

Exogenous Selenium Alleviates Salt Stress in Rice Seedlings by Improving Growth and Antioxidant Defense

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Abstract

Salinity is one of the major constraints for cultivation of rice (*Oryza sativa* L.) at the world level, as rice is highly susceptible to the salinity than other cereals. In order to elucidate the mechanism to improve salinity tolerance by selenium (Se), we analyzed the morphological characteristics and biochemical features including antioxidant enzymatic activity of salt-stressed rice at germination and seedling stages of BRRI dhan29 as salt-sensitive variety. Salinity inhibited seed germination and growth of rice seedlings, which could be attributed to reduced shoot and root growth, decreased photosynthetic pigments, increased hydrogen peroxide (H_2O_2) accumulation, and elevated levels of lipid peroxidation measured as malondialdehyde (MDA). Under salt stress condition, Se increased the germination percentage and accelerated shoot growth but did not the root growth. Application of Se at 1μM displayed amplified chlorophyll content, as well as suppressed the accumulation of H_2O_2 and diminished levels of MDA contributing to oxidative damage protection. Moreover, the defensive role of Se counter to oxidative stress was connected with the elevated activities of antioxidant enzymes such as catalase (CAT), peroxidase (POX) and ascorbate peroxidase (APX). Our results suggests that exogenous application of Se rendered the plants more tolerant to salt stress-induced oxidative damage by enhancing their antioxidant defense systems.

In vitro Screening Followed by Molecular Confirmation for Drought Tolerance Among Popular Potato Cultivars in Bangladesh

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Abstract

Introduction: Potato (*Solanum tuberosum* L.) is one of the most important vegetables in the Bangladesh. Production of potato hinders due to many abiotic stresses; among them drought stress is the most critical one. The crop has a high-water demand and is sensitive to drought stress. The present study was conducted to screen for drought tolerance among sixteen (16) germplasms of potato such as

CIP-101, CIP-102, CIP-111, CIP-126, Cardinal, Diamant, BARI ALU -17, BARI ALU -72 , BARI ALU- 73, Lal sheel, Dohazari and to examine their physiological response under *in vitro* condition at different level of drought stress induced by sorbitol followed by molecular confirmation.
Methodology: Stem cuttings from *in vitro* grown potato plantlets were used as explant for *in vitro* screening experiment. Drought stress was induced by adding four different concentrations of sorbitol (0, 40, 60, 100 g/L) to Murashige and Skoog medium. Data were recorded on number of shoots, shoot length, number of leaves, number of roots and root length. The sixteen (16) potato germplasms differed significantly in response to drought stress for different parameters. The cultivar BARI Alu-17, BARI Alu-72, BARI Alu-73, CIP-126, Cardinal and Sheel bilatee showed comparatively more drought tolerance for all the parameters studied. Molecular study was also performed to check the presence of drought stress mitigating factor *ER2*4.
Findings: The sixteen (16) potato germplasms differed significantly in response to drought stress for different parameters. The cultivar BARI Alu-17, BARI Alu-72, BARI Alu-73, CIP-126, Cardinal and Sheel bilatee showed comparatively more drought tolerance for all the parameters studied. CIP-117, CIP-124, Lal sheel, Ruma, Dohazari showed susceptible characteristics against different levels of drought stress. Molecular study using drought stress mitigating factor *ER2*4 specific primer revealed that all the germplasms except CIP 117, CIP 124, Ruma and lal sheel showed the presence of *ER24* in the genotype which is a clear reflection of *in vitro* screening study.
Conclusion: The results of this study can be utilized as a selection indicator for potato breeding programs and used as a baseline for improvement of potato cultivars 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.

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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
During the period July 2019 to June 2020 different winter and summer vegetables were cultivated under fruit (malta, guava and mango) and medicinal (amloki, horitoki and bohera) tree-based agroforestry system in charland ecosystem. Performance of multi-storeyed agroforestry system in charland ecosystem also evaluated in this study period. During winter season spinach, red amaranth, mustard, radish, turnip, carrot and in summer season Indian spinach, kangkong, jute as leafy vegetable, stem amaranth was used as crop component of this study. Growth and yield of all winter and summer vegetables were observed in association with both fruit and medicinal tree species. It was found that performance of all winter and summer vegetables significantly influenced by different fruit and medicinal tree species. In association with fruit tree species yield reduction range was 18 – 38 % where highest yield reduction was under guava tree species and lowest under mango tree species. In combination with medicinal tree species yield reduction range was 20 – 35 % where highest yield reduction was under Horitoki tree species and lowest under amloki tree species. By considering the yield of 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. Under multistoried agroforestry system, eight years old lombu (*Khaya anthotheca*) tree was used as silvicultural component at the upper layer, ginger, panchamukhi kachu and turmeric as root crops were cultivated at the ground layer, papaya plant was in between the lombu trees at the second layer, Chui jhal (*Piper chaba*) as vine crop on the lombu tree at the third layer. As evidence from the results of this experiment it was found that LER of all crop combinations were more than one which indicate all of these multistoried agroforestry practices will be profitable for char-based farming system.

Estimation and Evaluation of Genetic Diversity in Mango (*Mangifera indica* L.) Using Microsatellite DNA Marker

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Abstract
Mango (*Mangifera indica* L.) is an important and popular fruit of Bangladesh belonging to the family Anacardiaceae. Knowledge of intra-specific genetic variation in mango genotypes is an imperative step for developing coherent strategies for future gain in its productivity, conservation, utilization and improvement. This study was therefore, conducted to determine intra-specific genetic diversity in mango genotypes of Bangladesh using microsatellite DNA marker. To do this, so far 48 genotypes of mango in which 25 from Bangladesh Agricultural University Germplasm Center released varieties (BAU AAM 1-25), 12 from Bangladesh Agricultural Research Institute released varieties (BARI AAM 1-12), and 11 popular local genotypes such as Common Fazli, Surma Fazli, Chini Fazli, Nag Fazli, Langra, Harivanga, Khirsa Pati, Ashini, Amrupali, Dashehari and Neelum from regional horticulture

research centre, Chapainawabgonj district were collected. Initially our microsatellite loci were analyzed to investigate DNA level variation in 25 BAU-GPC released varieties and three other genotypes viz., Amrupali, Dashehari and Neelum. Differences were found in observed number of alleles, heterozygosity and proportion of polymorphic loci among the genotypes. Total 33 alleles were amplified from 4 loci (MMCT35, LMMA7, MiIIHR30, MMCA268) where all the loci were polymorphic in nature and overall polymorphism was found 100%.The average number of alleles per locus was 8.25. The allele size ranged from 139 to 248 bp. Average observed heterozygosity was 0.73 among the 28 mango genotypes. Average genetic differentiation was 0.55 and gene flow (Nm) was 0.20 which indicates a high level of genetic variation among genotypes. The highest genetic distance value (3.35) was found between BAUAAM 2 and BAUAAM 4 that proved their high genetic dissimilarities. Genetic distance based on UPGMA dendrogram separated 28 mango genotypes into two clusters where 14 are in one cluster and remain 14 in another cluster. Dendrogram also showed strong genetic relation with morphological characters of the genotypes. This wide range of genetic distances among mango genotypes can help develop new variety through selective breeding program. To make conclusive remarks, all other genotypes will be subjected to microsatellite DNA analysis using more polymorphic loci.

Screening for Aphid Resistance in Country Bean (*Lablab purpureus* L.) Through Morpho-molecular Markers

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Abstract
Country bean is a major source of plant protein. Fifty one country bean genotypes were evaluated for genetic diversity for aphid resistance. Two field experiments were conducted during 2018-2019 and 2019-2020, respectively. The genotypes showed color variations in leaf, stem, vein, standard petal, wing, keel, flower bud, pod and dry seed. Variations were also observed in pod curvature, constriction and surface, leaf length, leaflet width and length, seed shape and size, pod beak position and orientation. Shannon diversity index ranged from 2.485 to 3.932. Genotypes are grouped into 7 clusters by K-means clustering. Variations were recorded in days to first flowering, number of inflorescences per plant, number of buds per raceme, raceme length, pod length, pod breadth, individual pod weight, number of pods per plant, pod yield per plant, number of seed per pod and hundred seed weight (15.74 to 33.97 % phenotypic coefficient of variation). PCA analysis showed that the first 4 axes had an Eigenvalue higher than 1 and represent about 73% of total variability or dispersion. Field screening of 51 country bean genotypes revealed that 30 showed moderately tolerance to aphids. These thirty genotypes were evaluated for aphid resistance in the net house by the artificial infestation. Sixteen genotypes showed tolerance based on their phenotypic characters and scale of infestation. Molecular characterization in 51 genotypes was conducted using 11 Simple Sequence Repeat markers (SSR) by denaturing polyacrylamide gel electrophoresis. The polymorphic information content (PIC) ranged from 0.25 to 0.97 with an average of 0.73 per locus. Primer BMD-12, AF067417, and PVAG-004 were found to be the best SSR markers to detect genetic differences between country bean genotypes. Major Allele Frequency ranged from 0.07 to 0.86 with an average of 0.45. Gene diversity extended from 0.25 to 0.97 with a mean of 0.74. Genetic relatedness among the population was investigated using the Jacard coefficient and Unweighted Pair Group Mean Analysis (UPGMA) algorithm. Finally, linked markers will be used to select country bean genotypes resistance to black bean aphid for confirmation of this result.

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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.

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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.

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.

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 events and temperature, relative humidity and sunshine hours have been analyzed from July to June for 1975-2014. Cyclone data were obtained from BMD; DPC of AIT; and BBS. Principal Component Analysis (PCA) and Clustering was used to find out the temperature (^{0}C) variations mostly responsible for the formation of cyclone in last 40 years, and NCEP–NCAR reanalysis data were used to find out the distribution of temperature anomaly over Bangladesh and Bay of Bengal. Among the 22 extreme cyclones in last 40 years, classified cluster 1 belongs only 1 cyclone when the temperature was about 42^{0}C which indicates too hot condition on that particular day. It is also visible from the synoptic feature that there was a formation of relatively warmer zone (positive anomaly) near to surface level in the southern part of Bangladesh. Again cluster 2 belong 9 cyclones those were occurred when the temperature was about 34^{0}C. In case of cluster 3, rests of the 12 cyclones were grouped when temperature was about 35^{0}C. Therefore, cluster 2 and 3 indicates that temperature of about 34^{0}C to 35^{0}C were mostly responsible for the formation of total 21 cyclones in past 40 years. For the clusters 2, and 3, existence of a relatively cooler zone (strong negative anomaly) near to surface level was also evident. At the same time, the upper atmosphere at 850hPa, 700hPa, 500hPa, and 300hPa level was dominated by the development of relatively warmer zone (strong positive anomaly). The larger warmer air mass at upper atmosphere could create profound influence to develop huge instability throughout the whole atmospheric column and may led to the genesis of extreme weather phenomenon like severe cyclones in Bangladesh's coastal areas.

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.

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.

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Agrometeorological Indices for Predicting Growth and Yield of Chickpea under Varing Thermal Regimes

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Abstract

Field experiment was conducted during 2019-2020 at Bangladesh Agricultural University, Mymensingh for characterization of thermal environment for growth and yield optimization in chickpea under different thermal regimes. Four temperature regimes (D1=November 5, D2=November 20, D3= December 5 and D4 = December 20) with three chickpea cultivars (V1 = BARI Chola 5, V2 = BARI Chola 10 and V3 =BARI Chola 11) were grown under irrigated conditions. Meteorological data were recorded. Two widely used thermal indices viz, growing degree days (GDD), and heliothermal units (HTU) were computed. The GDD and HTU were varies by the growing environment and varieties. From sowing to harvest early sowing November 5 had higher GDD and later sowing December 20 had lower GDD. In the case of varieties, V2 required higher GDD and V3 required lower GDD from sowing to harvest. HTU varied from 11764.07 C day hr (D4) to 13879.4 C day hr (D1). Variety V1 required 13757.85C day hr while 13347.05C day hr and 11636.8 C day hr for V2 and V3 respectively. The days required from sowing to harvest was 136.3, 122.6, 118.6 and 107.4 days in D1, D2, D3 and D4 growing conditions respectively. Higher heat use efficiency (1.11) was recorded for D2 (20th November). Therefore the optimum time of sowing of chickpea is mid of November for all varieties. Among the genotypes, BARI Chola 11 took a significantly lower number of days for harvest and also showed better yield in late sowing condition is the promising variety. Accumulated GDD and HTU can predict physiological maturity and grain yield with an accuracy of 92% and 99%, respectively. Yields of chickpea cultivars were highly influenced by differential thermal environment, and cultivars vary greatly in their response to heat utilization which significantly explains the variability in economic yield.

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.

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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.

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 500 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.

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.

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Frozen Semen Production and Popularization of Artificial Insemination in Black Bengal Goat

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Abstract
The research was carried out in Artificial Insemination Center and Reproductive Biotechnology Laboratory, Department of Animal Breeding and Genetics, Bangladesh Agricultural University. The experiment was performed to maintaining superior nucleus breeding Black Bengal bucks, production of high quality frozen semen from Black Bengal goat, exposing undergraduate students in various aspects of frozen semen technology and popularizing artificial insemination (AI) by using frozen semen.Five breeding bucks at weaning age were purchased from DLS. Three bucks are in trail condition to ejaculation of semen. From each buck, 20 ejaculates were evaluated. The range of ejaculate volume, individual motility, sperm concentration, live spermatozoa and normal spermatozoa were as 0.31 to 0.51 ml, 78 to 80%, 2.46 to 3.10 billion/ml, 83 to 87% and 82 to 86%, respectively. After dilution, on dilution motility was found 70 to 77% and post-thaw motility was 48 to 57%. The initial semen characteristics are desirable for frozen semen production. The work has hampered due to outbreak of pandemic Covid-19 during research period. So trail of frozen semen production is continuing with regular basis in Reproductive Biotechnology Laboratory, Department of Animal Breeding and Genetics, Bangladesh Agricultural University. The research work is still going on to production of frozen semen and artificial insemination will be performed at BAU surrounding villages.
Keywords: Black Bengal goat, buck, frozen semen, artificial insemination

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.

Community Driven Breeding Approach Using Brahman Inheritance for the Genetic Improvement of Indigenous Cattle for Beef Production (2nd Year)

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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.

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 Nagpuri) 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. After accomplishment of all project activities, the proposed research will enhance the genetic merit and sustainable conservation of native sheep of Bangladesh.

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 has been proposed with the goal to standardize the procedures of in vitro production of cattle embryo with known sex, to make the technology readily adoptable to the cattle industry. The experiment has been carried out to optimize the culture conditions for in vitro maturation, in vitro fertilization and in vitro embryo culture procedure. 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. At day-5 stage, one half of cultured bisected embryos is used to analyze for the determination of the sex by PCR. For the sexing of embryo, DNA has been extracted from biopsied cells of the embryo by appropriate genomic DNA isolation kit and further amplified through a duplex PCR using the primes for the DNA sequence which differs between sexes in case of bovine species. Culturing second half of the biopsied blastomeres from the same embryo were continued in vitro up to day-7 and developmental rate as well as viability has been assessed. Result of this study and devising procedure for the in vitro production of bovine embryo and analysis of microsurgical bisection of in vitro produced embryos in combination with PCR based sex determination will provide a rapid and reliable approach to be adopted for increasing the number of calves with predetermined sex from embryo transfer programs in Bangladesh.

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.

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 current 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 822 pure RCC of different ages, stages and sexes available in the hands BAU, BLRI, DLS, BRAC, ADL, PKSF, Green Farming Cooperative, Nahar Dairy Ltd, private owners, etc. have been collected. A standard database of the compiled information has been developed and then uploaded to National RCC website. Further, Non-descript cows/heifers are being bred with RCC semen produced at the BAU AI Centre and graded RCC progeny produced in and around BAU are being tracked using the developed RCC Herdbook. 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 completed using Illumina NGS technology and the NGS data analyses are ongoing. 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 testing and their body weight, growth, testicular measurement and semen characteristics were being routinely recorded. Meanwhile, a total of 8 (eight) Certified RCC Bulls have been offered for use to American Dairy Ltd. (ADL), Lal Teer Ltd., ACI

Genetics Ltd. and a private owner of Dinajpur, some growing bulls are still under test and some bulls have already been culled for disqualification.

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

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Abstract
The present study was aimed to investigate the growth, morphology, morphometry and meat yield performances of F_1 crossbreds between Nageswari and Pekin ducks. Accordingly, Pekin and Nageswari drakes and ducks those had been maintained as foundation stocks were grouped into 4 different flocks in order to get pure Pekin (P) and Nageswari (N) day old ducklings as well as their reciprocal crossbreds (P♂ x N♀ and N♂ x P♀). A total of 157-day old ducklings were hatched out (hatchability 70%) from 220 eggs and were maintained in 4 different pens under intensive management at a shed of BAU AI center up to 44th week of age. Feeding, vaccination schedule, biosecurity measures and management practices were similar for all individuals throughout the experimental period. Growth performances were highly significant among the 4 genotypes (P<0.001) from day old to 20th week of age. The average live weights of P, N, P♂ x N♀ and N♂ x P♀ genotypes at 12th week of age (marketing age) were 2022.63±47.08, 1561.13±57.73, 1767.55±27.99 and 1637.25±25.03g, respectively. The morphology and plumage pattern of crossbred ducks were almost similar to Nageswari breed due to dominant inheritance of Black allele. Genotype had significant differences among the genotypes for almost all morphometric measurements except wing length and bill length. Meat yield characteristics had significant differences for most of the studied traits among the four different genotypes. In this study, the age at first laying of P, N, P♂ × N♀ and N♂ × P♀ genotypes were 165, 148, 137 and 132 day, respectively. Hen day egg production (HDEP%) at 36th week was found non-significant among the aforesaid genotypes and were 76.19±2.89, 77.55±8.74, 69.48±0.84 and 75.43±1.84, respectively. Taken together, our results revealed that P♂ x N♀ crossbred could be a valid alternative against the exotic Pekin duck for higher meat production with better adaptability in Bangladesh.

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
This study was aimed to investigate the A1 and A2 allelic patterns of β-Casein (CSN2) gene and its molecular characterization in Indigenous and Holstein×Indigenous crossbred cattle population of Bangladesh. A total of 310 blood samples were collected from unrelated individuals of aforesaid two genotypes those are being maintained at different private and government dairy farms, institutional and university herds as well as from farmers' herds. Five primer pairs either selected based on the previously reported information or synthesized to amplify all exons of CSN2 gene. Notably, an allele specific primer set was designed targeting 67th amino acid position (Proline>Histidine) located at exon

7 of CSN2 gene for genotyping A1 and A2 allelic variants using conventional PCR protocol. The concentration of extracted DNA varied between 19.0-182.1 ng/µl and purity of those samples ranged between 1.78 and 2.00. However, based on DNA concentration, 255 samples were finally used for genotyping of A1 and A2 variants in indigenous and crossbred animals. The frequencies of A1A1, A1A2 and A2A2 genotypes of CSN2 gene were 0.02, 0.16 and 0.82, respectively in different indigenous cattle varieties of Bangladesh. On the other hand, the corresponding genotype frequencies were 0.14, 0.50 and 0.39, respectively in Holstein-Indigenous crossbreds. Moreover, the A1 and A2 allele frequencies were 0.10 and 0.90, and 0.39 and 0.61 in the investigated samples of indigenous and crossbred cattle, respectively. The distribution of unfavorable A1 (mutant) allele in indigenous cattle varieties might be due to existence of taurine remnants in the sampled individuals. In addition, all exons were amplified by this time using five pairs of primers and will be sent for sequencing. Taken together, the adopted allele specific PCR method could be used to screen favorable A2A2 genotypes for production of premium quality milk.

