INTERNATIONAL SYMPOSIUM

FOR 50 YEARS

GLORY AND SUCCESS OF

BANGLADESH RICE RESEARCH INSTITUTE

THEME OF THE SYMPOSIUM:

HALF A CENTURY OF RICE RESEARCH AT BRRI ENSURING FOOD SECURITY IN BANGLADESH

PROGRAMME & ABSTRACT

23-24 February 2023

BRRI Auditorium, BRRI
Gazipur-1701

International Symposium for 50 Years Glory and Success of Bangladesh Rice Research Institute

Theme of the Symposium

Half a Century of Rice Research at BRRI Ensuring Food Security in Bangladesh

24 February 2023
BRRI Auditorium, BRRI, Gazipur 1701

Bangladesh Rice Research Institute

International Symposium for 50 Years Glory and Success of Bangladesh Rice Research Institute

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Preface

Bangladesh Rice Research Institute (BRRI) is proud to commemorate 50 years of glory and success of rice research in Bangladesh. I want to express my sincere gratitude and appreciation to all of our partners from home and abroad to contribute in the last 5 decades' journey of BRRI for ensuring food security in Bangladesh.

This book of proceedings compiles the abstracts of the speeches and posters delivered in the International Symposium, which will take place at the BRRI campus on February 24, 2023. On the eve of such a significant occasion for BRRI, we intend to provide a substantial platform for top specialists in the domains of rice science to come together and exchange their knowledge to identify and resolve the myriad problems that are presently emerging. The symposium will also provide an ideal forum for the exchange of knowledge and results regarding the impacts and challenges of rice science for increasing the productivity of rice is of great significances.

I really appreciate and thank everyone who worked hard to make this event successful and significant, especially our esteemed colleagues and enlightened well-wishers across the globe. At this very special moment, BRRI is overwhelmed to embrace all of your excellence so far and hope to ensure sustainable food security of the nation in its way forward.

May Bangladesh live forever.

Dr. Md. Shahjahan Kabir
Director General

Welcome Note

Dear fellow researchers, scientists and distinguished guests,

On behalf of the Bangladesh Rice Research Institute (BRRI), it is my immense pleasure to welcome all of you to the International Symposium for 50 years glory and success of Bangladesh Rice Research Institute.

We hope this international symposium with experts in the fields of genetics, genomics, bioinformatics, agricultural production policies and priorities share their expertise to figure out and solve the problem of increasing productivity of rice. This is in pursuit of BRRI's goal to disseminate knowledge and skills and to promote discussions on important issues relevant to rice science. Leading academics and influential personnel in the different fields have been invited to moderate sessions and give lectures. In my opinion, this will ensure that the symposium is of the highest caliber for all participants.

For your involvement, the organizing committee has scheduled two interactive technical sessions. At this exciting period, participants can also anticipate growing their network at the Symposium.

Thank you all of the outstanding visitors and attendees who helped make this Symposium possible.

I wish everyone a fruitful meeting and an enjoyable stay at BRRI. Yours faithfully,

Dr. Mohammad Khalequzzaman
Convener
International Symposium for 50 years glory and success of
Bangladesh Rice Research Institute
and
Director (Research)

50 Years Glory and Success of Bangladesh Rice Research Institute

23-24 February 2023

PROGRAMME

23-24 February 2023, BRRI Auditorium, BRRI, Gazipur-1701

Session: Inaugural Session

23 February 2023, BRRI Main Field

10.00 Guests take seats at the venue

1st Part

11.00 Arrival of the Hon'ble Prime Minister
11.05 Paying tribute to the Portrait of Bangabandhu
11.10 Releasing Pegions & Balloons
11.15 Inaguration of Bangabandhu-Pierre Trudeau Agriculture Technology Center
11.20 Visit Bangladesh Rice Research Institute's Innovations

2nd Part

11.45 Arrival of the Chief Guest at the program venue
11.46 Lyrical "Dhankavya"
11.56 Welcome Address
Dr. Md. Shajahan Kabir, Director General, Bangladesh Rice Research Institute
12.00 Presentation of documentary
50 years Glory and Success of Bangladesh Rice Research Institute
12.05 Address by Special Guests
Dr. Steven Webb, CEO and Executive Director, Global Institute of Food Security, Canada
Dr. Jean Balié, Director General, International Rice Research Institute, Philippines
Dr. Sheikh Mohammad Bokhtiar, Executive Chairman, Bangladesh Agricultural Research Council
Wahida Akter, Secretary, Ministry of Agriculture
12.25 Address by Chairperson
Dr. Muhammad Abdur Razzaque MP
Hon'ble Minister, Ministry of Agriculture
12.35 Presenting Crest to Hon'ble Prime Minister
12.40 Unveiling 5 books of Bangladesh Rice Research Institute and Bangladesh Agricultural Research Council
12.45 Address by the Chief Guest
Sheikh Hasina MP
Hon'ble Prime Minister, Government of the People's Republic of Bangladesh

Session: Technical Session

24 February 2023
Venue: BRRI Auditorium

8:30-9:05 Registration

9:05 -9:15 Welcome address and inauguration of the symposium
Dr. Md. Shahjahan Kabir, Director General, BRRI

9:15-9:20 Introduction of the Session chair and panel member
MC of the session: MC committee of the celebration ceremony

09:20-12:30 Session- I: Accelerated Genetic Gain: Genomics and Phenomics

Session chair:
Prof. Dr. Md. Lutful Hassan
Vice Chancellor, Bangladesh Agricultural University, Mymensingh
e-mail: lutfulhassan@yahoo.co.uk

Panel Member:

- **Dr. Mirza Mofazzal Islam,** DG, BINA, Mymensingh
  e-mail: mirza_islam@yahoo.com
- **Prof. Zeba Islam Seraj**
  Department of Biochemistry and Molecular Biology, University of Dhaka
  e-mail: ziseraj@gmail.com
- **Dr. Mohammad Rafiqul Islam**
  Scientist II (Plant Breeding), IRRI Bangladesh Office, Dhaka
  e-mail: mr.islam@irri.org

Rapporteur:

- Dr. Md. Akhalasur Rahman, PSO, Plant Breeding Division
- Dr. Hisam Al-Rabbi, SSO, Biotechnology Division

9:20-9:45 Paper 1: Translation of Genetics to Farmers' Fields: Transformational Progresses and Prospects
K M Iftekharuddaula
CSO and Head, Plant Breeding Division, Bangladesh Rice Research Institute
e-mail: kiftekhar03@yahoo.com

9:45-10:00 Paper 2: Application of bioinformatics for crop improvement
Dr. Andrew Sharpe
Bangabandhu Research Chair in Food Security at GIFS, Global Institute for Food Security, University of Saskatchewan, 421 Downey Road, suite 101, Saskatoon, SK S7N 4L8, Canada, e-mail: andrew.sharpe@gifs.ca

10:00-10:15 Paper 3: Application of cell technologies and genome editing tools for accelerated genomic gain and crop improvement
Dr. Pankaj Bhowmik
Senior Research Officer and Scientific Support Lead Sustainable Protein Production (SPP) Program, National Research Council of Canada, 110 Gymnasium Palace, Saskatoon SK S7N 0W9, Canada

10:15-10:30 Paper 4: Resources for enabling efficient MAS in modern rice breeding programs (On zoom)
Dr. Damien J. Platten
Breeding Innovations and Informatics Unit, Head, Native Trait Discovery and Deployment International Rice Research Institute, Los Baños, Laguna 4031, Philippines

10:30-10:45 Paper 5: Achieving nutritional security through development of healthier rice: progress and prospects (On zoom)
Dr. BPM Swamy
Senior Scientist, IRRI Philippines, e-mail: m.swamy@irri.org

10:45-11:00 Tea Break

11:00-11:15 Paper 6: New phenotyping method using crop growth model: Apply to rice-yield big data (On zoom)
Prof. Dr. Hiroyuki Shimono
Crop Science Laboratory, Iwate University, Agri-Innovation Center, 3-18-8, Ueda, Morioka, Iwate, 020-8550, Japan, e-mail: shimn@iwate-u.ac.jp

11:15-11:30 Paper 7: The role of bioinformatics in modern rice research (On zoom)
Prof Dr. Md. Nurul Haque Mollah
Head of Bioinformatics Lab (dry), Dept. of Statistics, University of Rajshahi, Rajshahi-6205, Bangladesh, e-mail: mollah.stat.bio@ru.ac.bd

11:30-11:40 Paper 8: CRISPR-based technology for point-of-care disease diagnosis and crop improvement
Prof. Dr. Md. Tofazzal Islam
Institute of Biotechnology and Genetic Engineering (IBGE), Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur 1706, Bangladesh
e-mail: tofazzalislam@bsmrau.edu.bd

11:40-12:30 Panel discussion and Open house
Session chair & Panel members

12:30-14:30 Lunch and Prayer

14:30-17.25 Session- II: Accelerated productivity: Policies and Priorities
Session chair:
Pro. Dr. Md. Giasuddin Miah
Vice Chancellor, Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Gazipur, e-mail: giash1960@gmail.com

Panel Members
- **Dr. Wais Kabir,** Former Executive Chairman, Bangladesh Agricultral Research Council, e-mail: waiskabir@hotmail.com
- **Dr. Takashi Yamano,** Principal Economist, Asian Development Bank (ADB) e-mail: tyamano@adb.org
- **Dr. Mirza Hasanuzzaman,** Professor, Dept. of Agronomy, Sher-E-Bangla Agricultural University, Dhaka, e-mail: mhzsauag@yahoo.com

Rapporteur:

- Dr. A K M Saiful Islam, CSO, FMPHT
- Dr. Md. Sazzadur Rahman, PSO, Plant Physiology Division

14:30-14:55 Paper 1: Prioritising yield loss components in rice for accelerated productivity
Dr. Moin Us Salam
Freelance Consultant (Agriculture Sector Development and Modelling) e-mail: moinsalam1@gmail.com

14:55-15:10 Paper 2: Agricultural Mechanization in Bangladesh: Present Status and Future Strategy
Dr. Ayub Hossain
CSO, FMPHE, BARI, e-mail: ayub.fmpe@bari.gov.bd

15:10-14:25 Paper 3: Transformational footprint of private Seed Sector for enhancing productivity of rice farm lands in Bangladesh
Mohammad Masum
Chairman, Supreme Seed Company Ltd. Uttara, Dhaka, Bangladesh, e-mail: masum@surovigroup.com

14:25-15:40 Paper 4: Enabling Farmers in Combating Pest and Diseases in Rice Crops: Artificial Intelligence for Food Safety
Dr. Mohammed Eunus Ali, Professor and Group Leader, DataLab@BUET
Department of Computer Science and Engineering (CSE), Bangladesh University of Engineering and Technology (BUET), Dhaka, Bangladesh.
e-mail: mohammed.eunus.ali@gmail.com

15:40-15:55 Tea Break

15:55-16:10 Paper 5: Government Paddy and Rice Procurement Program in Bangladesh: Effectiveness and Suggestions for Improvement
Dr. M. Nahid Sattar
Associate Professor, Department of Agricultural Economics, Faculty of Agricultural Economics & Rural Sociology, Bangladesh Agricultural University, Mymensingh, e-mail: nahidsattar@bau.edu.bd

16:10-16:25 Paper 6: Agricultural transformation in Bangladesh– Policy and institutional experiences
Dr. Mohammad Jahangir Alam
Professor, Department of Agribusiness and Marketing, Faculty of Agricultural Economics & Rural Sociology, Bangladesh Agricultural University, Mymensingh, e-mail: mjahangir.alam@bau.edu.bd

16:25-17:25 Panel discussion and Open house
Session chair & Panel members

17:25-18:00 Closing Ceremony
Vote of Thanks: Director Research, Closing Remarks: Director General, BRRI

Session-I:
Accelerated Genetic Gain: Genomics and Phenomics

Dr. Khandakar Md. Iftekharuddaula is a Chief Scientific Officer and Head, Plant Breeding Division. He was born in Kushtia in 1971. He Joined BRRI Regional Station, Cumilla as SO on 20 August 1998 and promoted to CSO in 2019. He obtained Bachelor of Science in Agriculture in 1993 and Masters of Science in Genetics and Plant Breeding in 2003. He also obtained PhD in Genetics and Plant Breeding in 2010 from the same University doing research work at IRRI on Marker Assisted Backcross Breeding. He has so far supervised seven Masters and two PhD students. His total number of journal publications is 72 with H-Index 16, i-10-Index 20. A number of research projects have been implemented by him which are Stress Tolerant Rice Varieties for the Poor Farmers in South Asia (STRASA), Water Saving and Aerobic Rice, Development of Submergence and Salinity Tolerant Rice Varieties (BMZ), Integrated Agricultural Productivity Project (IAPP), Transforming Rice Breeding (TRB), AGGRi Alliance, NATP Bacterial Blight, NATP Multiple Salt Tolerant QTLs, etc. He acted as Collaborative Research Fellow in Transforming Rice Breeding Project during 2016 to 2019 at BRRI. He is blessed with one son and one daughter.

Translation of Genetics to Farmers' Fields: Transformational Progresses and Prospects

KM Iftekharuddaula*, PS Biswas, MA Hossain, M Akhlasur Rahman, M Khatun, MA Kader, MRA Sarker, S Ghosal, H Khatun, RR Majumder, ME Ahmed, SK Debsharma, N Jahan and MY Khan

Plant Breeding Division, Bangladesh Rice Research Institute

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Abstract

Food security is not the permanently achievable aspect under the scenario of increasing population, climate vulnerabilities, and decreasing resources. Therefore, high yielding modern rice varieties are required for fulfilling market and farmers' demand both for favourable and unfavourable environments. Breeding is a continuous intervention because of growing susceptibility against pest population, maintaining genetic diversity, climate change adaptation, changes in the demand of consumers and market and policy level demand. BRRI has so far released 106 modern varieties of which 99 are inbred and 7 are hybrid. However, all the varieties have not been equally adopted in the farmer's fields. Highest adoption was recorded for BRRI dhan48 (39.9%), BRRI dhan49 (14.3%) and BRRI dhan29 (25.7%) in T. Aus, T. Aman and Boro seasons, respectively. As a part of modernization of breeding program, every year around 1.5 million progenies are developed (F2-F5) through FRGA. In total, 2, 04,260 LST lines were evaluated where around 10% selection intensity was applied for promoting to OYT. Again, 21,396 lines in OYT and 5,570lines in AYT have so far been evaluated. In total, 58,180 LST lines were fingerprinted with trait-markers, 25,040F1 plants were assayed with QC SNP Panel and 2,604 lines were assayed with 1k-RiCA panel for MAS and parent selection based on GEBV. BRRI has introduced digital data management through B4R, Google Sheets, Bar tender and Harvest Master. However, for the selection of parents and cross combination, and for the promotion of breeding lines, 18 Product profiles were developed for different ecosystems. The maximum magnitude of grain yield was found 11.0 t/ha having165 days growth duration in Boro season (BR11723-4R-172) and 7.7 t/ha with 117 days growth duration (BR11716-4R-102) was found in T. Aman season during 2020-21. BRRI breeding program has also been started increasing frequencies of oligogenic traits like disease and insect resistance through rapid generation based forward cyclic breeding. Earlier as a part of molecular breeding, BRRI dhan79, a submergence-cum-stagnant water tolerant T. Aman variety, has been developed through MABC. One of the BRRI dhan44-Sub1 breeding lines with 98% background recovery has been promoted to ALART. A number of QTL mappings have been done, for example, arsenic phyto-toxicity tolerance from BRRI dhan47, seedling stage cold tolerance from Habiganj Boro VI, high zinc content form Kalabokri. Moreover, seedling stage cold tolerance QTLs have been introgressed into BRRI dhan28and pro-vitamin-A rich transgenes into BRRI dhan28, BRRI dhan49 and BRRI dhan62. BRRI breeding programs need to be modernized to the further extent for better delivery of genetic gain and development of steady pipelines of farmers and consumers-preferred varieties.

Keywords: Genetic gain, diversity, climate change, modern rice

Dr. Andrew Sharpe is the Bangabandhu Research Chair in Food Security at the Global Institute for Food Security (GIFS) at the University of Saskatchewan (USask), Canada. The Chair was established in 2021 to carry out research in key areas of crop genomics and phenomics and post-harvest processing traits. The Chair is part of the Bangladesh Partnership that is co-led by GIFS and the Bangladesh Agriculture Research Council (BARC). Previously Dr. Sharpe was the Program Director (2018-21) for the 'Plant Phenotyping and Imaging Research Centre (P2 IRC)'at USask. This interdisciplinary program with contributions from multiple USask faculties (e.g., Plant Science, Soil Science, Computer Science and Engineering) and research facilities (e.g., Canadian Light Source) has a focus on the use of imaging technology, digital data acquisition and machine learning tools together with genomics and bioinformatics resources to accelerate the delivery of climate resilient crops. Dr. Sharpe was also Director of Genomics and Bioinformatics (2015-18) at GIFS, in which he established an integrative 'omics platform, the 'Omics and Precision Agriculture Laboratory (OPAL)' at GIFS that supports with genomics, phenomics and informatics needs of the researchers in Saskatoon and Canada. He was also co-lead for the Genome Canada 'Canadian Triticum Applied Genomics (CTAG2)' project (2015-20) that established the first de novo wheat genome assembly, and he has led efforts to furnish reference genomes and pan-genomes in canola, wheat and other crops.

Application of Bioinformatics for Crop Improvement

Andrew Sharpe

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Abstract

A key development of computational informatics in recent years has been the ability to generate high quality plant genome assemblies where the contiguity and coverage of genome is greatly improved. These achievements have been based upon the availability of new computationally efficient algorithms together with huge strides that have been made in DNA sequencing technologies in terms of increasing read lengths, sequence quality and declining costs to generate the data. Initially short read technologies were used to generate plant genome assemblies, however poor contiguity of generated assemblies, together with unavailability of large regions of the genome because of ploidy derived duplication and / or the collapse of highly repetitive regions, compromised the assemblies. The development of lower cost long read sequencing technologies such as Oxford Nanopore Technologies (ONT) and Pacific Biosciences (PacBio) have now largely resolved these limitations. Concomitant with these improvements there is a growing appreciation that copy number variants, presence/absence variants and structural rearrangements have played an important role in the adaptation of phenotype in many crops. Thus, the new informatics tools and long read sequencing technologies offer a unique opportunity to capture this often-elusive structural variation (SV) in crop genomes. In recently years GIFS has engaged in generating de novo whole genome assemblies of multiple crop genomes using these technologies, including repeat rich diploid species, paleohexaploid species and more recent tetra- and hexaploid species (including canola and wheat). These assemblies reveal not just almost total representation of the repetitive regions but also higher representation of total genes. The efficiency and cost effectiveness of the process now enables multiple accessions within each species to be assembled and allow the development of 'pangenomes' where large proportions of the single nucleotide variation (SNV) and SVs are characterised in each species. These resources provide rich repositories of genetic variation that can exploited for molecular breeding in each crop.

Keywords: Bioinformatics, crop improvement, DNA sequencing, SNV, SV

Dr. Pankaj Bhowmik received his Ph.D. in Plant Physiology and Molecular Biology from Kagawa University, Japan. Following JSPS, Killam and NSERC postdoctoral training. Pankaj joined the National Research Council of Canada in Saskatoon in 2009 where he is now a Senior Research Officer and a member of the Cell Technologies team. Pankaj also has an additional role as the Scientific Support Lead for NRC's Sustainable Protein Production (SPP) program where he closely works with small and large companies in the plant biotech and ag-food sector, academia and other Government Departments to establish multi-organizational research collaborations with external stakeholders. He has more than 20 years of experience in plant cell technologies and tissue culture. His specific research focuses on improvement of crops through tissue culture, transformation and gene editing.

Application of Cell Technologies and Genome Editing Tools for Accelerated Genomic Gain and Crop Improvement

Pankaj Bhowmik

National Research Council of Canada, 110 Gymnasium Place,
Saskatoon, SK S7N 0W9, Canada

Abstract

Cell technologies and genome editing are expanding traditional plant breeding tools for crop improvement by introducing new traits more quickly and precisely. Our main objective is to advance cell technologies and gene editing tools which can be deployed efficiently to multiple crop species for direct introduction of major-effect allelic variants into elite varieties. Thus, saving time and resources, and eliminating yield drag resulting from the residual donor genes at the end of backcrossing. On several ongoing projects, we are working with multiple industry partners to develop a crop agnostic gene-editing platform for improving different traits in cereals, oilseeds, pulse crops and greenhouse vegetables and fruits. A number of parameters such as optimization of the promoters to drive and express Cas9 and utilization of different fluorescent reporters and selection markers have been evaluated in different crop species. Several delivery methods including electroporation, biolistic and Agrobacterium-mediated transformation and plant regeneration have also been optimized for achieving high-efficiency genome editing. Significant progress has been made in terms of optimization of mesophyll protoplasts system for gRNA validation and delivery of gene editing components into haploid wheat microspore system. These results along with the ongoing progress and challenges in developing improved and crop-agnostic gene editing technology will be presented.

Keywords: Cell technology, genome editing, genetic gain, gRNA, Cas9

Dr. Damien J. Platten has worked at the International Rice Research Institute since 2009, where he contributes to native trait discovery and deployment efforts. Much of his work revolves around enabling marker-assisted selection in mainstream breeding programs. Genome resequencing datasets are used to inform the design and implementation of reliable trait markers, and deployment and augmentation efforts make major genes available to mainstream breeding efforts in clean, high-quality elite genomic backgrounds without the yield penalties and linkage drag associated with the original donor landraces. Associated with these activities, analytical pipelines to help apply markers successfully have been developed.

Resources for Enabling Efficient Mas in Modern Rice Breeding Programs

J. Damien Platten

Research Unit Leader - Breeding Innovations and Informatics
International Rice Research Institute, Los Baños, Laguna 4031, Philippines

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Abstract

Modern breeding approaches utilise marker-assisted breeding tools to improve many aspects of the breeding pipeline and process. This short presentation will give an overview of some of the resources and tools that have been developed to enable the effective implementation of MAS in modern rice breeding programs. These include mid-density marker platforms for enabling genomic selection, accurate marker systems for major genes, and availability of pre-breeding products to introduce major genes into the breeding process without the penalties normally associated with the original donors. These tools are freely available to public-sector partners, and tips will be shared on how to use them effectively. Application of these resources enables a more efficient and effective breeding strategy.

