Mitigation and Adaptation Co-Benefits (MAC-B)

Modelling Trial in Bangladesh Project

Proceedings of the MAC-B Stakeholder Workshop

September 15, 2022

Golden Tulip: The Grandmark, Dhaka, Bangladesh

Mitigation and Adaptation Co-Benefits Modelling Trial in Bangladesh Project

MAC-B Stakeholder Workshop Agenda

Golden Tulip: The Grandmark Dhaka, House 84, Rd No. 7, Block H, Banani, Dhaka 1213

September 15, 2022

09:00-16:45, Bangladesh local time

09:00–09:30	Registration	
09:30–09:45	Welcome and introductions	Dr. Timothy Krupnik (CIMMYT) and Mr. Erik Mencos (Columbia University, virtually)
Opening Remarks		
09:45–09:55	Dr. Veronica Doerr, Research Program Manager, Climate Change, ACIAR (virtually)	
09:55–10:05	Dr. Md. Shahjahan Kabir, Director General, Bangladesh Rice Research Institute (BRRI)	
10:05–10:15	Dr. Mian Sayeed Hassan, Member-Director, Natural Resources Division, Bangladesh Agricultural Research Council (BARC)	
10:15–10:35	Climate Change Challenges in Agriculture: Overview of the AgMIP and MAC-B Project	Dr. Cynthia Rosenzweig (NASA/Columbia University, virtually) and Dr. Timothy Krupnik (CIMMYT)
10:35–11:00	Group photo Coffee/tea break	All participants
Presentations of Preliminary Findings of Research on Mitigation and Adaptation Co-Benefits		
11:00–11:20	Climate Team	Dr. Sonali McDermid (NYU) and Md. Bazlur Rashid (BMD)
11:20–11:40	Crop, GHG and Soils Team	Dr. Tao Li (DNDC), Dr. Tek Bahadur Sapkota (CIMMYT), Dr. Umme Aminun Naher (BRRI) and Dr. Apurbo Kumar Chaki (BARI)
11:40–12:00	Economics Team	Dr. Roberto Valdivia (OSU) and Dr. Md. Rajibul Alam (Ministry of Public Administration)

12:00–12:20	Stakeholder engagement and social aspects	Sk. Ghulam Hussain (CIMMYT-BD) and Dr. Hom Gartaula (CIMMYT-India)
12:20–12:50	Questions and discussion	All participants
12:50–13:00	Remarks by the session chair	Dr. Debasish Sarker, Director-General, Bangladesh Agricultural Research Institute (BARI)
13:00–14:00	Lunch and prayer break	
Panel Discussion: Mitigation and Adaptation Co-Benefits		
14:00–14:50	Dr. Md. Abdur Rashid Sarker, Professor, Department of Economics, University of Rajshahi	
	Dr. S.M. Mofijul Islam, Senior Scientific Officer, Soil Science Division, Bangladesh Rice Research Institute, Joydebpur, Gazipur.	
	Dr. Sohela Akhter, Director (TCRC), Bangladesh Agricultural Research Institute (BARI)	
	Mr. Malik Fida A. Khan, Executive Director, Centre for Environmental and Geographic Information Services (CEGIS)	
14:50–15:00	Dr. Mohammed Asaduzzaman, Professorial Fellow, Bangladesh Institute of Development Studies (BIDS)	Moderator
Breakout Sessions on the MAC-B Focus Areas		
15:00–15:50	Biophysical Impacts (Crop, GHG, Soils)	Group facilitators: Dr. Umme Aminun Naher (BRRI) and Dr. Tek Sapkota (CIMMYT)
	Economic Impacts	Group facilitators: Dr. Roberto Valdivia (OSU) and Dr. Md. Rajibul Alam (MoPA)
	Gender and Social Aspects	Group facilitators: Sk. Ghulam Hussain (CIMMYT-BD) and Dr. Hom Gartaula (CIMMYT)
15:50–16:20	Plenary Presentation per Focus Areas	Group rapporteurs
16:20–16:30	Synthesis, reflections and next steps	Dr. Timothy Krupnik (CIMMYT)
Wrap-Up and Closing		
16:30–16:45	Professor Dr. Ainun Nishat, Professor Emeritus at BRAC University, Bangladesh	

Proceedings of the MAC-B Stakeholder Workshop

The 'Mitigation and Adaptation Co-Benefits (MAC-B) Modelling Trial in Bangladesh' project is supported by the Australian Centre for International Agricultural Research (ACIAR) and led by Columbia University in partnership with the International Maize and Wheat Improvement Center (CIMMYT), Bangladesh Rice Research Institute (BRRI), Bangladesh Agricultural Research Institute (BARI), Oregon State University, New York University, and DNDC-ART. As a part of the project activities, the MAC-B Stakeholder Workshop was organized at the Golden Tulip: The Grandmark Dhaka, Bangladesh, on September 15, 2022, from 9:00 am until 4:45 pm (Bangladesh local time). Of the total of 54 experts and scientists who participated, 31 attended in person from various organizations in Bangladesh and 23 joined the workshop virtually from Australia, India, Japan, United States of America and Bangladesh. In this hybrid event, preliminary findings were presented by the research team to engage stakeholders in generating key relevant and feasible interventions for simulation by the MAC-B modelers. The one-day workshop was designed in such a way that the stakeholders could become involved in structured discussion on the barriers and bridges to cross-scale linkages and participate in break-out groups to foster interactions between stakeholders and scientists.