Maintenance of Reproductive Biotechnology Laboratory and *In Vitro* Production of Embryo

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Abstract
The present research project was been undertaken for maintaining the reproductive biotechnology laboratory and for *in vitro* production of embryo. Repairing of the CO_2 incubator, laminar airflow, water bath and dryer so far been finished. Required chemicals and reagents for embryo culture, culture dishes, pasture pipette, specific type of syringe with needles, glass slides, cover slips, gloves etc been purchased. Two alternative CO_2 gas cylinders also been furnished. Three masters student conducted their research work in this laboratory and their thesis titles were; i) Morphometric and histochemical study of cattle and goat reproductive organ ii) Evaluation of bovine ovaries and follicles by histological study intended for *in vitro* production of embryos iii) Evaluation of goat ovaries and follicles by histological study intended for *in vitro* production of embryos. The reproductive organs were collect from local slaughterhouse and divided into ovary with corpus luteum (CL) and without CL. The weight, length and width of ovary been measured with the help of electrical weighing balance and digital slide calipers. The weights of goat left and right ovary was 0.58±0.06 and 0.89±0.11g but in case of cattle, the weights of left and right ovary were 1.77±0.41 and 2.20±0.57g. Average weights of the bovine ovaries with and without CL were 2.93±0.38 and 1.52±0.30g, respectively where ovary weight was significantly ($p<0.05$) higher in CL present group than CL absent group. Depending on the follicular diameter, it was find that 2-6 mm follicles with CL and without CL were 9.83±2.23 and 15.90±1.73, respectively. Besides, the histological study revealed that the total number of follicles in goat ovaries with corpus luteum was 10.07±2.47 among which the primary, secondary, antral and graafian follicles were 4.44±1.59, 4.05±1.61, 0.92±0.21 and 0.14±0.06, respectively. While the total number of follicles in ovaries without corpus luteum was 11.10±3.39 among which the primary, secondary, antral and graafian follicles were 4.44±1.59, 1.45±0.83, 6.27±1.31 and 0.42±0.25, respectively and it might be conclude that CL absence ovaries would be the potential source for quality follicle. The recovery of oocytes using the slashing technique is useful for practical application as it ensures the better yield and higher number of oocytes with the excellent grade. In contrast, follicular aspiration and slicing are the methods of choice for goat in vitro embryo production. The culture condition of the experiment was found to be optimized as it efficiently supports IVM, IVF and subsequent development of goat embryos.

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Impact of Community Based Breeding Program for the Sustainable Genetic Improvement of Black Bengal Goat

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Abstract
Black Bengal goat is a potential genetic resource in Bangladesh. Every year a large number of heated does remain unserved due to acute shortage of genetically superior breeding bucks. Therefore, the productive and reproductive life is being shortened. From this point of view, this study was being carried out to introduce community based breeding program and analyze its impact on the genetic improvement of Black Bengal goat. A baseline survey was conducted to identify the promising goat rearers, their socio-economic status and problems regarding goat rearing. Based on the survey results, a total of 30 goat rearers in three areas were selected, trained and build up community with them. Besides these, three genetically superior breeding bucks were distributed to three potential farmers in these communities. Management and performance of bucks and does were monitored closely. From the study, it was observed that scarcity of breeding bucks have been decreased in these areas and no heated does remain unserved. Analysis of the growth performance showed that male kids attained higher body weight (1.28±0.04 kg) than that of female kids (1.06±0.02 kg). Subsequently with the passage of time, males reached higher body weight than females. Average daily body weight gain up to 12 months of age was also significantly ($p<0.05$) higher in male (42.82±0.67 g/day) than females (36.03±0.38 g/day). Age at sexual maturity was 199.32±2.41 days; service per conception 1.17±0.04, litter size was 1.76±0.08 in the respective areas. Heritability estimates for body weights at birth, 3, 6, 9 and 12 months of age were 0.44, 0.46, 0.45, 0.48 and 0.47, respectively. These results suggested that community based breeding program not only reduced the scarcity of good quality breeding bucks but also expedite the genetic improvement of Black Bengal goats.

Entrepreneurship Development Among Women Through Community Based Goat Rearing in Char Area of Bangladesh

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Abstract
Bangladesh is one of the largest deltas in the world where riverine chars are extremely vulnerable to climate change especially for erosion and flood hazards. Each year a large percentage of the chars get flooded. The flooding, if it comes early, can damage the crops in the fields. At that time, char dwellers have no other means to maintain their livelihood. From that point of view, this study is being conducted to develop entrepreneurship among women through community based goat rearing in char area of Bangladesh. A benchmark survey was conducted using a pre-tested questionnaire for socio-economic status of char dwellers following purposive random sampling technique. About 80% people are involved in daily labor activities in agricultural field where 87% are illiterate and no other ways of extra income. Based on the analytical report of the benchmark survey, poor distressed but 100 potential women in the char areas were selected for the next course of action. Poor distressed women are our focus group in this project to develop entrepreneurship. Selected women were trained for scientific rearing and management of goat. Five groups/communities were formed in char area of Mymensingh district via Focus Group Discussion (FGD) so that the community members can share the knowledge

and help each other for upliftment their living standard. Some supports like vaccines, medicines and technical support were provided to the goat rearers of char area. Productive and reproductive performances of Black Bengal goat are also being recorded by the community members. This is an on-going research work. Through the involvement in scientific goat rearing by the char dwellers, not only make them profitable but also scale up their livelihood, empower the women and ensure nutritional security for their family members by extra source of income.

Growth Competence, Semen Profile and Reproductive Performances of Pure Dorper Sheep Under Farming Condition of Bangladesh: A Way Forward to Mitigate the Demand of Meat Production

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Abstract
Dorper sheep has gained worldwide recognition for its excellent body conformation, fast growing rate, and good carcass quality. Though this breed has a good adaptability to the different conditions but the productive and reproductive performance varied based on agro-climatic conditions. Therefore, the present study was conducted to evaluate the growth competence, seminal attributes and reproductive characteristics of Dorper sheep under our farming condition. A total of 20 sheep were selected for this research work of which five (5) were breeding rams and fifteen (15) were ewes. After importation to our country, they were adapted in our climatic and managemental condition. From our study, it was revealed that this sheep breed was excellent to cope with our environment and managemental condition. Thereafter, breeding rams were trained to collect semen and semen was collected successfully by AV method. It was found that average semen volume was 1.06±0.04 ml, sperm concentration 2894.20±24.71×10^6/ml, sperm viability 82.41±3.28% and progressive sperm motility 71.17±3.21%. Average fertility was recorded 69.21%. The average litter size was 1.20 of which 45% were twin births. Birth weights of male lambs (3.81±0.19 kg) were higher than female lambs (3.58±0.21 kg) and the average daily gain in F1 generation was 143.88±0.94 and 130.72±0.38 g/head/day in male and female Dorper sheep, respectively upto 6-months of age. These results have suggested that Dorper sheep can be adapted in our farming condition with standard fertility, prolificacy and growth rate. Therefore, it is recommended that Dorper sheep can be introduced in our country to minimize the scarcity of animal protein and ensure the food security of Bangladesh.

Kinematic Response and Motility Pattern to Low Density Lipoproteins (Ldl) in Fresh Diluted and Short Term Preserved Spermatozoa of Black Bengal Goat

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Abstract
Black Bengal goat is a potential genetic resource in Bangladesh. But low survival of goat spermatozoa after freezing is still a major drawback for widespread use of frozen semen through AI. The present study was conducted to evaluate the kinematic response and motility pattern to low density lipoproteins (LDL) in fresh diluted and short term preserved spermatozoa of Black Bengal goat. Four mature Black Bengal breeding bucks were used and semen was collected twice a week

through artificial vagina. Fresh semen was evaluated and found the seminal attributes like semen volume 0.51-0.92 ml, sperm concentration 2659.91-2938.22×10^6/ml, mass motility 82.13-87.76%, live spermatozoa 83.98-88.75%, normal spermatozoa 91.16-94.36%. Thereafter, semen was diluted with 8% LDL replacing egg yolk in TRIS based extender to reach a final concentration of 200 million sperm/ml and divided into two parts. One aliquot was evaluated as fresh diluted semen within 15-20 minutes and another aliquot was evaluated after 48 hours of storage at 4° C through CASA system. Progressive motility and live spermatozoa percentage were significantly higher ($p<0.05$) in fresh diluted semen as compared to preserved semen at 4° C. Regarding motility patterns, rapid progression was significantly ($p<0.01$) higher in fresh diluted semen whereas slow progression and non-progression was significantly higher ($p<0.05$) in short term preserved semen. In fresh diluted semen the kinematic characteristics like average path velocity (VAP), straight line velocity (VSL), linearity (Lin%), straightness (Str%), wobble (WOB%), beat cross frequency (BCF%) and maximum amplitude-lateral head displacement (ALH) were significantly higher ($p<0.01$) than short term stored semen. However, VCL did not show any significant difference between fresh diluted and short term preserved semen. These results suggested that though decreasing temperature affects path and velocities of spermatozoa but LDL has a protective action on flagella activity and energy production system of spermatozoa during short term storage of semen.

Characterization, Conservation and Improvement of Indigenous Aseel Chicken of Bangladesh

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Abstract

Bangladesh has a rich heritage of possessing indigenous chicken germplasm. The aim of the study was to characterize, conserve and improve the indigenous Aseel chicken of Bangladesh. A benchmark survey was conducted to collect information on population structure, distribution pattern of Aseel chicken from home tract in Bangladesh. It was revealed that total number of Aseel chicken is only 468 of which 72% were found in Sarail and the rest 28% were found in Sadar, Nasirnagar and Ashuganj upazila of Brahmanbaria district. At *In situ* condition, cocks were reared under intensive whereas hens, pullets, cockerels and chicks were reared under semi-intensive management system. A nucleus breeding flock (NBF) has been established in Bangladesh Agricultural University for *ex situ* conservation. Selected Aseel chicken of different ages from their home tract (Brahmanbaria) was brought into the NBF. Characterization and diversity in the performance of Aseel chicken were studied both *in situ* and *ex situ*. From the study, it was found that different morphological variants like shank, beak and eye colour were yellow, ear lobe colour red and comb type was pea in both sexes of Aseel chicken. Adult body weight was 2910.82±82.12 g vs 2234.20±78.24 g in male vs female chicken, respectively. Age at first lay was found 251.26±4.33 vs 244.29±8.62 days, average egg weight 43.38±0.08 vs 46.38±0.07 g, total number of eggs per year 46.22±2.01 vs 52.41±3.43, and hatchability was 71.23 ± 8.17 vs 73.23±7.63% in *in situ* and *ex situ* condition, respectively. Selective breeding was applied in the NBF and observed that egg production, egg size and growth rates were improved in *ex situ* condition. This study also revealed the diversity in productive and reproductive performance among individuals of Aseel population which suggested that selective breeding may play a pivotal role for the further improvement of Assel chicken in Bangladesh.

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Development of Cost Effective Feed Formula for Sustainable Rabbit Farming in Bangladesh

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Abstract
In order to maximize food production and meet protein requirements in Bangladesh, fast growing important micro livestock such as rabbit has immense potentials and good attributes as a means of alternative nutritious diet and source of rural family income. Thirty (30) New Zealand White Rabbits (female) of approximately 2 months' age were used in a 4 months' experimental period to study the effect of diet containing different levels of energy and protein on growth performance. Rabbit were divided into five treatment groups, i.e. diet T_0 = standard concentrate mixture (energy 2600 kcal/kg + protein 17%) and are used as control, diet T_1 = concentrate mixture with low energy and low protein (energy 2400 kcal/kg + protein 15%), diet T_2 = concentrate mixture with high energy and low protein (energy 2800 kcal/kg + protein 15%), diet T_3 = concentrate mixture with low energy and high protein (energy 2400 kcal/kg + protein 19%), diet T_4 = concentrate mixture with high energy and high protein (energy 2800 kcal/kg + protein 19%), respectively. Green grasses (Napier) were supplied ad-libitum. The result showed that the final body weight of different treatment group T_0, T_1, T_2, T_3 and T_4 were 768.25, 777.25, 822.00, 868.00 and 930.25 g, respectively. Final body weight among the different treatment groups differed significantly ($p<0.05$). In group T_4, the body weight was found to be highest compared with other treatment groups. The total live weight gain, daily live weight gains and FCR did not differ significantly. Calculated growth velocity (GV) were 2.16 in T_0, 1.5 in T_1, 1.78 in T_2, 1.58 in T_3, 0.89 in T_4. In T_4 group, growth velocity was significantly ($p<0.05$) lower (0.89) than T_0 (2.16) control group. Total feed intake significantly ($p<0.01$) increased with the increased level of energy in feed. The feed intake was significantly different ($p<0.01$) in different treatments group where high energy high protein group had the highest feed intake and control group had lowest feed intake. It could be concluded from the present study that T_4 that is high energy high protein diet was found suitable for maximum growth performance of rabbit.

Prediction of Beef Quality Through Near Infrared Reflectance Spectroscopy and Multivariate Analysis

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Abstract
An alternative method of wet based laboratory technique for meat samples is near-infrared reflectance spectroscopy (NIRS) which reduces costs, faster, simpler, non-invasive, non-destructive and environment friendly. The objective of this study was to evaluate the feasibility of NIRS to predict beef quality. Samples of longissimus dorsi muscle (n=60) were collected and spectra were obtained prior to beef quality analysis. Multivariate calibration was performed by partial least squares regression. 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. Calibration equations were developed from corresponding spectra absorption value and reference data of pH, color traits (L*, a*, and b*), drip loss (%), cooking loss (%), crude protein (%), ether extract (%), moisture (%), dry matter (%), and ash (%) using partial least squares regressions. Predictive ability of the models was assessed by coefficient of determination

of cross-validation (R^2_{cv}) and root mean square error of cross-validation. Predictions were good for pH (R^2_{cv}=0.95), L* (R^2_{cv}=0.96), a* (R^2_{cv}=0.96), b* (R^2_{cv}=0.97), drip loss (R^2_{cv}=0.95), cooking loss (R^2_{cv}=0.95), crude protein (R^2_{cv}=0.94), ether extract (R^2_{cv}=0.95), moisture (R^2_{cv}=0.91), dry matter (R^2_{cv}=0.91), and ash (R^2_{cv}=0.91). Based on these results, the NIR spectroscopy and multivariate analysis method were plausibly efficient for the rapid assessment of physicochemical traits of color, pH, drip loss, cook loss, dry matter, moisture, protein, fat, and ash content of beef.

Production Performance of Jamuna Basin Lamb under Semi-Intensive Management System in Bangladesh

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Abstract

The study was aimed to understand the production performances of Jamuna basin lambs at different ages from some selected areas of Sherpur district. For this purpose, growth performance data on 360 lambs were collected from October 2018 to September 2019. Statistical analyses were done using SPSS-v-20 version computer software. The means of body weight of Jamuna basin lambs were 1.46±0.01, 3.58±0.05, 6.65±0.10, 9.84±0.25, 14.74±0.74 and 17.00±0.63 kg, respectively at birth, one, three, six, nine and twelve months of age. Sex had significant effect ($p<0.05$) at six month f age. Body weight and average daily gains were higher in male than female lambs at different ages. Litter size had highly significant effect ($p<0.001$) on birth weight and weight at one month of age. Single born lamb had higher birth weight and average daily gain than twins and triplets. A significant ($p<0.05$) effect was found on the weight at three months of age due to seasonal influence. Average Daily Gain (ADG) from one, three, six, nine and twelve month was found 119.33±2.25 & 119.00±2.20, 73.89±2.17 & 71.67±2.45, 54.67±4.03 & 54.83±4.67, 54.59±2.30 & 52.59±3.60 and 51.34±3.59 & 46.27±4.11 g/day, respectively in location wise. Mortality was relatively higher within 3 month of age. The improvement in litter size, body weight and survival represent potentially significant economic advantage of Jamuna basin lamb. In conclusion, sex, litter size, body weight, season, location and flock size used in the study are important source of variation for growth traits in Jamuna basin lamb.

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

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Abstract

Insufficient milk yield of does and low birth weight of kids are two major drawbacks that cause high kid mortality in Black Bengal goats. Inadequate nutrition during gestation can delay the onset of lactogenesis, reduce colostrum and milk production, and affect colostrum viscosity. However, the effect of nutrition level during late pregnancy of dams on birth weight, growth rate and gonad development of kids has not been known yet. The proposed study is aimed to examine the effect of different levels of dietary energy during late pregnancy on performance of Black Bengal does and their kids. The goats (n=30) were purchased from government the Goat Development Farm, Savar, Dhaka. Three diets were formulated using commonly available feed ingredients such as German grass, wheat bran, maize crushed, soybean meal, molasses, DCP (dicalcium phosphate) and common salt. The

medium energy (ME) diet will be formulated to contain 10.4 MJME/Kg DM (NRC, 1981). Other diets will contain high energy, HE=11.73 MJME/Kg DM and Low energy, LE= 8.67 MJME/Kg DM. All diets will be iso-nitrogenous containing 14% crude protein in dry matter. High and low energy (HE and LE) will differ from medium energy (ME) by 15%. Birthweights of kids, weekly liveweight changes of kids and dams, milk production, and postpartum reproductive efficiencies are being recorded. Gonads of kids are being processed for histological examination. Hope the results of this on-going project will provide valuable information to develop a feeding strategy of pregnant goats to maximize the productivity of kids and dams.

Effect of L-carnitine on Vitrification of Buffalo Oocytes

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Abstract

The buffalo (*Bubalus bubalis*, L.) is an important component of livestock in several countries in the world. The scarcity of buffalo oocytes is a drawback for exploiting embryo technologies. Cryopreservation of oocytes collected from slaughtered buffaloes might increase the availability of buffalo oocytes for reproductive technologies. The present study was aimed to know the effects of L-carnitine on vitrification of buffalo oocytes. Oocyte-granulosa cell complexes were aspirated from ovaries of slaughtered buffaloes and cryopreserved in vitrification medium supplemented with 0, 0.5, 1, 1.5 mg/ml L-carnitine. After that the oocytes were incubated into the equilibrium solution for 5 minutes at room temperature. The oocytes were transferred into the vitrification solution for 1 minute. Then, 2-3 oocytes were loaded on the filmstrip of a cryotop and immediately plunged into liquid nitrogen. For thawing, oocytes were immersed in 38.5 °C warming solution consisting of TCM-199 + 20% v/v FCS supplemented with 1M sucrose for 1 minute. The oocytes were cultured at 38.5°C for 24 hours under 5% CO_2 in humidified air for in vitro maturation. Oocytes were fixed in aceto-ethanol and stained with 1% (w/v) aceto-orcein to assess the nuclear maturation. Recovery rate did not differ significantly in L-carnitine treated vitrified-warmed buffalo oocytes. Significantly higher percentage of survived oocytes and lower percentage of zona pellucida (ZP) and cytoplasmic anomalies were observed in 0.5 and 1 mg/ml L-carnitine groups than remaining ones. Moreover, significantly higher percentage of vitrified oocytes reached the MII stage in 0.5 mg/ml L-carnitine. Meanwhile, a lower percentage of degeneration was observed in 0.5 mg/ml L-carnitine treated group than the control. Thus, these experiments suggested that L-carnitine also enhanced survival rates and developmental competence of vitrified oocytes.