Keywords: Modern rice breeding, MAS, breeding pipeline, marker, genomic selection

Dr. B.P Mallikarjuna Swamy was born to a farming family in India and has always had a keen interest in agriculture from his early young age. His desire to be a researcher in agriculture to improve the livelihood of farming families made him pursue his career in Agricultural Sciences. He successfully completed his Doctoral Degree in Genetics in India, 2009. His PhD work resulted in mapping of major QTLs for yield and related traits, registered novel germplasm, and released a high yielding rice variety. Later he moved to International Rice Research Institute (IRRI) as a Post-doctoral fellow in drought molecular Breeding, wherein he mapped major QTLs for grain yield under drought and successfully pyramided them into popular rice varieties along with other major QTLs for biotic and abiotic stresses. He significantly contributed to the genetics of drought tolerance in rice through meta-analysis and identification candidate genes. His works were well recognized at IRRI and worldwide, so he was appointed as Lead Breeder for Healthier rice development in 2013. He has been playing a pivotal role in developing healthier rice and major milestone have been achieved in developing Golden rice and Micronutrient rich rice varieties. He is also a prolific writer and published in high impact journals and actively involved in disseminating knowledge of health and nutrition, and training future researchers. He is active member of plant science societies and editorial board member of scientific Journals. His unquenching thirst for science, desire to address complex problems in rice science makes him an invaluable member of any research team.

Achieving Nutritional Security Through Development of Healthier Rice: Progress and Prospects

B.P. Mallikarjuna Swamy*, Russell Reinke, Mercy Samia, Mary Ann Inabangan-Asilo, Amery Amparado, Chau Thanh Nha, Alvin Palanog, Gwen Iris Descalsota-Empleo and Mark Ian Calayugan

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Abstract

Globally more than two billion people, particularly children and women suffer from Iron, Zinc and Vitamin A deficiency related health problems. Micronutrient deficiencies are highly prevalent in South and South East Asia, where rice is the major staple food and supplies 50 to 80% of the daily caloric intake, but polished rice is low in essential micronutrients (Fe, 2-3 ppm; Zn, 12-14 ppm, β-Carotene, 0 ppm). Zinc deficiency causes stunting, diarrhoea, impaired immune function and infertility; iron deficiency causes anaemia and poor cognitive development; while, vitamin A deficiency causes blindness and reduced immunity, resulting in serious global health problems. Biofortification of rice with micronutrients has been suggested to be one of the most sustainable, targeted, food-based and cost-effective approaches to combat micronutrient malnutrition. Rice genetic resources especially Aus accessions have huge genetic variation for grain zinc which can be efficiently used in breeding programs to develop high zinc rice varieties; similarly, genetically modified high iron rice and golden rice can supply iron and provitamin A respectively. Development of healthier rice varieties with micronutrients and vitamin A will contribute significantly to improve the health of human populations and resulting in inclusive growth. We are implementing genomics assisted breeding programs to mainstream zinc biofortification at International Rice Research Institute. Recent progress in development of healthier rice varieties will be discussed in the presentation.

Keywords: Healthier rice, nutritional security, β-Carotene, Zinc, micronutrient

Dr. Hiroyuki Shimono is a professor of Iwate University, Japan. He obtained his BS, MS and PhD degree from the Faculty of Agriculture, Hokkaido University, Japan. Screening new cultivars through yield trials in multiple environments has improved crop yields, but the accumulated data from these trials have not been effectively reused. Dr. Shimono and his group proposed a simple method that quantifies cultivar-specific characteristics of productivity using two regression coefficients for yield-ability (β) and yield-plasticity (α). Dr. Shimono worked as Postdoc Fellowship at the National Agricultural Research Center for Tohoku region, Japan (2003-2005) and also JSPS Postdoc Fellowship at the Japan Society for the Promotion Japan (2005-2007). He served also as Visiting Scientist in Beltsville Agricultural Research Center, USDA-ARS, USA and Australian National University, Australia. He awarded Japan Prize in Agricultural Sciences, Achievement Award for Young Scientists 2010 (The Foundation of Agricultural Sciences of Japan) and also awarded Young Scientists Award of Japanese Society of Crop Science 2010 (The Crop Science Society of Japan). He has seven selected publications those have high impact in crop science.

New Phenotyping Method Using Crop Growth Model: Apply to Rice-yield Big Data

Hiroyuki Shimono[1*], Akira Abe[2], Chyon Kim[1], Chiashi Sato[3] and Hiroyoshi Iwata[4]

[1]Iwate University, [2]Iwate Biotechnology Research Center, [3]Ifuu Rinrin, [4]Laboratory of Biometry and Bioinformatics, Graduate School of Agricultural and Life Sciences, The University of Tokyo

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Abstract

Screening new cultivars through yield trials in multiple environments has improved crop yields, but the accumulated data from these trials has not been effectively reused. We propose a simple method that quantifies cultivar-specific characteristics of productivity using two regression coefficients for yield-ability (β) and yield-plasticity (α). The recorded yields of each cultivar were expressed using a unique linear regression in response to the theoretical potential yield calculated by a weather-driven crop growth model called the "YpCGM method." We applied this analysis to 72,510 independent datasets from yield trials of rice (Oryza sativa L.) that used 237 core cultivars measured in breeding programs at 110 locations in Japan over 38 years. The coefficients of β and α differed among the 237 cultivars, with values ranging from 2.5 to 7.3 t/ha and from –0.23 to +0.95, respectively. Genomic prediction validated the values of these two coefficients by a 10-fold cross-validation based on pedigree information and the rice genome's 91,800 single-nucleotide polymorphisms. The YpCGM method can upcycle accumulated yield data for use in genetic gain analysis and genome-wide association studies to guide future breeding programs in developing new cultivars suitable for the world's changing climate.

Keywords: Big data, genomic prediction, genetic gains, meta-analysis, pedigree

Dr. Md. Nurul Haque Mollah received his B.Sc. (Hons.) and M.Sc. degrees in statistics from the University of Rajshahi, Bangladesh. He completed his PhD degree research in Statistical Science from the Institute of Statistical Mathematics (ISM), Tokyo, Japan in 2005. He joined as a lecturer in the Department of Statistics, University of Rajshahi in 1996 and then was promoted to Assistant Professor, Associate Professor and Professor in 1999, 2005 and 2010, respectively. He was also a post-doctoral researcher on statistical bioinformatics from 2006 to 2008 at ISM, Tokyo, Japan. His area of research specialization covers multivariate statistics, robust statistical inference, biostatistics, data science, computational biology and bioinformatics. He has published more than 130 research articles in the reputed international journals, and 150 articles in the proceedings of national and international conferences. He has supervised more than 50 research students at Master and PhD levels. He successfully led several research projects funded by University Grant Commission (UGC, Ministry of Science and Technology (MOST), Bangladesh medical research council (BMRC), BANBEIS and World Bank as the Principal Investigator (PI). He also organized several national/international workshops, seminars and conferences as convener/co-convener. He also served as a founder president of Bioinformatics Research Group of Rajshahi University and Bangladesh Bioinformatics and Computational Biology Association.

The Role of Bioinformatics in Modern Rice Research

Md. Alamin[1, 2], Most. Humaira Sultana[1] and Md. Nurul Haque Mollah[1*]

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Abstract

Bioinformatics is acting an increasingly important role in modern rice research. Most importantly, major challenges in maximizing crop yields involve weeds, different environmental and biological factors affecting rice production in Bangladesh and worldwide. Bioinformatics tools are used to understand gene expression mechanisms better and develop new rice varieties with desired traits. It can facilitate breeding to generate improved varieties for higher quality and rice yields. Also, bioinformatics is increasingly important in modern rice research because it provides insights into the structure, function, and evolution of genes. Recent advances in bioinformatics have made it possible to analyze and compare large-scale datasets from different species of rice, allowing researchers to understand better the genetic basis of several traits such as disease resistance, drought tolerance, and yield. The use of computational tools and techniques allows for the collection and investigation of large amounts of data related to rice cultivation and genetics, enabling researchers to gain insight into the biology of the crop and maximize yields. This data can be used to identify genes associated with traits such as disease resistance, drought tolerance, and yield, as well as to monitor changes in the genetic makeup of the crop over time. Moreover, bioinformatics is used to develop predictive models for selecting and breeding new rice varieties with desired traits. It can also facilitate gene editing through genome-wide association studies, allowing for targeted modification of specific genes associated with a particular trait. In conclusion, bioinformatics can be used to monitor changes in the genetic makeup of the crop over time, enabling researchers to identify new variants of genes and develop improved varieties of rice.

Keywords: Bioinformatics, gene structure, gene function, evolution of gene, datasets

Professor Dr. Tofazzal Islam is an internationally reputed researcher in the field of molecular host-microbe interactions and agrobiotechnology. He did his PhD at the Hokkaido University in applied Biosciences. Dr. Islam conducted postdoctoral research at Hokkaido University, University of Goettingen, University of Nottingham and West Virginia University under the fellowship programs of JSPS, Alexander von Humboldt, Commonwealth and Fulbright, respectively. Prof. Tofazzal discovered a large number (>50) of bioactive secondary metabolites from the host and non-host organisms, and elucidated the mode of actions of some of these natural products. He has been leading a large group of national and international researchers for the mitigation of worrisome wheat blast disease caused by *Magnaporthe oryzae Trticum* since its first epidemic outbreak in Bangladesh in 2016 using genomics, genome editing and other advanced molecular approaches. His team developed a rapid, convenient and highly sensitive method for the diagnosis of wheat blast fungus in collaboration with researchers in China, USA and KSA using CRISPR-Cas12a technology. Recently, his team sequenced the whole genome of a year-round fruiting jackfruit which opens opportunity for molecular breeding and agro-processing of this national fruit for food and nutritional security. He is the Editor-in-Chief of two series books, *Bacilli and Agrobiotechnology,* and *CRISPR-Cas Methods* that publish by Springer Nature. He serves as an Academic Editor of *PLOS ONE*, Editor of *Scientific Reports*, Associate Editor of *Frontiers in Microbiology* and Member of Editorial Advisory Board of *CABI Reviews*. Prof. Islam is an elected Fellow of Bangladesh Academy of Sciences (FBAS), American Phytopathological Society (FAPS), Bangladesh Academy of Agriculture (FBAA) and The World Academy of Sciences (FTWAS). He received many awards and medals including a Gold Medal of Bangladesh Academy of Sciences, Commonwealth Innovation Award, Islamic Development Bank Innovation Award, and the GNOBB Award. He published more than 350 articles in the international journals and book series with >7,500 citations (h-index 46). He is the highest cited researcher in Bangladesh in the field of Genetics and Molecular Biology. His research team utilizes frontier technologies to mitigate new challenges in agriculture such as wheat blast.

CRISPR-based Technology for Point-of-care Disease Diagnosis and Crop Improvement

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Abstract

The Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR)-CRISPR-associated (Cas)-mediated genome editing is a transformative new technology, which revolutionize basic and applied biology. In a decade of its discovery, the CRISPR has emerged as a powerful technology for improvement of agrifood and point-of-care diagnosis of disease pathogens. One of the key features of CRISPR-edited plants and organisms is that the edited final product is free from transgene(s) and thus can rapidly release to the practical field without any delay for biosafety assessment. A good number of CRISPR-edited plants (including rice), fishes and microorganisms are commercialized in several countries. Wheat blast is a destructive fungal disease caused by a filamentous fungus *Magnaporthe oryzae Triticum* (MoT), which poses a serious threat to wheat production in South America, Bangladesh and Zambia. We aimed to utilize the CRISPR technology for the development of a durable blast resistant wheat and a point-of-care diagnostic method for a rapid and convenient detection of wheat blast fungus. We edited a total of 10 S-genes in the genome of hexaploid wheat using CRISPR-Cas9 and generated 7,000 lines. These lines were screened using artificial inoculation with MoT conidia followed by sequencing that resulted some edited lines with moderate blast resistance. Characterization of the CRISPR-edited wheat lines are in progress. To develop an accurate and sensitive method to detect MoT, we sequenced the genomes of *M. oryzae* isolates from rice and wheat, and identified two unique DNA fragments, MoT-6098 and MoT-6099 in the genome of MoT. Based on these DNA fragments, we first developed a polymerase chain reaction (PCR) method and validated it using field samples. Finally, we designed guide RNAs (gRNAs) and used Cas12a enzyme to precisely target the DNA sequences of MoT-6098 and MoT-6099. The activated Cas12a exhibited indiscriminate single-stranded deoxyribonuclease (ssDNase) activity. Using this CRISPR-Cas12a technology, we developed a new, accurate, convenient, cost-effective and rapid method for the detection of MoT-specific DNA sequences in infected wheat seeds and plants. This novel technique can also be easily adapted by quarantine personnel, plant pathologists and agriculture extension workers for quickly detecting MoT in infected plants, seed lots and alternate hosts as well as monitoring and surveillance of wheat blast disease in the farmers' field. Changing the guide-RNA, we found that the CRISPR-based lateral flow assay is effective in detection of any plant diseases or GMOs or marker-based selection breeding. In this talk, I shall discuss the potentials of CRISPR technology for point-of-care disease diagnosis and crop improvement, with special reference to our findings on wheat blast.

Keywords: CRISPR-Cas, *Magnaporthe oryzae Triticum,* gRNA, Cas12a, GMO

Session-II:
Accelerated productivity: Policies and Priorities

Dr. Moin Us Salam is an agricultural scientist internationally recognized as agro-systems analyst, crop modelling, forecaster of crop diseases and agriculture sector development expert. Dr. Salam served the Department of Agriculture and Food Western Australia (DAFWA) for 17 years and held the position of a Principal Research Officer, which was the highest level attainable for a practicing scientist in the public service of the Government of Western Australia. He studied in Reading University, UK, for PhD and University of Florida, Gainesville, USA, for postdoc. Dr. Salam was associated with the Bangladesh Agricultural University (BAU), Mymensingh, Bangladesh, for 17 as a student and a faculty in the Department of Agronomy. He stood First Class in First Position both in bachelor and master's degrees from BAU. As academic recognition, among others, he received Chancellor Award 1987 by the President of the People's Republic of Bangladesh and the Chancellor of the Universities for outstanding results in the Bachelor of Science in Agriculture (Honours) examinations. As academic recognition, among others, he received 'Global Achievements Awards in the Field of Phyllosphere Biology" in 2012 by the Amity University, Uttar Pradesh, India. Currently, Dr. Salam is working as a Freelance International Consultant. His recent work places included International Maize Wheat Improvement Center (CIMMYT), United States Agency for International Development (USAID) through Dhaka Ahsania Mission (DAM), Food and Agriculture Organization (FAO) of the United Nations, International Rice Research Institute (IRRI), and the University of Western Australia (UWA). He has published 100 refereed papers in reputed journals (including Agronomy Journal, Agricultural Systems, Annual Review of Phytopathology, Australasian Plant Pathology, Crop Protection, Diversity and Distributions, Ecological Modelling, Euphytica, European Journal of Plant Pathology, International Journal of Food Security, Microbial Ecology, Plant Pathology and Phytopathology) and 45 papers in conference proceedings, 15 articles in books and delivered 25 Consultancy Reports. Dr Salam significantly contributed for the Bangladesh Rice Research Institute (BRRI) in developing Rice Vision 2050 and Doubling Rice Productivity. BRRI conferred him the 'Plaque of Recognition in 2021 for his outstanding scientific contributions to formulate and materialize the "Doubling Rice Productivity in Bangladesh (DRP)" strategic document.

Prioritising Yield Loss Components in Rice For Accelerated Productivity

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Abstract

Against the backdrop of declining arable land, future rice production increases in Bangladesh will have to come from higher yields, simultaneously following two pathways - enriching genetic potential and maximizing management potential. Genetic potential is defined as 'the yield of a cultivar when grown in environments to which it is adapted, with nutrients and water non-limiting and with pests, diseases, weeds, lodging, and other stresses effectively controlled'. Inability of effectively managing biotic and abiotic stresses causes 'yield gap' between the achieved and genetic potential yields, and often termed it as 'yield loss'. This paper presents yield loss scenarios of rice, its spatio-temporal variability, and measuring approaches. It also highlights on disentangling agronomic and economic yield gaps. The paper further attempts to dissect the total yield loss into biotic and abiotic components and sub-components and prioritise action(s) for accelerated productivity. The actions incorporate growth-stage-based and precision management approaches for achieving productivity with efficiency and speed.

Keywords: Rice, yield loss, genetic potential, yield gap, managements

Dr. Md. Ayub Hossain is the Chief Scientific Officer of Farm Machinery and Postharvest Process Engineering Division of Bangladesh Agricultural Research Institute, Gazipur. Dr. Hossain obtained BSc. Agricultural Engineering (Hons) degree from Faculty of Agricultural Engineering and Technology of Bangladesh Agricultural University (BAU) in 1986. He completed MS degree from the Department of Farm Power and Machinery, BAU in 1996. He awarded PhD in Farm Power and Machinery from BAU in 1984 under Commonwealth Split-Site Scholarship between BAU and University of Newcastle upon Tyne, UK. He also completed Post-doctoral under Alexander von Humboldt Fellowship at Leibniz Institute of Agricultural Engineering, Potsdam, Germany. He has published about 150 technical articles including 85 scientific papers in various journals at home and abroad. He also regularly publishes various articles on science research in daily and monthly magazines. He joined in Bangladesh Agricultural Research Institute (BARI) in 1992 as a Scientific Officer in the discipline of Agricultural Engineering. He worked in different responsibilities and positions in BARI. About a dozen of contact research projects funded by Ministry of Agriculture (MoA), Food and Agriculture Organization (FAO), World Bank, WorldFish, USAID, Bangladesh Agricultural Research Council (BARC), Krishi Gobeshona Council (KGF) were carried by his leadership. The major fields of his research are farm machinery and mechanization, conservation agriculture, solar irrigation and crop drying. He is the life fellow of Institute of Engineers' Bangladesh (IEB), life member of Krishibid Institute Bangladesh (KIB), Bangladesh Society of Agricultural Engineering (BSAE), Bangladesh Solar Energy Society (BSES) and Bangladesh Association of Advancement of Sciences (BAAS).

Agricultural Mechanization in Bangladesh: Present Status and Future Strategy

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Abstract

Mechanized farming is an indispensable part of modern agriculture. Agricultural mechanization program has been accelerated in Bangladesh in the recent years. Current programs and policies of the government favours the growing demand of agricultural mechanization. This paper presents the status of agricultural machinery in the country with the historical background, policy, and future strategies. Over the last two decades, the use of mechanical farm power (3.15 kW/ha) has increased rapidly. Few components of agricultural mechanization have achieved significant progress such as land preparation (96%), irrigation (92%), threshing (90%), spraying (98%) and milling (97%). But, comparatively slower progress of mechanization has been made in planting, weeding, fertilizing, harvesting, drying and storing activities. Only a few agricultural machines (Tractor, power tiller, combine harvester, reaper, rice transplanter, etc.) are being imported and most of the machines are locally produced. NARIs have developed a good number of the agricultural machinery which are manufacturing by local manufactures and successfully using by the farmers throughout the country. Local manufacturers and light engineering workshops are successfully manufacturing most of the spare parts (85%) of almost all agricultural machines. The government of Bangladesh has been providing development assistance to the farmers on some selected agricultural machines to speed up agricultural mechanization. Research and development programs have undertaken by different organizations to address fourth industrial revolution in agriculture. The government should take necessary actions for strengthening agricultural mechanization in all NARIs and Department of Agricultural Extension.

Keywords: Modern agriculture, agricultural mechanization, power tiller, combine harvester

Mr. Mohammed Masum was born in 1945, obtained degree in Agriculture (B. Ag) in 1967, served in EPADC/BADC for 9 years, started own business in Agriculture and other sectors, started Supreme Seed Company in 1978. Associated with the development of Seed Industry particularly private Seed Industry for the last 52 years. Now he is the Chairman of Supreme Seed Company Limited, Bangladesh.

Transformational Footprint of Private Seed Sector for Enhancing Productivity of Rice Farm Lands in Bangladesh

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Abstract

Private sector enters into seed sector after the enforcement of seed policy 1993 and seed rules 1998. Initially their involvement was in seed production and marketing of foundation seed, certified seed, truthfully labelled seed and in hybrid rice seed to some extent. There is no doubt that BRRI has been very successful in rice research and development by developing high yielding modern rice varieties and other related technologies enabling the country to meet its growing populations. Contribution of BRRI in rice production is reflected in national rice production which is increased over three folds from 1971. BADC is the major contributor in rice seed system producing about 24.40% total rice seed while private sectors producing 18.10 against 44.18% of formal seed in 2019. In 2018, private sector has been allowed to conduct research & development in plant breeding and release of their own varieties which resulted in promptly releasing two inbred rice varieties within three years' time by two private companies. Few more private seed companies have started vigorous rice breeding activities and expecting many more new varieties will be released in future. This allows farmers to choose rice varieties from public and private sectors. Private sector has taken the leadership role in introducing, breeding and marketing of hybrid rice varieties in Bangladesh which started in 1998-99. Until now, 218 hybrid rice varieties have been registered in Bangladesh of which only 15 registered by public sector and the rest are from private sector. Hybrid rice (F1) seed production is also- increasing in local market with locally developed hybrid rice. In 2021, 10722 ton hybrid rice seed (F1) have been produced by private seed companies challenging the climatic hazards in the country. The role of hybrid rice cultivation in Bangladesh in achieving self-sufficiency and food security are well-known & well documented. Currently, national coverage of hybrid rice is about 10% of total land under rice cultivation which is expected to go up to 25-30% in next 10 years' time, where private sector would play a vital role for enhancing productivity of rice farm lands & increasing farmer's income.

Keywords: Private sector, seed company, hybrid rice, BRRI, BADC

Dr. Mohammed Eunus Ali is a Professor in the Department of Computer Science and Engineering (CSE) at Bangladesh University of Engineering and Technology (BUET), Dhaka since May 2014. He is the group leader of the Data Science and Engineering Research Lab (DataLab) in the department of Computer Science and Engineering at BUET. He received his PhD degree in Computer Science and Software Engineering from the University of Melbourne in 2010. He also worked as a Research Fellow and Visiting Research Scholars in the University of Melbourne, Monash University, Swinburne University of Technology, and RMIT University. Dr. Eunus is the recipient of the prestigious UGC Award in the year 2012 for his outstanding research contribution. Dr. Eunus's research falls in the intersection of data management and machine learning. His research areas cover a wide range of topics in database systems and information management that include spatial databases, practical machine learning, NLP and smart agriculture. Dr. Eunus's research papers have been published in top ranking journals and conferences such as the VLDB Journal, TKDE, Biosystems, DMKD, Information Systems, ICDE, PVLDB, and UbiComp. He served as a Program Committee Member of many prestigious conferences that include SIGMOD, VLDB, AAAI, and SIGSPATIAL. Dr. Eunus is also involved in different projects that investigate the role of ICT for the development of developing countries like Bangladesh. Dr. Eunus was the founding Chair of BUET ACM Chapter.