Welcome and Introductions (09:30–09:45)

Dr. Timothy Krupnik (International Maize and Wheat Improvement Center, CIMMYT and CGIA) and **Mr. Erik Mencos** (Columbia University, virtually) welcomed everyone to the MAC-B stakeholder workshop, both those joining in person and online. Dr. Krupnik explained how the MAC-B project (which stands for 'mitigation and adaptation co-benefits') is working to increase rice production in Bangladesh in the face of the climate crisis. He also explained that it is a pilot project, aimed at determining what can be done with large and unique data sets that might not otherwise be used for modelling.

After his words of welcome, Dr. Krupnik requested Dr. Veronica Doerr (ACIAR, virtually), Dr. Mohammad Khalequzzaman (Director of Research, BRRI), Dr. Mian Sayeed Hassan (Natural

In-person Speakers at the Opening Session of the the MAC-B Stakeholder Workshop

Resource and Management Division, BARC), Dr. Cynthia Rosenzweig (NASA/Columbia University, virtually) and Dr. Roberto Valdivia (OSU) to give their opening remarks.

Opening remarks (9:45–11:00)

Dr. Veronica Doerr (Research Program Manager, Climate Change, ACIAR, virtually) stated that having worked in the field of climate change for quite some time, one must be simultaneously both optimistic and pessimistic. She said, "We saw incredible heatwaves all around South Asia this year and the devastating floods in Pakistan right now. All these climate change effects are making me think about what we are doing. We have spent decades doing quality research, yet sometimes we are not able to implement mitigation and adaptation solutions on the ground. We have made progress and there are some successes, but sometimes it is frustrating that results are not quick enough. There are many reasons behind it, which social scientists can explain, but as researchers, I think there are two key things that can really change this situation and accelerate implementation that is completely in our control. One of those is interactions between the people who research mitigation and the people who research adaptation. They often don't talk to each other and collaborate, and we desperately need that, particularly in agriculture. As agriculture has the potential to be a dual-solution space for climate change, it is essential to reach across whatever technical divides might be there so that we work on dual solutions that address both adaptation and mitigation in agriculture. This is very much in our control.

Another thing that we can do is be conscious about our research work to get to implementation as fast as we can. So here in Australia, we have invested in some land sector mitigation actions (about 400 individual field research experiments) through internal investments for some time But we cannot afford that time anymore. We can't try everything. The MAC-B research model is designed to address the collaboration of the two areas - adaptation and mitigation - and to be used as the vehicle of this collaboration between adaptation scientists and mitigation scientists. It's also a tool to bring the best of the field research together through modelling. This way we don't have to do 400 different studies but rather identify the most promising experiments that can bring us the quickest solutions. Through MAC-B, we as researchers can participate in accelerating those actions and the process of learning about the action. I am frustrated, but I am also inspired by working with the MAC-B project – I feel like that's how I feel all the time working in climate change. I hope you feel the same way too."

In response to Dr. Veronica Doerr, Dr. Timothy Krupnik said, "I think in the year 2022, climate change has come very much to the doorstep of everyone on the planet; it is no longer a problem of the Global South. We have also seen that countries who are large emitters of the Global North are facing it too. Examples are Europe struggling with the extreme temperatures this summer, the disastrous flooding in Pakistan, and the droughts running through Africa. What I am encouraged by is the intention of forcing change into action. Let's hope it is not too late."

Next, **Dr. Mohammad Khalequzzaman (Director of Research, BRRI)** started by mentioning that the MAC-B project is very valuable and that the time is ripe for such an activity. He stated, "I would like to

discuss here some of the climate change scenarios in Bangladesh and their impact on rice production. Based on 1985 to 2000, the occurrence of variation of temperature is increasing day by day. Rice production can be hampered due to maximum and minimum temperatures, especially in the *aus* season, in the northwest and southwest of Bangladesh. Observed data show that if the minimum temperature decreases by one degree, *boro* rice production will be reduced by 3.4 tons per hectare.