Primordial Follicular Dynamics of Black Bengal Goats

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Abstract

The number of primordial follicles is set during pregnancy or just after birth in most mammalian species. The experiment was aimed to examine the primordial follicular dynamics of Black Bengal goat during fetal and neonatal stages. The experiment is conducting with female Black Bengal goats. The goats were purchased from the local market and their approximate age were 9–10 months. The

goats are rearing in Goat, Sheep and Horse farm under the department of Animal Science, Bangladesh Agricultural University. Diets were formulated using commonly available feed ingredients. The require energy diet were formulated to contain the recommended level of metabolizable energy (ME) 10.40 MJ/kg DM and crude protein (CP) 14% according to the NRC (1981) for goat. All the goat are in stall fed. The goats already mated naturally with buck after estrus. Goats were divided into four groups to collect fetus and kid ovaries at various stages of pregnancy and just after birth. Collection of fetus ovary will done at 50 days of pregnancy (Group, A), 100 days of pregnancy (Group, B), 150 days of pregnancy (Group, C), and neonatal ovary at 3 days after parturition (Group, D). Among the four groups, ovaries were already collected from group D and paraffin block of ovarian tissues has been made. Ovaries from other groups will be collected soon. The ovaries will fix in Bouin's solution, dehydrate in alcohol, clean with xylene and embed in paraffin to prepare paraffin block of ovarian tissues. Histological sections of the ovarian block will prepare by using rotatory microtome. The sections will stain with haematoxylin and eosin. Finally the stain sections will observe with the help of a light microscope to count the number of primordial follicles in the fetal and neonatal ovary.

Impact of Deep Bedded Pack Barn in Reducing Heat Stress and Foot Problems for Cows at Satkhira District in Bangladesh

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Abstract

The objectives of this study were to find out the level of heat stress and foot problems of dairy cattle managed in the deep bedded pack barn system. Temperature-Humidity Index (THI) values were determined to measure the level of heat stress. Outbreaks of foot diseases were also recorded. The experiment was carried out in a cattle farm located in Satkhira district, a south-western region of Bangladesh. The maximum and minimum temperature of Satkhira district is about 2^{o}C higher and relative humidity is comparatively lower than the normal values of the country. It indicates that the chances of heat stress for animals rearing at Satkhira district are higher. Holstein-Friesian upgraded heifers which converted later from heifers to lactating cows were kept on deep bedded pack system allowing the space of 10 ft by 10 ft areas in open barn housing system. For enhancing the decomposition of bedding materials and reducing the odors, indigenous microorganisms were sprayed. For getting temperature and humidity data, digital meters were used. The THI values were found 69, 70, 74, 80, 80 and 86 for the months of January, February, March, April, May and June of the year 2020. It indicates that animals did not in heat stress in January and February (less than 72) but from March to June, animals were started to feel in heat stress from mild to moderate (74 to 86) heat stress condition. In comparison to cows rearing stall feeding system on concrete floor suffered more heat stress. From March to June, it showed moderate to severe stress and even sometimes in very severe stress. There were no remarkable foot problems found for calves, pregnant heifers and milking cows in deep bedded pack. In addition, a farmer can able to earn about 2500 BDT per month from selling high quality organic fertilizer.

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Fermented Rice in Cost Effective Healthy Beef Production

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Abstract
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. 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. 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. 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.

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
Phosphorus is one of the major nutrients in poultry excreta, and feed supplementation with microbial phytase and phytase-rich cereals have been investigated as a solution for phosphorus retention. Buckwheat (*Fagopyrum esculentum*) is a pseudocereal available in Bangladesh (locally known as Dhemsi); contain high phytase activity. However, there is a lack of studies assessing the use of this pseudocereal as a feed source; and therefore, information on its phytase content is still limited. In this connection, chemical composition and phytase activity in buckwheat were measured to assay the variability in buckwheat from different regions in Bangladesh. Buckwheat was purchased from three different districts under Rangpur division namely, Nilphamari, Panchagarh and Lalmonirhat. For germination, seeds were soaked in water for 12 hour, and then placed in a tray lined with wet paper for 36 hour at room temperature (23±2 °C) maintaining a dark condition, and then dried under sun ray. After that, both non-germinated buckwheat and germinated buckwheat seeds were ground to pass through 1.0-mm aperture for analysis of proximate components, total phosphorus, phytate phosphorus and phytase activity. Results of the study clarified that, chemical composition and phytase activity varied among buckwheat collected from different regions, and germination tended to increase (P<0.05) phytase activity with concomitant decrease (P<0.05) of phytate phosphorus content in buckwheat. It is mentionable that, among the examined buckwheat, non-germinated buckwheat and germinated buckwheat from Nilphamari district showed highest (P<0.05) phytase activity and lowest (P>0.05) percentage of phytate phosphorus in terms of total phosphorus. In conclusion, both non-germinated and germinated 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 point.

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 reduces pH 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.

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

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A Study of Standardization of Papaya (*Carica papaya*) Latex for Cottage Cheese Preparation

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Abstract
The study was investigated to standardize the desire level of papaya latex on quality of cheese prepared from whole milk. Evaluation is carried on milk clotting activity of the crude proteolytic enzymes from mature fruits on quality of cottage cheese prepared from cow and buffalo whole milk (Phase I). Thereafter, the source latex was considered from different parts of papaya (*Carica papaya*) plant (Phase II). In phase-II, milk and latex named as sample; A: Latex from mature fruit; B: Latex from immature fruit; C: Latex from mature leaf; D: Latex from lower part of the plant and E: Latex from upper part of the plant. The quality of different cottage cheese samples were prepared and then evaluated by organoleptic scores and chemical tests. Phase I: it found that preparation of cheese from cow milk with 3 drops and cheese from buffalo milk with 6 drops latex from mature fruits source had highest acceptability due to its acceptable taste and higher nutritive value. Phase II: in judging by a panel of expert judges, it was observed that flavor, body and texture, finish, color, and total score were ranked non-significantly higher in cheese samples using latex from immature fruits B (93.34±0.45) than those of others. In chemical analysis, there was a significant($p<0.01$) difference in total solids, fat and ash values among the different type of cheeses. In case of chemical analysis, the highest total solids, protein, fat and ash values were found highest in B, C, E, and C, respectively. Therefore, the latex collected from immature part of plants (B, D) produce better quality cheese. Cheese from cow milk, time on curd coagulation have significant difference($P<0.01$) but non-significant difference was found in yield. These innovative manufacturing processes may also lead to the optimization and production of new cheese varieties.

Feeding and Management Package for Improved Productive and Reproductive Performance of Crossbred Lactating Dairy Cow under Farm Condition

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Abstract
An on-farm lactation long experiment was conducted to exemplify the effects of feeding and whole management package on growth, milk production and composition, lactation persistency and reproductive performance of crossbred cows. Six Holstein-Friesian (21 day's pre-partum) crossbred cows were equally divided into two groups. Each cow received 3kg concentrate during the pre-partum period, 5.0 Kg in post-partum and 3.0 Kg concentrate in peak tail head period. About 35.0 kg/cow/day German grass was provided as basal diet with 24 hours water availability. The total ration in control and treatment group were supplied with 9.39 and 8.95 MJ ME/Kg DM and 11.12 and 13.56% CP, respectively. In treated group green grass was supplied in chopped form and proper milking and house sanitation was maintained. BAUDF management procedure was provided to the control group. Average daily milk yield (7.36 vs 4.07, L), lactation length (301 vs 261, d), and lactation yield (2244 vs 1172 L) was significantly improved in treated cows compared to the control cows. All the milk quality attributes were found similar between the groups and the fat and SNF content of the milk ranged from 47 – 48 g/kg and 81 – 82 g/kg milk, respectively. In addition, post-partum heat period

(13d) and days-open (23d) was remarkably reduced in treated group than the control group. Improved feeding & management package reduced per kg milk production cost by BDT 13.0. Expenditure per cow/d was 32.0 BDT less in treated cows than the control cows and consequently the higher income from milk/cow/d (BDT 536.30 vs 331.08) and profit/cow/d (BDT 248.52 vs 74.64) was found in treated cows. In conclusion, feeding and management package during pre-partum and whole lactation had positive impact on milk yield, lactation persistency and reproductive performance of crossbred dairy cows and farm profitability.

Profitable Dairying by High Yielding Fodder Cultivation through Maximum Utilization of Land in Bangladesh

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Abstract
This experiment was aimed at assessing the biomass yield and nutritive quality of various suitable fodders per unit of land per year as well as soil properties by varying seed rates and doses of fertilizer application. The treatments were organized into a factorial design and distributed according to a completely randomized design with three replications. Five (05) different fodders and combinations were selected for the study *viz*. Deshi Maize, Hybrid Maize, Maize-Soybean Intercropping, Soybean, and Jumbo. Three seed rates (15; 20; and 25 kg/acre) and three doses of inorganic fertilizer (0 kg; 35 kg urea, 25 TSP, 15 kg MP; 45 kg urea, 35 kg TSP and 20 kg MP/ acre) along with 750 kg/acre basal doses of organic manure (cow dung) were applied at land preparation. The data regarding production characteristics based on the morphology of different fodder crops revealed that the plant height, stem circumference, and leaf area significantly deferred (p=0.000) among the treatment groups but leaf number (p=0.940). The height plant height, stem circumference, and leaf area were recorded for the fertilization at the rate of 45:35:20=Urea: TSP: MP kg/acre and 25kg/ acre seed rate for maize, maize-soybean intercropping and jumbo grass. Among the five different fodders, the number of the leaf was found non-significant irrespective of the fertilization and seed rate. There was also the non-significant effect that was found in the case of inorganic fertilizer and interaction with seed rate on the leaf/stem ratio (p=0.170 and p=0.230, respectively) but the higher trend of inorganic fertilization slightly increased the ratio (p=0.00). On the contrary, the biomass yield for all the fodder groups was significantly differed (p=0.000) except Soybean (p=0.160). The maximum biomass yield was found in the case of Maize-Soybean intercropping (17 ton/acre) in the fertilizer and seed rate combinations of 35:25:15=Urea: TSP: MP kg/acre and 20kg/ acre, respectively. Besides, the biomass yield from Deshi Maize was found less than one-third compared to the yield of hybrid maize (p=0.000). Thus, the best combination of fertilizer could be noted at 35:25:15 = Urea: TSP: MP kg/acre and 20kg/ acre to obtain better results in terms of biomass yield. It might recommend that better fertilizer management and choice of fodder crops can improve the ultimate productivity as per annual cultivation per unit of land.

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 (T1, T2, T3 T4 and T5) 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 T1, T2, T3 T4 and T5 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 T1, T2, T3 T4 and T5 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%.

Improvement of Milk Yield and Quality of Buffalo Through Scientific Feeding and Management under Village Condition

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Abstract

A series of six experiments were conducted to evaluate the existing feeding and management of buffaloes and also to develop appropriate ration for increasing their milk yield and quality. First experiment was a survey work and data on different parameters related to buffalo rearing, distribution, feeding and management were collected from Bhola (Coastal area), Mymensingh (River basin area) and Dinajpur (Drought area) districts. The second experiment was also conducted in the same area to get information on milk yield, milk quality and marketing of buffalo milk. Highest number of lactating buffaloes were found in coastal area followed by drought and river basin area. Concentrate feed and green grass supplied were not same in all areas. Average lactation yield in river basin and drought areas were double than that of coastal area. All the chemical components of milk in different areas were within normal range. The third experiment was a feeding trial in which three groups of lactating buffaloes were given three different concentrate diets separately and they were designated as T_1 (14% CP) T_2 (16% CP) & T_3 (18% CP) diets. In addition to concentrates Napier grass silage was given to buffaloes of all groups *ad libitum*. Performances of buffaloes in terms of milk yield, composition and increase in body weight were better in T_2 diet (16% concentrates). In 4th experiment 16% CP containing concentrates were used and variations were made on the amount of concentrates. The amount of concentrates were calculated on the basis of body weight and the diets were T_1 (30% of total DM on 2.5% of body weight), T_2 (30% of total DM on 3.0% of body weight), T_3 (30% of total DM on 3.5% of body weight). Together with concentrates Napier grass silage was given *ad libitum* basis to all groups. The result showed that performance of diet T_1 was better in comparison to others. The 5th experiment was conducted in village areas in which T_1 diet of 4th experiment was selected for validation trial. Validation trial was conducted with ten milking buffaloes and found that T_1 diet

selected from 4th experiment performed better. The last experiment (6th) was conducted to monitor the feasibility of using milk replacer on growth performance of buffalo calves and it was found that milk replacer could save at least 25% rearing cost of calf. Finally judging from the results of feeding trials it could be concluded that a concentrate mixture having 16% CP given on the basis of 30% of the DM calculated on 2.5% of the body weight was found better for our native lactating buffaloes.

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.

Aging Effects on Taste Sensitivities of Growing Broiler Chickens Using One-Cup Drinking Experiments

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Abstract

The sense of taste has a key role in nutrient sensing and food intake in animals. A standardize and simple method for the detection of tastant-detection thresholds is required for chemosensory research in poultry. In humans, taste sensitivity decreases with age, although the extent of loss varies depending on the taste quality. The elucidation of the sense of taste in chicken offers opportunities to create and improve feedstuffs for chickens and to contribute to the understanding of the mammalian sense of taste. In this study, we have tested five different taste compounds to elucidate the aging effects on taste sensitivities of growing broiler chickens system using one-cup drinking experiments. We found that growing broiler chickens showed significantly lower aversion than younger chicks for all the five basic

taste active compounds. We also observed that broiler chickens expressed higher taste aversion for bitter taste active compound (caffeine) than sweet (sucrose) and umami (MSG) taste compounds. In addition to that, the taste preferences of broiler chickens were very much concentration dependent. The findings of the 10-minutes drinking experiments suggest that taste sensitivities decline with the ages of chickens like human and chickens have taste acuity with dose-dependent manner. This information will help to elucidate the role of taste perception in feed-intake regulation, feed choice, and acceptance in different growth stages of broiler chickens.

Novel Dietary Additive Mixtures of Local Origin in Bangladesh Enhance Older Hen's Performance

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

Assessment of Poultry Feed Ingredients and Milling Practices for the Development of a Digital Feed Formulation Package

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Abstract
This study was conducted to assess the poultry feed ingredients availability, uses, physical grades, combined nutrients content score, market dynamics, origin and price variation along with the feed milling knowledges of the small-scale feed producers with a view to develop the digitally accessible feed formulation package available at off- and on-line. A total of 60 feed millers in 12 distinct administrative and geographical zones of Bangladesh were interviewed and assessed for their

ingredients and feed qualities and feed milling practices. During this survey, a total of 250 individual feed ingredient samples under energy source, protein source, mineral source, and additive sources were collected from the small-scale feed miller's facility and feed ingredients shops. The samples were assessed for their physical and chemical composition. Depending on combined nutrients content score, each and every ingredient was classed into several grades those were also made identifiable at pictographic forms. Knowledge of the feed millers on scientific feed manufacturing and other milling practices were assessed using a mixed type questionnaire. The results obtained so far from the field activity and laboratory works indicated that every single feed ingredient used by the small-scale poultry feed millers in the study area were of several categories depending on their combined nutrients content score. The knowledge of the feed millers were deficient for scientific ration formulation and analytical techniques and facilities. The findings suggested that the digitally accessible least cost feed formulation software embedded with nutrient score dependent pictorial digital library may helpful for their cheaper and efficient feed formulation.
Keywords: Feed ingredients, Feed formulation, Ration formulation software, Small-scale producers

Productivity and Profitability of Indigenous Chickens for Meat Yield as Affected by Flock Size and Rural Environment

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Abstract

Sustainable development has become one of the most important issues in the agricultural sector in Bangladesh. The main aim of poultry production is to produce proteins of higher biological value in a sustainable manner. Indigenous chickens have special demand of the consumers in the country in spite of the higher costs. In this study, four hundred eighty (480) desi chicks were reared in rural households to determine the growth performance, meat yield traits, and profitability of flock sizes. Two different feeding trials following either in full confinement or in a semi-scavenging system have been conducted under village conditions adjacent to Bangladesh Agricultural University, Mymensingh. The birds were provided with diets of identical composition. The number of chicks in each trial was two hundred forty which were divided into three flock sizes considering treatments (10, 20 & 30 birds), and each flock was replicated into four different households. Diets were supplied into two phases: starter and grower. A starter diet was supplied from 0-7 weeks and a grower diet was provided from 8-15 weeks of age. Growth performance data were recorded weekly and the feed conversion ratio was calculated. At the end of the trial, a total of 24 birds were slaughtered to investigate meat yield traits. Data were subjected to analysis of variance (ANOVA) with a 3×2 factorial design employing SAS statistical computer package program. Results showed that birds that were reared in the small flock (10 birds) in full confinement and semi-scavenging system, attained better growth, and higher feed intake, improved feed conversion ratio, dressing yields as compared to other flock sizes (20 and 30 birds). Small flock sizes (full confinement and semi-scavenging system) also showed the lowest production cost with maximum income. It may be concluded that a flock size of 10 birds both in full confinement and semi-scavenging system may be considered for desi chicken meat yields and profitability.

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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.

Dietary Supplementation of Linoleic Acid for Increasing the Pullet Egg Size

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Abstract

Linoleic acid (LN) is beneficial to human health for its multiple properties of antiobesity, antidiabetic, anticancer, antiatherogenic, and immunity improvement. The use of LN in laying hen diets to produce eggs enriched with essential nutrients has become a common practice in the table egg industry and linoleic acid levels in egg yolks increase in a dose-dependent manner. An experiment was conducted to investigate the effect of LN of the diet on egg weight, egg production and egg quality characteristics on NovoGen brown commercial layers of 20 to 40 weeks of age. There were three dietary treatments of four replications per treatment maintaining four birds per replication. All the diets were iso-caloric and iso-nitrogenous except for the doses of LN. The diets contained T1 (control diet with no LN), T2 (control diet + 1.5% LN) and T3 (control diet + 2.5% LN). In this experiment, we supplied soybean oil as the potential source of LN, as because soybean oil contain about 53% LN, soybean oil frequently use as the laying birds ration formulation and we had try to avoid the use of synthetic LN for the safer egg production. We had measured the boiled yolk weight, because the yolk weight directly reflects the

egg weight. The results showed the egg weight, yolk weight, and egg quality parameters were better in the diet contained higher in linoleic acid. The yolk weight was significantly improved in the diet containing 2% soybean oil (2.5% LN) compared to 1% soybean oil (2.5% LN) and control (0% LN) groups. Additionally, both the internal and external egg quality parameters, especially shell thickness, Haugh Unit (HU), yolk index were improved in the dietary group treated with both 1% and 2% soybean oil (both 1.5 % and 2.5% LN). Taken together, it may be concluded that LN has a positive effect in not only the increase in egg size but also in the egg quality characteristics and thus improve the overall health benefit for human consumption.

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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 agriculture policy has also given priority to coastal agriculture, haor and wet land, hill agriculture, Barind agriculture, char land agriculture. 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. 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). The main goal of the research was how, the policy interventions were dominated by top-down approaches reflected in rural development processes in wetland. The impact of these policy approaches that would affect the capacity of smallholders on poverty alleviation and food system are main research area of the study. The study findings and output focused attitudinal issue of policy practices. Investigations on community responses to policy interventions were identified while majority community areas attempt to implement policy strategies.