Enabling Farmers in Combating Pest and Diseases in Rice Crops: Artificial intelligence for Rice Crop Management

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Abstract

Plant pests and diseases affect food crops, cause significant losses to farmers and threaten food security, especially in developing and under-developed nations. The amount of estimated loss is more than 500 million Euro/ year in Bangladesh and India. Of that amount, a significant amount accounts for two main cereal crops: Rice (Aus, Amon, Boro) and Wheat. Rice occupies about 80 percent of the gross cropped area and accounts for 96 percent of total cereal production in Bangladesh (BBS, 2021). Recent study suggested that approximately 10-15 percent average rice yield loss occurred due to various diseases and insect pests nutritional and other associated operational issues in Bangladesh. The key reasons for such huge losses are the lack of proper knowledge of these issues among farmers and insufficient support from extension personnel across Bangladesh. A 2021statistics in Bangladesh shows that countrywide only 16,460 agricultural officers are giving field support to 1,65, 62, 974 farmers. With this sharp contrast among the number of farmers and the number of agricultural support personnel, it is possible to give support to less than 1% of the farmers. In this talk, we will highlight how an artificial intelligence (AI) driven support system for farmers can be developed in combating rice crop diseases, pests, and nutritional deficiencies. In particular, we will focus on state-of-the-art AI techniques and discuss the future opportunities that can help farmers in different aspects, ranging from image capturing to issue identifications, and finally to suggest appropriate measures for rice crop management.

Keywords: Pests, diseases, rice, artificial intelligence, food security

Dr. M. Nahid Sattar is an Associate Professor in Department of Agricultural Economics at Bangladesh Agricultural University, Mymensingh. He obtained PhD from Michigan State University, USA with funding from the USAID/BHEARD program; MA in Development Economics from the University of East Anglia, UK under the Commonwealth Scholarship; and MS and BSc in Agricultural Economics from Bangladesh Agricultural University. His research area includes economic analysis of agricultural production systems, sustainable use of natural resources, policy issues like paddy and rice procurement, as well as a range of other topics in agricultural, development and environmental economics.

Public Paddy and Rice Procurement Program in Bangladesh: Key Lessons for Policy

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Abstract

While Bangladesh has achieved major success in rice production since its independence, it is often believed that rice farmers do not get the desired price for their product. The government has a food grain procurement program, which aims to support producers as well as build a buffer stock for supplying food during crisis periods as well as through some regular safety net channels. However, there has been some criticisms of this system that include purchasing small amount compared to total production, the paddy procurement criteria being hard to follow for farmers, rice millers and other market agents benefitting from this system while paddy farmers being left out, etc. This study reviews the current situation of paddy and rice procurement in Bangladesh from existing academic literature, newspaper reports and available data. It also synthesizes similar programs in other major rice producing countries and draws lessons from them. Finally, some suggestions are made on strategies for improving the paddy and rice procurement program in Bangladesh.

Keywords: Paddy, procurement, production, price, policy

Dr. Mohammad Jahangir Alam is a Professor in Agricultural and Public Policy Economics at the Department of Agribusiness and Marketing, Bangladesh Agricultural University. Dr. Alam is an Adjunct Professor in the School of Economics and Business, University of South Australia, Australia and in School of Business Administration in Zhongnan University of Economics and Law, Wuhan, China. He was a Visiting Research Fellow at Crawford School of Public Policy at Australian National University, Australia. He was a Fulbright Scholar at Dyson School of Applied Economics and Management, Cornell University, USA. He was a Visiting Fellow at the Department of Agricultural Economics and Agribusiness at Louisiana State University, USA and a Commonwealth Post-doc Fellow at SOAS, University of London, UK. Dr. Alam was a Visiting Professor (EU Erasmus Mundus) at Dublin Institute of Technology, Ireland where he taught `Global Food System` and a Visiting PhD Scholar at Department of Agricultural Economics and Agribusiness, University of Arkansas, USA during his PhD studies at Ghent University, Belgium. He has published more than 100 articles in peer-reviewed journals, several book chapters and written several research reports with Google Citation index of 2383 and h-index of 23. He has research experiences in Bangladesh, Belgium, UK, Australia, and USA. Dr. Alam is experienced in collaborating with IFPRI, FAO, IRRI, Australian National University, University of Plymouth, University of South Australia, SOAS, London School of Hygiene and Tropical Medicine, Wageningen University, Lincoln University New Zealand, University of Oxford, University of Arkansas, Asian Productivity Organization etc either as consultant or as a team leader/member in different research projects. He has delivered many projects funded by the USAID, ACIAR, DFAT, EU, BMGF, FCDO etc, to name a few. Dr. Alam has been collaborating with several Australian and European Universities on several projects related to agricultural transformation, fertiliser management, climate -smart agricultural technologies, food system Foresighting. Dr. Alam has been involved in agricultural and food systems in Bangladesh, FAO of the United Nations, IFPRI, to name a few.

Agricultural Transformation in Bangladesh– Policy and Institutional Experiences

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Abstract

Characterized as a 'food deficit' during the early 1970s, Bangladesh has turned herself into a 'food full of basket'. In the backdrop of this tremendous turnover, this study examines the transformation of the country's agriculture. It uses the framework presented by Laborde and associates in 2018 and fits agriculture transformation in Bangladesh into three stages. Agriculture entered into the first stage (1971-1989) of transformation not long after Bangladesh achieved independence in 1971 when it faced a challenging situation to feed its 75 million people. Policies were developed, actions were planned and organizations were established and/or restructured. This is the stage when agriculture was the major contributor to GDP (~42%). The stage had a comparative advantage in net annual cropped land but the country faced chronic food shortages, with a rice balance of the staple food, of -3.69 million tons. Stage 2 (1990-2010) was characterized by greater political stability. However, production of staple foods was still insufficient. Non-agricultural sectors began to grow and agriculture's share in GDP fell by about half. Agriculture started growing despite the constraint of reduced net annual cropped land. It had high employment but low mechanization, resulting in low labour productivity. In stage 3 (post-2010), the unchanged government began implementing planned development. The economy became stronger, staple foods were in surplus despite a continued decline in land resources, and farm mechanization increased rapidly. Agriculture's contribution to GDP declined to around 13%, but its value to the national economy increased, thereby characterizing agriculture as more efficient than in the previous stages. This study further shows that agricultural labour productivity increased stage by stage, while the share of labour to agriculture decreased. In addition, the irrigated area expanded and the use of fertilizers increased. The country experienced increased yields of crops. Furthermore, BDAT-2 and 3 highlighted higher livestock and fisheries productivity and production. We provide data-driven evidence on the agricultural input supply, value addition, and research and extension services from both the public and private sectors in each stage. We also document policies, strategies, institutional innovation, and legislation that drove the stages of transformation. Future development of Bangladesh agriculture will be challenged from two sides – demand, from population pressure and product quality, and constraints in the natural production environment including climate change. To step into the final stage, the country would need to sustain the achievements and further vitalize the ongoing momentum to be sped up in agricultural research.

Keywords: Transformation, agriculture, policy, GDP, mechanization

Submitted Abstracts For Presentation

High-throughput Plant Phenotyping and Analysis of Complex Traits for The Plant Growth and Development Study

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Abstract

High-throughput multifunctional robotic plant phenotyping is now considering advance technologies of genetic gain in plant breeding programs. It has integrated imaging techniques and generated a large number of complex traits. Due to the rapid progress of advanced phenotyping technologies, plant development research has entered a new era named as 'phenomics'. It is urgent to develop an analytical approach or technical system to identify significant phenotypic traits from the large-scale phenotypic datasets. Bioinformatics technologies also need to extract information from the vast volumes of omics data for bridging the phenotypic-genotypic gap. Statistical learning has rapidly evolved in plant phenotyping and genotyping, and accelerates the analysis of imaging data. Here, we provide an overview of imaging techniques, image data pre-processing and applications of statistical learning methods in the phenomics research. It can be supportive in advance of our views for the plant growth and development study.

Keywords: High-throughput phenotyping, phenomics, imaging data, complex-traits, bioinformatics

Experience with Biotech Crops at BARI: From Lab to The Field

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Abstract

Biotechnology research at BARI started with the establishment of a tissue culture laboratory for potato tuber production in 1985 and another laboratory for micropropagation of horticultural crops in 1993. The initial research was confined for developing micropropagation based technology. Research in advanced area of biotechnology gained momentum after the establishment of a independent Biotechnology Division in 1998. Development of transgenic Bt-eggplant started in 2004 under the USAID funded Agricultural Biotechnology Support Project II (ABSPII)with technical support from Cornell University, USA and MAHYCO, a private company of India which resulted in the 'EE – 1'transgenic event. That event was transferred into Bangladeshi eggplant varieties during 2005-2006. Generation advancement and various contained and confined trials were done during 2007 – 2012 at BARI. Simultaneously, under the same project, development of Late-blight resistant transgenic potatoes was initiated in 2007. Meanwhile, a modern molecular genetics and genetic engineering research laboratory along with a contained greenhouse research and confined field trial facility were established in 2009 at the Biotechnology Division, BARI with the support of Bangladesh government. Subsequently, four Bt-eggplant varieties were released by BARI for cultivation in 2013. Feed the Future South Asia Eggplant Improvement Partnership (FtFSAEIP) took over the Bt-eggplant programme and continued with further extension and implementation of stewardship measures during 2015-2020.Likewise, Feed the Future Biotechnology Potato Partnership (FtFBPP) took over the Late-blight resistant transgenic potato programme and continued the development of varieties harbouring 3 resistant (3-R) genes taken from wild potatoes. Two such selected transgenic lines have been tested recently under contained greenhouse conditions at the Biotechnology Division, BARI and showed resistance against local strains of the Late-blight pathogen. Besides support from the donor partners, concerted efforts from BARI, DAE and BADC resulted in more than 65000 farmers growing Bt-eggplant in Bangladesh durin gthe 2020-21 season. The introduction of Bt-eggplants resulted in significant reduction of insecticide applications in the crop and several-fold increase in farmers'net income.

Keywords: Biotechnology, crops, micropropagation, transgenic, BARI

Adaptation of New Technologies for the Improvement of Commercially Viable Crops in Bangladesh for The Tackling of Future Challenges

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Abstract

The economic development of Bangladesh depends on agricultural production contributing 13.48 percent to the national GDP and providing employment for 40.5 percent of the population. We need to produce more crops on fewer lands while overcoming natural obstacles to feed people and livestock. The development of promising crops is required to boost productivity, nutritional quality, climatic survival, and resistance to biological adversaries. New technologies are providing an excellent solution to achieve those goals. Cereals, vegetables, and fodder crops are commercially important crops that need continuous improvement through up-to-date technologies to fulfil the demands and tackling the challenges. New breeding techniques like; advanced genome engineering, genome editing, mutation breeding are the potential strategies to adapt. Bioreactor culture, soilless culture, modern tissue culture, vertical farming can also provide a sustainable solution for crop improvement as well as food security. The application of advanced technologies for crop improvement will be discussed.

Keywords: Economic development, production, crops, technologies, adaptation

Genetic Improvement of Root Elongation in Bangladeshi Rice

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Abstract

Large amount of nitrogen fertilizer has been utilized to obtain more grain yield in current practice of rice cultivation. Since, nitrogen uptaken into rice plants brings changing plant growths such as increases of tiller number at vegetative stage, spikelet number at early phase of panicle formation, and grain filling at grain filling stage. Roots is a sole organ for uptake water and nutrient uptake. Therefore, to enhance global food security, it is important to improve the nitrogen-use efficiency of rice by modulating root developments. Here, I will introduce the topic of genetic improvement of root elongation A total of 257 Bangladeshi accessions (211 landraces and 46 improved varieties) were evaluated the total root length, maximum root length (MRL) and root number under different concentrations of ammonium and nitrate nitrogen in seedlings grown in hydroponic conditions. Improving each root elongation could be a major target of genetic improvement in improved varieties in Bangladesh, by demonstrating MRL of the varieties were significantly lower than that of landrace varieties. A major QTL for root elongation on long-arm region of chromosome 6, designated as qRL6.1, have been identified in a mapping population developed from a Kasalath (Aus ecotype) and Koshihikari. Kasalth allele at the qRL6.1 enhanced root elongation under different concentrations of ammonium and nitrate nitrogen in seedlings. Introgression of the Kasalath qRL6.1 into four improved varieties belonging to Boro ecotype is ongoing.

Keywords: Rice, root elongation, nitrogen fertilizer, growths, mapping population

Glimpses of Three Decades of Rice Research in BSMRAU

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Abstract

Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU) was established in November 1998 which is transformed from IPSA (Institute of Postgraduate Studies in Agriculture). It is the premier institution of higher education and research in agriculture in Bangladesh. Besides academic program, the university has been conducting researches for generating knowledge and developing technologies. Rice breeding started in early nineties and the objectives of rice breeding are to develop short duration, high yielding, long grain T Aman rice variety. BSMRAU has developed more than 60 varieties of different crops and 14 technologies. The research was initiated with the cross between KK 8 (Thai variety) × Badshabhog (Local cultivar) in 1994. First rice variety, BU Dhan 1 (BU-9425-12-15-50-74-123) was released by National Seed Board in 2008 which can harvest within 110 days with grain yield of 4.43 t/ha. This variety play important role for mitigating Monga in North Western districts of Bangladesh. BU Dhan 2, as premium quality inbred variety of rice developed for commercial cultivation from the cross between Basmati (India) × IR58025B which possesses the characteristics of earliness, aroma along with high zinc (22.20 mg/kg) and iron (11.00 mg/kg) content. BSMRAU also developed a CMS based hybrid variety (BU Aromatic Hybrid Dhan 1) in 2016. It has also collected 172 T Aman rice genotypes form eight coastal districts (Khulna, Bagerhat, Patuakhali, Barguna, Feni, Noakhali, Cox's Bazar and Satkhira and) 82 rice genotypes form three coastal districts. Apart from these 36 aromatic rice genotypes collected from Sherpur, Bandarban and Bhola. Diversified B and R lines are being identified using the collected genotypes as pollen parent towards developing hybrid varieties for coastal belts of Bangladesh. Altogether 57B (40B+17B) line and 42R (15R+27R) lines were identified from total of 208 genotypes against five male sterile lines viz, IR 58A, IR 62A, IR 68A, BRRI-1A and Gan46A. Conversion of identified B lines into A lines are continuing through backcross breeding and some are already fixed. Large-scale adoption of BSMRAU developed improved varieties under modern crop management practices has resulted increase in rice production. four crops cropping pattern also developed (BU Dhan 1 Mustard/Potato BU Mungbean 4 Aus Dhan Parija) using this short duration aman rice and mung bean variety. As rice is an important food crop of Bangladesh, BSMRAU is implementing projects on varietal improvement of rice for salinity/submergence tolerance, short duration, biofortification through modern breeding tools along with management practices and protection from pests and diseases. It has also worked with in collaboration with reputed national and international institutes including IRRI and Hence its contributing in food security in Bangladesh.

Keywords: Rice, higher education and research, food security, BSMRAU, BU Dhan

Sustainable Groundwater Management and Boro Rice Cultivation in Bangladesh

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Abstract

Bangladesh has made remarkable development in agriculture over the last few decades. Production of rice has increased from 11.6 MT in 1977 to 36 MT in 2018. This development made the country self-sufficient in rice production with 168 million population whereas it was a net importer of rice with 75 million people. This increase was driven by cultivation of Boro rice in the dry season, made possible by the growing availability of irrigation particularly by groundwater. But there are serious concerns about the sustainability of groundwater use, especially in the northwest region. Many studies showed that groundwater levels are falling in some areas particularly in the Barind region and that the use of groundwater is unsustainable. There is a general perception with the researchers and policy makers that cultivation of Boro rice is the main reason of groundwater decline as farmers waste water by applying too much in the field than is required. There is strong perception that 3,000 to 5,000 litre of water is required to grow 1 kg of rice. So, to make groundwater sustainable, many farm-scale water-saving measures have been promoted from stopping seepage from water delivery canals, to new agronomic practices such as alternative wetting and drying (AWD) and conservation practices. Therefore, it is crucial to know the actual field-level water usage and, irrigation water productivity, which will help identifying options to sustain groundwater irrigation. We carried our extensive monitoring of water use by the farmers for irrigation and carried out modelling using state-of-the-art models to understand the sustainability of groundwater. The results suggest that several factors in addition to some net over use for the current decline in groundwater levels in some areas of the northwest region. Comparison of the actual water supplied to the field and the estimated requirements shows that farmers are, in general, very efficient in supplying water to rice in our controlled irrigation systems. The average total amount of water available in the field to grow one kilogram of rice was 1,606 litres (L) in 2015-16 and 1,605 L in 2016-17. The Average irrigation water supplied to the field was 1,402 L kg-1 in 2015-16 and 1,086 L kg-1 in 2016-17. However, not all water supplied to the rice plots are consumed by the plants. Actual crop evapotranspiration is the real water use and based on that only 661 L in 2015-16 and 584 L in 2016-17 were required to grow one kilogram of rice. Percolation and seepage water return to the underlying aquifer as return flow. So, the current government policy of so called 'water savings' by reducing pumping of groundwater is unlikely to have any major impacts on the sustainable groundwater irrigation in the NW region.

Keywords: Groundwater, Boro rice, irrigation, AWD, rainfall

Breeder Seed Delivery from BRRI: Development of Rice Seed System of Bangladesh

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Abstract

Seed system of Bangladesh received a tremendous positive change due to congenial policies and its application by proactive public and private organizations and entrepreneurial initiatives of the government, public sector R & D actors and NGOs. Demand of rice breeder seed is increasing with unrealistic mode because of the demand coming from private seed entrepreneurs. This paper aims to review the status of rice Breeder Seed supply to GO and Private Sector (PS) and the scenario of rice seed system development in Bangladesh. The total rice seed requirement of Bangladesh is about 302875 tons annually of which 32,250 tons in Aus, 156,800 tons in Aman and 113,825 tons in Boro season. Of the large volume of seed needed, the public sector i.e., BADC was able to provide only 26.61%, Department of Agricultural Extension met 4.04%, Private Sector including NGOs provide 10.80% of total requirement. The rest 58.55% the total rice seed used from farmers own effort. This indicates a tremendous scarcity of good quality formal seed in the country. Healthy competitions to produce quality seeds among the entrepreneurs have been increasing. As a result, seed supply from formal rice seed system is increasing and recently it becomes 42% in rice. Due to use of increased volume of quality seed, farmers have started to get its benefit viz. uniform crops and good yield. Consequently, the quality seed production, supply and use work together as a 'movement' has impacted positively on the rice seed market for ensuring food security and rural economic development of Bangladesh.

Keywords: Breeder seed, demand, public and private, BADC, Rice.

Developing Climate-resilient Rice Through Modern Breeding Approaches Targeting Farmers Need and Market Demand

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Abstract

Climate change adversely affects agricultural production and reduces resources annually. Rice productivity improvement is one of the crucial challenges in abiotic stress-prone environments. It is essential to further increase the yield of the premier staple food rice to ensure global food security. We focused on designing climate-resilient rice (CRR) emphasizing salt-stress tolerance coupled with high yield potential considering product profile. The integration of state-of-the-art breeding approaches and research management techniques within the current cultivar development pipelines would build a step-change towards varietal improvement for the abiotic stress-prone environments. Proper execution of breeder's equations for crop improvement pipeline could deliver a better rate of genetic gain. Single Seed Descent based Rapid Generation Advance (RGA) technique in field and greenhouse- the most promising method and high-throughput marker-assisted breeding (MAB) approaches are applied for quick, economical and efficient selection of CRR for salt-stress prone environments. Moreover, MAB is commonly used in the salt-tolerant rice breeding program. Various innovative genomic breeding tools such as, forward breeding, speed breeding, and identification and deployment of superior haplotype through haplotype-based breeding can potentially be applied for improved precision and efficiency in the breeding of salt-tolerant rice. Furthermore, all-inclusive rice breeding including increasing selection efficiency, intensity, and accuracy of selection and reduction of breeding cycle time could play a vital role in developing climate-resilient rice suited for target salt-stress prone environments.

Keywords: Climate-resilient rice (CRR), breeding, abiotic, stress-prone, yield

C4 Rice Research: Shaping Our Roadmap and its Current Position

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Abstract

Demand for food is increasing with the ever-increasing population. But the cultivable land is shrinking due to urbanization. Moreover, the world's climate including Bangladesh is getting warmer due to climate change which may pose a great threat to food security. The development of more productive C4 rice is very critical to ascertain food security along with higher water and nitrogen efficiency. For developing C4 rice, we need to have a detailed insight into C4 plants. These C4 plants are characterized by their Kranz anatomy and highly reduced photorespiration. Kranz anatomy has bigger vascular bundle sheath cells with active chloroplast surrounded by compact mesophyll tissues. This anatomy also has higher vein density leaving fewer layers of mesophyll tissues in between. Scientists thrived over a decade to understand the genetics of Kranz anatomy and the pathways involved in reduced photorespiration. So far, forward genetics and transcriptomics approaches reveal that Kranz anatomy is a very complex system operated by numerous genes. Different studies discovered over 50 genes concerning C4 photosynthesis. But genetic engineering demands some key genes or major regulators giving significant change upon transformation which are yet to be discovered. To date, the major reported breakthrough is the transformation of GOLDEN2 in rice which contributed to enhanced chloroplast development and mitochondrial biogenesis in bundle sheath cells. Therefore, we need to keep working to find some key regulators for C4 photosynthesis. Transcriptomics along with genome editing might play a vital role in achieving this goal. For the transcriptomics study, we treated Setaria italica plants with NMU (N-Nitroso-N-methyl urea) to obtain M1 plants. After successive selfing and selection, 1794 (M3 generation) panicles have been found for further screening if they have lost their C4 property using high throughput phenotyping system.