Overall rainfall in Bangladesh is not changing over time, but uneven distribution and intensity is increasing. As a result, runoff is increasing, causing a lower amount of groundwater recharge. Day by day, increasing runoff is causing groundwater declines. During the flood of 1998, we saw how it decreased agricultural production in the country by 45%. Bangladesh has suffered around 20 droughts within the last 50 years. It caused the northwest of Bangladesh to lead to shortcomings in rice production of 3.5 million tons in 1990. If the sea rises by one-meter, normal flood waves can increase from 7.4 to 9.1 meters. Cyclones cause considerable damage to rice production – Cyclone Sidr in 2007 caused damage in 70% of the coastal region.

However, let's consider the success of the rice varieties in Bangladesh. We have developed 108 modern varieties, of which 28 are stress tolerant. Eleven are salinity tolerant, three submergence tolerant, three drought tolerant, four cold tolerant, two tidal submergence tolerant, one deep water tolerant, and one salinity and submergence tolerant. Apart from these, nine premium quality rice, seven zinc-enhanced rice, and more than three low glycemic index rice [varieties] for diabetic patients have been developed. BRRI-released varieties have covered more than 80% of the cultivation area, and their contribution to national rice production is 91%.

We have found that alternate wetting and drying (AWD) methods. have saved 4-5 irrigations compared to the farmers practising cultivation in continuous standing water. AWD saves about 25%-35% on fuel costs and 40% of water from shallow tubewells to deep tubewells. It also increases rice production by 0.5 tons per hectare; it reduces methane gas emissions from the environment caused by the rice fields and it reduces arsenic.

Most importantly, this is an environmentally friendly modern technology and procedure. However, there needs to be more knowledge among farmers regarding adaptation of the AWD land-based irrigation system. However, unreliable water and electricity supplies discourage farmers from adopting this technology, [and there are] few benefit-sharing practices among the farmers, the pump owners, and the water users.

In response to Dr. Mohammad Khalequzzaman, Dr. Tim Krupnik mentioned that the project has an interesting mix of key partners, with cross-ministerial partnerships and scientists contributing from different organizations.

In his speech, **Dr. Mian Syeed Hassan** (Member-Director, Natural Resources Management Division, BARC) said, “In Bangladesh, two-thirds of the rural population is directly involved in agriculture and more than 80% of households in rural areas rely on agriculture. Bangladesh is one of the countries most vulnerable to climate change - according to some studies, it is the seventh most vulnerable country in the world.

According to the Bangladesh Meteorological Department, in July this year, the average rainfall was only 211 mm, 57.6% less than the average July rainfall over the last 30 years - the lowest since 1981 (it was, on average, 496 mm for the past 30 years). The maximum average temperature was 33.7 degrees Celsius this year, which was a 2.6-degree rise from the average of 31.1 degrees Celsius in the past 30 years. Crop management has been the key tactic regarding rice production in Bangladesh.

Farmers have been growing over 50 varieties of rice in more than 300 patterns, and cropping intensities have reached about 200%. Bangladesh has been increasing production by intensifying rice-based cropping systems, emphasizing resource efficiency and climate adaptation benefits. According to the FAO Food Outlook 2022, Bangladesh produced 37.8 million tons of rice in 2021. Over the past four decades, Bangladesh had a population growth rate of 1.3% and a rice production growth rate of 2.8%.

Globally, Bangladesh stands third in rice and vegetable production, second in jute production, sixth in potato, and eighth in mango and guava production.. We have many more options to harvest, adapt, mitigate and get co-benefits from agricultural sectors. We have developed climate-smart crop varieties, fertilizers, water management practices, mechanization of cropping and harvesting, and resource-conserving crop establishment practices.

Bangladesh has developed its National Adaptation Plan 2022, the Second Perspective Plan 2041, the Bangladesh Delta Plan 2100, and the National Agriculture Policy 2018. Other policies are also aligned towards the same goal: better production, better nutrition, a better environment, and a better life. Then we can measure the co-benefits of mitigation and adaptation in terms of health, biodiversity and environmental conservation, economy, and productivity of farmers' livelihoods. To implement long-term policy, we must enhance initiatives for simultaneous research and development. Bangladesh's government has committed to a greenhouse gas reduction of 21.85% by 2030. Bangladesh also aims to become an upper-middle-income country over the next decade. With careful planning and policy development, climate mitigation and adaptation interventions can have many positive impacts providing co-benefits to society."

Finally, **Dr. Mian Sayeed** mentioned that according to recent research findings, there are three key challenges to the implementation of adaptation and mitigation co-benefits in Bangladesh. These include:

- Lack of capacity
- Lack of local political support
- Lack of technical development

According to Dr. Syed, the main missing link is finding the right stakeholders to represent the communities suffering from the effects of climate change.

In response to Dr. Mian Syeed, Dr. Timothy Krupnik said, "I want to focus on how you said climate change affects the vulnerable. Climate change affects farmers in different ways, particularly the most vulnerable. And in many ways the most vulnerable members within farming households. It is also important to reflect on these multiple vulnerabilities in modelling efforts, which are often seen to be separate from such work."