Economics of Community-based Seaweed Production in Some Selected 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-grown products in food, feed and medicinal applications. Interest in production of seaweeds in coastal waters is rising, in particular in combination with offshore fishing by 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. Based on current available information, offshore seaweed production in the Cox's Bazer district of Bangladesh economically feasible under community management. A survey was carried for collecting information from 100 seaweed grower purposive random sampling. The study based on farmer's opinion reveled that the technology of seaweed cultivation is very simple and needs very low initial investments. The results showed that 38,400 Tk is needed for initial investment for a plot size of 10 decimal and 50 long line rope settlement unit. The estimated net profit margin was 193,956 Tk. for

4 weeks cultivation period per unit. The overall a positive picture of the seaweed production is obtained. The research identified some major constraints to commercial seaweed cultivation. Because a fragile market of seaweeds exists in Bangladesh. Still a seaweed would open a new avenue for blue economy-based GDP and can be a sector of the durable economy along with ensuring trade potentials. Sensitivity analysis showed that revenues would have to increase by roughly 50%, all other things equal, to make a profit. A number of opportunities to improve the economic feasibility of Sea seaweed value chain are identified. Technical innovation and the design of systems that enable multiple harvests per year can reduce production costs. Successful marketing of seaweed as human food, feed, medicinal use and the development of biorefinery concepts can increase the value of the produced seaweed.

Economic Viability of *Boro* Rice Production in *Haor* Ecosystem of Kishoreganj District

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Abstract

The study was carried out to evaluate the economic viability of *Boro* rice production in *haor* ecosystem of Kishoreganj district. A total of 175 rice farmers were selected from Mithamoin upazila on the basis of farm size category following random sampling technique. Data were analyzed with a combination of descriptive statistics, mathematical and statistical techniques. It was found from descriptive statistics that average farm size of the farmers was 0.54 ha, where majority of the farmers were small category. Varietal diversity index (VDI) pointed out that most of the farmers had low *Boro* rice varietal diversity in the study area. The study revealed that *Boro* rice production was profitable and productivity index was very high. Estimates of transcendental production model indicated that power tiller and insecticides cost had significant impact on profitability of *Boro* rice production. It was exposed from the Mann-Whitney *U* test that biotic stress caused lower yield of production. Considering severity ranking model (SRM), the severity of damage was extreme for disease infestation. Following garrett's ranking technique (GRT), lower price of output, early flash flood inundation and lack of short-duration and high-yielding variety were found the major constraints faced by the farmers. The study recommended that short-duration, high-yielding and pest tolerant *Boro* rice varieties should be developed for the farmers. Therefore, proper extension services by the government are necessary to encourage farmers for adopting such technological improvements in order to produce *Boro* rice economically more viable.

Value Chain Analysis of Honey in Bangladesh: Production Practices and Livelihood Status Perspective

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Abstract

The study was designed to develop honey value chain, analyze production practices and stakeholders' activities along with their livelihood status. Primary data were collected from Modhupur upazila of Tangail district, Gurudashpur upazila of Natore district and Birol upazila of Dinajpur district. A total of 6 input suppliers, 60 beekeepers, 3 processors, 3 traders, 6 retailers and 6 consumers were interviewed for data collection. The study depicts that assemble and set up the wooden box with artificial wooden beehives near the fields was the main procedure for honey production. *Apis melifera*

is the major honey bee reared by the beekeepers and the average number of boxes per beekeeper is 50, harvested honey per box per year is around 35 kg. Profitability analysis shows that honey production was profitable and the benefit-cost ratio (BCR) is 1.83. Estimates of logit model indicates that age of household head, educational level, farm size, farm income and non-farm income were the significant factors that influence beekeepers' decision for adoption of honey production. The study identified six actors in honey value chain i.e., input supplier, producer, processor, wholesaler, retailer and consumer. Among the actors, processors added the highest value of total value addition followed by beekeepers. Engagement in different activities of beekeeping had a great impact on their livelihood. SWOT analysis indicates favorable environment for beekeeping as strength, inadequate market infrastructure as weakness, high demand for honey as opportunities, and dominancy of the middlemen as threat, respectively. Lack of credit, lower price of honey as well as lack of storage facilities were the main problems faced by the stakeholders. To overcome the problems as well as to make this business more profitable, the study recommended to form contract based cooperative groups, establish proper storage facilities and provide necessary training by the government and non-government organizations.

Incorporating Salt-Tolerant Wheat and Pulses into Smallholder Farming Systems in 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.

Water Saving Technologies in Bangladesh Crop Farming: Socioeconomic and Environmental Perspective

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Abstract

The study was conducted to evaluate the socioeconomic and environmental impacts of water saving technologies (WST) on *Boro* rice farming in Bangladesh. A total of 480 farmers (80 focal and 400 control) were selected as sample from Mymensingh, Comilla, Bogra and Gaibandha districts. For analyzing the data, a combination of descriptive, mathematical and statistical techniques were used.

The study revealed that 62.5 and 37.5 percent focal farmers adopted alternative wetting and drying (AWD) and system of rice intensification (SRI) methods, respectively. The profitability and productivity of *Boro* rice as well as water productivity was comparatively higher for focal farmers compared to control farmers. It was also found that focal farmers' water requirement was significantly lower than control farmers. Most of the focal farmers (78.8 percent) experienced improved environmental quality after adopting WST. Logit regression model depicted that educational level of household head, farming experience, extension contact and knowledge on WST were found having significant influence in adopting WST by the farmers. The study also revealed that focal farmers' income from rice crops was almost 6.0 percent higher than control farmers. Considering the research findings, some crucial policy recommendations have been arisen which are: i) nourishment of farmers' knowledge about water saving irrigation technologies; ii) arrangement of training programs by different local, national and international institutions; iii) regular extension contact from the view point of extension agents; iv) ensuring the availability of sufficient machineries in the market through import from abroad by the government; v) enhancing direct financial support as well as subsidy programmes by the government to the farmers; vi) accessibility of the farmers to institutional credit; and vii) restricting the overuse of groundwater and use of chemical fertilizers to protect the environment from being damaged.

Financial Profitability and Value Chain Analysis of Pineapple in Selected Areas of Bangladesh

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Abstract

This study was undertaken to estimate the financial profitability and assess the value chain of pineapple in Madhupur upazila of Tangail, Bangladesh. A total of 100 stakeholders were interviewed randomly using a structured questionnaire to collect primary data. The study depicts that 76.7 percent farmers used Giant Kew variety for pineapple production. Profitability analysis shows that pineapple production was profitable in the study area. The study reveals that among the market actors, wholesalers added the highest value (34.2 percent) of total value addition. The study also identified six significant factors namely income, farming experience, credit access, market price, labour availability and lower production of paddy having positive influence on farmers' decision to adopt pineapple production. The study found higher price of inputs, lack of preservation and processing facilities, and lack of operating capital as the major problems for production, value addition and marketing of pineapple, respectively. The study recommended to ensure reasonable price of the inputs along with better infrastructure, transportation and processing facilities to overcome the problems. Furthermore, monitoring facilities of government and non-government organizations should be increased to improve quality of pineapple.

Rural - Urban Migration: Factors behind the Decision of the Farm Households and their Livelihood Analysis

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Abstract

Migration is an important livelihood strategy particularly in rural Bangladesh for poor households. The study aims to analyze the driving factors of migration at the household level, livelihood aspects of the

households. The study conducted mainly based on primary data. 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. Descriptive statistics used mainly to analyze the socioeconomic characteristics of two categories of households. Probit model was used to analyze the drivers of migration. Descriptive results showed that household head age, family size, value of household asset holding, number of economically active males (age between 15-59), old dependent members (age between 60 and above) are significantly higher in the case of households with migrant compared to the households without any migrant member. The results showed that most of the remittance receiving households perceived that poor living conditions (48%), search of work (75%), too many family members (38%), migration network (91%), were the major push factors to drive their one or more members to move into the urban areas. The model results showed that variables household head age, family size, household asset value, household debt positively influence the migration decision of the farm households. On the other hand, variables farm size, household head education, value of livestock holding negatively influence the decision of the households to migrate their member to move into the cities. The study found that monthly income, expenditure, value of housing is higher in the case of remittance receiving households which is statistically significant. Households with migrant are also in a better position in terms of food security, sanitation and drinking water facilities. 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.

Economic Benefits and Impact of Agroforestry Practices on Livelihood of Char Land People in Some Selected Areas of Bangladesh

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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 and impact of agroforestry practices on livelihood of char lands people in 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). It was also found that though majority of the farmers in the study are familiar with agroforestry practice (65%), few of them experienced it. The farmers who adopted agroforestry practices or interested to adopt, expect support (cash or kind) from project or government. The tree species under agroforestry include Akashi, Eucalyptus, Mahogani, Mango, Jackfruit, Guava, Lemon, and Coconut. Results of case studies of agroforestry farmers reveal that agroforestry can be substantially improve the livelihood of char land people. 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.

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Use of Biogas Plant in Bangladesh: Impact, Financial Viability and Future Prospect

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Abstract
Access to cheap, steadfast and workable energy is crucial in achieving many of the sustainable development goals. Biogas is an environment-friendly alternative source of fossil fuel energy. This study was design to measure the intensity of biogas plant uses, investigate the impact of biogas plant on livelihoods, determine the financial viability of biogas plant; analyzes the problems and constrains of the biogas plant faced by the households and examine the future prospects of biogas plant. A total 100 households was selected through multi-stage cluster sampling technique from Mymensingh and Lakshmipur districts in Bangladesh. Data were collected through direct face to face interview by using semi-structure interview schedule. Simple statistical techniques, livelihood approach and financial analytical techniques (NPV, BCR, IRR and NBI) were used to achieve the objectives. The average size of biogas plant was 125 cft gas productions per day. The cost of installation was an average Tk.35400. Water-dung ratio was more than 1:1 in 76% of the plants. Cash in hand, education, health, nutrition, capacity to work, skill and knowledge increased in 92%, 67%, 76%, 72%, 63 %, 54% and network and connection, mutual support, common rules, women empowerment and leadership increased in 59%, 66%, 69%, 62%, 57%, respectively after using the biogas plant. NPV, BCR and IRR were TK.9087.10, 1.25 and 16.70%, respectively. Some problems and constraints were faced by the biogas plant users such as: non-availability of feeding materials, sub-standard quality of construction materials and non-availability of repair and maintenance services. Net benefit increased (NBI) was Tk. 1181.32. The result indicates that the future prospect of biogas plant is positive. There is high need to ensuring availability of feeding materials, equally important is the formulation of quality standards on construction, operation and maintenance of biogas plant giving special attention to the local conditions.

An Economic Analysis of Tilapia-Carp Polyculture in a Selected Area of Bangladesh

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Abstract
Aquaculture is moving on the way of intensification to fulfill the increasing demand of protein as capture fisheries are declining. The study was conducted to identify the socioeconomic characteristics, analyze the tilapia-carp polyculture system, profitability of tilapia-carp polyculture, and credit profile of the stratified randomly selected 50 sample farmers from Sherpur district in Bangladesh. Primary data were collected through field survey using an interview schedule. Some statistical measures like average percentage and ratios were calculated. The findings revealed that 36% of the respondents belonged to the age group of 25-29 years, 68% belong to medium family size (5 to 6 people), 44% respondents' education level was higher secondary, 44% respondents' primary occupation was fish farming and 46 % of were belonged to in annual income level of Tk. 150001-200000. Average fingerlings released in the tilapia-carp polyculture were 24240 per hectare per year. Most of the fingerlings collected from private hatcheries. The annual per hectare production of tilapia and carp were 8028 kg and 11085 kg., respectively. Per hectare per year gross cost, gross margin, gross return

and net return were Tk. 1093008, Tk. 759447, Tk. 1735455 and Tk. 642447, respectively. The BCR of tilapia-carp polyculture for cash cost was 1.78 and full cost was 1.59. About 20% of the respondents took loan from different sources and they received 84.51% of their applied amount and 84.73 % of the loan money used in productive purposes. Mortality of fingerlings, the high price of the ingredient, low price of fish, high interest rate and non-availability of good quality fingerlings at proper time were identified to be the major problems in conducting pond fish production. Government and other agencies should come forward to provide subsidized feed, technical supports and credit facilities for the tilapia-carp fish farmers to make the enterprise effectively.

Nature, Extent of and Reasons for Post-harvest Losses of Fisheries at Farm level in the Developing Countries

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Abstract

Post-harvest loss (PHL) in fisheries is critical because of its impact on welfare and economic growth. However, precise estimation of PHL is more challenging in developing countries mainly due to poor data, unorganized landing points, and markets. This study estimated PHL in fisheries applying the Questionnaire Loss Assessment Method (QLAM) based on random interviews of 2582 fisher folks taking Bangladesh as the representative case to the rest of the developing countries because of its contribution to global fish production and to the local economy. The estimated PHL and monetary value loss were 6.887% and \$82.451 ton^{-1} respectively in capture and 4.071% and \$20.896 ton^{-1} respectively in culture fisheries. Higher monetary value losses were found in rivers and ponds for capture and culture fisheries respectively. However, the estimated post-harvest value loss was higher for *Tenualosa ilisha* and *Puntius chola* in capture and for *Labeo rohita* and *Cirrhinus cirrhosis* in culture fisheries, which were even more at the selling stage compared to the harvesting, packaging, and transportation. Predominantly, the marketing and temperature for physical loss and excess supply for market loss was a critical factor in both fisheries. The implications are that cost-effective reduction of PHL may improve operators' income, food security and reduce poverty.

Consumer Preferences and Willingness to Pay for Pesticide Free Vegetables: A Choice Experiment in Bangladesh

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Abstract

Vegetables are high-value crops and the cultivation of vegetables are increasing day by day. About 142 types of home-grown and exotic vegetables were grown in Bangladesh with production 14.34 million tons in 2016–2017. In Bangladesh, intensive pesticide and chemical fertilizer application has played an important role in raising agricultural productivity to achieve food self-sufficiency since the green revolution. The Department of Agriculture Extension (DAE), Bangladesh has set up some project to disseminate technologies among the producers to produce pesticide free vegetables. Despite the importance of this growing food production method and markets, there is a lack of knowledge about

consumer preferences and willingness to pay for these pesticide free products in Bangladesh. A survey including a choice experiment was conducted at local market in Mymensingh, Gazipur and Dhaka city. Data were analyzed using descriptive methods and a mixed logit model. There was a substantial heterogeneity in preferences across consumers. The results show that the average household consumption of vegetables was highest for potato followed by cauliflower, water gourd, brinjal, sweet gourd, cabbage, tomato, radish and leafy vegetables. Freshness, insect damage free, drit free, greenish leaves, colour, price, cleanliness, safe to eat, good for health and nutritive value were identified as important attributes during buying vegetables. Most of the consumers were known the effect of pesticide borne health risk and suggested to ban some pesticides and monitoring the use of others. Consumers were considered pesticide free product as being safer, healthy, no harmful effect, better taste, more nutritive value, and good for environment, and would like to pay a premium for those products. Different level of contamination, fresh vs not fresh were identified as important determinants in consumers' choice decisions. Consumer preferences for freshness, without contamination in the direction of substantial organic production of vegetables in 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 increasing enterprise development and income generation by smallholder farmers in Chittagong hill tracts region. Enterprise development and income generation has important role in generating employment and enhancing livelihood opportunities of rural people. It is also improving the nutritional status of people. This study was carried out in 2019 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 income and expenditure per household are respectively BDT 215345.07 and BDT 177247.67. People of the CHT consumed 20 food items like rice, wheat, muri, potato, brinjal, leafy vegetables, lentil, soyban oil, total meat, fish, egg, onion, garlic, chili, turmeric, ginger, other spices, milk, sugar, fruits, and daily per capita consumption of above items are respectively 447, 40, 14, 98, 48, 95, 17, 28, 16, 69, 49, 47, 9, 10, 6, 5, 4, 220, 17 and 62 g at the aggregate level. 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 is 1128.35g. Increase of per capita rice consumption increase the calorie and protein intakes. Daily per capita calorie and protein intakes are respectively 2443 kcal and 79g.Overall absolute and hard-core poverty indices on the basis of DCI method are respectively 36% and 16% and they are respectively 45% and 36% on the basis of CBN method. Poverty incidence is the highest in Khagrachari district and the lowest in Bandarban district. 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.

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Impact of Haor Agriculture on Farmers' Livelihood and Rural Markets Development in Netrokona District of Bangladesh

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Abstract
Haor area in northeastern region of Bangladesh is geographically remote, ecologically vulnerable and environmentally isolated where poverty is severe and livelihood is onerous. This study explored status of poverty and livelihood in the haor area focused on examining income determinants of the poor household, exploring the dynamics of poverty and the investigating haor market inefficiencies. A mixed methodology (qualitative and quantitative) of technique is used to analyze the cross sectional primary data collected through field surveys. Data were collected from five villages i.e. Chawrapara, Chandpur, Gaglajur, Mohabbotnagar and Manderbari of Gaglajore union at Mohanganj upazila of Netrokona district. A total of 292 households and 50 market intermediaries were interviewed through a well-structured and pre tested questionnaire. Descriptive and econometric analysis was carried out for reaching the objectives. The result indicated that the average age of household head was higher in Chandpur (44 years), average family size is higher in Manderbari (6 persons), uneducated people is higher in Mohabbotnagar (93.3%) and higher crop cultivation land is in Mohabbotnagar (170 decimal). In terms of household income it is showed that higher income per year is in Chandpur (Tk. 64271). The results demonstrated that the incidence of income poverty is 73% among the sample households of which 29% and 44% can be considered the moderately and extremely poor, respectively. The poor are primarily uneducated, landless, unemployed and female-headed households with the latter two groups constituting the extremely poor strata. The household income of the poor households is highly influenced by credit accessibility, remittances, dry season income, household size, employment status and age of household head. The poor who are uneducated and capital deficient resort to seasonal domestic migration as an income diversifying strategy but one which is largely ineffective. The agricultural markets are mostly inefficient due to limited access to the market and long distance of wholesale market. Persistent poverty and inefficiencies of market have serious consequences on the livelihood strategies of the poor; as current poverty reduction strategies in the *Haor* area have limited impact, there is a need to examine and formulate appropriate policy interventions aimed at generating steady sources of income for the poor households.

Value Chain Analysis of Fish Seed Farms in Some Selected Areas of Mymensingh Division

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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.

Business Performance of Aquaculture Entrepreneurs in a Challenging Context: Does Entrepreneurial Orientation Matter?

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Abstract
Our study intends to offer new insights into the relationship between entrepreneurial orientation (EO) and performance of entrepreneurs operating in a challenging context. Specifically, we analyse the influence of EO and the business environment on business performance of aquaculture entrepreneurs in Bangladesh. Data were collected through a survey using a structured questionnaire from a sample of in total 320 Bangladeshi aquaculture entrepreneurs. An exploratory factor analysis shows that EO dimensions of aquaculture entrepreneurs in this context are innovative, proactive and risk-taking in nature. The results based on hierarchical multiple regression analyses suggest that, next to financial- and human capital (such as, business- experience and training), EO dimensions (explicitly, innovativeness, risk-taking and proactiveness) positively relate to business performance, but barriers in the business environment (for example, infrastructural instability, environmental threats (floods and heavy rains) and political interference) exert a negative influence on it. Our findings contribute to the research efforts directed at understanding the dimensionality of the EO construct and the role that external factor (namely, the business environment) have in explaining performance in a challenging context such as developing countries. This provides the opportunity to gain insights on what EO dimensions can contribute to increase business performances of aquaculture entrepreneurs.

Gender Difference in Access to Soil Health Management Services in Rural Bangladesh

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Abstract
Women's contribution to soil health management is seldom recognized in interventions that aim to improve soil health and land management outcomes even though there are strong linkages between sustainable soil use, management and conservation and gender equality. Gendered inequalities prevail

in access and use of fertilizer that lead to difference productive outcomes. Present study investigates gender-related access barriers to soil health management through qualitative and quantitative survey. A total of 100 households were taken as samples in which both husband and wife were interviewed separately. For qualitative survey, 21 small group interviews (SGIs,) covering 58 people in 34 HHs, including 10 women managing a farm, were conducted. The findings offer various insights into the current sources of agricultural information and training, including those most trusted; experiences of interactions with extension service providers, especially with the formal extension system; interest in accessing additional information/training; and perceived barriers to accessing information and/or participating in training. It is revealed that current access to relevant and appropriate nutrient management resources (training, information and extension) is limited. Access is poor for men and women, but women face additional barriers as the resources available are not promoted or tailored to women. Although men and women did not necessarily express a need for more resources, most people expressed an interest in learning more, and all survey respondents indicated that a lack of knowledge and skills were barriers to changing practice. Financial constraints appear to be a barrier to individuals applying the recommended fertilizer dose along with a lack of site-specific recommendations to help farmers. Study suggested to develop and promote soil testing services to enable site-specific recommendations and arrange needs-specific training for women especially for women managing farms.