Keywords: Kranz anatomy, major regulator, transcriptomics, genome editing, high throughput phenotyping.

Identification of Physiological Races, Gene Deployment and Durable Resistance of Bacterial Blight, Blast and Tungro Diseases of Rice in Bangladesh

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Abstract

Rice is the staple food of Bangladesh and more than half of the world population depends on rice for their daily calorie intake. Bacterial blight (BB), blast, and tungro are the main rice diseases worldwide, including Bangladesh. Blast disease causes a 50% yield loss of rice worldwide, equivalent to the feed value of 60 million people. Neck blast disease can cause 100% yield loss. Bacterial blight disease can reduce yields by 10–80% in South and Southeast Asian countries. Tungro yield loss ranged from 38 to 100% and cost US$1.5 billion in rice production annually. Disease-resistant rice varieties are sustainable and eco-friendly. Development of disease resistance variety is an environment friendly and durable approach to control rice diseases. Moreover, identification of available races or strains of the pathogen is very crucial to find out the effective resistant genes against the available races or strains. Several studies were carried out in Plant Pathology Division of Bangladesh Rice Research Institute (BRRI). Pathogenicity tests of 300 bacterial blight isolates on NILs and pyramid lines for bacterial blight resistance identified the physiological races. This study found no isolates virulent to all resistant genes. BB isolate reaction patterns against NILs identified 13 races. *Xa21, Xa27, xa13, xa7*, and *xa5* were found to be effective genes for rice bacterial blight resistance in Bangladesh. Pathogenicity tests identified 267 blast pathogen races from 331 isolates. Twenty-five (25) differential isolates were identified against 23 differential varieties and developed differential systems for blast-resistant varieties. Based on pathogenicity test of isolates against monogenic lines, effective resistant genes were *Pish, Pita-2, Pi9* and *Pb1* for blast in Bangladesh. Two strains of rice tungro virus-bacilliform and spherical were found nationwide, with Bangladesh's most effective resistant gene being tsv1. Thus, adaptive susceptible varieties with multiple R genes may be resistant to three major diseases. For the development of durable BB and blast resistant varieties, backcross breeding followed by marker assisted selection were followed for introgressing BB and blast resistant gene(s) into susceptible varieties (BRRI dhan28, BRRI dhan29 and BRRI dhan58). The gene pyramiding program includes highly BB-resistant IRBB57 (*Xa4, xa5*, and *Xa21*) and blast-resistant parents (*Pi9-US, Pb1-US*). In the background of BRRI dhan28, four advanced lines were developed with blast resistant (*Pi9 & Pb1*) and bacterial blight resistant (*Xa21 & Xa4*) genes. In the background of dhan29, seven materials were developed with both genes. BRRI dhan58 was used to establish six advanced lines with blast resistant (*Pb1*) and bacterial blight resistant (*Xa21 & Xa4*) genes.

Keywords: Bacterial blight (BB), blast, tungro, resistance, yield

Microwave Assisted Synthesis of Starch Stabilized Silver Nanoparticles with Antipathogenic Activities

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Abstract

A simple but robust technique was applied to synthesis silver nanoparticles (AgNPs) at the Laboratory of Plant Pathology, Bangladesh Rice Research Institute (BRRI), Gazipur, Bangladesh. AgNP was biosynthesized through microwave reaction by converting of silver ion (Ag+) in aqueous glucose and starch solutions. The glucose reduced and food grade starch stabilized particles remained colloidally stable. The UV-Vis analyses showed smaller sizes of AgNPs (between 1 to 100nm) produced with higher yields based upon the peak of particle solution. Antipathogenic activities of AgNPs against major rice pathogens (*Pyricularia oryzae, Rhizoctonia solani* and *Xanthomonas oryzae pv. oryzae*) were found in in-vitro test. Thus, this study sustainably produced antipathogenic AgNPs from minimal inputs. In the broad context, the current work might be quantified a sustainable platform technology to produce AgNPs with antipathogenic properties.

Keywords: Silver nanoparticles, microwave, glucose, starch and antipathogenic

Eco-engineering: A Technique for Eco-friendly Rice Insect Pests management

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Abstract

Eight experiments on eco-friendly insect pest management were conducted both in Boro and T. Aman seasons in different locations of Bangladesh to conserve natural enemies through ecological engineering approaches and to reduce insecticide application in rice production. Pesticides are commonly used in food crop production systems to control crop pests and diseases and to ensure maximized yield with high market values. However, the accumulation of these chemical inputs in crop fields increases the risk to biodiversity, non-target animals and human health. Nowadays, safe food production is a big concern in which pesticide residues are remains low or absent in the food and that could be produced in a sustainable method. Use of chemical pesticide is a most common and popular practice to control pests in rice production which disrupts the faunal biodiversity in rice eco system. Not only that population of predators and parasitoids are reduced or extinct from the rice field. Moreover, these beneficial insects often do not persist in rice production landscapes due to the absence of shelter or nutritional sources though they have the potentiality to suppress crop pests and to reduce chemical pesticide use in rice production eco system. In this study, we modified the existing rice landscape through an eco-engineering technique that enhances the activity of natural biocontrol agents for crop protection. Here, planting nectar-rich flowering plants (marigold, cosmos and sunflower in Boro season, cosmos and sesame in T. Aman season) on rice bunds provides food and shelter to enhance biocontrol agents' activity and reduce pest numbers, which cause grain yield losses. The abundance of predators and parasitoids and parasitism rates increased significantly in the eco-engineering plots compared to 3-4 times insecticide-treated plots. Moreover, irrespective of season and locations, insect infestation was remained below the economic threshold level (ETL) both in eco-engineering and insecticide treated plots. This study indicates that manipulation of habitat for natural enemies in rice landscapes which provides nectar sources, alternative prey and refuges for natural enemies enhances. Thus biocontrol service in rice fields will be enhanced and maintains similar yield or increase rice equivalent yield even though application of insecticides will be reduced in the crop fields.

Keywords: Eco-engineering, natural enemies, flowering plants, predator and parasitoid.

Optimization of Vermicompost Rates on Net Carbon Stock Under Rice-rice System

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Abstract

Continuous rice cropping using organic and inorganic fertilizers management might influences net carbon absorption, emission, rice yield and net carbon stock, which was investigated in 2020 to 2021 at Bangladesh Rice Research Farm, Gazipur (23o85.9' N and 90o82.4' E), Bangladesh. The influence of different rates of vermicompost (VC) with chemical fertilizers on greenhouse gas emission (GHG), absorption and rice yield during Boro-T. Aman season rice cultivation was determined. Static close chamber was used for estimating of CH4, N2O and CO2 during Boro-T. Aman rice growing season in Bangladesh. Vermicompost (VC) contained 50% moisture, 2.0% total N, 0.52% P, 0.42% K and 0.3% S. VC was @ 0.5, 1.0, 1.5, 2.0 t ha-1 with full doses of chemical fertilizer compared with recommended chemical fertilizer (RCF). The experimental plot size was 3 m x 5 m with three replications in a randomized block design. Thirty-five-day old (BRRI dhan29) and twenty-five-day-old (BRRIdhan49) seedlings were transplanted at 20 cm × 20 cm spacing during Boro and T. Aman rice culture. Total GHG flux, GHG intensity and GHG emission factor were significantly lower with 0.5 t ha-1 VC than other VC treatments during Boro-T. Aman rice growing system. The net carbon stock rates were 86-387 and 322-461 kg C ha-1 during Boro and T. Aman rice culture under different rates of VC application. In both seasons, the net ecosystem carbon balance was higher under 0.5 t ha-1 VC than other doses of VC application. Rice grain yield was higher compare to other VC treatment. At least 110 kg ha-1 VC is required to maintain soil organic carbon level at zero. Therefore, it could be concluded that 0.5 t ha-1 VC with recommended chemical fertilization treatment is important management practice for reducing GHG emission and increase net carbon stock as well as rice yield productivity under rice fallow-rice ecosystem in Bangladesh.

Keywords: Carbon absorption, Carbon emission, GHG intensity, Net carbon sequestration

Ensuring Nutritional Security Through Rice Grain Quality and Nutrition Research in Bangladesh

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Abstract

Rice is the staple food of about 135 million people of Bangladesh and solely derives 80% of their energy from rice, which contains 80% carbohydrates, 7 to 10 % protein, 3% fat and 3% fiber. The inadequate dietary diversity in food among low-income communities has led to nutritional consequences, particularly essential nutrients, like energy, protein, fats, vitamins, and minerals, are required for growth and development. Consumption of large-scale cereal-based foods with small concentration of micro and macro nutrients is the major reason behind the difficulty of nutritional deficiency. The common strategies for sustaining nutrient rich cereal include food fortification, dietary diversification and supplementation. Rice breeding programs are able to focus on developing new varieties carrying enhanced amounts of protein, Fe, Zn and beta carotene to cure a deficiency in minerals/protein/vitamin. The current paper thereby focuses on the role of various nutrients in rice and human health; more specifically tries to facilitate the avenue for nutritional security driven by various grain quality and nutrition researches.

Keywords: Rice, protein, zinc, vitamin, nutritional security

Comparative Advantage of Export Potential Aromatic Rice Varieties in Bangladesh: The Case of BRRI dhan50

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Abstract

This study aims to investigate whether export potential aromatic rice variety i.e., BRRI dhan50 has the comparative advantage in producing and exporting in the short run for the Boro (dry) season and to review international standards for rice export and way-out the link to the export policy. With that view, we estimated "Domestic Resource Cost (DRC)" as an indicator of comparative advantage using the cross-sectional data. A prominent aromatic rice-producing district namely, Jashore was selected purposively for this study. Data were obtained randomly through field-level survey of 160 farmers under Jessore sadar and Monirumpur upazilas of Jashore district. The analyses show that, in an import parity situation, DRC values were 0.65 and 0.73, respectively, when head rice recovery was 56 and 52%. It means Bangladesh has comparative advantage for producing export potential aromatic rice (BRRI dhan50) at import substitution. On the other hand, in the export parity situation, DRC values were 0.91 and 1.06, respectively, when head rice recovery was 56 and 52%. This implies that, Bangladesh has comparative advantage in exporting the potential aromatic rice like BRRI dhan50 at export substitution with head rice recovery at 56%. The government policymakers should create desired situation for the commercial export of quality aromatic rice from Bangladesh. However, research efforts need to be prioritized for developing new export potential Basmati type aromatic rice varieties incorporating the required genotype of international export breeding standard having high yield potential.

Keywords: Aromatic rice, export breeding standard, DRC, import parity, export parity

Dissection of Genetic Architecture of Rice Complex Traits by Genome-wide Epistasis and Pleiotropy Analysis

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Abstract

Genes involved in complex traits do not function alone. Combination of multiple genetic and environmental factors are responsible for complex traits. Single locus association or simple genotype-phenotype relationship may fail to explain such complex traits. Epistasis or gene-gene interaction is recognized to play fundamental role in pinpointing the genetic architecture of complex traits. Besides, multi-trait epistasis analysis could help to find the pleiotropic genes those affecting more than one trait. A two-step approach based on mixed linear model was developed for epistasis analysis that account population stratification and polygenic effect. To investigate the performance of our method, simulation studies were performed and compared with the classical and pc-linear approach. Furthermore, two important rice agronomic traits–flowering time and plant height–were analyzed using the developed epistasis method. To characterize and validate the identified epistatic variants, various bioinformatics analysis such as gene ontology (GO) and Kyoto Encyclopedia of Genes and Genomes (KEGG) pathway enrichment analysis, protein-protein interactions (PPIs), subcellular location (SCL) and tissue-specific gene expression of the gene/protein were assessed. A pleiotropic interaction network and a genotype-phenotype map were also constructed using the candidate epistatic genes of both traits. Simulation studies show that our method gives better power and low false discovery rate compared to classical and pc-linear approach. Several novel genes were identified from the whole genome epistasis analysis of rice flowering time and plant height traits. Bioinformatics analyses also confirm the involvement of the identified candidate genes to the related traits. Seven pleiotropic genes were identified from the epistatic pleiotropic network and some of them were found in literature those validated by experimental analysis. The findings of this study highlight the importance of epistasis and pleiotropy analysis and provided novel insights into the genetic architecture of rice complex traits which could assist breeding programmes.

Keywords: Epistasis analysis, pleiotropy analysis, mixed-linear model, flowering time

Rga: Cutting-edge Technology for Shortening The Breeding Cycle to Enhance Genetic Gain in Rice

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Abstract

Integration of advanced agricultural technologies is now critical to make a step change towards any crop improvement program. Rapid generation advance (RGA) has become a cutting-edge technology to boost up the production of rice worldwide through reducing the breeding cycle thereby enhancing genetic gain. Increasing the rate of genetic gain through proper executions of breeder's equations by increasing selection efficiency, selection intensity, selection accuracy and shortening the breeding cycle is crucial. Shortening of generation cycle through modified environments and early seed harvest in segregating (F2–F6) populations allow several (3-4) generations per year which is known as RGA. This technique is adopted with the single seed descent (SSD) method of breeding where a single seed from a single plant of segregating population is used to a dvance generations with no selection to produce fixed lines. In RGA technique, growing segregating population in close spacing, controlling the light intensity and temperature result in the reduction in time, space and resources and thereby reduces cost in cultivar development. It has also been reported as the most efficient method for improving the quantitative trait like yield compared to pedigree method or bulk method of breeding. RGA was also reported to be better compared to DH method because of its simplicity and leveraging more recombination. BRRI has a pioneering role among the NARS institutes in utilizing this rapid breeding method to enhance the rate of genetic gain in a sustainable manner. In the near future, greenhouse/screenhouse automation technology may further enhance the efficiency of RGA as a form of speed breeding.

Keywords: RGA, Genetic gain, SSD, speed breeding

Targeted Genome Editing in Rice Using CRISPR-Cas9 Technology

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Abstract

Clustered regularly interspaced short palindromic repeats (CRISPR)/CRISPR-associated protein (Cas) (CRISPR/Cas)is a breakthrough technique allowing precise and specific genome editing that are stably inherited across the following generations. The mutated plants developed by CRISPR/Cas9 neither containing foreign gene (GMO) nor requiring year after years to produce a new variety. Since the CRISPR/Cas genome editing was first implemented in 2013, has become the most common and cost effective breeding tools for food crop improvement, economic traits such as scent, color, medicinal, nutritional and economic value, as well resilience toward challenging and unpredictable abiotic and biotic stresses.In this study, we will employ CRISPR/Cas9 tool to create novel alleles of CYP71A1 and BADH2 in elite rice varieties BRRI dhan28, BRRI dhan29, BRRI dhan87, BRRI dhan89 and BRRI dhan92 .The CYP71A1 knockout mutant leading to develop brown planthopper and stem borer resistance rice lines by prevention of serotonin biosynthesis. The BADH2 knockout mutants produce aroma in non-aromatic rice by increasing an aromatic compound 2-Acetyl 1-Pyrroline (2AP). Synthetic guide RNAs (CYP71A1-sgRNA:5'-TGGTCGCGTTGAGGAGGAGC-3') and (BADH2-sgRNA:5'-TATGGCTTCAGCTGCTCCTA-3') was designed by targeting the 1stexon and 7thexon of CYP71A1 and BADH2, respectively. Oligomer of designed sgRNA was synthesized and cloned into VK005-01 and pRGEB31binary vector carrying Cas9 gene. Recombinants vectors with sgRNA were identified by PCR and confirmed by sequencing. The successful recombinant vectorsVK005-01 and pRGEB31 having Cas9/CYP71A1 or BADH2 sgRNA were transformed into competent Agrobacterium tumefaciens LBA4404 strain by freeze-thaw method. The recombinant LBA4404 carrying Cas9/CYP71A1 or BADH2 sgRNA were further identified and stored in -80°C for co-cultivation with calli of above-mentioned rice varieties. Seeds of ricevarieties were collected and used for callus induction. The growing calli will be used for Agrobacterium mediated transformation and successful transformation will be screened in selection media for regenerating mutant plants. Desire mutation of rice plant will be ensuring by sequencing of targeted region.

Keywords: CRISPR-Cas9, rice, genome editing, insect resistance, aroma

Biotechnological Advances in BRRI for Sustainable Rice Production

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Abstract

Development of rice varieties using different biotechnological tools is very important to meet the food demand of ever-growing population, and to ensure food and nutritional security in Bangladesh. Realizing its importance, biotechnological research was initiated at BRRI in 1982 involving rice tissue culture work. Later in 2002, research at molecular level was started. At present, this division is engaged with multiple techniques of biotechnological and molecular breeding research including tissue culture, wide hybridization, embryo rescue, marker assisted selection (MAS), gene pyramiding, QTL identification, DNA fingerprinting, gene cloning, genetic transformation and CRISPR/Cas9 genome editing. With the leadership of Biotechnology division, BRRI has released five high yielding varieties such as BRRI dhan86, BRRI dhan87, BRRI dhan89, BRRI dhan92 and BRRI dhan96. Two (*Xa4* & *Xa21*) and three (*Xa4, xa13* & *Xa21*) bacterial blight resistance genes were pyramided in BRRI dhan29 and BRRI dhan28, respectively through the marker assisted breeding, two major QTLs for yield contributing trait were identified in a mapping population developed from a cross between BRRI dhan28/*O. rufipogon*. A functional marker of *BADH2* gene was validated to differentiate aromatic and non-aromatic rice varieties. Efficient *Agrobacterium*-mediated genetic transformation protocol was established for Bangladeshi rice genotypes and already developed salt tolerant putative transgenic rice lines containing *GlyI* and *GlyII*, and *AeMDHA* genes. *Vacuolar ATPase* (*PVA1*) salt tolerant gene was cloned from a wild rice *Oryza coarctata*. CRISPR-Cas9 genome editing technique has been started for developing blast resistant rice and aromatic rice. With a view to develop C4 rice, mutant population of a C4 plant, Kaoun (*Setaria italica*) was developed to identify the mutant plant having loss of C4 properties which will be used to find out major genes controlling C4 photosynthetic property followed by cloning and transformation. Moreover, development of antioxidant enriched black rice and low Glycemic Index rice variety have recently been taken up for the betterment of human health of Bangladesh. Thus, the Biotechnology Division of BRRI has been working towards contributing to the food and nutritional security of Bangladesh.

Keywords: Biotechnology, molecular breeding, genome editing, C4 rice

Genomic Selection of Complex Traits of Maize NAM Population Based on Genetic Effects of Additive, Dominance, Epistasis, and G×E Interactions

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Abstract

Maize is one of the world's most economically important crops, accounting for roughly 24% of global grain production and providing food, fuel, feed, and fiber. Several studies have been undertaken to analyze genetic architectures of maize traits to aid in breeding programs for crop improvement. In this study, we analyzed several important traits of Maize NAM population including cob weight, diameter, days to tassel, kernel fill percentage, and plant height, and incorporated the results of our past investigations on others important traits to build a genetic network and design superior lines based on genetic architecture of multiple important traits for breeding enhancements. Genetic effects of additive, dominance, epistasis, and G×E interactions were estimated for identifying associated loci, and predicting optimal genotype combinations of superior lines under multiple environments to facilitate marker-assisted selection.

Keywords: Maize, G×E interactions, NAM population, genetic architectures

Cool Rice in a Hot Climate: High Temperature-induced Spikelet Fertility QTL (*qHTSF4.1*) Improves Heat Tolerance at The Flowering Stage of Rice

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Abstract

Rice is a daily necessity for more than half of the world's population, and it remains the poorest people's major source of nutrition. To combat poverty and provide food security, rice production must expand considerably, despite the effects of climate change. Global warming is expected to result in the occurrence of high temperature-induced spikelet sterility in rice. Anthesis, with the emergence of the anthers, is the most temperature sensitive step during the reproductive phase, followed by microgametogenesis. Several desirable characteristics have been proposed to lessen the impacts of temperature-induced spikelet sterility, which may offset expected yield losses if present varieties are retained. As a result, a combined MABC (genotype-phenotype) method was used to improve the spikelet fertility features of BRRI dhan28 and BRRI dhan29 by introducing high temperature induced spikelet fertility QTL (*qHTSF4.1*) from N22. From the second backcross generation, seventeen introgression lineages were chosen and promoted. During Boro 2020-21, one introgression line in the background of BRRI dhan28 was tested for preliminary yield evaluation. When compared to the parent BRRI dhan28 and checks, the line gave the highest yield 6.57 tha-1 with an earliness of roughly 1-5 days. Except for intermediate amylose (21.9%), the line also demonstrated enhanced or comparable grain quality features. Another 67 introgression lines were chosen from the third backcross generation and advanced to the observational yield study; all of these lines were found to have a high amylose content (>25%). Out of a total of 84 introgression lines, 55 were tested alongside parents (BRRI dhan28, BRRI dhan29, and N22) during flowering under control glass house conditions with high temperature (35±3 ℃) and high humidity (75±5%). At harvest, spikelet fertility in high temperature treated plants was examined and scored in comparison to control plants. The results showed that the tested lines scored 3-7, with spikelet fertility ranging from 32 to 68 percent. The parents, BRRI dhan28, scored 7 with spikelet fertility of 21% and donor N22 scored 5 with fertility of 53%. The best combination of high spikelet fertility, high yield, and good grain quality will promote cultivation as a high temperature tolerant variety in the future.

Keywords: Rice, high temperature, spikelet fertility, QTL, N22

The Impact of Climate Changes on The Water Footprint of Boro Rice in North-west Bangladesh

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Abstract

Long-term water resource management and agricultural planning involve an understanding of future crop water requirements and irrigation demand in the context of climate change. Water footprint (WF) is a useful statistic for estimating the total amount of water used by any product or service. A hybrid ensemble of machine learning algorithms, including Random Subspace (RSS), Additive Regression (AR), Bagging, Random Forest (RF), and M5 Pruned (M5P), was used to investigate the impacts of climate change on future WFs and their components (blue, green, and grey) of dry season Boro rice in north-west Bangladesh (i.e. Bogra and Rajshahi, Rangpur and Dinajpur regions). The climate data were obtained from an ensemble of 40 bias-corrected general circulation models (GCMs) under the representative concentration pathway (RCP) 4.5 and 8.5 scenarios of the Intergovernmental Panel on Climate Change (IPCC). The ML models were calibrated (training) and validated (testing) using historical datasets from 1976 to 2000 and 2000 to 2005, respectively. The changes in water footprints were assessed for the beginning (2020-2059), and end of this century (2060-2099) relative to the 1976-2005 baseline. The results indicated that the blue water footprint is expected to rise in the future under both scenarios; the largest increase is expected to happen in the Rajshahi region by 18.75% under RCP8.5 during the period (2020-2059) compared to the historical era (1976-2005). However, no substantial changes were seen in the Dinajpur area. A reduction in the green water footprint is predicted in both scenarios for the future. The largest reduction is expected to occur in the Dinajpur region by 42% under the RCP4.5 scenario, while the smallest reduction is expected in the Bogra region under both scenarios. Except for RCP8.5, the grey water footprint is expected to rise in the future under both scenarios. The proposed research framework and the results produced from the proposed technique will aid in the sustainable planning of future water in the agriculture sector under climate change conditions.