Dr. Krupnik introduced Dr. Cynthia Rosenzweig of NASA and Columbia University and remarked that "We are extremely proud to have Dr. Rosenzweig involved in this project as she is the 2022 World Food Prize laureate for recognizing efforts in the field of climate change adaptation and mitigation modelling.

Dr. Cynthia Rosenzweig (NASA/Columbia University, virtually) provided an overview of AgMIP and the MAC-B project AgMIP's main mission is to bring science-based agricultural decision-making models and assessments of climate change to achieve local to global food security. It is a global network comprising more than a thousand agriculture, climate, and food researchers. The intention is to provide science-based assessments for national mitigation and adaptation plans. AgMIP has over 50 initiatives, all working for present and future of food security. With a goal to make a more sustainable, productive, and resilient future. I am excited to work with the MAC-B project in Bangladesh. The diagram presented here shows the regional integrated assessment methodology AgMIP has used in many regions of Africa and South Asia. We are implementing similar actions in the MAC-B project in Bangladesh. As you can see, it always links back to engaging stakeholders. The project analyses alternate wetting and drying (AWD), which is often considered part of the System of Rice Intensification (SRI).

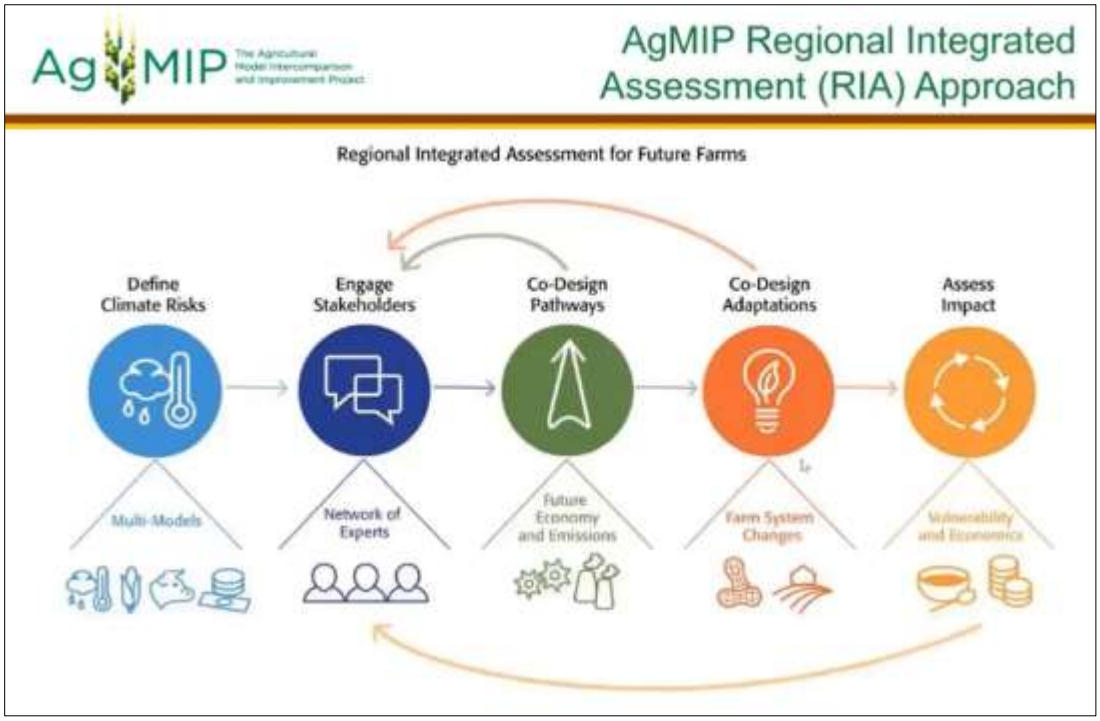

Figure 1. AgMIP Regional Integrated Assessment methodology

Dr. Rosenzweig presented Climate Change Projections in South Asia from the Intergovernmental Panel on Climate Change (IPCC).

Climate Change Projections in South Asia

- Heatwaves and humid heat stress will be more intense and frequent during the 21st century (medium confidence)
- Both annual and summer monsoon precipitation will increase during the 21st century, with enhanced interannual variability (medium confidence)

IPCC AR6, 2021

And she explained the mission of the MAC-B project:

MAC-B Project Mission

- The MAC-B project will trial a modeling approach for quickly and efficiently determining the likely best options for changing agricultural practices in ways that deliver both mitigation and adaptation benefits.
- The intended long-term outcome is to be able to accelerate the process of identifying the most promising options, and thus progress to trialing and scaling more quickly than has generally been done to date.

Dr. Rosenzweig showed that the MAC-B project framework links stakeholder engagement, emissions and mitigation models, and impacts and adaptation models for evidence-based decision-making related to policies and programs.