Technological Change and Gender Role in Agricultural Activities in Netrokona District

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Abstract

The present study provides a systematic estimate of male female participation in agricultural production and using agricultural technology in Netrokona district. The study was to analyzed the gender role in agricultural activities with respect to the change of technologies and determine their implications for improvement of household status. The study was followed the simple random sampling technique to select 300 sample respondents for household survey through the semi-structured questionnaire. Descriptive analysis such as, number and percentages, rank order was used. Pearson's product moment correlation coefficient (r) was used in order to explore the relationship between the concerned variables. Qualitative, quantitative data analysis and WPI techniques was measured. The findings showed that involvement on crop production about 43.66% of the respondents, where 31% involved in vegetable production and 25 % poultry rearing. There has been significant change occurred with the livestock rearing activities which are 116.79% after adoption in new technology. According to this study, male are involved in decision making in the following activities as reported by the respondents: sale of produce (84%), purchase and repair (78%), weed control (70%), land preparation (76%), where women respondents reported that they are mostly did harvesting 89%, processing 81%, manuring 48% and weed control 59%. It is evident that the perception regarding farming with adoption new technology attain highest score and 2nd highest ranked perception is technical training on technology, similarly the 3rd ranked occupied is adoption in HYV. The experience on modern technology of respondents has a positive coefficient and it was 0.492. 65.2% respondents mentioned women as users of indigenous agricultural or traditional technologies. The information generated from this diverse environment could also be generalized to those areas with similar characteristics, with the hope that the right technology will be targeted to the right population during programme implementation.

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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.

Field Test of Grain Drying Yard Constructed by Waste Ceramic Aggregates

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Abstract
Drying operation of crop grains is the principal operation in the agricultural sector. In the third world country the crop grains is drying mostly over the normal concrete pavement. This study introduce waste ceramic mortar pavement to show the temperature holding capacity between normal concrete and ceramic mortar pavement. Temperature holding capacity is the main function for drying the grains based on sun drying system. For maintaining the good quality of crop grains it is necessary to reduce the excess moisture content of crop grains for maintaining the quality of the grain. In this study, data logger machine with thermocouple used to show the thermal behavior of waste ceramic mortar pavement and normal concrete pavement. Concrete pavement is more suitable for food crop grain drying over waste ceramic pavement. As temperature is comparatively lower in ceramic pavement, ceramic pavement can be used as seeds and other special types of grains drying yard.

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Development of an Environment-friendly Bio-slurry Management System at Farmers' Level

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Abstract
This study aimed to identify the present practices of bio-slurry management and to develop an environmentally safe bio-slurry management system at farmers' level. The performance evaluation of the developed system and its cost-effectiveness are also discussed. The suburban and rural people having bio-gas plant ownership are enjoying the benefit of using biogas but they are languishing with the hazards of managing biogas-spent slurry. The study was accomplished by collecting data from the stakeholders through pretested questionnaires and field investigations in some15 sampled biogas plants of purposively selected areas of Mymensingh, Bogura and Gazipur and, by developing an instrumented device and employing it for slurry management at farmer's bio-gas plant premises. Among these 15 biogas plants, 74% of the farmers used sun drying method, 13% of the farmer used direct dumping method in the rivers or ponds or crop fields and 13% of the farmers do not use any methods for managing bio-slurry. No mechanical or scientific methods are being practiced to manage the bio-slurry properly. The manufacturing cost of the developed device was about 18,000/- with expected life of about 3 years. The cost per year for managing bio-slurry was founded around Tk.4,000 for 2 m^3 biogas plant and Tk.6,000 for 2.4 m^3 biogas plant. The developed cost-effective and portable device would be satisfactorily used for hazard-free biogas-spent slurry management. Both the male and the female farmer would be able to safely handle the device for a hazard-free management/drying of the biogas-spent slurry. Moreover, the water that can be separated easily from the semi-solid bio-slurry can be used as pesticides. Thereby, the use of this technology would financially benefit the suburban and rural people having bio-gas plant ownership.

Comparison of Vegetation Growing Capacity of Porous Concrete for Slope Protection

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Abstract
Slope protection in Bangladesh is very essential for hills, river banks and rural earthen roads. Traditional concrete block is using for slope protection which are not suitable in all cases. These are expensive and heavy weight. In this case porous concrete block can be used which is cost effective & having light weight. On the other hand vegetation is also possible through its pour space which gives natural strength. As new material, physical and mechanical properties of porous concrete such as density, void ratio, permeability and compressive strength was determined to know about the acceptability and usability. Compressive strength was the most important mechanical property. The tests were performed in the concrete and material testing laboratory of Farm Structure & Environmental Engineering Department, Bangladesh agricultural university, Mymensingh, Bangladesh. After 90 days of casting the compressive strength of porous & traditional concrete was found 2151 psi & 742 psi respectively. Vegetation growing capacity is one of the major properties of porous concrete. Four types of block mould were designed for preparing the porous concrete block. And finally one design was selected base on the easiness of preparation and handling, durability during

transportation and self strength. A uniform size (3/4") coarse aggregate (brick khoa) was prepared for making porous concrete samples.Water cement ratio was 0.5 for preparing porous concrete. No fine aggregate was used for preparing porous concrete. At first cement paste was prepared then mixed with coarse aggregate to prepare porous concrete. Selected designed samples were prepared for placing on the natural slope in the experimental site. Traditional concrete (1:2:4) was prepared and placed for comparing the vegetation growing capacity. After sowing the grass seed on the porous and traditional concrete, porous concrete was fully covered with vegetation fifteen days after sowing and traditional concrete was as before. Considering the cost, weight and vegetation growing capacity porous concrete can be used for slope protection.

Design and Develop Improve Storage Technology for Paddy Seeds with Locally Available Materials

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Abstract
In Bangladesh, substantial quantitative and qualitative loss in stored grain is occurred due to a lack of improved storage technology. The study was carried out to design and develop improve storage technology for cereal crops with locally available materials. BRRI dhan49 was collected for the experiment and sun-dried to reduce the moisture content equal to or below 12% at the threshing yard before storage. The experiment was laid out in a completely randomized design (CRD) with three replications and four treatments in the advanced storage laboratory, department of farm power and machinery, BAU. Treatments of the study were metal bin, improved plastic drum, improved plastic bucket, and jute bag. Moisture content, weight loss, insect infestation, storage loss, and germination rate were calculated during storage and after eight months of storage. The O2 and CO2 were monitored first 28 days of storage. Results showed that after the 17th day of the experiment, O2 level dropped to 7.40%, 7.18%, and 7.64% respectively in a metal bin, improved plastic drum, and improved plastic container with a slight increase in O2 level in the last 12th days. At the same time, the level of CO2 was inversely proportional to the levels of O2, which were 13.06%, 13.85%, and 12.01%, respectively, and a slight decrease on the 12th day. The highest moisture content was found at 14.2% in the Jute bag and the lowest moisture content was found at 12.71% in the metal bin. Maximum storage loss was recorded at 11.38% in the Jute bag and the lowest storage loss recorded 0.92% in the metal bin. Dead insects were found in a metal bin, improved plastic drum, and improved plastic container as O2 level decrease and CO2 level increase in developed hermetic storage technology. The highest germination rate (84%) was observed in the metal bin, followed by improved plastic drum (82%), improved plastic container (81%), and lowest germination rate (57%) was recorded in the jute bag. Improved plastic drums and improved plastic buckets are commercially available in Bangladesh's local market. However, the metal bin can be easily manufactured in different sizes up to 3 tones capacity by local artesian with locally available materials. Therefore, developed metal bin storage technologies could be an effective paddy storage technology for reducing quantitative and qualitative storage loss and enhances the livelihood of smallholder farmers in Bangladesh.

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Design and Development of a Power Operated Seed-cum-Fertilizer Distributor

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Abstract

Seed broadcasting is a prevalent seed sowing technique in Bangladesh. To make broadcasting handy for farmers, this study was undertaken to develop an power operated seed broadcasting mechanism as a modification of BAUZIA seed-fertilizer distributor. The hand operated BAUZIA seed-fertilizer distributor was further designed and modified with a motor operated rotating arm in the department of farm power and machinery of Bangladesh Agricultural University, Mymensingh to broadcast seeds and granular fertilizers in the field. The concept of "Kinematics of particle" and "the principle of the gravity drift" were applied in designing the machine. Experiment was conducted for determination of uniformity co-efficient of distribution (UCD), field capacity, field efficiency of the machine and application rate of the seeds (wheat) and fertilizer (fine urea and TSP). The UCD of the seed and fertilizer were determined by collecting paper box method and compere with that of traditional hand broadcasting method. This simple mechanical device of 5.4 kg weight was designed to carry on the shoulder of an operator during operation. Normally, the UCD of traditional hand broadcasting system ranges between 40% to 70%, depending on the operator's skill. In the laboratory test, the average UCD of the developed machine at a beater speed of 900 rpm for wheat was found as 83.9±0.4%. The average effective field capacity of the machine was calculated as 0.52 ha/hr and field efficiency was found as 81%. The seeds application rate was found 113.4 kg/ha. The extensive performance tests conducted in the laboratory's testing bed indicate that the seed- fertilizer distributor could be used by farmers in their field.

Quality Control of Welded Structures for Fabrication of Sustainable Agricultural Machinery in Bangladesh

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Abstract

There is no alternate of quality welding for permanent joining of metallic materials. Welding is widely used in all sectors. So, it is necessary to inspect quality of welding parts. In Bangladesh, generally the quality of welded structures is not checked in most of the cases. In the study, two methods namely tensile strength testing method and DC four terminal method were used to inspect welding quality. All tests were performed at Electrical Engineering Lab and Strength of Materials Testing Lab, Bangladesh Agricultural University. Mild steel (MS) flat bar, MS square bar and MS round bar were used as specimens in the study. For tensile strength method, tensile strength of the specimens was taken before welding and after welding. Then, relative strength or joint efficiency was calculated using standard method. Both yield and ultimate strengths without welding were found higher than that of the samples with welded joint. The joint efficiency of square bar and round bar were found 83.88% and 74.60% based on ultimate strength and 90.7% and 68.6% based on yield strength, respectively. In four terminal voltage drop technique, before welding and after welding conditions the voltage drop were measured

on all specimens. Voltage drop on the same specimen after welding was found higher than without welding. It indicates that higher resistance in the current flowing path at the welded region was developed than the base metallic region. It is also indicated that materials properties and bonding nature at the welded points were not exactly similar to the base metal. In this way it is possible to know the quality level of welded part in comparison to base metal. From the study, it is found that four terminal voltage drop technique is less time consuming and economic than tensile strength method for quality inspection of the welded joint.

Bio Energy Potential from Agro-Industrial Wastes in Co-digestion with Dairy Manure

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Abstract
Biogas produced from renewable resources could play a vital role in solving energy and environmental problems for growing number of both livestock and poultry farms in Bangladesh. The Green energy Knowledge Hub with modern biogas lab facilities has been established at the Department of Farm Power and Machinery, Bangladesh Agricultural University, Mymensingh. The wastes generated from dairy farms and biomass from the field could be used as feedstock for biogas production and gas optimization. In this regard, GEKH (Green Energy Knowledge Hub) investigated the biomethane potential of selected biomass and explored the co-digestion effect of dairy manure with potential biomass on biogas production. Corn, corn stalk, corn cob, rice husk and rice bran these five were used to test their bio-methane potential. Batch study was conducted in incubator at a constant temperature 35˚C and the retention time was 60 days. Batch study of selected agricultural waste revealed that corn cob was generating more biogas and methane and degradability of corn cob is higher than the other wastes so the biogas generation period is longer. The highest cumulative biogas production for corn cob is 2094 ml/g VS during the batch assay. Selected agricultural waste revealed that corn cob was generating 18-24% more biogas than others. Co-digestion of dairy manure with corn cob gave higher volume of gas production and methane content then single digestion of corn cob. Volume of biogas in every reactor varies into a range of 0.4-0.6 ml/gm VS daily and the methane percentage varies between 47-58%. The capacity buildings of students and other stakeholders have been enhanced through long- and short-term training, respectively on biogas production.

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.

Post-Harvest Loss Reduction Innovation Lab (PHLIL)-Bangladesh Phase II

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Abstract

Paddy is the staple crop of Bangladesh. Farmers and BADC produce paddy seed and store in gunny bag. Sun-drying of paddy is unreliable and inefficient resulting in post-harvest loss of paddy and seed quality deterioration during storage. Major rice mills need meso-scale dryer to sustain in the market. Hence, the project aims to identify and adopt appropriate paddy drying and storage technologies for farmers, major rice mills and government organizations to reduce post-harvest loss and improve grain and seed quality. The adapted LPG based BAU-STR dryer was found a sustainable paddy drying technology for the farmers. Several field demonstrations, FGD, and training programs of BAU-STR dryer, hermetic bag and gender sensitization (M: 91, F: 133) were conducted in the Mymensingh, Netrokna, Bogra, Jashore, Jhalokathi and Barishal districts of Bangladesh and positive feedback was obtained about the technologies. To identify the appropriate size of mechanical dryer for major rice mil, necessary data of 22 rice mill of Mymensingh division were collected and analyzed during the Aman season of 2020. A 12 ton per batch capacity dryer would be an appropriate option for major rice mill. The dryer will optimize the capacity utilization of the major rice mills to 72.5%. Hermetic cocoon and hermetic bag were compared with gunny bag in case of Boro paddy at BADC seed processing centers (Balashpur and Madhupur) during July-October 2020. Moisture content of paddy remained unchanged in hermetic cocoon but slightly fluctuated in gunny bag. Seed germination rate increased from 89% to 91% in hermetically stored seed but fallen to 84.25% in gunny bag. O_2 level decreased from 19.86% to 3.70 % whereas CO_2 level increased from 0.44% to 11.24% during observation, preventing molds development in cocoon, making it suitable for storage.

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Training and Implementation of Off-Farm Hermetic Grain Storage in Bangladesh

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Abstract
Bangladesh is an agriculture based country and storage of paddy is a common practice in farmers/traders/millers levels to meet year round consumption, high selling price during off season and seed for the next season. Hence, storage of paddy is one the most crucial postharvest operations in Bangladesh. In traditional storage system- insect, rodent and atmospheric conditions cause both qualitative and quantitative losses of stored paddy. Therefore, alternative improved storage technologies need to be introduced which allows paddy to be stored safely for extended periods. In the study, the main objective was to assess the performances of alternative hermetic cocoon storage system along with the traditional storage practices at miller level. Five storage approaches namely, PVC indoor, PVC exposed, laminated PE indoor, laminated PE exposed, PE indoor, traditional indoor and traditional exposed were considered. *Aman* paddy (BRRI Dhan49) was used to store in 5 ton capacity of each cocoon along with traditional storage practices. Paddy was stored during January 18, 2020 to May 10, 2020. O_2 and CO_2 levels, moisture content, insect infestation, storage losses and germination test were conducted with standard methods. O_2 and CO_2 concentrations were changed from 21% to 2.3% and 0.4% to 13%, respectively. Maximum insect population was found in traditional indoor (TRI) storage system (about 18 insects/ 250g paddy). No insect was detected in hermetic cocoon LPEE, LPEI and PE. Maximum weight loss of paddy was found 8.17 kg/100 kg in TRE. The highest storage losses of paddy were observed in TRE (8.2%). Almost negligible amount of storage losses were observed in hermetic cocoons. Farmer will get return on investment after two seasons (1 year) of storage in PEI type hermetic cocoon. Based on the performances and user friendly status, PEI type hermetic cocoon is feasible to use in the miller/trader/farmers level for consumption purpose.

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.

Detection and Quantification of Plant Leaf Disease In-Field Using Image Processing Technique

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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 guidebook 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 color information binary images were split into the diseased and non-diseased parts. 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.

Machine Vision System for 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. At first, soil images were captured using a CANON EOS 800D DSLR camera (24.2 megapixels) and RGB images were converted into L*a*b images for further analysis. Later, thirteen features - contrast, correlation, energy, homogeneity, mean, std. deviation, entropy, RMS, variance, soundness, kurtosis, sharpness, IDM from soil image was extracted for the development of a multivariate classification model. Four multivariate classification algorithms namely linear discriminant analysis, logistic regression, linear-SVM and medium-KNN were applied to classify soil samples based on the difference in the content of SOC, pH, Total N, P and S. It was apparent that the classification accuracy of all four models was nearly similar. However, higher accuracy was obtained from linear SVM and Medium-KNN method i.e. 80%. Though this classification accuracy seems good, but needs further improvement of the model since the classification accuracy of a multivariate classification model greater than 90% is preferable. Finally, it could be concluded that machine vision technology has a good prospect to assess soil properties.

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.

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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.

Yield and Water Productivity of Sunflower Under Deficit Irrigation

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Abstract
A field experiment was carried out at Field Irrigation Laboratory of the Department of Irrigation and Water Management, Bangladesh Agricultural University, Mymensingh during December 2019 to April, 2020. The aim of the study was to investigate the impact of water stress on yield and yield components of sunflower under different irrigation treatments, and to determine the water productivity under different irrigation conditions. 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.

Seeds of sunflower were sown in line with spacing of 70 cm x 30 cm. 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) were applied. The experimental fields of T5 treatment were watered at each growth period. In T3 treatment, fields were watered at flowering and grain filling stage. In T2 and T4 treatment, fields were watered at flowering and grain filling stages, respectively. T1 treatment was rainfed (no irrigation). Plant height development was determined by measuring (from soil surface to growing tip) five plants for each plot prior to each irrigation application or at 10 days apart. From the harvest data effective and non-effective seed number, seed yield, biomass yield, dry matter yield and harvest index were determined. The highest plant height (177.78 cm) was obtained from T5 treatment. All the yield parameters were highest in T5 treatment.The lowest seed yield (2.67 t/ha) and harvest index (0.33) werefound in T3 treatment.The highest water productivity (114.69 kg/m^3) was obtained from T4 treatment and second highest from T2 treatment. This study concludes that irrigation only flowering stage is preferable due to superiority in seed yield with higher water productivity where water is a limiting factor.

Investigation of Nitrate Leaching From Rice Cultivation for Different Fertilizer Application Rates in a Lysimeter Study

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Abstract
Nitrogen, fertilized in rice fields, subjects to leaching and makes it way to ground- and surface water and is of increasing environmental degradation concern because it causes hypoxia, loss of biodiversity, and habitat degradation in ecosystems. This study investigated the leaching of nitrate nitrogen from a double cropping rice cultivation system under the conditions of usual water management and different fertilizer application rates. Three nitrogen application rates, such as low (100 kg N/ha), medium (200 kg N/ha), and high (300 kg N/ha) were used along with a treatment without any nitrogen application to serve as a control. Nitrate nitrogen leaching was investigated in Boro and Aman seasons for two rice cultivars, BRRI 29 and BINA 7, respectively. Agronomic and yield characteristics showed better performance with increasing nitrogen application rates, which was expected. NO3-N concentration observed in leachate samples ranged from 0.61 to 14.8 ml/L, which is below the allowable range of drinking water for human consumption. Rate of fertilizer application has been found no correlation with the concentration of nitrate nitrogen in leachate from rice fields. Results of this study is expected to help water and fertilizer management for better environmental management.