Keywords: Climate change, water footprint, sustainable water management

Submitted Abstracts For Poster

Field Rapid Generation Advance (FRGA): An Appropriate Tool for Step-Change Breeding in Rice Variety Development

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Abstract

Bangladesh Rice Research Institute has first started FGRA directly transplanted in the field at raised or flatbed condition without using minoru trays for seedling growing. To date developing new varieties according to the product profiles for a region is the realistic aim of a breeder. We need a revolutionary change in the variety development and replacement system. The key objectives are to enhance the current breeding cycles for varietal development through rapid cycle breeding for increasing efficiency than the pedigree system. The FRGA system may be one of the pragmatic options. We showed that the rapid development of larger breeding populations is possible using FRGA. The fast track and modernized breeding system of BRRI might be able to initiate a new revolution in rice breeding and develop more potential rice varieties in a shorter time meeting the demand of multiple stakeholders and ensuring the food security of the country.

Keywords: FRGA, rice breeding, food security, variety development

Recent Advances in Breeding for Developing Climate Resilient Rice Varieties

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Abstract

Salinity is one of the most important abiotic stress that limits agricultural productivity and threats to food security in Bangladesh as rice is the leading staple food but is sensitive to salt stress. Breeding high yielding salt-tolerant rice is a sustainable way to develop varieties for high saline zone and bring these high saline areas under rice cultivation leads to maintaining food security for achieving Sustainable Development Goals (SDGs), The physiological, genetic, and molecular pathways of salt tolerance have extensively been studied, but these pathways need to be addressed from the salt tolerance enhancement perspective and these should appropriately be combined with the cutting-edge breeding approaches. There is an adequate variation for salt tolerance in rice germplasm and salt tolerance is a complex quantitative trait thus attempts are being focused on using this variation to develop high yielding salt-tolerant varieties through applying holistic approaches of breeding including conventional, molecular, and modern breeding methods. Gene discovery via QTL cloning and understanding the gene action for salt tolerance in rice is important for use in future breeding programs. A number of QTLs and gene-based markers for salt tolerance have been reported that have immense potential to be used in Genomic-Assisted Breeding. Seventeen climate-resilient rice (CRR) varieties suitable for salt-stress environments have been developed and released in Bangladesh and a series of salt-tolerant breeding lines developed based on region/country-specific product profiles for the target region of Bangladesh.

Keywords: Climate resilient rice, salinity, food security, gene discovery.

Genomic Selection Approach for Enhancing Genetic Gain in Yield of Rice

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Abstract

The advances in sciences and uses of advanced technology in agriculture have made tremendous changes in crop productivity including rice. But the growth of genetic improvement in rice crops is still very slow in Bangladesh as well as in other South and Southeast Asian rice growing countries and it is far behind the required rate of growth that could address the future demands for food by the ever-growing population in these areas. Breeder's equation suggests that by increasing the selection differential and decreasing cycle time, the rate of genetic improvement can be accelerated. Selection intensity and selection accuracy are the two crucial factors for increasing selection differential between the parents and the progeny populations. Realizing higher genetic variance between these populations with high selection intensity together with higher accuracy within the shortest possible time is the prerequisite for enhancing genetic gain for any trait. Comprehensive yield testing in multi-locations at early generations together with the shortest line fixation time can promote rapid recycling of parents in the breeding program through recurrent selection. Research results of different studies conducted with different crops and animals by different group of researchers showed that the application of selection scheme with key target trait markers together with genomic selection approach in the breeding program is very effective for capturing variations for the quantitative traits. At BRRI, we have started using GS technology together with trait marker selection at early generation of RGA derived breeding lines to select high value parents for recycling. Our initial result shows significant improvement in selection differential for yield. In this paper, we report the progress and prospects of using GS for enhancing genetic gain in rice grown under irrigated Boro environment in Bangladesh.

Keywords: Genomic selection, genetic gain, yield, Boro rice.

Introgression of Multiple Salt Tolerant QTLs into BRRI Dhan63 Using Fluorescent-Labeled SNP Marker Through KASP Genotyping

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Abstract

Rice production is a great challenge due to increasing salinity in the southern coastal regions of Bangladesh. Rice is sensitive to salt stress both at seedling and reproductive stages. However, breeding rice for salinity tolerance together with high yield is difficult as the traits are controlled by multiple genes. A study was undertaken to introgress multiple salt tolerant QTLs into BRRI dhan63 for developing higher salt tolerance with higher yield compared to existing varieties using fluorescent-labeled SNP marker through the KASP (Kompetitive Allele Specific PCR) genotyping technique. The target QTLs were transferred from two recombinant inbred lines (RILs), I-14 (*Root length and Shoot K+* QTL) and I-71 (*Saltol*) derived from IR29/Horkuch. The two RILs were separately crossed with the recipient parent, BRRI dhan63, a premium quality Boro rice variety sensitive to salt stress to produce F1. The two F1s were then crossed amongst themselves to obtain the three target QTLs from the donor into a single recipient background. The selected double crossed F1 plants containing multiple QTLs were backcrossed twice with the recipient parent to recover the background genome. The target QTLs and recipient genome recovery of the selected progenies were monitored using fluorescent-based KASP genotyping. A total of 17 homozygous BC2F3 individuals were selected with ~80% recipient genome recovery. The selected BC2F3 progenies harboured all three target QTLs (*RL, Shoot K+, Saltol*) will be tested for salinity at seedling and reproductive stages.

Keywords: QTLs, salt tolerance, KASP, marker assisted backcrossing.

Salinity Tolerant Rice Varieties Recently Developed by BRRI

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Abstract

The increasing threat of salinity has become partially linked to the consequences of climate change, especially in low-lying coastal regions. The coastal areas of Bangladesh cover more than 30% of the cultivable lands of the country. About 53% of the coastal areas are affected by salinity. More than 1.0 million hectares are categorized into four levels of salinity throughout the coastal districts of Bangladesh. Salinity affects crops depending on the degree of salinity at the critical stages of growth, which reduces yield and in severe cases total yield is lost. Thus, recently plant breeders of BRRI developed three salinity tolerant rice varieties (BRRI dhan67, BRRI dhan97, and BRRI dhan99) for dry and one (BRRI dhan73) for the wet season with better adaptability in coastal zones of Bangladesh. These varieties can withstand salinity stress up to EC 12.0 dSm-1 at the seedling stage and 8.0 dSm^{-1} for the whole life cycle with high yield potential.

Keywords: Salinity, climate change, seedling stage, yield

Development of Promising Drought Tolerant Lines with Combinations of QTLs/Genes of Biotic Stress Tolerances

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Abstract

Marker assisted selection has moved forward to pyramid multiple drought grain yield QTLs (*qDTYs*) to combat drought with sustainable yield along with biotic and abiotic stress tolerance genes to overcome adverse pest infestation caused by drought. The current study was conducted in the experimental station of the International Rice Research Institute (IRRI) in the seasons of WS2018, DS2019 and WS2019. The study focused on the development of promising lines with 6-9 genes/QTLs of biotic and abiotic stress tolerance genes under an elite genetic background to generate pyramided lines of abiotic ($qDTY_{1.1}$, $qDTY_{2.1}$, $qDTY_{3.1}$, $qDTY_{12.1}$) and biotic (*xa5, xa13, Xa21, GM4, Sub1, Pita2A*) stress tolerance with the aim to develop a climate resilient variety. A total of 41 promising pyramided lines with combinations of different grain yield drought QTLs along with biotic-abiotic stress tolerant genes were developed under the current study. Identified promising lines with acceptable plant height, growth duration, and stable yield could mitigate the demand of the farmers of the targeted drought prone areas of Bangladesh.

Keywords: *qDTYs*, drought tolerance, MAS, biotic and abiotic stress, rice.

Dissecting Genomic Loci Responsible for Salinity Tolerance at Both Seedling and Reproductive Stages in Rice

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Abstract

Rice is sensitive to salinity both at seedling and reproductive stages but the relationship between these two stages is different or poor. For the dissection of QTLs for both stages, an $F_{2:3}$ population was derived from a cross between salt-sensitive parent BRH11-9-11-4-5B (CN6) and salt-tolerant donor IR58443-63-10-3. Salinity stress was imposed 12 dSm^{-1} at the seedling stage and 8 dSm^{-1} at the reproductive stage to evaluate the 94 progeny rows. A genetic linkage map was constructed using 183 polymorphic microsatellite markers on 94 progenies applying bidirectional trait based selective genotyping. A number of QTLs under salinity stress were detected with LOD >3, out of these, 31 QTLs associated with different salt tolerant related traits were common at both stages and explained 10.6 to 44.1% phenotypic variation. Three QTLs clusters were observed on the long arm of chromosome 1 (RM237-RM11504) sharing the genomic region with 106 cM, 144 cM, and 161.5 cM, respectively. Other co-localized QTL regions were also identified on chromosome 3 (RM36-RM14632), 11 (RM254-RM224), and 12 (RM511-RM28268) located on 45.5cM, 106.8 cM, and 70 cM positions, respectively. These genomic regions need to be further investigated with more markers for fine mapping for a detailed understanding of their potential roles in molecular and physiological pathways affecting salt tolerance in rice.

Keywords: Salinity tolerance, QTL, microsatellite markers, cM, LOD

Mapping Genomic Loci Associated with Salt-Tolerance Using The Bangladeshi Rice Landrace Akundi

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Abstract

Rice is the premier food crop for more than half of the world's population. Achieving high-yield potential is always a dominant objective in rice breeding. However, there are various abiotic stresses such as salt, cold, drought; heat that hampered the rice yield extremely. Salinity is one of the major abiotic stresses which decreased rice yield. The main purpose of this study is to identify new quantitative trait loci (QTL) which regulate salt tolerance in the seedling stage of rice. Two F2:3 mapping populations derived from two crosses of BRRI dhan28 / Akundi and BRRI dhan49 / Akundi where BRRI dhan28, a sensitive irrigated season variety, BRRI dhan49, a sensitive rainfed season variety and Akundi, a salt tolerance Bangladeshi rice donor commonly used for both populations. These mapping populations were genotyped by 1kRica single nucleotide polymorphisms (SNP) markers. Akundi provides an alternative donor source of salt tolerance aside from other commonly known donors like Capsule, Nona Bokra, and Pokkali which is used in salt tolerance breeding programs worldwide including Bangladesh. Introgression of the new QTL identified in this study will expedite the designing of new salt tolerant varieties that are highly tolerant of salt stress.

Keywords: Salt tolerance, QTL, landrace, seedling stage.

Introgression of *Saltol* QTL for The Development of Backcross Inbred Lines for Salt Tolerance Through Marker Assisted Backcrossing Approach

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Abstract

Salt stress is a prominent abiotic barrier in rice-growing regions around the world. Salinity is a major issue in southern Bangladesh, affecting around one million hectares of rice fields along the coast on a regular basis. A large salinity tolerance QTL on chromosome 1, *Saltol*, allows investigators to use marker-assisted backcrossing to effectively introgress tolerance into popular but salt-sensitive Bangladeshi mega-varieties. The use of marker-assisted selection (MAS) to generate salt-tolerant rice cultivars in Bangladesh has been enabled by a large quantitative trait locus (QTL) on chromosome 1 (*Saltol*) that promotes tolerance to salt stress during the vegetative stage. We employed 'FL478' as a tolerant donor and the extensively cultivated 'BRRI dhan49' as a recurrent parent for the development of BILs by three rounds of backcrossing using DNA based markers for selection. Forty BILs with over 95 percent BRRI dhan49 alleles were selected at the BC_3F_2 generation, other than the *Saltol* locus. Foreground selection was carried out using RM493 in all generations. For recombinant selection, two InDel markers (G11a and SalT1) were utilized, while fifty SSR markers were used for background selection. Evaluation of Saltol introgressed lines for salinity tolerance at the seedling stage using a hydroponic system at salt stress of 12dS/m was done in BC_3F_4 generation. The BILs performed better in salt stress conditions at the seedling stage compared to recurrent parent BRRI dhan49. All the introgressed lines did not show any undesirable traits. Finally, fifteen BILs were found tolerant to salinity and selected under salt stress conditions considering low SES score, low Na^+ uptake, high K^+ uptake, and low $Na^{+/}/K^+$ ratio. The fifteen BILs were used to assess the yield performance in three hotspots in the southern part of the country and finally selected three BILs for further evaluation. The developed BILs would be useful for developing salt tolerant rice varieties or for using in further breeding programs.

Keywords: *Saltol* locus, Backcross Inbreed Lines (BILs), Salt stress, Marker Assisted Backcross Breeding (MABC).

Pyramiding of Bacterial Blight Resistance into The Restorer Line of Hybrid Rice Using Marker-Assisted Backcrossing

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Abstract

Hybrid rice technology is one of the viable promising, sustainable, and proven technologies for enhancing rice productivity with a yield advantage of 15–20 % over inbred varieties. Bacterial blight (BB) is one of the major constraints of hybrid rice production in the world including Bangladesh. The main reason is that most of the parental lines of hybrid rice are susceptible to available races of *Xoo*. So, gene pyramiding is the best authentic approach for the development of durable resistant hybrids. The present study highlights the development of durable BB resistance into the background of a promising restorer BRRI31R, by incorporating three major BB resistant genes, *xa5, xa13,* and *Xa21* from a BB pyramided line of IRBB60 through marker–assisted backcrossing. We have successfully introgressed three BB resistance genes into BRRI31R. Whole backcross progenies were confirmed and advanced based on foreground selection associated with the genes. Pyramided lines were screened against dominant fertility restore genes *Rf3* and *Rf4* using gene-based/linked markers. Two pyramided restorer lines, BRRI31R-MASP3 & BRRI31R-MASP4 were selected from the cross combination BRRI31R × IRBB60 in BC3F5 progenies. These pyramided lines having three BB resistant genes, *Xa5, xa13 & Xa21* with two fertility restore genes, *Rf3 & Rf4*, and exhibited high levels of resistance against five virulent *BXo* races. Gene pyramided restorer lines, BRRI31R-MASP3 & BRRI31R-MASP4 can directly be used as the male parent for the development of new BB resistant hybrid rice variety and also replacement as a restorer line of BRRI hybrid dhan5 to enhance F_1 seed as well as rice production in Bangladesh.

Keywords: Hybrid rice, bacterial blight resistance, gene pyramiding, marker-assisted backcrossing.

Diversity and Population Structure of Pigmented *Aus* Rice Genotypes

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Abstract

While the functionality and healthy food value of pigmented rice have increased its popularity, such that market demand for it is expected to rise, most genotypes suffer from low grain yield. To perform diversity and population structure analyses of pigmented rice genotypes, therefore, becomes essential for improving yields for commercial production. In this study, ninety-four pigmented rice genotypes from the Bangladesh Rice Research Institute (BRRI) genebank were characterized genetically using sixty-one simple sequence repeat (SSR) markers. A total of 236 alleles were detected by the markers. The average number of alleles per locus was 3.87, ranging from two to ten. Additionally, 11 unique alleles were identified for use as a germplasm diagnostic tool. The highest amplicon size was produced by RM472 (301bp) and the lowest by RM413 (67bp). The gene diversity ranged from 0.06 to 0.75, with an average of 0.45. The highest and lowest polymorphic information content (PIC) indices were 0.71 and 0.06 found in markers RM289 and RM338, respectively. The frequency of the most common allele at each locus ranged from 37.23% (RM303) to 96.74% (RM338). On average, 68.34% of the 94 Aus rice germplasm shared a common major allele at any given locus. A dendrogram constructed using the SSR primers clustered the 94 pigmented rice genotypes into three major groups (I, II, and III) whereas the model-based clustering method also divided these genotypes into three groups (A, B, and C). Based on nei genetic distances and principal coordinate analysis (PCoA), the genotypes namely- May may binni, Sada binni, Mosair, Aus dhan, Goria, Kala binni, and Akuee have been identified as diverse accessions and suitable as parents in future rice breeding program.

Keywords: Pigmented rice; genetic diversity; population structure; polymorphism information content

Genetic Diversity Analysis in Irrigated Rice (*Oryza sativa* L.) Landraces of Bangladesh Using SSR Markers

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Abstract

Genetic diversity and relationships among 96 irrigated (Boro) rice landraces of Bangladesh were evaluated using twelve SSR markers at the genetic resources and seed division of Bangladesh Rice Research Institute (BRRI) to characterize and discriminate the varieties as well as to establish the sovereignty of Bangladeshi rice gene pool. The number of alleles per locus ranged from 11 alleles (RM163) to 41 alleles (RM283), with an average of 21 alleles. The polymorphism information content (PIC) ranged from 0.75 (RM163) to 0.95 (RM283) with an average of 0.891, which revealed that much variation was present among the studied genotypes. RM283 was found the best marker for the identification and diversity estimation of Boro rice genotypes as revealed by PIC values. The frequency of the most common allele at each locus ranged from 8% (RM283) to 34% (RM275, RM277). The UPGMA dendrogram based on Nei's genetic distance grouped the whole germplasm into 7 distinct clusters with a similarity coefficient of 0.11. Based on the constructed dendrogram using SSR markers those accessions that are far from each other by virtue of genetic distance and diversity index (like Pashusail and Tulsi boro; Raja sail and Kali boro; Bashful and Jamir; Begun bitchi and Boro deshi; Banjira and Bogra (Deshi); Jagli boro and Lahi boro; Bimion and Gorchi sail; Jhati sail and Khaia boro; Tepi boro and Jamir boro) are strongly recommended to select as the parent for future breeding programs to develop high yielding and stress tolerant rice variety in contribution to global food security. The findings of this study should be also useful for varietal identification and could help in providing guides for assisting rice breeders in selecting suitable genetically diverse parents for the crossing program.

Keywords: Genetic diversity, irrigated rice, landrace, microsatellite markers, rice (*Oryza sativa* L.).

BRRI Genebank: A Profound Reservoir of Authenticity

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Abstract

BRRI Genebank is an ex-situ conservation of diversified rice genetic resources such as landraces, cultivars, modern and obsolete varieties, genetic stocks, breeding lines, and wild species. While these germplasms possess unique genetic information and hold immense possibilities to cope with climatic change and mitigate global hunger through intense research, still they are facing a serious threat due to genetic erosion. Therefore, Genebank plays a vital role to preserve biodiversity and to achieve food security and sustainable agriculture by conserving this vulnerable authentic germplasm for future use. Hence, BRRI Genebank is continuously contributing to the Sustainable Development Goals (SDG) of zero hunger, no poverty, good health, and well-being by not only the safe conservation and maintenance of 8868 rice germplasms but also the continuous collection of new authentic germplasms, characterization, evaluation and sharing these unique genetic resources with other research institutes, partners and stakeholders worldwide.

Keywords: Genebank, rice germplasm, genetic resources, conservation

Validation of A Simple Functional Marker for Fragrance in Non-Basmati Fragrant Rice

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Abstract

Aroma is one of the most important commercial traits in rice varieties. Usually, the rice aroma is determined by a number of sensory methods that have many limitations. Identification of aroma using functional molecular markers (FM) has advantages over traditional methods because these can be adopted to use in early seedling stages avoiding the effects of individual variations and environmental effects. The fragrance of aromatic rice is mainly controlled by the Betaine Aldehyde Dehydrogenase homolog 2 (*BADH2*) gene located on chromosome 8 and developed by 8 bp deletion in the exon 7 of this major gene. 2-acetyl-1-pyrroline (2-AP) is the main compound of aroma produced due to this deletion. A functional marker has been developed based on the gene sequence of the mutated version of *BADH2*, to distinguish the alleles of the major fragrance gene in rice. A study was conducted to examine the potential of this co-dominant marker among non-Basmati aromatic and non-aromatic rice varieties. A total of 78 rice varieties including 36 non-Basmati aromatic and 42 non-aromatics were genetically analyzed by this marker. The marker targeted the polymorphism in *BADH2* gene due to 8 bp deletion and amplified 257 bp and 355 bp fragments in fragrant and non-fragrant genotypes, respectively. Perfect co-segregation with the trait of fragrance was observed in the F_2 population of BRRI dhan28/Kalijira and BRRI dhan87/Kalijira. This functional marker can be used in routine genotyping to screen fragrance in large scale breeding materials and germplasms of rice.

Keywords: Aromatic rice, MAS, *BADH2* gene, functional marker

Biotechnological Research Advancement in BRRI for Sustainable Rice Production

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Abstract

The development of rice variety using different biotechnological tools is very important to meet the food demand of the ever-growing population and to ensure food and nutritional security in Bangladesh. Realizing its importance, biotechnological research was initiated at BRRI in 1982 involving rice tissue culture work. Later in 2002, research at the molecular level was started. At present, this division is engaged with multiple biotechnological techniques including tissue culture, wide hybridization, embryo rescue, marker assisted selection (MAS), gene pyramiding, QTL identification, DNA fingerprinting, gene cloning, genetic transformation, and CRISPR/Cas9 genome editing. With the leadership of the Biotechnology division, BRRI has released six high yielding varieties viz. BRRI dhan86, BRRI dhan87, BRRI dhan89, BRRI dhan92, BRRI dhan96 and BRRI dhan103. Through the molecular marker assisted breeding, two (*Xa4 & Xa21*) and three (*Xa4, xa13 & Xa21*) bacterial blight resistance gene were pyramided in BRRI dhan29 and BRRI dhan28, respectively. Two major QTLs for yield contributing trait were identified in a mapping population developed from a cross between BRRI dhan28/O. *rufipogon*. A functional marker of *BADH2* gene was validated to differentiate aromatic and non-aromatic rice varieties. An efficient *Agrobacterium*-mediated genetic transformation protocol was established for Bangladeshi rice genotypes and already developed salt tolerant putative transgenic rice lines containing *GlyI* and *GlyII*, and *AeMDHAR* genes. Vacuolar ATPase (*PVA1*) salt tolerant gene was cloned from a wild rice *Oryza coarctata*. CRISPR-Cas9 genome editing technique has been started for developing blast resistant rice and aromatic rice. With a view to developing C4 rice, mutant population of a C4 plant, Kaoun (*Setaria italica*) was developed to identify the mutant plant having loss of C4 properties which will be used to find out major genes controlling C4 photosynthetic properties followed by cloning and transformation. Moreover, the development of antioxidant enriched black rice and low glycemic index (GI) rice varieties have recently been taken up for the betterment of the human health of Bangladesh. Thus, the Biotechnology Division of BRRI has been working towards to contribute for food and nutritional security of Bangladesh.