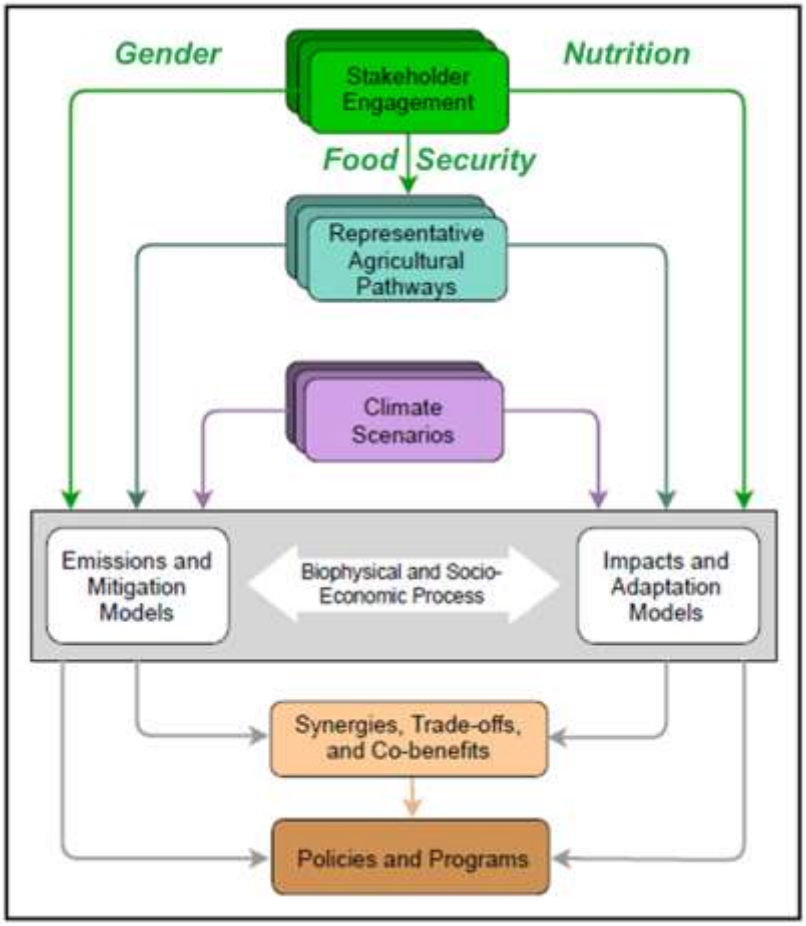

Figure 2. MAC-B Assessment Framework

Dr. Krupnik then explained that the AgMIP and MAC-B project is unique in terms of crop modelling in Bangladesh, elsewhere in South Asia, and perhaps even globally. The project has chosen research locations in Lalmonirhat, Rangpur, Rajshahi, Kishoreganj, Faridpur and Gopalganj, based on the large-scale data set available. The project uses combined data from over 6000 farmers, including their production, management, and economic practices, to assess rice production throughout the country. The dataset also considers high elevation, medium elevation and medium low elevation, because in order to increase mitigation and adaptation it is important to understand how rice production responds under these differing conditions. Dr. Tim Krupnik said that "in this project we want to develop plans that will provide both mitigation and adaptation benefits, and include different crop and rice management options. Farmers don't manage rice alone: they manage a basket of different crops, so the implication of climate change on the whole farming system is important. We want to ensure the capacity exists fully within the countries that we work in, including Bangladesh, so we can essentially be self-reliant when it comes to this modelling effort".