Effect of Soil Texture on the Performance of Different Conservation Techniques for Irrigated Rice Cultivation

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Abstract
An experiment was conducted at the Central Farm and Field Irrigation Laboratory of Bangladesh Agricultural University(BAU), Mymensingh, to investigate the water productivity, growth and yield

characteristics of 'BRRI dhan 28' during Boro season from 4 February to 11 May, 2019 and 26 January to 8 May,2020 with two different soil textures (silt loam and loam) and three different irrigation techniques namely Alternate Wetting and Drying (AWD), Raised Bed (RB), and the conventional Continuous Flooding (CF) method. For this purpose, the experimental layout was made with 12 plots. The three irrigation techniques/treatments were laid randomly with three replications for each treatment. It was observed that seepage and percolation in CF treatment was higher than that of AWD and RB. Highest yield (6.70±0.04 t/ha) was found for 15 cm disappearance AWD (irrigation when water level falls to 15 cm depth from ground surface) for silt loam soil and the corresponding yield for loam soil was 6.53±0.50 t/ha under AWD 10 cm treatment . CF irrigation yielded lowest harvest for both soils (5.47 ± 0.05 t/ha for silt loam and 5.28±0.19 t/ha for loam). For both soil textures (silt loam and loam), CF treatment required higher amount of water over the conserving treatments (AWD and RB) that showed greater productivity. For silt loam soil, AWD technique performed comparatively better than other techniques specially 15 cm AWD and 10 cm AWD for loam soil because it requires minimum water for rice cultivation and its water productivity was maximum.

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, to develop a mathematical model to calculate optimum distance between furrows in Raised Bed (RB) water management method for rice cultivation. BRRI dhan 28 was grown during the Boro season (14 February to 27 May, 2020). There were four irrigation treatments consisting of three treatments for different bed sizes (25, 45 and 65 cm) of RB irrigation and one for Conventional Flooding (CF) irrigation treatment. Each treatment had three replications. The average highest yield was found to be 4.96±0.124 t/ha for 45 cm RB technique and its water productivity was also higher (0.50±0.014) kg/m^3 compared to CF and other RB treatments. The average lowest yield was found to be 3.703 ± 0.494 t/ha for 65 cm RB technique. Of the all treatments, CF required highest amount of water, thereby, resulting in lowest water productivity. It was found that RB technique with 65 cm bed size required the lowest amount of water and saved almost 33.50 percent irrigation water over the CF method. For the 45 cm and 25 cm RB treatments these values were 30.25 and 26.04, respectively. Darcy's infiltration model showed a good relationship between the measured and calculated infiltration rates with mean R^2 value of 0.994 for all bed size in RB technique which can be used in predicting infiltration characteristics. Though 65 cm RB required lowest amount of water, its yield was found lower than that of 45 cm RB. The 45 cm RB treatment produced highest water productivity (0.50±0.014 kg/m^3) and grain yield (4.96±0.124 t/ha). Sufficient water could not be reached to the central portion of 65 cm RB which caused its lower productivity (0.371±0.045 kg/m^3). For 25 cm RB 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 (0.38±0.033 kg/m^3). 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.

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Rice Yield, Water Productivity and Nutrient Loss as Affected by Integrated Water-soil-waste Management

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Abstract

Animal manure application to cropland increases soil organic matter and recycles nutrients at the farm level. A study was conducted using a field lysimeter during four rice seasons to assess the effects of dairy manure application on water losses, nutrient leaching, and rice yield compared with chemical fertilization. Water input and output from the lysimeter, plant growth, and yield data were recorded. Leachate and ponded water samples were analyzed for nitrogen and phosphorus content. The manure application increased soil water content by 3–4% but did not affect percolation loss that ranged 44–64% of input water in silt loam soil. A mathematical model HYDRUS-1D adequately simulated water fluxes in the rice field (CD= 0.37–1.41, NSE = 0.18–0.85, and R^2= 0.62–0.91). The model predicted percolation with only 0.3–8.5% overestimation and evapotranspiration with only 0.8–4.2% underestimation. Average evapotranspiration loss was 4.2–4.6 mm/day for different years. The leaching concentrations of nutrients were higher for the chemical fertilization (1.5–6.7 mg N/L and 0.02–0.37 mg P/L) in several leaching events during the study period compared with the manure treatment (1.1–5.9 mg N/L and 0–0.26 mg P/L). Overall, fertilization with animal manure reduced the leaching load of nitrogen by 13% and phosphorus by 23.6%. On the other hand, manure application increased the runoff loss potential of N and P in several sampling events. The soil persistence of nutrients was higher in the manure-treated soil (1.42 g N/kg and 0.055 g P/kg) than under the chemical fertilization (0.81 g N/kg and 0.012 g P/kg). Manure application increased rice yield by 15% and water productivity by 0.07 kg/m^3 by augmenting soil water availability during the drying cycle of alternate wetting and drying irrigation. The findings will help appropriately manage animal manure in agricultural fields.

Water Fluxes, Water Footprint and Maize Yield as Affected by Water Management Techniques: Experiment and Modeling Approach

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Abstract

Maize cultivation is increasing rapidly in Bangladesh. As a dry season crop, it faces water scarcity in some parts of the country, so appropriate water conservation practices are needed. Hence, the effects of different deficit irrigation techniques on maize yield, water balance, and water footprint were investigated through lysimeter and field experiments. There were four treatments: (i) full irrigation, (ii) irrigation at upper-half root zone (RZ) only (upper-RZ), (iii) irrigation at one-side of RZ only (side-RZ), (iv) irrigation at one-side of RZ alternatively (alternate side-RZ), and (v) no irrigation (rainfed). Soil water content, plant growth, and yield data were recorded. A mathematical model called HYDRUS 1D was calibrated and validated, and then the model estimated water fluxes in the RZ. The model performance was satisfactory, i.e. RMSE = 0.6–2.3%, CD = 0.37–1.41, NSE = 0.18–0.88, and R2 = 0.62–0.91. The actual evapotranspiration was 3.3–3.5 mm/d with a crop coefficient of 0.77–0.83

and seasonal percolation loss was 30–51% of infiltrated rainwater. In the lysimeter, the side-RZ irrigation (7.4 t/ha) did not reduce maize yield, but the upper-RZ treatment (6.9 t/ha) did, compared with the full irrigation treatment (8.3 t/ha). In the field, the full irrigation (7.9 t/ha) did not increase yield than the side-RZ (8.5 t/ha) or upper-RZ (7.2 t/ha) treatments. However, the side-RZ irrigation gave a 20% higher yield than the upper-RZ irrigation. The irrigation water footprint of maize for the deficit irrigation treatments ranged 238–261 L/kg in the lysimeter and 118–141 L/kg in the field, and for full irrigation treatment, it was 435 and 257 L/kg in the lysimeter and field, respectively. Due to the groundwater contribution to the root water uptake, the field soil required 120 and 178 L/kg less water for the deficit and full irrigation treatments, respectively.

Water Governance and Management Assessment to Improve the Production Potential in G-K Irrigation Project

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Abstract
The Ganges–Kobodak (G-K) irrigation project has been performing at much lower than the expected level and water governance and management are thought to be the reasons. This study evaluated the existing water governance and management of the project and provided guidelines for their improvement. Each tertiary canal of the project covers head, middle and tail ends of a large area. So, representative areas under tertiary canals comprising head (Mirpur upazila of Kushtia), middle (Alamdanga upazila of Chuadanga) and tail (Shailkupa upazila of Jhenaidah) ends of the project were selected for this study. For each site, one relatively good- and one relatively poor-performing water management groups (WMGs) were selected. Primary data on water governance and management were collected through household survey, Focus Group Discussion (FGD), and Key Informant Interview (KII) by using structured questionnaires, checklists and guidelines, respectively. Secondary data were collected from the G-K Project Office, Upazila Agriculture Office and other relevant offices. The data were analyzed statistically, mostly by using Likert's scale. The results reveal problems of water governance in terms of transparency, financial accountability, decision-making for budget usage and O&M of water regulators, administrative management, and conflict management of WMGs. Major biophysical factors affecting water governance and management are status of hydraulic structures, canal networks, and on-farm water management. Major socio-economic factors include irrigation service charge, man-made obstacles, level of participation in WMG activities, access to water, and physical participation in operation and maintenance of water gate and regulator. The biophysical and socio-economic factors vary between good- and poor- performing WMGs, and among the head, middle and tail sections of the canals. The tail section faces more problems and head section faces minimum problems in terms of both water governance and management. Water management organizations need to be run as per their set rules and regulations and lessons of good-performing WMGs need to be replicated in poor-performing cases.

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Low Cost Process Development for Commercial Production of Soya Sauce

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Abstract
Soy sauce production, *koji* is prepared by the solid-state culture of steamed soybeans and parched wheat with seed spores of *Aspergillus oryzae* for 2-3 days. Hydrolysis by various enzymes, lactic acid fermentation by *Pediococcus halophilus,* and alcohol fermentation by *Zygosaccharomyces rouxii* take place. This study investigated the relationship between the enzyme activity and the amount of seed koji, proportion of raw materials and the duration time of koji, respectively. Standard of high-quality of seed koji was germination rate >90%, spore count >109 ($A \cdot g^{-1}$). With the increase of the amount of the seed koji, the protease activity was significantly increased but once more than a certain numerical, protease activity declined due to lack of space. When the ratio of raw material was 5:5, the protease activity reached a maximum. Meanwhile, the protease activity attained the highest at 36 hr. Once more than 35 hrs, *A. oryzae* began to pick spores and affect the generation of the protease. During the fermentation of soy sauce, proteins in the raw materials were hydrolyzed into small molecular including peptides and amino acids by the proteases produced from *A. oryzae*. HPLC analysis found five fatty acid in the both method prepared soy sauce. In fermentation process of the soy sauce, the level of the protein content was very important. In addition, the fatty acids components in the method B exhibited a higher unsaturated fatty acids content, the linoleic acid content in crude fat of 51.61%, γ-linolenic acid content in crude fat of 0.55%. Linoleic acid, α-Linolenic andγ- Linolenic acid were the essential fatty acids of the human body. Thereby, method B had advantages to be the fermented soy sauce. HPLC analysis suggested that there are 18 amino acid in the soy sauce with significant amount of essential and branched chain amino acid.

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.

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.

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.

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Seed Production of Gangetic Leaf Fish, *Nandus nandus* Through Domestication and Induced Breeding

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Abstract
Recently, artificial breeding using PG extract of *Nandus nandus* has been worked by some researchers. However, the seed production has not been yet successful due to problems in handling and larval rearing. Wild meni of different sizes from different sources were collected and reared in ponds with water hyacinth substrate. Fish were stocked (30/dec) in three ponds and were provided feed; pond without commercial feed, pond with 30% protein meal and pond with 40% protein meal were considered as treatment T_1 (control), T_2 and T_3, respectively. Highest growth in terms of wt. was found in T_3 (male 35.06±0.95, female 62.46±0.64) followed by T_2 (male 29.56±0.94, female 52.72±2.44) and T_1 (male 25.80±1.64, female 46.60±1.14). Synthetic hormone (GnRH) trade name is Ovupin and PG extract were used for induced breeding of *N. nandus*. Doses of ovupin and PG extract were 0.5ml/kg and 4 mg/kg BW for female and 0.25 ml/kg and 2 mg/kg BW for male, respectively. Single dose was used for both male and female. Ovulation period was recorded 10-12hrs after Ovupin injection and 8-10hrs after PG extract injection. Hatching of fertilized eggs were started 17-18hrs and 18-20hrs after fertilization in Ovupin and PG extract, respectively. However, fish injected with PG extract and Ovupin do not show much difference in fertilization rate 80.05% and 79.99%, respectively but hatching rate was little bit higher in case of PG extract 89.99% than Ovupin 86.99%. In both cases it was very difficult to determination of survival rate of larvae due to high mortality. During experimental period more than 90% of larvae were died within a day due to high temperature of the environment (37^0C). Results showed that either synthetic hormone or PG extract may administer as inducing agents for *N. nandus* spawning. The most critical condition of this research was the survivability of larvae. Therefore, further work is needed for artificial seed production of *N. nandus* to protect the biodiversity of meni fish.

Gonadosomatic Index and Gonad Histological Assessment of Indian River Shad, *Tenualosa ilisha* During Early Gonadal Development in the Selected Habitats of Bangladesh

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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 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.

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 ($p<0.01$).

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. 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. 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 highest annual income of fishers was found 20,080 and 24,000 BDT per year at Chandpur and Patuakhali districts, respectively. The results of the present study revealed that the fish species are decreasing day by day in these rivers due to the effects of climate changes.

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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.

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.
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Effects of Dietary Poly Unsaturated 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 Ca2+ 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.

RNA Seq Analysis and Genome Annotation of Hilsa Shad (*Tenualosa Ilisha*)

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Abstract
Information on genomics of hilsa shad *Tenualosa ilisha* is scanty. 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 kidney were collected from live fish of the river Meghna and total RNA was extracted from the tissues using Trizol Kit (QIAGEN). The poly(A) mRNA isolation was performed using Poly(A) mRNA Magnetic Isolation Module. First strand cDNA was synthesized using ProtoScript II Reverse Transcriptase and the second-strand cDNA was synthesized using Second Strand Synthesis Enzyme Mix. Size selection of Adaptor-ligated DNA was then performed using beads, and fragments of ~400 bp (with the approximate insert size of 300 bp) were recovered and amplified by PCR. 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. The sumlength of sequence was 93270161 bp, average length was 1044 bp, minimum length was 80bp and the maximum length was 17176 bp. We have detected transcripts of 46749 proteins. From the whole transcripts of the liver, we have identified the transcript of 20 genes of seven gene families which are involved in osmoregulation through ion-balance. The genes families include: Aquaporin, Apolipoprotein a-iv, Solute carrier family, Serine threonine-protein kinase, Rho GTPase-activating protein, ATPase-activating protein, Mitogen-activated protein kinase. We have also identified transcripts of two gene family namely metabotropic glutamate receptor and protocadherin which were found to involve in migratory behavior of rainbow. The RNASeq study has created an opportunity to identify important genes from *T. ilisha*.

Captive Rearing of Indigenous Mohashol *Tor Tor* in Ponds Using Two Formulated Feeds for Broodstock Development

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Abstract

For development of broodstock in captive condition, a number of juveniles of *Tor tor* (Someshwari river-origin) were collected from Durgapur, Netrokona and stocked in ponds at BAU campus. For 12 months growth study, two ponds (6 decimal each) were stocked with 16 fish in each at 1500-2000 kg/ha in February 2020. The initial mean length and weight of fish in pond-1 were 59.54cm and 2730g, and in pond-2 were 59.17cm and 2818.75g, respectively. Two formulated feeds containing 37.65% protein (Treatment-1) and 44.02% protein (Treatment-2) were prepared using locally available ingredients such as fish meal, mustard oil cake, soybean meal, rice bran, vitamin-mineral premix and provided in pond-1 and pond-2 respectively at 5% body weight of fish twice a day. To observe the length and weight increment in both treatments sampling was done in each month and during sampling all the fish were caught to observe the growth and health condition. Some secondary sexual characters such as size of abdomen, genital papilla, fins etc. of fish were also checked to understand the progress of maturation. The growth data from February to June 2020 showed that fish in both treatments increased slowly but steadily, and in June 2020, the mean length and weight in T_1 were 59.86cm and 2763.59g, and in T_2 were 59.77cm and 2855.88g, respectively. Water quality parameters such as temperature, dissolved oxygen and pH were recorded daily at 9 am and 3 pm in both ponds and the range of water temperature, dissolved oxygen and pH in pond-1 were 25.9 to 32.1^{o}C, 4.8 to 6.9, pH 7.5 to 8.5; and in pond-2 were 25.2 to 32.5^{o}C, 4.8 to 6.8, 7.3 to 8.6 respectively. It is expected that breeding trials and cryopreservation of sperm will be conducted after maturation of fish during June to September, 2021.

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Effects of Exogenous Multi-Enzyme Supplementation to Wheat-Based Diets on Growth Performance, Nutrient Utilization and Intestinal Histology of *Ompok Pabda*

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Abstract
A study was conducted to evaluate the effects of supplementation of an exogenous multi-enzyme in feeds substituting different levels of fish meal (FM) with wheat bran (WB) on growth performance and general health status of *Ompok pabda***.** Four diets were prepared by replacing fish meal at the rate of 25%, 50%, 75% and 0% with wheat bran and considered as feed-1, feed-2, feed-3, and feed-4 (control), respectively. First three diets were supplemented with the multi-enzyme (β-xylanase and β-glucanase) at the level of 0.2% whereas no enzyme was included to control. Each cistern was stocked with fifty (50) *O. pabda* having initial weight of 2.94±0.21 g and fish was fed with the diets twice a day at 5% of body weight for four months. Sampling was done twice a month for examining the growth of fish. Liver, stomach and intestine of fish were collected for histomorphometric analysis. In initial sampling periods, the growth parameters were found higher in feed-4 (control) compared to other feeds. But after 120 days of rearing, growth parameters were found significantly ($P<0.5$) higher in fish fed with feed-1, feed-2, and feed-4 compared to feed-3. Significantly ($P<0.05$) higher hepatosomatic index (HSI) and lower digestive somatic index (DSI) were also observed in feeds 1, 2, and 4 compared to feed-3. There were no significant differences in the intestinal absorptive surface area and number of goblet cells in either intestinal region. The activity of amylase in the hepatopancreas and intestine was improved by dietary multi-enzymes. The level of RBC was higher in fish fed the enzyme supplemented diet compared to control diet. Considering the above result it recommended that as a source of protein replacement of FM up to 50% with WB is possible without any adverse effect on the growth performance and health condition of *O. pabda.*

Improved Genetic Variation of *Labeo Ariza* Through Diallel Cross Scheme Manifested by Molecular Marker Characterization

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Abstract
Diallel cross is a breeding scheme that is used to estimate the combining ability and the effects of reciprocal crosses among strains or varieties. The objective of the present study was to evaluate the genetic variation in diallel crosses of the Minnow *Labeo ariza* originated from three geographically separated rivers in Bangladesh. A complete (3×3) diallel cross was performed as a starting point for a stock improvement program of the species for aquaculture. Forty eight mature broods (16 from each riverine stock with 1:1 sex ratio) were successfully induced bred with carp pituitary extracts and used for producing intra-species intra- (three) and inter-stock (six) cross groups, designated as Group1 (Kangsha♀×Kangsha♂), Group2 (Jamuna♀×Jamuna♂), Group3 (Atrai♀×Atrai♂), Group4 (Kangsha♀×Atrai♂), Group5 (Kangsha♀×Jamuna♂), Group6 (Atrai♀×Kangsha♂), Group7 (Atrai♀×Jamuna♂), Group8 (Jamuna♀×Kangsha♂) and Group9 (Jamuna♀×Atrai). Genetic variation among the nine different groups was assessed by genotyping four microsatellite markers viz. Lr3, Lr22, Lr24 and Lr27. The genetic variations in four of the six cross-bred groups were higher than those of the three parental groups. On the basis of allelic richness and genetic diversity, Group4 (K♀× A♂)

was considered superior for continuing the stock improvement programme for *L. ariza*, kept as a reference stock for advancing this group for facilitating future breeding and selection programmes be undertaken in carp hatcheries of Bangladesh and elsewhere.

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.