Keywords: Tissue culture, gene cloning, genetic transformation, genome editing.

Bioinformatics and Molecular Approach to Identify The Target Genes Controlling Flag Leaf in Rice

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Abstract

Rice is one of the most important staple food crops globally, and more than fifty percent of the world's population feeds it. About 30% of rice yield increased due to the development of semidwarf varieties. However, rice production is still increasing, but the growth rate has decreased. Studies have shown that the gene cloning and functional studies of dwarf and semi dwarf genes had a different impact on biological and physiological characteristics, giving evidence for their use in rice production. The leaf morphology of rice is an important agronomic trait that greatly affects grain yield. We present a previously identified and characterized mutant named *screw flag leaf 1* (*sfl1*) here. The *sfl1* mutants showed some distinguishing characteristics, including the screw flag leaf and panicle at the bottom phenotype at the reproductive stage. Gene cloning and sequencing results disclosed that there was just one base substitution in the second exon of the candidate gene *Os10g0416200*, which encodes the 3-ketoacyl-CoA synthase 20 protein (KCS20). Furthermore, we have identified 288 KCS genes from several plant species using bioinformatics approaches. Moreover, RNA-seq analyses indicated that the gene expression, transcription, binding factors, different regulations, and metabolic process-related genes played a key role in controlling the growth and development of screw flag leaf in rice. These results deliver a crucial foundation for the practical analysis of the SFL1 gene in rice leaf and its implementation in rice breeding.

Keywords: Rice (*Oryza sativa* L.), screw flag leaf, sequencing, bioinformatics approaches, RNA-seq.

In Silico Identification, Characterization and Expression Analysis of Dicer-Like, Argonaute and RNA-Dependent RNA Polymerase Gene Families in Wheat (*Triticum aestivum* L.)

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Abstract

Dicer-Like (DCL), Argonaute (AGO), and RNA-dependent RNA polymerase (RDR) are known as the RNA silencing machinery genes that regulate the expression of genes using small RNA molecules (21-24nt). A complete cycle of gene silencing occurs by the members of these three families and their regulatory elements. But their structures, chromosomal locations, sub-cellular locations, functional pathways, cis-regulatory elements have not been yet rigorously studied. Our analysis identified 7 *TaDCL*, 39 *TaAGO*, and 16 *TaRDR* genes from the wheat genome. Phylogenetic analysis with Arabidopsis and rice RNAi-dependent pathway genes showed *TaDCL, TaAGO,* and *TaRDR* proteins clustered into four, eight, and four subgroups respectively. Domain, and exon-intron structure analyses showed that these proteins conserved identical characteristics within groups and maintain differences between groups. GO analysis implied that several potential biological and molecular pathways are linked to the RNAi mechanism. CRE analysis predicted that they widely act as light, stress, and hormone responses. *In silico* expression analysis exhibited that an increased number of RNAi-dependent genes are expressed in different tissues and organs. Several genes also showed high expression under drought and heat stress conditions. Overall, the findings would provide an excellent foundation for further molecular investigation of these genes and their regulatory elements for wheat crop improvement against various stressors.

Keywords: Wheat genome, RNAi-related genes, Cis-regulatory elements, *In silico* expression

Genome-wide Identification and Characterization of RNA Silencing Machinery Gene Families in Rice (*Oryza sativa* kitaake)

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Abstract

RNA interference (RNAi) controls numerous eukaryotic gene expression that are implicated in defense mechanisms, growth, and genome stability throughout developmental periods, and also post-transcriptional and chromatin alteration levels. The association of the Argonaute (AGO), Dicer-Like (DCL) and RNA-dependent RNA polymerase (RDR) gene families and their govern elements is closely associated with the gene-silencing mechanism in the RNAi pathways. However, in the case of the economical and nutritive valuable crop plant rice new Kitaake variety (*O. sativa* Kitaake), these RNAi gene families, as well as their sub-cellular positions, functional mechanisms, and regulating components, have not been thoroughly investigated. Though some analysis had done in mother rice variety but not more detailed. Incorporated bioinformatics methods were used to perform in silico characterization, regulatory factor and gene abundance, study of RNA silencing genes in *O. sativa* Kitaake (OsK). In Osk, genome-wide comparative study using a phylogenetic tree approach identified 11 OsKDCL, 31 OsKAGO, and 7 OsKRDR as RNAi aspirant genes that relate to the RNAi genes of the ideal plant Arabidopsis thaliana. The three gene family domain and motif compositions, as well as gene structure studies, revealed nearly homogeneity among the same members of the group. The expected genes have straight participation in gene-silencing and other essential pathways, according to the Gene Ontology enrichment review. Our genome-wide comparisons and comprehensive bioinformatics studies revealed important information about Kitaake rice RNA silencing elements, paving the foundation for future research into the expected genes functional pathways and regulatory factors. Also, our extensive research, which included fungi, rice, and Arabidopsis, concluded that RNAi originated from lower to higher species.

Keywords: RNA interference, gene expression, gene-silencing, regulatory factors.

Physiological Characterization of BRRI dhan71 for Drought Tolerance at Reproductive Phase Under Control Conditions

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Abstract

Drought is a major problem for crop production in rain-fed agricultural areas worldwide, limiting the growth and productivity of many crops. It is the most important abiotic constraints for rice production in north-western region of Bangladesh dependent on usually insufficient rainfall during T. Aman season and causes a substantial yield loss. Two consecutive experiments were conducted at Plant Physiology Division, Bangladesh Rice Research Institute, Bangladesh during T. Aman'2014. In the first experiment, 9 rice genotypes were evaluated to assess the performance under control drought condition at reproductive phase. The second experiment was done for physiological characterization of better performer genotypes. Plant height and straw yield was reduced significantly due to drought stress revealed plant growth was affected by water stress. Remarkable reduction was found in panicle length and panicle exertion rate under stress condition which was due to the reduction of last internodes length. Among the tested genotypes NERICA Mutant, IR82589-B-B-84-3 and IR83377-B-B-93-3 were able to produce grain under severe drought stress at reproductive stage. Proline accumulation was 8.53 to 15.69-fold higher in IR82589-B-B-84-3 over control plants. Similarly, the soluble sugar increased by 42.4 to 109.3% over control plants. The higher level of proline and soluble sugar accumulation under stress condition lead to osmotic adjustment that might contribute to the higher stress tolerance among the tested genotypes. After field evaluation by National Seed Board of Bangladesh IR82589-B-B-84-3 genotype was released as BRRI dhan71 for drought prone areas of Bangladesh.

Keywords: BRRI dhan71, rice (*Oryza sativa* L.), drought stress, physiological characterization, reproductive phase

Climate Resilient Agronomic Technologies in Rice Production

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Abstract

Sustainable rice production for feeding the increasing population is a challenge for food security in Bangladesh. It is an enormous task to improve rice productivity as climate change is anticipated to lead to greater variability in hydrometeorological aberrations resulting in increased frequencies of extreme events like recurrent dry spells, erratic rainfall, salinity, submergence in the wet season, a flash flood in haor areas, cold stress and high temperature is aggravating this problem. Different stress-tolerant rice varieties have been developed at Bangladesh Rice Research Institute and made available to farmers for cultivation. Studies have suggested that these newly available varieties possess remarkably higher grain yield potentials than local and HYVs in the stress-prone environment. The yield potential of stress-tolerant variety can be further enhanced up to 8-9 t ha^{-1} by using smart agronomic interventions. Climate resilient agronomic technologies are urea super granule for increasing yield of Aman rice in tidal submergence ecosystem and drought-prone areas of Bangladesh, direct dry seeded rice in Aus season, direct wet seeded rice by drum seeder to reduce one-week growth duration in haor areas to avoid flash flood, management options for escaping drought and agronomic management for drought tolerant T. Aman varieties, alternate wetting and drying technology for rice to reduce water consumption and methane emission, Post-flash flood management options of submergence tolerance rice, agronomic and fertilizer management options for the coastal saline environment and dry seedbed technique which minimize cold stress and reduce growth duration of rice in northern areas of Bangladesh. The resilience of rice production systems can be increased by proper dissemination of these agronomic technologies for varieties in the target areas. This review article addresses possible adaptation and mitigation strategies for making rice production sustainable and more climate-smart, based on cost-effective management options and production systems in the context of a gradually changing climate.

Keywords: Climate-smart technology, agronomic management, rice production, food security

Intervention Through Introducing Modern Rice Varieties at Fallow Land in *Boro* Season

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Abstract

Bangladesh is self-sufficient in producing rice to feed the increasing population; however, it is very much vulnerable due to several abiotic and biotic stresses. Interventions are essential for sustainable food security by increasing rice yield and production significantly both the horizontally and vertically. Many lands remain fallow in Chattogram and Rangamati region during Boro season. Only 5 to 10% area is cultivated in Boro season and rest of the land (90%) remains fallow. However, there is a lot of opportunity to utilize those fallow lands through introducing modern rice varieties along with irrigation facilities, mechanization and motivation. Seed Production and Dissemination Program Frontline demonstrations were set up at Subarnachar of Noakhali and Muhuri irrigation project area of Feni during Boro 2020-21 where Boro rice rarely cultivated. The objectives were to investigate the adaptability of modern rice varieties, rapid dissemination of newly released rice varieties, and motivate farmers to produce and preserve good quality seeds. Frontline demonstrations of modern Boro rice varieties like BRRI dhan58, BRRI dhan67, BRRI dhan74, BRRI dhan89, and BRRI dhan92 were set in seven ha (52 bigha) land in collaboration with the Department of Agricultural Extension (DAE), Bangladesh Agricultural Development Corporation (BADC), and farmers. The essential steps taken by BRRI with fruitful cooperation of the stakeholders were; motivational discussion, providing inputs like seed, fertilizers, signboards, technical consultation as and when necessary. The BADC provided irrigation facilities by setting a solar pump at Subarnachar and low lift pump at Muhuri project area to uplift water from canal. To motivate farmers and extension personnel, BRRI Sonagazi organized crop cut and field day. Mean grain yield of BRRI dhan58, BRRI dhan67, BRRI dhan74, BRRI dhan89, and BRRI dhan92 were 7.10, 6.95, 7.29, 8.57 and 9.00 t ha-1, respectively. Mean yield of BRRI dhan89 and BRRI dhan92 were almost one t ha-1 higher than hybrid rice varieties cultivated by neighboring farmers. Among the tested varieties, farmers preference sequence was BRRI dhan92>BRRI dhan89>BRRI dhan74>BBRI dhan67>BRRI dhan58. Farmers were impressed attaining higher yield, and were motivated to cultivate the varieties especially BRRI dhan89 and BRRI dhan92 in next years.

Keywords: Cropping system, *Boro* expansion, seed production & dissemination program, solar irrigation

Long-Term Omission of Nutrients and Organic Amendment Effects on Rice Yield

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Abstract

The missing element trial is an effective technique for identifying the nutritional problem in soil. It also helps to study the response of rice crop under nutrient stress and optimal conditions. Long-term experimentation is valuable in understanding decade-scale transformations in grain yield and soil properties. A long-term field experiment is on-going at BRRI, Gazipur farm since 1985 to evaluate changes in rice yield trend, soil physical, chemical and biological properties and to find out the management options for overcoming the soil problem(s). Twelve treatments included complete fertilization; omission of N, P, K, S, Zn from the complete fertilizer; IPNS based chemical fertilization with cow dung (CD), poultry manure (PM), vermi-compost (VC). Design is RCB with 4 replications. Omission of N, P, K and S decreased rice grain yield compared to complete fertilizer treatment. Organic amendments as IPNS for cowdung, poultry manure and vermi-compost showed increasing trend of grain yield. Sole application of chemical fertilizer showed almost plateau yield trend. Soil analysis results from several times indicated that soil organic matter is built up due to long-term rice cultivation under Boro-Fallow-T. Aman cropping pattern. Nitrogen is identified as most yield limiting nutrient followed by P and K. Sulphur has become limiting nutrient in recent years.

Keywords: IPNS, organic amendment, chemical fertilizer, rice yield

Determination of Critical Limit of Nutrients for Soils and Rice

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Abstract

Critical limit of a nutrient in plant refers to a level at or below which plant either develops deficiency symptoms or causes reduction in crop yields. As such there is a need to determine and update the critical limit of different plant nutrients in order to formulate an optimum fertilizer dose of deficient nutrients for different crops and soils for achieving satisfactory crop yield. Soil Science Division, BRRI conducted a bench mark survey and collected a total 180 soil samples from AEZ 18, 19 and 20 as per protocol in 2018-19. Soil analysis varied from very low to very high level of nutrient status and chemical properties among different soils under study. Critical limit of P, K, S and Zn for 80 soils and rice crop were determined through vigorous pot trials and laboratory study. Dry matter yields of nine-week-old rice plant were recorded, and plant samples were analyzed for the particular nutrients under study. Critical limit for a particular nutrient and rice was determined by Cate and Nelson method (1965) and also by statistical approach developed by Waugh *et al.* (1973). The estimated critical level of P, K, S and Zn for rice crop was 8.7 $mgkg^{-1}$, 0.09 meq/100g soil, 16.1 mgkg-1 and 0.70 $mgkg^{-1}$, respectively. In FRG-2018, the mentioned critical limit of P, K, S and Zn for rice was 8 $mgkg^{-1}$, 0.12 meq/100g soil, 10 $mgkg^{-1}$ and 0.6 $mgkg^{-1}$, respectively. The estimated critical limit of P, K, S and Zn were validated by field experiments using different levels of STB doses. In all cases, the 100% STB dose performed best. From the response curve of quadratic equation, the economic optimum dose of P, K, S and Zn were 42,115, 24 and 2.72 $kgha^{-1}$, respectively. The calculated optimum dose of each nutrient was found almost nearer compared to 100% STB dose.

Keywords: Critical limit, phosphorus, potassium, sulphur, zinc, rice

Industrial Effluent and Soil Health of Sripur and Gazipur

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Abstract

The rice soils of Sripur, Mirzapur, and Pirojali were irrigated with polluted industrial water. Benchmark survey was done with 30 rice soil samples with the objective to characterize the biochemical properties of heavy metal polluted industrial area of Sripur-Gazipur. We found soils of Mirzapur and Pirujali were acidic in nature and pH ranged from 4.95 to 5.88 and 4.42 to 6.0, respectively. Soils of the studied area contained >2.5% organic matter, 0.15-0.20% total N, 0.16-0.22 meq/100g soil available K, high level of Fe (87 to 838 ppm), Pb (44 to169 ppm), and Cd (0.63 to 4.38 ppm). Zn (3-65 ppm) status is found significantly higher than the flood plain soil of other AEZs. According to WHO, soils are toxic with Pb and Cd. Total bacteria population ranged from 7.7 $\times 10^7$ to 2.2 $\times$ 10^5 $cfug^{-1}$ dry soil, respectively. The free-living N_2 fixing and phosphate solubilizing bacteria population were very low ranging from 1.2×10^7 to 1.1×10^3 $cfug^{-1}$ dry soil and 1.3×10^6 to 2.2 $\times10^5$ $cfug^{-1}$ dry soil, respectively. Fungus and actinomycetes populations were also very low and most of the cases missing. Average biomass carbon ranged from 100 to 123 $mgkg^{-1}$. An incubation study was performed at laboratory to determine mineralization of organic materials (OM) and evaluate the effect of OM for amelioration of heavy metal pollution in Sripur. Result showed that irrespective of soils, higher amount of C, N and P accumulation was found in vermicompost (VC) applied treatment. Application of VC significantly increased C mineralization rate among the treatments and slightly higher (k=0.081) trend was found in the polluted soil. Applications of treatments were not able to reduce soil Cd and Pb concentration below the toxic limit. A number of total 12 experiments were conducted at Mirzapur, Pirojali and Sripur during 2018-20 with the objective to ameliorate heavy metal polluted soil and improve rice yield by organic amendment. Biochar, VC, poultry manure, organic fertilizer and bacteria inoculum were applied as organic source along with chemical fertilizer as IPNS basis. OM application rate was 2ton ha^{-1} except bacteria inoculum. In the field experiments, there was little or no significant positive effect found on grain yield of rice due to application of OM's and chemical fertilizer. The studied soils contained high OM and Fe^{+2}, and after 45 days of transplanting severe Fe toxicity appeared in rice plant. There was a positive relationship (r = 0.80) found between soil OM and Fe content of the study areas. There were abundant nutrients due to application of OM but their impact on grain yield was suppressed by Fe toxicity. In general, rice soils of Sripur, Mirzapur and Pirujali were acidic in nature, rich in OM and contaminated with Fe^{++}, Pb, Cd.

Keywords: Industrial effluent, soil health, mineralization, Fe toxicity

Distribution of Zinc and Boron Fractions and Their Contribution to Plant Availability in Diverse Soil Types

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Abstract

Deficiencies of soil micronutrients particularly, zinc (Zn) and boron (B), in the intensively cropped soils of Bangladesh is well recognized. Understanding the distribution of the fractions of Zn and B and their contribution to plant uptake under various environmental conditions are fundamental aspects of soil chemistry. Samples from five major agroecological zones (AEZ) with contrasting physiography and soil types were fractionated to exchangeable, oxide-bound, organic and mineral-bound fractions to study the effect of physiographic variability on Zn and B fractions and their availability to plants. Plant available Zn and B were extracted by diethylenetriamine pentaacetic acid (DTPA) and hot calcium chloride, respectively. A fractionation study revealed that the majority of Zn and B constituted the mineral bound and metal-oxide bound forms and only a trace of the elements was available to the plants. There were substantial variations in the quantities of Zn and B fractions among the samples. In general, the highest percent of exchangeable and plant available Zn was observed in the Old Himalayan Piedmont plain (OHPP) and Madhupur tract (Terrace) soils having acidic reaction, while the lowest was observed in the Ganges River floodplain (GRFP) soils with alkaline pH. In contrast, samples from GRFP had the highest conc. of oxide-bound and mineral-bound Zn fractions that are unavailable to the plants, while the lowest was in OHPP and Terrace soils. Higher conc. of mineral-bound Zn in GRFP soils indicated probable fixation by smectite type clay minerals. A multiple linear regression model explained 79% variation of the available Zn with a major contribution of manganese oxide (MnOx)-bound Zn. Thus, MnOx-bound Zn acted as a potential source of plant Zn in the studied soils. Likewise, samples from GRFP showed a greater quantity of specifically adsorbed B implying adsorption by smectite minerals. Multiple linear regression model accounted for 68% of the variation of plant available B. The main contributor was mineral-bound B, soil pH, and organic carbon. It indicates that mineral-bound B becomes available to the plants upon weathering. Also, soil organic matter acted as a source of labile B in the soil. Oxide-bound B contributed negatively to plant B availability implying significant adsorption by oxides of Fe and Al. These findings suggest that the oxide-bound and mineral-bound forms of soil Zn and B which may become available to plants upon desorption and chemical weathering. Development of appropriate soil management practices can make use of these potential sources of Zn and B in soil for increased uptake in the food crops.

Keywords: Micronutrients, availability of nutrients, soil management, organic matter

Nutrient Management Under Conservation Agriculture in Double Rice Cropping System

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Abstract

Conservation agriculture (CA) has three principles-minimum disturbance of soil, residue retention and crop rotation. CA has many advantages for soil health and environment. Nutrient requirement for rice cultivation under CA is not available. For this reason, an experiment was initiated at Farmer's field of Paba upazila, Rajshahi, in Boro 2018-19 seasons with the objectives to determine the nutrient requirement of rice in Boro-Fallow-T. Aman cropping pattern, and to improve soil health under conservation agriculture practices. Two crop establishment methods (unpuddled and puddled) in main plot, two residue management practices (straw retained and straw removed) in sub plot and four fertilizer doses as 125% of recommended fertilizer (RD), 100% of RD, 75% of RD, and 50% of RD were assigned in sub-sub plot following split-split plot design with three replications. In Boro 2018-19, Interaction effect of crop establishment methods and fertilizer doses was significant for grain yield. Puddled and unpuddled rice cultivation produced similar amount of grain at each level of fertilizer application. Recommended (100%) fertilizer was enough for the highest grain yield in puddled rice while 125% fertilizer required under unpuddled condition. Grain yields were significantly higher under puddled cultivation than un-puddled condition in Boro 2019-20. Rice straw incorporation significantly increased the rice yield in Boro season. 25% extra fertilizer application significantly increased the grain yield irrespective of residue management and crop establishment methods. In T. Aman 2019 puddled and unpuddled rice cultivation produced similar amount of grain at 100% level of fertilizer application. Moreover in T. Aman 2020, grain yields were similar under unpuddled and puddled cultivation. But rice straw incorporation significantly increased the rice yield in this season. However, 125%, 100% and 75% of RD of fertilizer produced statistically identical grain yield irrespective of residue management and crop establishment methods. In the light of above findings, we are concluded that 25% extra fertilizer are required in unpuddled condition in Boro season and rice straw incorporation significantly increased the rice yield both the seasons.