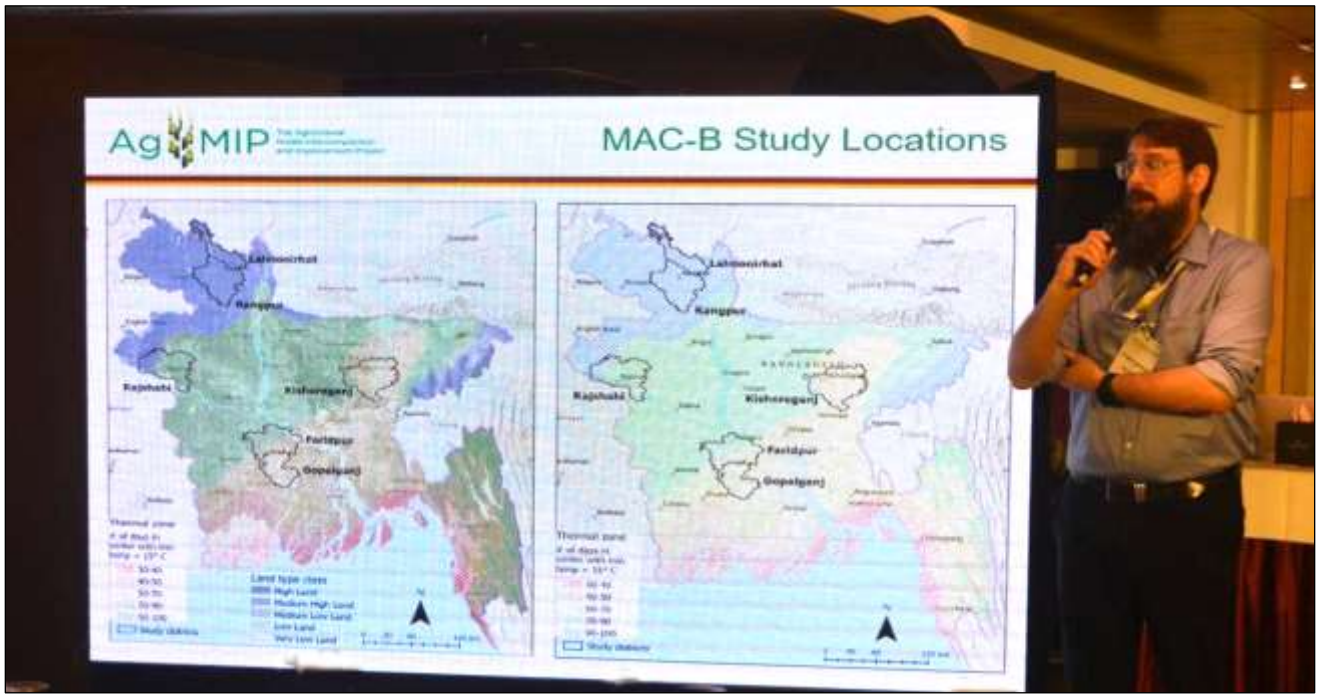

Figure 3. MAC-B Study Locations

Presentations of preliminary findings of research into mitigation and adaptation co-benefits (11:00–13:00)

Presentation 1 (11:00–11:20): Climate Team by Dr. Sonali McDermid (NYU) and Md. Bazlur Rashid (BMD):

Dr. Sonali McDermid (NYU) presented on the climate analysis for the MAC-B project. The main objectives of the Climate Team are to:

1. Provide scenarios of future climate change for MAC-B assessment at the site level
2. Understand how uncertainty in climate scenarios impacts decision-making