Landmark-based Morphometric Analysis Underlying the Effect of Line Breeding Program on the Growth of Bhagna, *Labeo Ariza* (Hamilton, 1822) Populations Implicated for Muscle Development

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Abstract

As Bhagna (*Labeo ariza*, Hamilton 1807) is declining in natural waterbody, it is high time to consider the issue and focus on quality seed production of this fish and thereby the present research was

undertaken. *L. ariza* from three distinct river (The Kangsha, the Atrai and the Jamuna) were collected and subjected to form six breeding line having 15 species in each line. The progeny from these lines have been inspected phenotypically to assess the structure and shape variation of the population based on landmark, morphometric and meristic characters. One-way ANOVA disclosed that all morphometric, meristic and truss system measurement were dissimilar among the six lines and line 4 exhibited significantly higher growth in all aspect. For the morphometric and truss measurements, discriminant functions graph exposed a well detached groups of six lines representing that the values differ significantly among the lines. The dendrogram constructed by means of morphometric and landmark data displayed one leading clusters of line 4 connected with all other lines combinedly. Dissimilarity among six lines of *L. ariza* in morphological point of view may be due to their ancestors born in separate environment and distinct geographical location. As the best growing line has been identified, the out comes from this research will be much more beneficial for prompting the culture of this species as well as for proper conservation, successful management and for conducting further research by scientific community.

Restoration of Indigenous Koi (*Anabas testudineus*) Through High Quality Seed Production by Line Breeding Trial in Bangladesh

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Abstract

An experiment was carried out for quality seed production of indigenous climbing perch, *Anabas tesudineus* using line breeding technique. Live fish were collected from three geographically distinct natural water bodies in Mymensingh division i.e. Kailla beel, Mymensingh (Mk); Salakandi beel Mymensingh (Ms) and Shamganj beel, Netrokona (Ns). Fishes were reared in cages using commercial feed with vitamin E. Length and weight gain per month was found to be highest in Ns (1.45±0.32cm and 6.34±1.34g) followed by Ms (1.29±0.87cm and 5.41±1.23g), Mk (0.85±0.75cm and 4.43±1.48g). The GSI were recorded highest in April and lowest in June. Furthermore, the water quality parameters, such as (Temperature 29.6±0.6°C, pH 8.9±0.1, DO 5.58±0.45 mg/L, Total alkalinity 117.23± 13.45 mg/L, Ammonia-Nitrogen 0.27 ±0.5 mg/L) were acceptable for fish culture. Three conspecific line groups were produced by cross breeding between Kailla beel (♀)× Kailla beel (♂) (Mk × Mk); Salakandi beel (♀) × Salakandi beel (♂) (Ms × Ms), Shamgonj beel (♀)× Shamgonj beel (♂) (Ns× Ns) using PG extracts at 6 mg/kg for females and 2 mg/kg for males. The conspecific line groups were considered as Line 1, Line 2 and Line 3, respectively. Similarly, three heterospecific line group (Salakandi beel (♀) × Shamgonj beel (♂) (Ms × Ns); Kailla beel (♀) × Salakandi beel (♂) (Mk × Ms); Shamgonj beel(♀)×Kailla beel(♂) (Ns × Mk) were produced through cross breeding and considered as Line 4, Line 5 and Line 6, respectively. Among them, Line 4 showed the highest result in case of fertilization (82.43±1.56%), hatching (93.79±1.96%) and survival of larvae (77.54±2.21%) which was significantly ($p<0.05$) different from other line groups. The highest weight gain per month, length gain per month and SGR (% day) were 7.23±1.69g, 1.81±0.05cm and 1.49±0.15% in Line 4. Hyperplastic small diameter muscle fibers were influenced according to the crossing pattern where small diameter muscle fiber (<20µm) in Line 4 showed significantly ($p<0.05$) higher number during muscle morphometric analysis. Similarly, the number of muscle fiber (21 to 30µm) and large diameter muscle fiber (<30µm) in Line 4 was higher than other treatment which denotes that heterospecific line group especially Line 4 has superior breeding and growth performance than the conspecific line groups.

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Effects of Probiotics on Health Status of *Anabas Testudineus* Cultured Under Pond Condition

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Abstract
Present study was conducted to determine the effects of probiotics on the growth performances, gut and liver histological changes, hematological changes and gut bacteriology of *A. testudineus* reared under pond condition. The experiment was designed with fifteen earthen ponds (0.75 decimal each) located beside the Faculty of Fisheries, Bangladesh Agricultural University, Mymensingh, considering five treatments each with three replications. Treatment 1 (T_1) was designed with the supplementation of soil probiotics (Super PS), T_2 was supplemented with gut probiotics (ZYMETIN), T_3 was set with the addition of soil, gut and water probiotics combinedly. Water additive probiotic, pH FIXER was added in T_4 and T_5 was designed as control without probiotic (basal diet only). Healthy and disease-free fingerlings (Average weight: 1.57 ± 0.02 gm) were stocked with the stocking density of 600/decimal. Sampling was done fortnightly. The study revealed that weight gain, percent weight gain, specific growth rate was significantly higher ($P<0.05$) in T_3 compared to other treatments. Gut villi length, enterocyte height (EH) and fold length (FL) were also found improved in T_3 during the culture period. In liver, pathologies like vacuums, hemorrhage and necrosis were observed in control group and almost normal structure in probiotics treated fish. Hematological parameters like WBC, RBC and hemoglobin contents were significantly ($P<0.05$) improved in probiotics supplemented treatments which indicated better physiological status in comparison with control fish (T_5). The presence of beneficial gut bacterial load was also recorded highest in T_3 which indicated the beneficial effects of mixed probiotic supplementation. Thus, combined supplementation of gut, soil and water additive probiotics would be very effective for the sustainable pond culture of healthy *A .testudineus*.

Development of Biosecurity Protocol for Commercial Aquaculture

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Abstract
Biosecurity is a set of procedures and measures used in aquaculture facilities to prevent the introduction and spread of pathogens within or between farms. It consists of various simple, and sometimes zero-cost measures that will keep pathogens away from fish and keep fish away from pathogens. Proper biosecurity practices are vital to maintain healthy fish stock. However, biosecurity aspects in aquaculture in Bangladesh are not well understood and the concept is quite new to the aqua farmers. In order to understand biosecurity issues in commercial aquaculture facilities, questionnaire interview was carried out with 100 fish farmers and 100 hatchery owners in Mymensingh and Jessore districts. Ten focus group discussions were also conducted. The status of biosecurity was evaluated through some set criteria like infrastructure, restriction on entry of visitors, use of foot bath, use of protective clothing, management of fish seed, feed and water, storage condition, sanitation and disinfection systems, record keeping, personnel's qualification and staff training. The overall biosecurity of both aquafarms and hatcheries in the study areas were not that satisfactory. Severe lacking on some important biosecurity measures were noticed which included lack of foot bathing facilities, poor restriction on visitors, use of protective clothing, sharing of equipments, lack of

qualified farm personnel, lack of written protocol and staff training, poor record keeping, poor pest management, absence of treatment and disposal of waste, poor pest management. A number of fish diseases were identified through regular monitoring and clinical investigation. The present study thus revealed that the biosecurity problems in commercial aquaculture facilities exist. It is therefore recommended to train farmers on basic farm level biosecurity principles and setting a national biosecurity strategy for aquafarms for sustainable and safe aquaculture production.

Study of Health Management Strategy for Commercially Cultured High Value Fish

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Abstract

Farming of high value fish *viz.* koi (*Anabas testudineus*), shing (*Heteropneustes fossilis*) and gulsa (*Mystus cavasius*) are expanding rapidly throughout the country. The study was carried out to understand constraints of health management, investigate disease problems, identify pathogens and recommend health management strategies of commercially cultured koi, shig and gulsa. One hundred farmers were interviewed through structured questionnaire in Mymensingh and Jessore districts. Most of the farmers practiced polyculture of gulsa with shing and monoculture of koi at high densities. It was found that all the three species suffered from a number of diseases including ulcerative hemorrhagic lesion, white spot, red spot, ventral and mouth reddening and fin rot. Diagnosis of disease was the single most important constraints of health management followed by lack of farmer's knowledge on fish health, presence of huge number of poor quality medicine, ineffectiveness and indiscriminate use of medicine, lack of farmer's ability on application of medicine and absence of qualified fish health professionals. Lack of good quality fish seed, feed and water were identified as the main resource problems associated with fish health management. Bacteriological and molecular techniques including PCR were employed to diagnose disease and identify pathogens. A number of bacterial isolates were recovered, identified and characterized from diseased fish. Five isolates of *Aeromonas veronii* were recovered and identified from koi along one isolate of each *Vibrio mimicus* and *Plesiomonas shigelloides*. Three different bacteria were isolated from shing including *Anthrobacter* sp., *Acinetobacter* sp. and *Bacillus* sp. Four different isolates of bacteria including *Bacillus aerius*, *Vibrio cholera, Micrococcus luteus* and *Bacillus* spp. were recovered from diseased gulsa. The isolates varied with their pathogenicity. An experimental infection model for *A. veronii* has been developed using different infection routes. Intrperitoneal challenge was the most effective route for experimentally infecting koi with *A. veronni.* Sensitivity of *A. veronii* isolates were tested against a range of antibiotics. An attempt was made to treat naturally infected fish with a number of commonly used commercial antibiotics and variations were found in the efficacy of antibiotics. The study recommends that farmers should be trained on disease diagnosis, health management and farm biosecurity and proper application drugs. Further study should focus on the development of effective vaccines against *A. veroii* and other potential pathogens of high value fish for their sustainable farming.

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Investigation on the Bacterial and Parasitic Diseases in the Spotted Snakehead, *Channa Punctatus* (Bloch, 1793)

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Abstract
The present study was conducted to determine the bacterial and parasitic diseases of spotted snakehead, *Channa punctatus* in Mymensingh region, Bangadesh. A total of 200 specimens of diseased *C. punctatus* were collected from different fish markets *viz., Pouroshova*, Kewatkhali and *Shesh More* markets and landing centers situated at Mymensingh sadar upazila. Clinical investigation related to bacterial pathogens were performed at Fish Disease Laboratory, Bangladesh Agricultural University (BAU), Mymensingh and fish parasitological examinations were done at Parasitology Laboratory, Department of Parasitology, BAU, Mymensingh. Bacterial involvement was found from diseased *C. punctatus* and identification was done by conventional biochemical techniques. Antibiotic-resistances were checked by disk diffusion method. Virulence was tested by experimental infection. Fish parasitic identification was done with determining prevalence, mean intensity and abundance using microscopic, morphological and molecular tools. About 15 fish pathogenic isolates were collected from infected fish. Biochemical analyses identified pathogenic strains of *Aeromonas hydrophila, A. veronii, Aeromonas* sp. *Edwardsiella tarda* and *Acinetobacter* sp. Most virulent bacteria were screened by the experimental infection of *Bardonymus gonionotus* (5.50 ± 0.50 g). Antibiogram studies revealed ampicillin resistant strains of *A. veronii*, isolated from hemorrhagic lesions of *C. punctatus.* Parasitological investigation revealed the larvae of nematode, *Eustrongylides* sp. from the abdominal cavity and ovaries of 101 *C. punctatus*. The worm was slender, elongated and cylindrical, medium to large in size and mouth was slit-like, surrounded by two lateral rows of somatic papillae, cephalic end was conical with 12 labial papillae arranged in two circles of 6 papillae each. Prevalence, mean intensity and abundance of *Eustrongylides* sp. infestations were 50.5%, 2.06 and 1.04, respectively and varied depend on fish size and fish markets. The prevalence of *Eustrongylides* sp. also varied from 26.0% to 61.32% in different fish markets and 26.0% to 59.82%. *Eustrongylides* sp. was also confirmed by amplifying ITS gene. The study has successfully reported the bacterial infections and parasitic infestation of *C. punctatus* in Mymensingh region which provides basic information for further detailed epidemiological and molecular study. Also, this is the first report on the identification of larval stage of *Eustrongylides* sp. from *C. punctatus* in Bangladesh.

Molecular and Biochemical Identification of Bacterial Pathogens of Farmed Catfish in Mymensingh Aquaculture Zone

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Abstract
Introduction: Studies were conducted to identify fish pathogenic bacteria isolated from disease affected catfish, cultured in different catfish farms located in Mymensingh aquaculture zone, Bangladesh. Methodology: Preliminary data were collected by questionnaire survey in thirty catfish farms located in Mymensingh sadar, Trishal and Muktagacha upazila of Mymensingh district. Clinical investigation of diseases and laboratory analyses of bacterial pathogens were performed at Fish Disease Laboratory, Bangladesh Agricultural University, Mymensingh. Samples (80) were collected from disease affected

ponds and bacterial identification was done by conventional biochemical techniques followed by molecular analyses of 16S rRNA sequence. Antibiotic-resistances were checked by disk diffusion method. Virulence was tested by experimental infection. Findings: that majority of the farmers (86.67%) did not have clear understanding about aquafarm biosecurity. No catfish farm was found having foot bath or quarantine facilities to prevent bacterial infection. However, some farmers measured water quality parameters (73.33%), managed feed storage facility (50%) stocked healthy fingerlings (70%), disinfected fish before stocking (23.33%), disposed dead fish regularly (56.67%) and regularly disinfected the equipments (23.33%). Bacterial involvement was found from epizootic ulcerative syndrome (EUS), hemorrhagic disease, gill rot, dropsy and tail and fin rot affected fish. About 26 fish pathogenic isolates were collected from various infected catfish. Biochemical tests and sequence analysis of 16S rRNA gene using universal primers identified pathogenic strains of *Aeromonas hydrophila, A. veronii, Edwardsiella tarda, Klebsiella* sp. and *Acinetobacter* sp. Virulent bacteria were screened by the experimental infection of *Bardonymus gonionotus* (6.74±1.95 gm) and *Pangasius hypophthalmus* (10.30±1.50 gm) and *Heteropneustes fossilis* (8.30±0.85 gm). Antibiogram tests revealed Ampicillin and Kanamycin resistant isolates. Conclusion: The study has successfully drawn up a scenario of the health management status of commercial catfish farms of Mymensingh. Biochemical and molecular assays have the prospect for important contribution in infection management and identification of bacterial pathogens in catfish.

Novel Molecular Approaches for Advancing Prediction and Mitigation of Disease Outbreaks in Aquaculture for Small Scale Farmers: Water Quality Parameters in Pangasius and Tilapia Aquaculture Ponds

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Abstract

Aquaculture contributes significantly to world food supplies and food security. Water quality is arguably one of the most critical factors of aquaculture because poor water quality leads to fish stress and risks of fish disease, increased use of chemicals, and ultimately, higher food safety risks for humans and environmental impacts. The essential water quality parameters including temperature, pH and dissolved oxygen (DO) were measured by digital underwater loggers and they have logged data after 10 minutes interval automatically. A total of 12 temperature loggers were installed in 6 pangasius and 6 tilapia ponds, and four pH and DO loggers installed in two pangasius and two tilapia ponds in Muktagacha, Tarakanda and Jamalpur Sadar Upazila under Mymensingh and Jamalpur district. The temperature of pangasius and tilapia ponds were 28.64±0.14 °C and 29.51±0.03°C and pH were 7.15±0.01 and 7.50±0.02, respectively indicating favorable condition of aquaculture. The average dissolved oxygen (DO) was moderately higher in tilapia ponds (2.56±0.03 ppm) than pangasius ponds (1.72±0.04 ppm) but remained at below the standard level of animal welfare for farmed fish. A 24-hours day of DO trend was analyzed after downloading the data from the underwater logger. The DO peaked at noon and remained above 5 ppm from 12:00 to 4:00 PM however, it dropped down to zero at midnight to early morning from 2:00 to 6:00 AM. As a result, due to poor DO level from midnight to early morning, the fish are gulping and come to upper layer for taking surface oxygen from the air. The common perception of the farmers is that fish perhaps hungry not gulping for DO and they supply feed in the early morning. As a result, fish cannot take feed at *ad libitum* because of low metabolism rate due to poor oxygen level in the pond water. Thus, a large amount of feed is wasted and decomposed that deteriorates the pond water quality and ultimately increases stress to fish, reduces growth and causes yellow color and off-flavor in flesh.

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Evaluating Costs and Benefits of Prophylactic Health Products and Novel Alternatives on Intensifying Small-Scale Aquaculture Farmers in Asia (IMAQulate): Effects of In-fed Probiotics on the Growth, Gut Microbial Content, Hematology and Histological Changes of Pangasius Ranging from Nursing to Grow-out Stage

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Abstract

The use of probiotic for disease prevention and improved nutrition in aquaculture is becoming popular due to an increasing demand for environment friendly aquaculture. An experimental study was conducted to assess the effects of in feed probiotic on gut microbial, hematological responsiveness and histological changes of pangasius (*Pangasianodon hypophthalmus*) in nursing to grow-out condition. Nursery stage was divided in two experimental group, treatment (T) and control (C) and fingerling and grow out stage were divided into four experimental group TT, TC, CT and CC. Probiotics was selected as a suitable commercial brand (Sanolife Pro-F) having *Bacillus* strains and a commercial nursery feed (powder form) for nursery and fingerling stage while grow out stage was continued with floating feed. Fish were sampled at the day of 30, 45, 60, 75 and 90 randomly from each treatment and control. Probiotic treated fish gained higher percent weight gain, specific growth rate and survival. Water quality parameters e.g. temperature (ºC), dissolved oxygen (mg/L) and pH were within the acceptable range. At fingerling stage, the highest average gut bacterial load was 2.0×10^6 CFU/mL in TC (in-feed Probiotic then normal feed) and the lowest was 2.6×10^5 CFU/mL in CT (normal feed then in-feed probiotic) in NA agar. The highest average gut bacterial load was 1.02×10^3 in TC and the lowest was in 0.76×10^1 CFU/mL CT in MRS agar. At the grow-out stage, the highest average bacterial load in gut was 3.65×10^6 in TT (in-feed probiotic treated condition) and the lowest was 1.3×10^5 CFU/mL in CC (normal feed in control condition) in NA agar. The highest average bacterial load in gut was 3.65×10^6 CFU/mL in TT and the lowest was in 1.3×10^5 CFU/mL in CC in MRS agar. Hemoglobin content (g /dl) 4.05±0.21 was highest in TT and lowest (3.1±0.14) was in CC at the grow-out stage. RBC (cells × 10^6 /mm^3) content (3.97±0.78) was highest in TT at grow-out stage and the lowest (0.59±0.12) was at the fingerling stage. At the grow-out, WBC (cells × 10^6 /mm^3) content (189.56±12.0) was highest and the lowest (75.4±17.66) was at the fingerling stage. Remarkable difference in regional distribution and localization along the intestinal length between the treatment and control group of the nursery and grow out stage were found in the intestinal villous height, cellular distribution of goblet cells, and intra-epithelial lymphocytes (IEL). The results from the study suggest that the in-feed probiotics has significant effects on the gut microbiota, hematological parameters and histological changes of fish and therefore, probiotics could be used for promoting growth, controlling diseases, reducing mortality and enhancing eco-friendly production in pangasius aquaculture.

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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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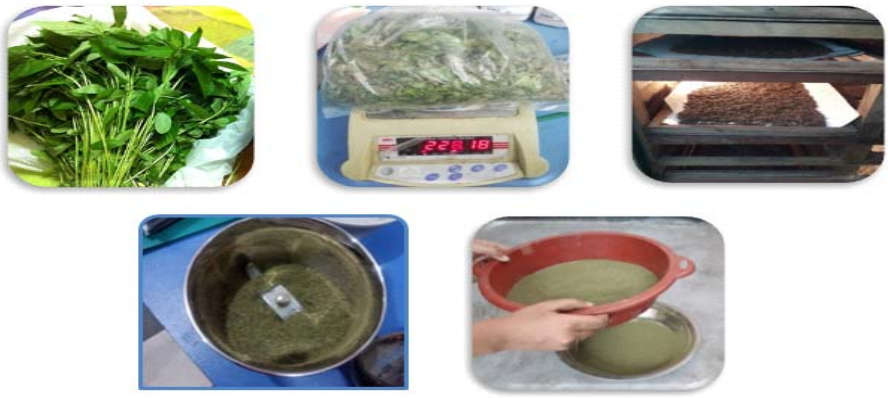
Abstract

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.