Keywords: CA, residue retention, crop rotation, unpuddled and puddled

Alternate Wetting and Drying: A Promising Water Saving Approach to Reduce Methane Emission Without Lessening Yield in Dry Season Rice

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Abstract

Despite enhance nitrous oxide (N2O) emission, alternate wetting and drying (AWD) irrigation reduces water input and CH4 emission over continuous flooded (CF) field with no significant yield reduction. Emission of these gases may further be impacted by broadcast prilled urea (PU) or deep place urea briquette (UB) either at their equal or differential N rates which should be evaluated for Bangladeshi paddy fields. To assess CH4 and N2O emissions, N fertilizers use efficiencies and grain yield, we set up an experiment at the paddy field managed by Soil Science Division of Bangladesh Rice Research Institute (BRRI) from January to April, 2020. The cultivated rice variety (BRRI dhan81) was grown under CF and AWD irrigations, with (broadcasted PU N: $PUN_{120/78}$ or deep placed UB N: UBN_{78}) or without N fertilizer application (N_0). Gas samples were collected regularly by closed chamber and analyzed by GC, to compare CH_4 and N_2O emissions. To record grain yield 125 hills $plot^{-1}$ (~ 5m2) was harvested. Grain yield in all N fertilized plots were significantly ($p<0.01$) greater than that in N unfertilized plots (N_0). However, water management and its interaction with N fertilizer treatments had no significant effects on grain yield ($p = 0.756$ and $p = 0.112$, resp.). The recovery (REN: 17-54%), physiological (PEN: 30-45 kg grain kg^{-1} N uptake) and agronomic (AEN: 13-25 kg grain kg-1 N applied) efficiencies were in line with previous studies. In each irrigation management, the recovery (RE_N), physiological (PE_N) and agronomic (AE_N) efficiencies at UBN_{78} were closer to that in PUN_{120}. Irrespective of N fertilizer treatment, overall CH_4 emission fluxes were greater in all CF plots than that in AWD particularly from 36 to 70 DAT. Cumulative seasonal CH_4 emission were significantly lower in AWD than CF ($p<0.01$) but did not statistically differ between N fertilized and unfertilized treatments ($p = 0.118$). Also, the interaction effects of N fertilizer and water management on seasonal CH_4 emissions were insignificant ($p = 0.439$). Seasonal CH_4 emission was decreased by 70 (in AWD-UBN_{78}), 86 (in AWD-PUN_{120}), 102 (in AWD-PUN_{78}) and 177 (in AWD-N_0) kg CH4 ha^{-1} resp., over corresponding treatments under CF which equals 20-41% reduction in CH_4 emission under AWD. The yield scale seasonal CH_4 emission (in kg CH_4 ha^{-1} t^{-1} grain yield) ranged from 48-72 in AWD and 65-130 in CF with its lower values in PUN_{120}-AWD (48) and UBN_{78}-AWD (56), and higher values in PUN_{120}-CF (65) and UBN_{78}-CF (73). So, UBN_{78}-AWD seemed almost equally capable to reduce seasonal CH_4 emission and provided comparable N fertilizer use efficiencies with that in PUN120-AWD, but requires further verification in more paddy fields.

Keywords: Alternate wetting and drying (AWD) irrigation, CH_4 emission, paddy, yield

Bio-chemical Characteristics of Different AEZ's Soil in Bangladesh

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Abstract

Study was conducted to determine soil microbial populations from seven AEZs of Bangladesh. Soil samples (0-15 cm depth) were collected using GPS recording from AEZ8 (Kishoreganj), AEZ21(Kishoreganj), AEZ10 (Faridpur Sadar), AEZ16 (Munshiganj), AEZ19 (Cumilla), AEZ22 (Habiganj and Moulovibazar), and AEZ27 (Rangpur) district. Total and beneficial bacteria, fungus and actinomycetes were grown in specific media and populations enumerated using spread plate count method. Study report showed that among the tested AEZ's, the highest total bacteria found in Kishoreganj (AEZ21), followed by Habiganj (AEZ22) and Faridpur Sadar (AEZ10). Total fungus population was higher in Cumilla (AEZ19). Actinomycetes population was low and almost similar in all tested AEZ's soil. The population of free-living N2 fixing, Rhizobium and phosphate solubilizing bacteria were lower in number compared to any healthy agricultural soil. The physico–chemical properties of the soils of respective AEZs are varied. The soil textures of the tested AEZs were mostly silt loam, silty clay loam and clay in nature. Among the tested 7 AEZs soil, pH ranged from 5.31 to 7.73. The highest pH value was obtained in Faridpur Sadar (AEZ10) and the lowest in Habiganj (AEZ22). The organic matter content ranged from 1.5% to 2.54% showing the highest value in Cumilla (AEZ19) and it was statistically similar to Habiganj (AEZ22) and Kishoregaj (AEZ8) and the lowest value obtained in Faridpur Sadar (AEZ10). Nitrogen content of the soils of sevens AEZs varies from 0.05% to 0.24% respectively. The lowest soil N was found in Rangpur. There was significant negative correlation found for free living N2 fixing population and soil N. The population of free-living N2 fixing, Rhizobium and phosphate solubilizing bacteria were lower in number compared to any healthy agricultural soil. Replenish of beneficial bacteria may improve soil health.

Keywords: Soil health, bacteria, different AEZ

The Regional Analysis of Future Changes in Precipitation and Temperature Using The Simclim Climate Model in Different Temporal Scales: A Case Study of Rajshahi District in Bangladesh

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Abstract

This study aimed to examine the annual, seasonal, and monthly variability of precipitation and temperature changes in a drought-prone region in Rajshahi, Bangladesh. The climate data were obtained from an ensemble of 7 bias-corrected Regional Climate Models (RCMs) under the representative concentration pathway (RCP) 4.5 and 8.5 scenarios of the Intergovernmental Panel on Climate Change (IPCC) from SimCLIM Desktop platform. The changes in precipitation and temperatures were assessed for the beginning (2020-2059), and end of this century (2060-2099) relative to the baseline (1986-2005) on an annual, seasonal, and monthly scale. Mann–Kendall (MK) test and Sen's slope estimator were used to quantifying the significance and magnitude of the trend at different time scales. The precipitation is expected to decrease in February, March, June, and December under both periods and scenarios; the highest decrease will be happed in February (13.04%) compared to the base period under RCP8.5 during the end of the century. However, the precipitation is likely to increase in the rest of the months; the highest increased is expected to occur in November (5.64%) during the end of the century under RCP8.5. The multi-model ensembles consistently simulate increasing maximum (Tmax) and minimum (Tmin) temperatures in all time scales by 2100 compared with the base period. The highest maximum and minimum temperatures are expected to increase in March by 7.54°C and 7.77°C, respectively during the end of the century under RCP8.5. MK test revealed the precipitation, Tmax and Tmin are likely to increase or decrease significantly (at 1% significance level) in both periods and scenarios. The Sen's slope (SS) analysis reveals that the greatest precipitation increasing rate was observed in Monsoon by 0.02-.08 mm/year under RCP4.5, while 0.31-0.39 mm/year under RCP8.5 in both periods. However, the winter displays in decreasing rate of precipitation up to 0.3 mm/year. The annual Tmax and Tmin are expected to increase with a rate of .03 to 0.5°C/year and .02 to .07°C/year, respectively under both scenarios; the highest rate is likely to occur at the end of the century. In the future, an uneven increase in precipitation and an unbalanced increase in temperature extremes would raise the risk associated with climate uncertainty management. We will be able to make better risk management decisions for agricultural operations based on future climate projections.

Keywords: Climate model, variability of precipitation, temperature changes, risk management

Water Resources and Cropping Intensification in Coastal Bangladesh

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Abstract

Coastal area of Bangladesh occupies 2.85 million ha (Mha) of which 1.0 Mha is affected by varying degrees of salinity in dry season. Rainfall variability, waterlogging, heavy textured soils, lack of fresh water in dry season, soil salinity and frequently occurred natural hazards are the major obstacles for crop intensification in coastal areas. Most of the coastal areas are covered by low yielding long duration T. Aman varieties, which hamper timely establishment of Rabi crops. Advancement of T. Aman harvesting season through the cultivation of high yielding short duration rice varieties could facilitate the timely establishment of different non-rice crops in dry season. But water scarcity in dry season is one of the major constraints for cropping intensification in coastal areas. Some technological interventions of coastal water resources like identification of fresh and brackish water interface, appropriate water management along with crops and soil management have the potentiality to improve land productivity and livelihood of the coastal farmers. Above the interface line, especially in Barishal region, Boro rice could be grown successfully. Below the interface line, most of the coastal river's water becomes saline (< 4 dS m-1) after December and increases to near about 24 dS m-1 in April-May. Therefore, less saline water could be trapped in the canals within December and then the trapped water could be used for cultivation of different Rabi crops and Boro rice. We have evaluated the performances of different non-rice and rice cops in dry season. Growing non-rice crops was a risky business in coastal heavy textured soils, especially under erratic heavy rainfall conditions. Early heavy rainfall delayed the Rabi crop establishment and thus paves the way of exposing to high temperature and high soil salinity. Heavy rainfall at vegetative and reproductive stages damages Rabi crops partially or fully. Under such scenarios, salt tolerant Boro rice performed better than other crops. Hence, Boro rice could be grown successfully having sufficient water available in coastal region for attaining food security. Another option could be introduction of Aus rice and thus improvement of total land productivity.

Keywords: Soil and water salinity, fresh and brackish water interface, water trapping, crop production.

Irrigation Water-energy Nexus: GHG Emissions in Bangladesh

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Abstract

Bangladesh has achieved huge success in crop production to feed the ever-increasing people of about 160 million. It has been possible through the expansion of modern rice varieties with ensured irrigation facilities. Total irrigated area has been increased from 1.52 million ha (Mha) in 1983 to 5.5 Mha in 2015 mainly by utilizing groundwater. The groundwater demand has been increased for agricultural and non-agricultural uses and thus its levels are also declining. Pumping of groundwater from deeper layers are not only the concerns for its sustainable use, but also pumping cost is increasing. Pumping of water for irrigation is one of the most energy consuming on-farm processes, which is directly related to greenhouse gas (GHG) emissions in Bangladesh, and it has not been addressed yet. We have derived, for the first time in Bangladesh, the detailed estimate of GHG emissions because of water pumping to irrigate crop fields. We have considered surface and groundwater irrigation devices and area coverage during 2019-20 for GHG estimation. Based on the water lifting heads, area coverage and fuel used, GHG emission varied among locations and sources of irrigation water. Total GHG emission, estimated from irrigated crops, was about 2.82 million tons (Mt) CO2eq of which only 0.26 Mt CO2eq from surface water irrigation and the rest 2.56 Mt CO2eq from groundwater sources. The hotspots of GHG emission were Rajshahi followed by Rangpur and Mymensingh Divisions and the least emission region was Barishal Division. The area coverage of STW, DTW and LLP were 56.8%, 19.2% and 24.0%, whereas the GHG emissions were 35.4%, 55.5% and 9.2%, respectively. The highest GHG emission with DTW was related with greater lifting heads. The results indicated, groundwater abstraction is a prime source of GHG emissions that has been rapidly increasing and is largely unregulated now. Water scarcity in Bangladesh is already in driving seat for policy implications. Our results suggest, it is the time to harness the holistic benefit of water and energy saving by adopting alternate wetting and drying irrigation method, by expanding surface water irrigation facilities along with high yielding and water-efficient rice variety cultivation in order to meet national planning targets.

Keywords: DTW, STW, LLP, lifting heads, major irrigated crops

Crop Improvement Through Genome Editing System to Achieve Food Security

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Abstract

The changing climate, which influences both biotic and abiotic stresses is the major threats to agricultural productivity. The development of climate resilient crop varieties using modern techniques are the sole way to address these unfavorable situations. Although traditional breeding techniques significantly increased the crop production, but modern techniques such as CRISPR (Clustered Regularly Interspaced Short Palindromic Repeats)/Cas9 are also needed for further crop improvement in order to achieve the food security for the world's ever-growing population. CRISPR/Cas9 developed in 2013, is being demonstrated to be a successful tool for creating targeted mutations in a diverse range of cells and species. It is a simple and effective technique of transforming a native background into a genotype with novel characteristics, accelerating the production of excellent breeding lines for new crop varieties. This system has been successfully used in a wide range of major cereals to develop powdery mildew resistant wheat, glutinous maize and Thermo-sensitive Genic Male Sterility (TGMS) maize by targeted mutagenesis of the *MILDEW-RESISTANCE LOCUS (MLO)*, Waxy and *ZmTMS5* genes, respectively. The glutinous, high-amylose, fragrant, sweet endosperm, blast resistant, herbicide resistant, salinity tolerant, cold tolerant, TGMS rice and nitrogen use efficient rice germplasms have also been developed by editing the *Waxy, SBEIIb, BADH2, ISA1, OsERF922, ALS, OsRR22, TIFY1b, TMS5* and *NRT1.1B* genes, respectively. This technique is also being used to speed up the breeding cycle. The key advantage of CRISPR/Cas9 system is its ability to genetically modify of an organism without incorporating any foreign DNA in it. Therefore, CRISPR/Cas9 system has emerged as a potential genome editing tool for plant improvement in order to accelerate new green revolution in near future which will ultimately aid in the achievement of zero hunger by assuring food security.

Keywords: Genome editing, CRISPR/Cas9, food security, climate change, biotic and abiotic stress.

Combating Rice Blast Disease: Pathogen Plasticity and Host Resistance

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Abstract

Rice blast caused by *P. oryzae (Cabara)* is a devastating trans-boundary fungal disease. It causes significant yield loss which intern has negative impact on farmers' livelihood and country's food safety. Recent outbreak of this disease has been shown the vulnerability of the cultivated varieties in Bangladesh. High pathogen diversity with the distribution of *Avr* races across the county is very important to understand the host-pathogen interaction. Therefore, study of pathogenic diversity with their virulence spectrum using the known resistant monogenic lines and native germplasm for exploring new source of blast resistance as well as development of resistant variety are immense for this disease control strategies. Review of these studies will lead to understand the pathogen plasticity with representative/differential set of isolates, identification of resistance gene(s) and the potentials of existing or new resistant varieties/germplasm. Pathotypic reactions of diversified isolates to twenty-three monogenenic differential rice varieties (DVs) exhibited 80-92% variability. Average virulence frequency was higher in northern region (AEZ2, 67%) followed by Comilla (AEZ19, 63%) and Gazipur regions (AEZ28, 55%). Different reports showed that *Pish, Pita-2, Pi9* and *Piz* had maximum resistance frequency. Genotyping of native rice germplasm including modern varieties having one or more resistance genes showed susceptible reaction. A few pathotypic resistant germplasm might have effective *Pita2, Pi9/Piz* or any novel gene(s). Absence of these resistant gene(s) in sustainably resistant BR16 and BRRI dhan33 varieties might possessed any novel gene(s). In recent years, some blast resistant lines have been developed using broad spectrum *Pi9* and *Pita2* gene(s) through marker assisted backcrossing. These lines showed pathotypic resistant in UBN (severity score 0-2) and blast hot spots (1.3-13.3% neck blast) over the locations compare to the BRRI dhan28 (severity 3-5, 6.7-85% neck blast). Among these, BR(Path)12452-BC3-42-22-11-4, BR(Path)12452-BC4-77-25-11-8-5 and BR(Path)12452-BC6-53-21-11 showed equal yield (6.0-6.5 t/ha) with similar growth durations (144-146 d). The lines developed with *Pita2* gene produced 4.5-5.0 t/ha yield in 144-46 days. Moreover, eleven long duration lines with *Pi9* gene yielded 8.7-10.1 t/ha with a few early or similar growth durations to BRRI dhan29. These lines could be used for breeding new resistant varieties and suggested to release as variety. Finally, an effective strategic plan for blast disease control needs continuous efforts on searching novel gene(s) and development of vertical as well as durable resistant lines in association with integration of edaphic nutrients, effective fungicide(s) spraying considering blast favorable weather conditions.

Keywords: *Piricularia oryzae,* virulence, differential varieties, resistance gene, blast resistant rice line, marker assisted backcrossing

Factors Affecting Rice Tungro Disease and Its Management Technology in Cumilla Region

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Abstract

Rice Tungro disease caused by Rice Tungro Virus (RTV) is transmitted by vector Green Leaf Hopper (GLH), *Nephotettix virescens*. Every year tungro disease infection is devastating in many rice growing areas in Cumilla region as well as country-wide. In Bangladesh, yield loss due to tungro was reported to be as high as 100% under severe conditions. Field experiments in the seedbed and main field were conducted in different locations of Nangalkot, Debidwar and Laksam Upazila, Cumilla during Aus, T. Aman and Boro 2019-20, 2020-21 seasons due to find out the factors and a sustainable management practice of rice tungro disease. From the study intensive rice cultivation (Rice- Rice- Rice), susceptible rice variety, presence of abundant GLH in the seedbed (~180 GLH/20 sweeping), increasing yearly temperature (35 to 38 °C), high rainfall with higher number of rainy days are found the most critical factors for tungro disease devastation. It is explored that severe Tungro disease infections in the main field come from the virus-infected seedlings of the seedbed and the tungro disease symptoms in the seedbed is the first report in Bangladesh. The present study revealed that preventive measure in the seedbed is the only way to control tungro disease devastation. Systemic insecticide spray in the seedbed for two times reduces GLH population from the seedbed and also in the main field. Hand sweeping along with light trap at night reduces the GLH population as well as the tungro infection also but it is costly and continuous process. Rice tungro disease management technology is 1. Seedbed along with surroundings should be free from GLH by light trapping/hand sweeping/insecticide spray 2. Two times spray registered systemic insecticide viz. MIPC 2.6g / Cartap 2.4g/ Carbaryl 3.4g per litre water are found most effective in the seedbed for controlling GLH. First spray should be done at 10, 10-15 and 15-20 days after seeding during Aus, T. Aman and Boro seasons, respectively and 2nd spray about 3-5 days before transplanting for all the seasons. Farmer can protect at least 17280/- (1080/- x 16 mound) per bigha by spraying insecticide in the seedbed 2 times cost 104/- (44 for insecticide+60 for labor) or by mechanical 1500/- for 5 times (hand sweep and light trap cost with labor).

Keywords: Tungro disease, management technology, virus, GLH.

Bakanae Disease Management with Neem Leaf Extract Mediated AgNP Using Nano Technology

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Abstract

Bakanae caused by *Fusarium fujikuroi* is an endemic fungal disease in rice and has sporadic distribution in Bangladesh mainly in greater Cumilla, Habigonj and Mymensingh districts. The incidence of bakanae is increasing in Bangladesh and growing more concern to rice growers as yield loss 21% -51.53% has been reported. In the present perspective of Bangladesh, it is essential to minimize yield loss due to diseases for increasing rice production in decreasing land area. Despite the considerable economic impact of bakanae, a few efficient and effective control methods are available, except the seed treatment with chemical fungicides. Recently, silver nanoparticles (NPs) have increased in popularity, due to "green synthesis" production in plants, bacteria, fungi, or yeast. Silver nanoparticles (AgNPs) have shown antifungal inhibition property. In this research, neem leaf extract and AgNO3 solution were used to synthesis AgNPs. AgNPs usually exhibit a SPR band due to the free electron excitation in the visible range of 400–500 nm by UV-Vis absorption spectroscopy. Hence, the SPR peaks of AgNPs produced using neems was centered at around 400 nm to 420 nm and indicate size of approximately 20 nm. , and synthesized silver nano particles were applied in in-vitro condition against *F. fujikoroi*. In in-vitro trial it was observed that AgNPs can successfully control the pathogen growth 100% and >95% when applied @12.08 mg/L on two isolates, respectively. It was also found that AgNPs @ 12 mg/L controlled bakanae disease infection when sprayed either on inoculated seedlings or root deep (4-6 hrs) method in net house condition. Nanoparticles sprayed on inoculated seedlings/root deep method, plants showed symptomless and as similar as control (un-inoculated) plants compared to infected plants. This nano green technology can be used in field condition to manage bakanae disease with environmentally safe and more effective way compared to chemical method.

Keywords: Bakanae, neem leaf extract, AgNP, nano technology

Optimum Sowing Window and Key Yield Drivers for Sunflower Sown after Wet Season Rice in a Salt-Affected Coastal Region of Bangladesh

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Abstract

Determining the optimum sowing window for dry season (rabi) crops in the salt-affected coastal zone of the Ganges delta is challenging since establishment may be delayed by excess soil water after the rice harvest which constrains soil preparation, while delays in sowing may expose the crop to soil dryness and salinity later in its growth. Field experiments were conducted over two years to identify the optimum sowing time between mid-November and January to maximise sunflower yield on clay-textured soils in Southern Bangladesh. Sunflower was dibbled into untilled wet soil on: 23 November, 30 November, 10 December, 20 December and 30 December in 2016-17, and 25 November, 14 December, 25 December, 10 January and 25 January (dibbled in tilled soil) in 2017-18, with two mulching treatments; rice straw applied ~ 5 t ha^{-1} (RS) and 15-20 % rice residue retained from the previous crop (RR). Higher grain yield (3.5-4 t ha^{-1}) was obtained for before 15 December sowing date, also having larger flower heads and heavier seed in the first year. But early sowing was also risky since, in the second year, sowing on 25 November was hampered by heavy rainfall at 14 days after sowing (causing waterlogging) that reduced yield compared to sowing on 14 December. The higher yield of early sowing between 20 November and 15 December usually got advantages for greater average soil water, less average soil salinity and greater average solute potential compared to sowing after 15 December. Lower yield in the late sowing was also suffered from increased temperature. In both seasons, a 3-factor multivariate regression model (temperature, soil water content and $EC_{1:5}$) suggested that the main driver of yield was soil $EC_{1:5}$ followed by air temperature. We recommend the optimum sowing window for sunflower between 20 November and 15 December which are earlier than present practice. However the earliest sowings do have an elevated risk of yield loss due to waterlogging.

Keywords: Sunflower, coastal region, salinity, optimum sowing

Determination of Crop Damage Phenomenon by Red Eelworm

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Abstract

An investigation was carried out at greater Kustia region of Bangladesh under the financial assistance of Mujibnagar Integrated Agricultural Development Project (MIAD) to identify red eelworm species and determination of crop damage phenomenon. At first, an intensive survey was conducted at the Mujibnagar project areas including field visit, discussion with farmers along with group discussions with Sub Assistant Agriculture Officer (SAAO) of DAE (Department of Agricultural Extension) were done during the survey period. Among the three major rice growing season, red eelworm is predominant generally in Boro season. The land with stagnant water and high organic matter content are the suitable environment for red eelworm development. At the early growth stage of rice plant during Boro season, red eelworm colonize surrounding the root zone. Actually farmers were become worried due to high population density of red eelworm at root zone. But, still it was in doubt whether red eelworm was plant parasitic or not for rice. Farmers were habituated to use carbofuran group pesticides and drain out the water immediately after appearance of red eelworm. None of the farmers were found who had experienced of rice cultivation without applying any carbofuran group pesticides after appearance of red eelworm in their cultivated land. Among the SAAOs, one group assume it might have negative effect on rice yield, while others viewed it might not have any significant effect on rice productivity and claimed application of carbofuran to control red eelworm is not a mendatory. One SAAO strongly claimed that he has experienced on rice cultivation without controlling the red eelworm and found no relationships between red eelworm infestation and plant growth. The population density depended only on the micro environmental factors of the specific land. Finally, Plant Pathology division of BRRI, Bangladesh decided to establish some demonstrations on red eelworm management with or without application of carbofuran group pesticides at the project site during Boro season. Demonstrations results revealed red eelworm management with carbofuran group had no significant impact on rice yield compare to rice field cultivated without using of any carbofuran pesticides. So, application of carbofuran to manage red eelworm is not economically sound approach to increase rice productivity.