3. Demonstrate how modelled mitigation potentials may provide feedback on the climate system.

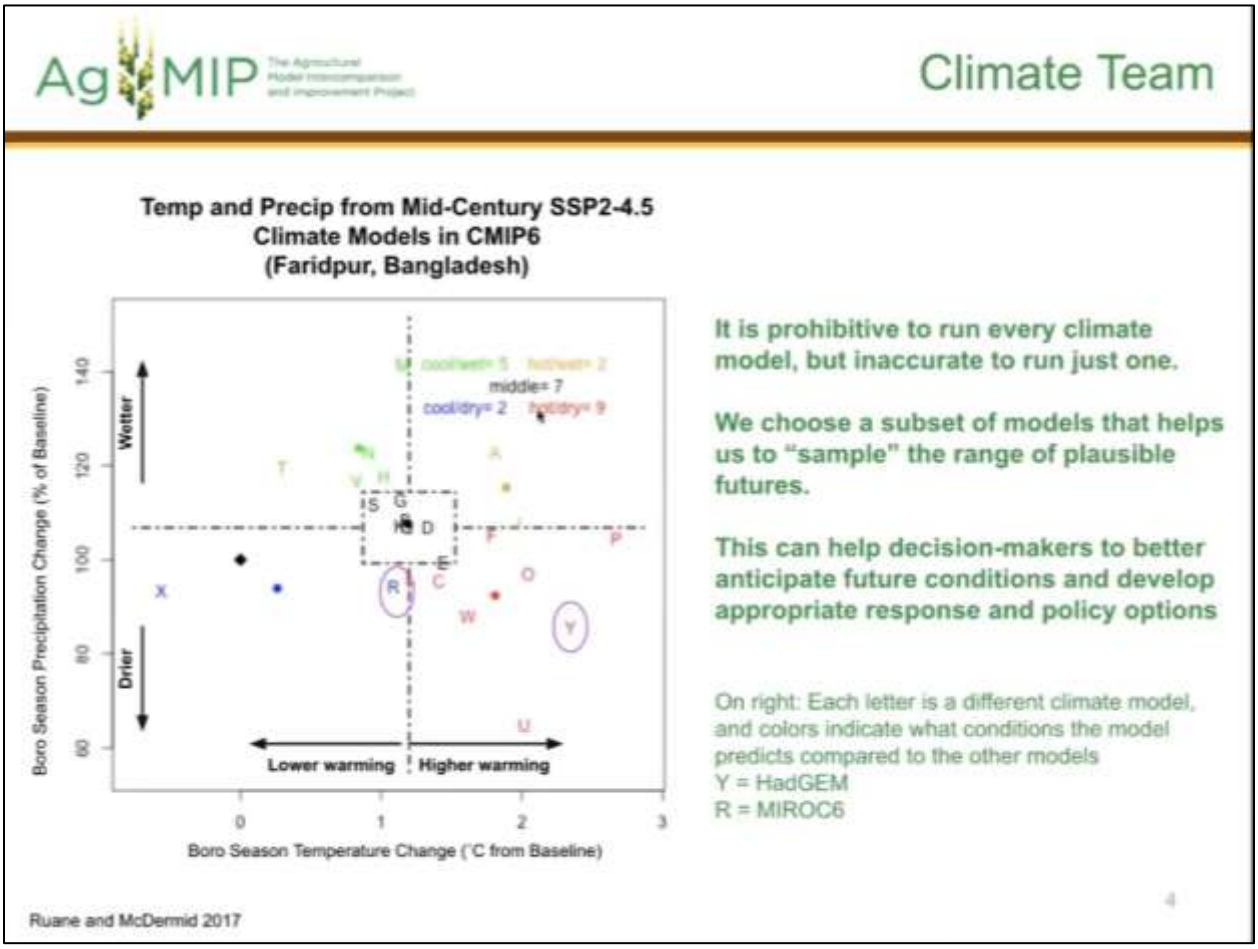

Figure 4. Temperature and Precipitation from Mid-Century Climate SSP2-4.5 Models in CMIP6 (Faridpur, Bangladesh)

The Climate Team compared multiple SSP2-4.5 climate models in CMIP6 and found that the MIROC6 and HadGEM models work very well to capture future climate projections in the Bangladesh region. This can help decision-makers to anticipate future conditions better and develop appropriate responses and policy options.

Presentation 2 (11:20–11:40): Crop, GHG and Soils Team by Dr. Tao Li (DNDC), Dr. Tek Bahadur Sapkota CIMMYT), Dr. Umme Aminun Naher (BRRI) and Dr. Apurbo Kumar Chaki (BARI)

Dr. Tek Sapkota (CIMMYT) presented by Zoom on some of the preliminary results of the modelling exercise, which used crop management, soil, and climate data (Fig 5). DNDC, DNDC-ORYZA and APSIM models were used. These models were calibrated and validated to capture uncertainties and to establish the confidence of model predictions.