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Aquaponics: Food Safety for Human Health through Good Aquaculture Practices

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Abstract

A low cost and easy to handle aquaponics systems were designed and built during March 2017 to June 2020 in the Aquaponics Oasis semi-open greenhouse. The system was designed based on 12 fish holding water tanks and 12 half drums as vegetable growing media beds. The fish tanks having 300-liter capacity were placed inside the lab and vegetable beds each having 2 sq. ft. growing area set outside of the lab to have better access to the Sun light on vegetables, where one fish tank and a vegetable bed made a single unit of aquaponics fish and vegetable growing system. After development the aquaponics system, five consecutive experiments one after another were conducted over the three years' period. The water pump operated continuously from 9 AM to 5 PM with a known density of fish biomass to maintain good water quality, vegetable production and healthy bacterial populations, whereas aeration operated for 24 hours. Nile tilapia (*Oreochromis niloticus*) and walking catfish (*Clarias batrachus*) were stocked in the rearing tanks separately, where water depth was maintained 0.5m. In density dependent experiment, 30, 40, 60 and 80 fish were released in T1, T2, T3 and T4 experiments, respectively. The mean initial length and weight of stocked fish ranged from 8.31±0.45 to 16.93±0.87cm, and weight 31.83±2.81 to 78.05±12.37 g. The fishes were fed twice daily with a commercial formulated pellet diet containing 30 to 35% protein at a rate of 3 to 5% of fish body weight per day. In addition, hydroponics unit, six saplings of bush bean/strawberry/tomato seedlings were typically planted in the growing beds into two rows with three replications consisted of brick lets/stones, where the roots are growing directly in the stones and get their nutrients from water supplied from the fish tanks that contains fish excrete. No chemical fertilizers or pesticides were added to the system. Water quality parameters, such as water pH, dissolved oxygen, ammonia, nitrite, electrical conductivity, and total dissolved solids were measured weekly or fortnightly. The macro and micronutrients were also analyzed two to three times during the experimental period. The highest strawberry production was 152.3±14.8 tons/ha/75 days found in the treatment T1 and the lowest production was (99.7±31.7 tons/ha/75 days) with T3 treatment. Moreover, the highest fish production was 282.40±25.73 tons/ha/93 days in T4 where fish density was 30 lakh fish/ha water body. From the above results it is clearly reveal that the fish stocking density has direct impact on the strawberry biomass in the present aquaponics study. Therefore, it is proved that strawberry production is feasible without soil only with fish wastewater in media based aquaponic system.

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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.

Developmental Deformity in Banded Gourami (*Trichogaster fasciata*) Exposed to Thiamethoxam Insecticide

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Abstract
Thiamethoxam (THM), a systemic neonicotinoid insecticide, is widely used in Bangladesh to control pests in agricultural crops. It has the potential to enter aquatic ecosystem through surface run off and

spray drift. The developmental toxicity of THM to fish in early life stages is not well investigated yet. Therefore, the purpose of this study was to assess acute toxicity of THM insecticide to banded gourami (*Trichogaster fasciata*) embryos and larvae by assessing mortality and morphological abnormalities upon exposure. To explore potential toxicity of THM, banded gourami embryos and larvae were exposed to sub-lethal concentrations (0, 0.02, 0.2, 2, 20, 200 mg/L) of THM. In case of embryo-toxicity studies, numbers of dead eggs increased significantly (one-way ANOVA; $F_{5,17}$= 283; P = 0.000) with increasing THM concentrations. After probit analysis, the 24h-LC_{10} and LC_{50} of THM for banded gourami embryos were estimated at 0.15 and 2.62 mgL^{-1}, respectively. Dose-response decreases in hatching success were recorded at 92.66±1.15, 88.66±1.15, 86.66±3.05, 72.66±7.02, 37.33±5.03 and 0%, respectively (P<0.05). Several malformations like broken eggshell, dark-brown yolk sac, yolk sac edema and unhatched egg were detected in banded gourami embryo exposed to THM. Number of dead larvae significantly increased with increasing THM concentrations. The 24h-, 48h-, 72h-, and 96h-LC_{50} values of one-day and three-days larvae were estimated at 14.50, 9.56, 5.10, 0.92 mgL^{-1} and 25.19, 22.82, 6.43, 1.65, respectively. Furthermore, results showed several malformations of banded gourami larvae including lordosis, notochord abnormality, yolk sac edema, hemorrhage body arcuation and irregular caudal fin when exposed to sub-lethal THM concentrations. The results of this study suggest that THM may have toxic effects on early life stages of banded gourami even at lower concentrations.

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.

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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 (T0, control), one (T1), two (T2), three (T3) or four (T4) 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 T0. For T1, T2, T3, T4 DO concentrations were recorded between 7.01±0.40 to 7.93±0.02 mg/L during 90-days of rearing. In case of T0, DO concentrations were <2 mg/L for first 30 days indicating hypoxia, followed by normoxia from day-45. In case of T1, T2, T3 and T4 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 (T1, T2, T3, T4) were significantly higher than T0; but there were no significant differences among T1, T2, T3 and T4. 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 T3 and T4 compared to T1 and T2 (0.03, 0.02 and 0.02). Relative growth rates (% of weight, length and width) were highest in T4 (11.94, 6.96 and 5.7) and lowest in T1 (10.49, 5.5 and 4.72). Again, survival rate (%) was also highest in T4 (73.33) and lowest in T1 (66.67); in T0, 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 T0 were found to be smaller in size, with developing acini and no previtellogenic oocytes were recorded; whereas in T1, T2, T3 and T4 previtellogenic oocytes and larger acini were evident. In day-60 histo-sections, oocytes (T1, T2, T3 and T4) 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 T1, T2, T3 and T4. This indicates that ovaries in T1, T2, T3 and T4 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 T0, whereas more developed and dense spermatids were evident in T1, T2, T3 and T4. These results indicate that testes were in late development stages in T0 and ripe in T1, T2, T3 and T4. The above results are indicative of the fact that hypoxia (T0) retarded development of ovary and testes, and on the contrary, relatively faster gonadal developments were observed in normoxia (T1, T2, T3 and T4 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.

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Occurrence, Assessment and Management of Japanese Threadfin Bream *Nemipterus japonicus* in the Bay of Bengal

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Abstract
Dealing with about 700 individuals of Japanese threadfin bream, *Nemipterus japonicusus*, a species having enormous commercial importance, collected monthly from the Bay of Bengal revealed that the standard length (SL) of male and female ranged from 8.5 to 22 and 8 to 21.4 cm, and the body weight (BW) from 17.09 to 276.65 and 14.71 to 300.69 g respectively over a year-long study. Bhattacharya procedure decomposed 4 age-groups on pooled length frequency histogram of each of male, female and unsexed individuals. Since statistics nullified differences between SLs of male and female, and their growth curves (t-test and F-test; $p>0.05$), consequentially present study adopted the growth modelling of unsexed gender. The growth equations provided by three models were as $SL_t = 25.17$ [1- exp {-0.637 (t + 0.014)}] for von Bertalanffy model; $SL_t = 23.4$ exp [-exp {-0.739 (t + 0.863)}] for Gompertz model; and $SL_t = 22.49$ / [1 + exp {-1.025 (t - 1.30)}] for Robertson model respectively, where t is age in years. Growth was best described by the von Bertalanffy equation for the species based on χ^2 values as goodness of fit index among three models. The relationship of pooled data of SL and BW was $BW = 0.035SL^{2.92}$, and the von Bertalanffy equation was fitted as BWt = 431.34 [1- exp {-0.646 (t +0.03)}]^3 in terms of BW (g). The study obtained growth performance 2.61, and the approximate longevity was 4.71 years.

Assessment of Population Parameters and Sustainable Yield of Flathead Sillago *Sillaginopsis panijus* in the Bay of Bengal

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Abstract
The research project assessed population parameters of flathead sillago, *Sillaginopsis panijus* collected from the Bay of Bengal to be used as input values for estimation of optimum yield with an ultimate objective to develop sustainable fisheries management regime for the valuable species. Conventional models were used to estimate population parameters using data of 500 specimens from 10 monthly samples collected from the industrial fisheries based in Chattagram city over a year. The standard length (SL) of sampled individuals ranged from 16.7 to 33.8 cm, and the body weight (BW) ranged from 42.2 to 466.5 g over the study period. The relationship of SL-BW for pooled data was $BW = 0.004SL^{3.28}$. Growth was best described by the von Bertalanffy equation based on χ^2 values as goodness of fit index comparing with Gompertz and Robertson models. The von Bertalanffy growth equation was $SL_t = 36.73$ [1- exp {-0.318 (t + 1.449)}] in terms of length, and $BW_t = 548.72$ [1- exp {-0.306 (t +1.317)}]^3 with regard to weight, where t is age in years. The study obtained growth performance and longevity 2.63, and 9.43 years respectively. Flathead sillago recruited at 19.95 cm and 1.01 years to the adult stock in the Bay of Bengal. Natural and fishing mortalities were estimated 0.78 and 1.50 per year respectively, while the exploitation rate was 0.66 during the year of study. The maximum yield per recruit was 22.24 g at fishing mortality of 0.9 per year, while *S. panijus* attained 73.59 kg relatively at 1.27 years if 1000 individuals recruited to parent stock in the Bay of Bengal.

Finally, the study suggested a format of management guide to be prepared incorporating the present findings.

Ecology and Succession of *Euglena* in Aquaculture Ponds

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Abstract
Reddish bloom of euglenophytes is very common in fish ponds of Bangladesh, and this bloom is causing various problems in aquaculture ponds. Considering the above, the seasonal succession of euglenophytes in a BAU fish pond and in a fish farmer's pond was studied in relation to the environmental factors like temperature, pH, dissolved oxygen, nitrate-nitrogen, phosphate-phosphorus etc. In the present study, 3 genera of euglenophytes (*Euglena, Phacus* and *Trachelomonas*), 17 genera of cyanophytes, 11 genera of chlorophytes and 7 genera of bacillariophytes were recorded in both BAU fish pond and fish farmer's pond. Morphology of *Euglena* was variable and strongly influenced by pH and nutrients. At acidic pH and higher conc. of nitrate and phosphate, *Euglena* was mostly spindle-like. At alkaline pH and lower conc. of nutrients, cells were found to be changed their shape first from spindle to oval and finally from oval to spherical. The highest cell density of euglenophytes was found in winter in both ponds. In our ecological study, the bloom of this group was influenced by a set of environmental factors such as comparatively lower water temperature, dissolved oxygen, acidic pH and higher phosphate and nitrate concentrations. Acidic pH and higher concentrations of nitrate-nitrogen and phosphate-phosphorus were found to be most conducive for the bloom of euglenophytes. Thick euglenophytes bloom inhibited the light penetration which hampered photosynthesis and growth of other phytoplankton those are preferred food of planktivorous fishes.

Feeding Biology of Punti, *Puntius* spp. and Environmental Conditions 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 beels 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, qualitative and quantitative aspects of natural fish feeds (plankton) and the feeding biology of punti, *Puntius* spp. in the beel were studied from July 2019 to June 2020. Water, plankton and fish samples were collected monthly and analyzed to study the water quality, biological productivity of the beel and the feeding biology of *Punitus* spp. Some of the water quality parameters were measured on the spot during sampling in each month. Throughout the study period, water temperature ranged from 20.1° to 31.8 °C, water depth 2.9 to 4.0 meter, Secchi disk transparency 24.5 to 48.5 cm, water pH 8.1 to 9.1, dissolved oxygen 6.1 to 10.5 mg/l, nitrate-nitrogen 0.19 to .316 mg/l, and phosphate-phosphorus 0.01 to 0.362 mg/l. Thirty-two genera of phytoplankton belonging to six diverse groups such as Chlorophyceae (12 genera), Bacillariophyceae (10 genera), Cyanophyceae (6 genera), Euglenohyceae (2 genera), Rhodophyceae (1 genus), Dinophyceae (1 genus) were found. Nine genera of zooplankton belonging to three broad groups such as- Rotifera (5 genera), Copepoda (3 genera) and Cladocera (1 genus) were also found. The fish (*P.*

sophore and *P. ticto*) was found to be a surface feeder and planktivorous. Phytoplankton dominated the diets of *Puntius* spp. (96.2 %). The gut content was composed of 28 genera of phytoplankton belonging to 5 diverse groups and six genera of zooplankton belonging to 3 diverse groups. Phytoplankton and zooplankton groups in order of dominance were Chlorophyceae (10 genera), Bacillariophyceae (10 genera), Cyanophyceae (5 genera), Euglenophyceae (2 genera), Rhodophyceae (1 genus), Rotifera (3 genera), Copepoda (2 genera) and Cladocera (1 genus). Overfishing, improper stocking of fingerlings, massive growth of aquatic floating and submersed macrophytes (water hyacinth and Vallisneria) were the major problems observed in the beel. Considering these problems, the beel management committee (BMC) members have been suggested to control the weed and fishing pressure and stock grass carp for aquatic weed control.

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.

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Effects of Pesticides on Human Health and Freshwater Ecosystems in Mymensingh District, Bangladesh

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Abstract
In Bangladesh, the use of different types of pesticides may affect farmers' health and contaminate the aquatic environment. The objectives of the current study were: i) to assess the farmers' perception on pesticide use and occupational health hazards caused by pesticide application and ii) to investigate the effects of profenofos (most widely used in study areas) on the different endpoints of male Nile tilapia (Oreochromis niloticus) and Banded Gourami (Trichogaster fasciata). A structured questionnaire was used to collect data from fifty vegetable farmers at Mymensingh Sadar Upazila during February and March of 2019. The 96-h LC50 values of profenofos for Nile tilapia and Banded Gourami were calculated as 1614 and 2972 µg/L, respectively. Results showed the mostly used pesticide was mefonexam (used by 40% interviewed farmers), followed by thiamethoxam + clorantraniliprole (24%), profenofos + cypermethrin (20%), and propineb (10%). The respondents were reported to face eye irritation (27%), headache (31%), dizziness (12%), vomiting (20%) and skin irritation (7 %). Blood glucose levels and WBC significantly increased and haemoglobin and RBC decreased significantly with increasing concentrations of profenofos. Major alterations on testes were damaged sertoli cell, degeneration of interstitial cell of leydig, breakage of seminiferous tubule, empty lumen, irregular seminiferous tubule. Noticeable alterations on gill tissues were necrosis, reduction of gill arches, vaccum, telangiectasia and edema. Furthermore, dose- and duration-dependent hispathological alterations were evident for liver and kidney of Nile tilapia and Banded Gourami exposed to different concentrations of profenofos. The present study revealed that profenofos alters the haematological parameters and histopathology of Nile tilapia and Banded Gourami, thus, the use of profenofos in agriculture should be carefully evaluated.

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 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), resulted 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.

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

Fish and fishery products are having an important place in global food market due to its unique taste and flavor. Beside this, the presence of easily digestible proteins, lipids, vitamins and minerals make it a highly demanded food commodity. 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. These fish mince based products may meet the nutritional demand of the people. Considering these points the present study was conducted and mentioned four value added products were prepared in the laboratory. Initially these 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 the arranged for panel tests (panels were formed on the basis of educational level, age, income of the panelists). Cutlet prepared with 40%, Sausage with 80%, Flake with 50% and Papad with 20% fish muscle was liked by the panels. On the basis of panelists choice all the samples were prepared again and stored under various temperature and packing conditions. Chemical analysis of all the samples are being done at certain time intervals. Consumer's preference to these products are in progress. After statistical analysis of all obtained data report will be submitted in time.

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

In order to utilize pangas fish *(Pangasianodon hypophthalmus*) waste and development of different fish products for human consumption, this study was carried out. Fish gelatin was developed

successfully from the pangas waste skin using different extraction procedure. The study was focused on designing a low cost isolation and characterization of gelatin from fish processing industry pangas waste. Gelatin preparation method was involved in pre-treatment, extraction and product recovery. Extraction process was carried out with hot water and diluted acid. Recovery treatments included filtration, evaporation and dehydration. Characterization of gelatin included qualitative and quantitative analysis. 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 found when extraction with citric acid at 70C 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 pangasius gelatin comparable with that of commercial gelatin. The study was also conducted to prepare fish noodles (pasta type) using pangas-waste mince with wheat flour and other ingredients to assess its quality and shelf-life. Pangas fish mince was incorporated with wheat flour and other ingredients in the substitution levels of 0, 30, 40 and 50%. 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) compared to 0, 30 and 40% pangas-waste mince in the noodle formulation. In order to prepare the fish chip from pangas-waste mince, 0, 20, 30 and 40% pangas fish mince was incorporated with wheat flour and other ingredients. Sensory evaluation and the panel examination suggested that fish chips having 40% pangas waste mince was the most preferable one. The chemical analysis of the products showed that-changes in proximate composition of the products stored in sealed pack at room temperature (28 to 32°C) was very slow. In case of fish noodles (pasta type; 40% fish waste mince) the initial moisture, ash, protein and lipid contents (%) were found 11.42, 14.66, 22.72 and 5.93; after 270 days of storage which values changed to 13.75, 16.62, 20.20 and 3.20. For the fish chips also a similar pattern was followed. The fish chips the initial values for moisture, ash, protein and lipid content (%) were 5.78, 1.93, 24.03 and 7.4 which changed to 8.05, 5.03, 22.68 and 3.7. The obtained results of the study indicated that the incorporation of pangas-waste mince with popular snack item like noodles and chips can be stored in sealed pack for longer period and can serve as a ready to cook product, become a good source of animal protein to the consumers.

Production, Consumer Preference and Profitability Analyses of Dried Products from Stinging Catfish, Shing (*Heteropneustes fossilis*)

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Abstract
This study was conducted with the aim of preparing high-quality value-added stinging catfish (*Heteropneustes fossilis*) products using a drying rack fitted with a mosquito net. The quality, nutritional properties, consumers' preference, and profitability of different dried stinging catfish products were also evaluated. Before drying the fishes were sorted, graded (small, below 15 g; medium, 15 g to 35 g; and large, 36 to 50 g), dressed (whole and zigzag cut) and in some cases treated with salt. It took around 4 days for small and medium no salt fishes and around 5 days for the rest for complete drying. The moisture content was reduced from an initial 74.75% (small), 72.79% (medium), 72.43% (large) to a final value ranges between 12.78 ± 0.05% to 16.81 ± 2.76% in all types of products. The final protein content (wet basis) of different products were between 48.02 ± 0.49% to 51.87 ± 0.07% in no salt-treated groups and 39.09 ± 0.25% to 43.75 ± 0.35% in salt-treated groups. The final lipid and ash content were between 19.43 ± 0.95% to 22.79 ± 0.61% and 9.01 ± 0.28% to 10.66 ± 0.75% for no salt-treated and 18.14 ± 0.99% to 20.86 ± 0.37%, respectively in different dried products. After 15 minutes and 30 minutes of soaking at 20°C, no significant difference was

recognized in the water reconstitution rate among different products. All the dried products were liked moderately to very much by the panelist based on their scores of sensory evaluation and eating quality assessment. Preliminary cost-benefit analyses showed the highest cost for large groups and the lowest for medium salt-treated groups. Finally, it can be concluded that using smaller to medium fishes and salt would be more suitable and economically viable for the production of quality dried products from stinging catfish.