Keywords: Rice, red eelworm, management, carbofuran, yield

Green Synthesis, Characterization of Nano-Particles and Their Efficacy Against Sheath Blight and Bacterial Blight Diseases of Rice, An Ecofriendly Approach

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Abstract

Rice plant suffer from different biotic and abiotic stresses, among the biotic stresses diseases are major threat for rice production. Disease management mainly dependent on application of chemicals, but chemicals are hazardous for both human health and environment. Application of nano-particles in rice disease management would be an alternative to combat these problems. Plant Pathology division of BRRI synthesized three nano-particles Copper Chitosan nano-particles (CuChNPs), Zinc Chitosan nano-particles (ZnChNPs), and Silver (Ag) nano particles during 2021-22 using chitosan and bacterial strains, respectively. Previously synthesized nano particles of Ag, CuO, ZnO, SiO2, MgO and K were also characterized using X-ray Diffraction (XRD), Fourier Transform Infrared Spectroscopy (FTIR), Particle size analyzer, Zeta potential, Scanning Electron Microscope (SEM) and Field Emission Scanning Electron Microscope (FESEM). Two nano particles CuChNPs and ZnChNPs were characterized using UV-vis Spectrophotometer, Particle size analyzer, Zeta potential, SEM and FESEM. Characterization results revealed that size of all nano particles was nano size which was ranging from 1-100 nm. Different concentrations of CuChNPs and ZnChNPs were tested against *Xanthomonas oryzae pv oryzae (Xoo)* and AgNPs and ZnONPs mediated fungicides (Folicur) were evaluated against Rhizoctonia *solani in-vitro* condition. Here, CuChNPs (1250 ppm) and ZnChNPs (6455 ppm) significantly reduced the growth of *Xoo* and ZnONPs and AgNPs mediated fungicides also reduced the mycelial growth of *R. solani* at the ratio of nanoparticles and folicur fungicides 7:1 and 9:1, respectively. Different concentration of AgNPs against Sheath Blight (ShB) and CuONPs and ZnONPs against Bacterial Leaf Blight (BLB) disease of rice were evaluated under glass house condition. In another greenhouse study CuONPs and ZnONPs mediated bacteriocides were tested against BLB while AgNPs against ShB. Here, AgNPs (0.05%) significantly reduce the severity of ShB. On the other hand, mixture of CuONPs and ZnONPs (1:1) at 3000ppm and 4000ppm and ZnONPs (4000ppm) reduced the severity of BLB disease. In case of nano mediated fungicide, 0.3% CuONPs along with 0.15% Bismerthiazol and 0.3% ZnONPs with 0.15% Bismerthiazol were found to reduce the development of BLB. On the other hand, 0.015% AgNPs performed better in reducing ShB disease at field conditions.

Keywords: Rice, sheath blight, blast, bacterial blight, nono-particles, management.

Efficacy of Rice Disease Management Packages at Field Level to Boost Rice Production

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Abstract

Rice diseases are one of the major threats for rice production which have a significant negative impact on national food security. Adaptive research and demonstration activities were undertaken by Plant Pathology Division, BRRI under the financial assistance from Integrated Agricultural Productivity Project (IAPP) to minimize the yield loss due to rice sheath blight and blast disease for enhancing rice productivity at greater Rangpur and Barisal regions of Bangladesh. A total of one hundred and one demonstrations (seventy seven for rice blast, and twenty four for rice sheath blight disease) were conducted at farmer's field level using BRRI varieties like BR11, BRRI dhan29, BRRI dhan47, BRRI dhan52 along with popular local varieties like Swarna, Sakkhorkhora, Kalijira etc. Management practices for sheath blight disease includes: removal of floating debris after final land preparation, application of ½ MOP at basal and ½ MOP with last top dress of urea (PI stage), judicial application of fungicides (Folicur @ 500 ml/ha)/Nativo (@ 250 g/ha) two times at 15 days interval, while blast disease management includes: application of ½ MOP at basal and ½ MOP with last top dress of urea (PI stage), provided by supplemental irrigation in the disease affected field, and finally judicial application of fungicides (Trooper @ 400 g/ha or Zeal @ 250 g/ha or Nativo @ 250 g/ha two times at 15 days interval). A rice field having an area of 33 decimal lands was randomly selected and divided the plot into two parts, where BRRI recommended practices were applied in one part, while the remaining portion treated as farmer's practice. After disease initiation, fungicides were sprayed two times with recommended doses at 15 days interval, balanced fertilization and other intercultural operations were done as and when necessary in BRRI recommended practice. BRRI recommended practices successfully managed rice blast and sheath blight disease 73.78% and 71.3%, respectively compared to farmer's practices, and adopting these technologies 0.28 to 1.52 t/ha rice yield advantage was achieved compared to farmer's managed plot. So, adoption of these disease management technologies also in other parts of Bangladesh not only increase the farmer's capability to manage rice blast and sheath blight disease, but also boost our national productivity to a great extent.

Keywords: Rice, sheath blight, blast, integrated disease management, yield.

Evaluation of Recharge and Bioryza Against Major Rice Diseases for Better Harvest

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Abstract

An investigation was carried out at farmer's field, Mithapukur, Rangpur (Geographical coordinates: 25º34´0´´ North, 89º16´0´´ East) in T. Aman season to validate the efficacy of both Recharge and Bioryza (bio-control agents) for rice disease management. A rice field having an area of 32 decimal lands was selected for the study, then the field was divided into four equal sub plots, where Bioryza (optimized blend of beneficial bacteria and fungi), Recharge (soil microorganism), mixed application of both Recharge and Bioryza were allocated in three different plots, and remaining plot used as control, where farmer's grown his crop following his own technique. Here, BRRI dhan46 was selected as a test variety, and Bioryza and Recharge applied both at seedling treatment as well as field application after transplanting. Very little amount of disease was observed up to maximum tillering stage of the crop, but diseases was quite prominent in later stage. In case of brown spot, disease incidence ranged from 35 to 50%, while it was around 70-80% in control plot with a severity scale varied from 5 to 7 (SES, 2014). In addition to this, 40-60% bacterial blight prevailed in bio-pesticide treated plot, while it was 60-70% in control plot. However, no significant variation was detected in case of yield due to application of bio-pesticide compared to control plot. Here, both Bioryza and Recharge produced all most similar yield 5.49 and 5.48 t/ha, respectively, while combined application of bio-pesticide produced the highest yield of 5.75 t/ha, but it was not statistically significant compared to control plot. In addition to this, bio-pesticide treated plot showed 5-7 cm taller plant growth compared to control plot at maximum tillering stage. Besides this, no other prominent features were identified. So, the application of bio-pesticide showed little effect in disease reduction. Combined application of both the bio-pesticides illustrated better effect rather than the individual application of both Bioryza and Recharge application in the field.

Keywords: Rice, recharge, bioryza, bio-pesticides, diseases, yield

Persistence of Tungro Bacilliform Virus in Infected Rice Leaves

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Abstract

Tungro is one of the major diseases of rice in Bangladesh and early infection of tungro may cause 100% yield loss. Tungro is a viral disease and there is no remedy to cure it after infection and so it is necessary to take preventive measures before destructive damage of rice. Moreover, tungro symptom is confusing with nutrient deficiency, insect attack (especially mealy bug) as well as other physiological disorder which make it difficult to identify tungro disease. The use of a molecular marker is the most accurate and time efficient method to detect the virus particle even the disease symptom does not express. The stability of the virus particle in the infected plant is yet unknown and so earlier believe is that it is not possible to detect the virus without bringing the whole plant instead of bringing infected leaf parts. To check the stability of the virus in collected parts from the infected plant this study was taken. Leaves were collected from infected plants BRRI dhan71 and kept them in two environmental conditions that is one in ambient temperature and another one in freeze condition. DNA was extracted by using modified cetyl trimethylammonium bromide (CTAB) method from both samples after 1, 3, 6, 12, 24, 90, 180, 270, 365 days of collection. Molecular marker RTBV P-1 (P24-Forward-CTCAAATATTGAGTCACGTC, P12-Reverse-TCTAAGACTCATCCTGGATA) was used for the detection of RTBV (Rice Tungro Bacilliform Virus) particle. After polymerase chain reaction (PCR, initial denaturation- 94°C - 5 min; denaturation- 94°C - 30 sec, annealing- 56°C- 40 sec, extension- 72°C - 1.3 min, 35 cycles; final extension-72°C 10 min), as well as gel documentation in 1.5% agarose gel at 120-volt virus particle was successfully detected at 860 bp in each interval in both condition of leaves. However, samples DNA of ambient temperature samples becomes little bit blur over the course of time. Moreover, samples from BR11, BRRI dhan48 were tested in the same way and produced similar result. The key message of this study is that the virus particle remains at least 365 (1 years) days in collected leaves at normal as well as freeze environment and it is possible to detect the virus by using the molecular marker. This finding will help the researchers to check the presence of tungro virus in collected samples from anywhere which is equivalent to 365 days of distance.

Keywords: Molecular markers, rice, stability of virus, tungro disease

Prospect of Aus Rice Area in Bangladesh

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Abstract

Rice is the main staple crop in Bangladesh. In Bangladesh rice is cultivated in three seasons and these are Aus, Aman, and Boro. Aus season covers mid-April to August. Aus season rice contributes about 8 % of total rice production. In the year 2018-19, aus area was 1.14 mha but in Bangladesh, there are more areas where Aus rice production is possible, especially highlands and medium highlands. Thus, we have a huge opportunity to extend the Aus area in Bangladesh. Hence, the aim of the study was to prepare an Aus production suitability map and determination of mouza wise Aus rice production possible area in Bangladesh. Spatial data of land type, and agroecological zone (AEZ) were collected from Bangladesh Agricultural Research Council, mouza and the agriculture land shape file collected from CEGIS. Highland and medium highland agricultural areas were found through the GIS tool and mapped. Finally, mouza-wise Aus suitable area were determined. The Aus suitable highland area was found at 1.81 mha and medium highland area were found at 0.66 mha and the total Aus-suitable area was found 2.47 mha. So, production is possible up to 50-60 lakh tons.

Keywords: Aus rice, GIS tool, spatial data

SAR-based Flood Mapping of 2020 Bangladesh in 2020 Scenario Using Sentinel-1 SAR and Google Earth Engine

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Abstract

Flood is important to understand and communicate the local flood risk, manage their floodplains, and require new and substantially-improved buildings to be built more safely and mitigate losses from future floods. These efforts make a safer community in which to live and work. A flood map also helps determine a property's flood risk and decide whether to require flood insurance as a requirement for a loan. Remote sensing and Geographic Information Systems is a great tools for Flood monitoring and mapping. Flooding in Bangladesh normally occurs during the monsoon season. Passive optical sensors and images captured from the solar reflectance of the earth's surface or atmosphere are unable to penetrate cloud cover and this is the main disadvantage of optical satellites for flood monitoring. SAR systems, the Sentinel-1 satellites, are active sensors that emit a radar pulse and record the land surface return at the satellite. They provide an advantage over optical sensors by enabling the collection of data through cloud cover and during the night. Objectives of the study are to prepare a flooding area map of Bangladesh in 2020 using remote sensing and to categorize the most flood-affected districts of Bangladesh in 2020 using remote sensing techniques also delineate the flood susceptible physiographic units of Bangladesh. Many areas in Bangladesh suffered from flood among them sever affected districts are Sirajganj, Tangail, Netrokona, Jamalpur, Naogaon, Sunamganj, Bogura, Habiganj, Kishorganj, Kurigram, Sylhet, Mymensingh, Pabna, Gaibandha, Brahmanbaria. Approximately 11% area of Bangladesh is affected by the flood. These areas are mainly the north-central and northeastern parts of Bangladesh. Old Brahmaputra Floodplain, Tista Floodplain, Low Ganges River Floodplain, and Karataya-Bangali Floodplain were severely affected by the flood.

Keywords: Sentinel-1, GIS, synthetic-aperture radar

Edaphic Suitability Mapping of Bangabandhu dhan100

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Abstract

Rice production must be sufficient to assure food security as rice is synonymous of food in Bangladesh. Agriculture in Bangladesh produces food for 169.10 million people from merely 8.01 million hectares of agricultural land. Due to the rising population, declining land resources, and increasing climate vulnerability, keeping the pace of food production is a great challenge. We have a very limited land resource, moreover, 0.4% of rice land is reduced every year, so we must ensure the proper use of what we have and protect potential land for rice production. The land of our country is not homogenous; it's varying spatially in various physical and chemical properties of soil. On the other hand, various rice varieties are suitable for some specific physical and chemical properties. For higher production on limited land, a variety-wise suitability map based on soil properties will be quite useful. Hence, the aim of the study was to prepare edaphic suitability maps for the newly released Bangabandhu dhan100. Spatial data were collected from BARC and rice variety-related data were collected from BRRI. Three suitability scales of Bangabandhu dhan100 were assigned in each soil class of various soil parameters. The suitability scale was weighted by the relative influence for suitability assessment and finally, the suitability map of Bangabandhu dhan100 was prepared using Arc GIS 10.3 software. Bangabandhu dhan100 is a BRRI-developed Boro rice variety. This variety is suitable in the western side and north-central parts of Bangladesh. We can increase production by cultivating specific rice varieties in the areas where they are suitable.

Keywords: Climate vulnerability, suitability mapping, Bangabandhu dhan100, rice production

Smart Profiling of Rice Varieties in Disaster-Prone Zones of Bangladesh

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Abstract

With the scenario of decreasing agricultural land, expected future rice productivity in Bangladesh will depend on increased yield. The yield of rice is predominantly dependant on variety. The varieties should be used in specific environments to harvest their yield potentials. Besides, the varieties have various life cycle to fit into desired cropping system especially in the disaster-prone zones. In fact, the choice of a variety to sow has a significant impact on the sustainability and profitability of rice in Bangladesh. Therefore, farmers require comparison between the varieties to choose the right one for their specific circumstances. This study was devoted to find out a suitable tool in order to profiling rice varieties following a smart ICT approach with exploring and designing rice varieties of Bangladesh according to preference category through developing a dynamic web and mobile applications. This study further establishes rice varieties be grouped according to their physical and physiological characteristics and tolerance to a biotic and biotic stresses. It suggests implementation of an electronic tool for profiling of rice varieties is very much potential in a field choosing suitable variety by the farmers. It highlights the potential of such a tool for applying in other crops as well. Farmers, extension officers, farm advisers, researchers, students and policy makers will be benefited from this app.

Keywords: Rice varieties, ICT, mobile application, web application, disaster-prone zone

Production and Supply System of Rice Bran Oil in Bangladesh

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Abstract

This research focuses on the manufacturing, marketing, and distribution of rice bran oil (RBO) in Bangladesh. In 2020, we used a sample of 165, including 15 rice bran oil millers and 150 traders from ten districts. The current production capacity of 15 rice bran oil mills is over 288,000 tons, with mills producing 197,680 tons using only 22% of the rice bran. About 4.67 million tons of rice bran can be used to generate 0.97 million tons of refined rice bran oil, which is one-third of Bangladesh's entire domestic edible oil requirement. Tk. 176,206/ton was the average total cost of rice bran oil production (including byproducts). The actual cost of RBO was Tk. 87,019/ton after subtracting returns from by-products. Rice bran oil millers supplied 63.73% at the local market and 36.27 % in the international market. 'Miller > Dealer > Retailer > Consumer' and 'Rice Bran Oil Miller > Company (Pran, Pusti, ACI, Aristrcate) Dealer > Retailer > Consumer' were the two most significant RBO supply chains. The value additions along the supply chain by miller, dealer, and retailer were 37.11%, 28.59%, and 34.30%, respectively. The key problems of RBO were the unavailability of adequate quality rice bran, lack of storage and preservation of rice bran, and lack of promotional activities at the consumer level. Because of the importance of rice bran oil, the government should aim to convert manual and husking rice mills to automated rice mills, and poultry and fish feed manufacturers should be urged to utilize de-oiled rice bran instead of rice bran. Based on the findings, the government should provide desired incentives to rice bran oil millers to enhance the supply of rice bran oil.

Keywords: Rice bran oil, rice bran, manufacturing cost, production capacity, supply chain

The Training Program of Bangladesh Rice Research Institute: Achievement and Future Directions

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Abstract

Since its establishment in 1970, The Bangladesh Rice Research Institute (BRRI) has pursued a dual but complementary mandate that includes rice related agricultural research and training. Subsequently, the first training program began in 1974. For almost 50 years, BRRI has been training rice scientists and extension workers of both public and private organizations. As of June 2020, a total of 1,41,259 trainees have been benefited from the course offered by BRRI. The result is that, personnel trained at BRRI have made a critical contribution in both research and extension activities in order to achieve a sustained increase in rice production. BRRI generally offered long term and short-term training course. From the beginning of 1974 to 1990, BRRI's main focus was on rice production training for the officers of Department of Agriculture Extension (DAE) that lasted 16 weeks. Many short-term training courses were generally oriented towards research methodology, scientific report writing, rice production technologies and included specialized course on rice management, disease and insect management. New training courses also evolved over time such as genetic resource; genomics; molecular biology; leadership courses etc. BRRI's research and training programs, undoubtedly, played a significant role in building the research capacity. Several studies point to BRRI's substantial contribution to the development of rice science and rice-related knowledge and technology and their dissemination and to the establishment of a fully functional rice research system. In a span of almost 50 years, BRRI has helped in the development of a well-trained group of research scientists and extensionists who are now giving the leadership in research and extension management.

Keywords: BRRI, training, technology dissemination.

Mapping The "Boro Season" Paddy Cultivation Area in Bangladesh from 2011 to 2017 Using Multi-Temporal MODIS Imagery

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Abstract

Information on paddy areas and spatial dissemination of paddy fields is required for carbon pollution assessment, water management and food safety. The Boro paddy fields are defined as the fundamental time of flooding and transplantation with the combination of land surface water (LSWI) and paddy crops. This paper established a more advanced method for paddy area detection and estimation using MODIS data. In this research, the algorithm LSWI+0.01 > EVI was developed and applied to detect paddy areas at the primary stages of flooding and transplantation at paddy fields. A total of 13 MODIS 8-day composite images of EVI and LSWI were used to produce the Boro season paddy cultivation area map. To measure the transient patterns in paddy crop coverage, growth and management systems, we have also mapped the overall area coverage and distribution of paddy crops over a few years from 2011 to 2017. A linear regression technique was used to validate the MODIS estimated paddy area based on the BBS statistical observed data. The results showed that there could be discriminations in paddy fields and quantification for spatial distribution. The average accuracy index values of R2, NSE, MBE, RMSE and MAE were found to be 0.92, 0.88, -2.48 km2, 208.90 km2 and 147.47 km2 respectively. The findings of this research suggested that the paddy area estimation using MODIS data could assist scientists, decision-makers, developers and administrations estimate the paddy area before harvesting time to make sure food safety at the national scale.

Keywords: Spatial dissemination, MODIS imagery, paddy area mapping

Solar Processing System of Paddy: An Environment Friendly Technology in Bangladesh

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Abstract

Hand beating and treading are the traditional methods of threshing in Bangladesh, which are laborious and time consuming. Now a day, farmers use pedal thresher equipped with diesel engine (4-6 hp) for threshing comfortably. But it emits carbon monoxide, unburnt hydrocarbons, and nitrogen oxides. Therefore, a thresher is developed in Bangladesh Rice Research Institute (BRRI) to use solar energy in paddy threshing. Eight-hundred-and-fifty-watt solar panel was installed at BRRI automobile workshop roof in series configurations to produce enough power and connected with a direct current (DC) battery to store solar energy. The battery storage was accompanied by a charge controller in order to prevent the batteries from reaching either an overcharged or over discharged condition. Four batteries of each 12 volt is connected in series to make it 48 volt to use in 0.5 hp 48 volt DC motor in developed BRRI thresher. A connector, an accelerator is used to start and control the motor. Its performance was evaluated in *Boro* season and got desired revolution per minute (300). Threshing capacity of the developed thresher was found 320 kg/hr. The capacity of the thresher was similar to open drum thresher. The developed thresher had more three advantages compare to traditional one *i.e.* first one solar energy used directly to thresh paddy, second one-stored solar energy in battery to operate smoothly in absence of sun light. Finally, combination of these two options can thresh paddy for longer period at higher efficiency. Moreover, two operators can thresh paddy simultaneously. Thus, it might be used widely at farmers level without emission of diesel exhaust gas causes lung damage, respiratory problems, and cause cancer in humans.

Keywords: Solar system, paddy processing, environment friendly, technology.

Design and Development of Manual Type Reaper

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Abstract

Harvesting is the beginning and major post-harvest operation for separation, processing and storage of grains. It is the process of collecting the mature crop from the field. Timely harvesting of paddy is very important to reduce postharvest losses. Most of the crops are generally harvested by sickle in Bangladesh which is quite tedious, labour-intensive job and costly. At harvesting time, labour shortage is a big problem. The suitable harvesting machine can be helpful for solving this problem. The imported reaper is costly which is out of the economical capability of the small-scale farmers. This paper tends to provide the design and development of manually operated reaper machine. The full design of the manual type reaper was done by Auto-CAD software to follow the design consideration and it was fabricated at Zomzom workshop, Pabna. The machine test was occurred at famer's field, Pabna. The field capacity of the machine is 0.055ha/hr and the field efficiency is 73.33%. The machine is suitable for small scale farmers to harvest paddy in less time and at low cost by considering different factors as power requirement, cost of equipment, ease of operation, field condition, time of operation and climatologically conditions. The operating, adjusting and maintaining principle are made simple for effective handling by unskilled operators.

Keywords: Manual type reaper, post-harvest loss, labour shortage

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