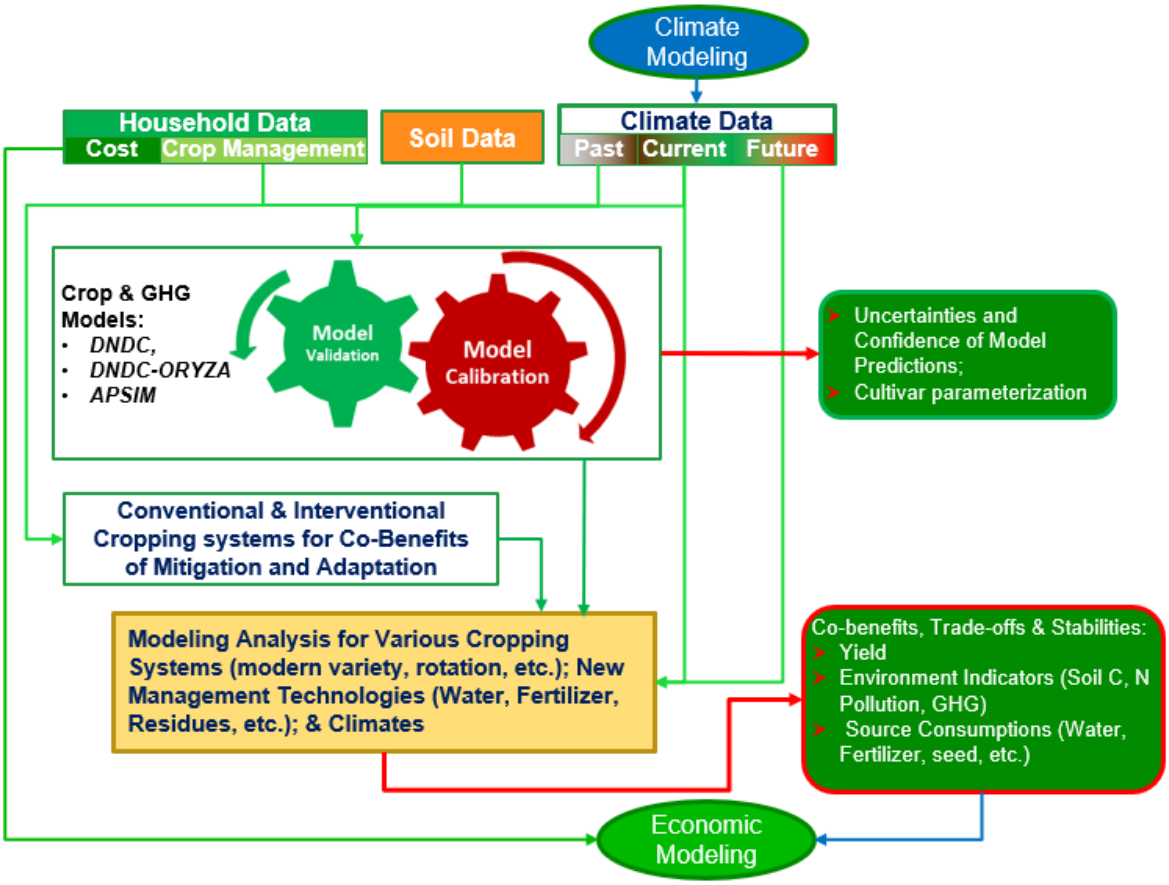

Figure 5. The framework of crop and greenhouse gases (GHG) modeling

The models showed the effect of different management practices on a range of economic and environmental indicators, such as crop yield, crop water requirement, carbon sequestration, and GHG emissions. Such information could be very important for decision-making at different levels. Specifically, this preliminary modeling exercise shows that climate change will negatively impact yield and soil fertility as well as increase GHG emissions under business-as-usual scenarios and thus change in management practices is important for climate adaptation as well as mitigation. Our modeling results showed a substantial amount of irrigation water and CH4 emissions reduction through the adoption of alternate wetting and drying (AWD) rice albeit with minor yield penalty both under current and future climate (Fig. 6). However, a uniform AWD won't be suitable for all fields and therefore it is worth developing site-specific AWD.

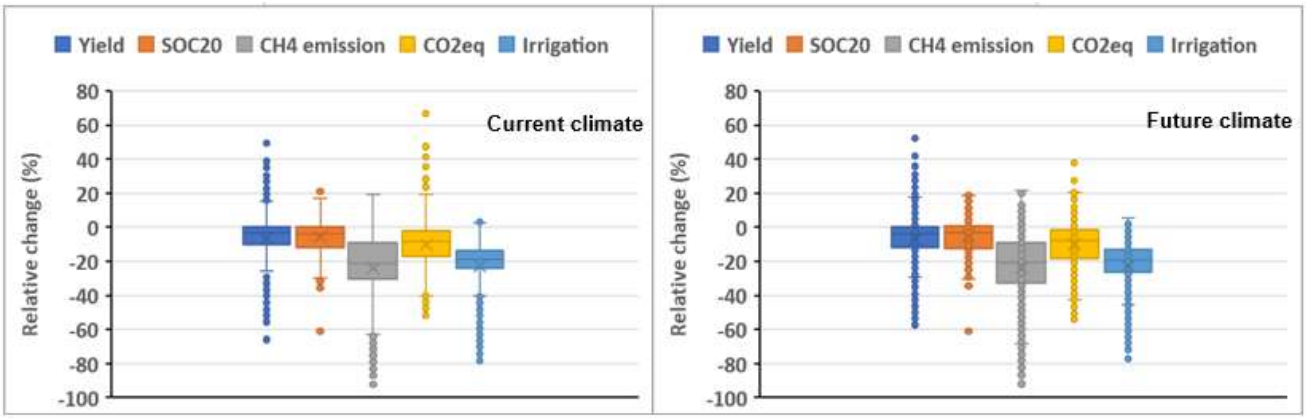

Figure 6. Effect of alternate wetting and drying on yield, C sequestration, irrigation water requirement and GHG emissions in rice production under current and future climate

Presentation 3 (11:40–12:00): Economics Team by Dr. Roberto Valdivia (OSU) and Dr. Md. Rajibul Alam (Ministry of Public Administration, Dhaka, Bangladesh)

Dr. Roberto Valdivia addressed the socio-economic modelling aspect of the methodology in his presentation. The Economics Team integrates the climate, soil, and crops results into the TOA-MD model (Trade-off Analysis for Multi-Dimensional Model Impact Assessment). He explained that through the AgMIP's Regional Integrated Assessment (RIA), a framework that links crops, livestock, and socio-economic data and models, the MAC-B project evaluates pathway/scenario uncertainties under current and future climate, biophysical and socioeconomic conditions. The goal of the socio-economic modelling is to capture the relevance of local contexts by co-designing, with scientists and stakeholders, adaptation and mitigation strategies that are of interest and suitable for specific farming systems.

Dr. Valdivia then presented the preliminary results in Bangladesh from the economic modelling, which show (1) the impacts of climate change on conventional rice cultivation technique (Figure 7), and (2) adoption of SRI/AWD under current climate (Figure 8). It is important to note that, for this pilot study, SRI/AWD have been selected as the "alternative" technology to be tested, while acknowledging that there are several other management options that could be tested. The purpose of this pilot project is to demonstrate how the AgMIP MAC-B framework can be used to produce information (e.g., key socio-economic and environmental) indicators to support policy decision making.

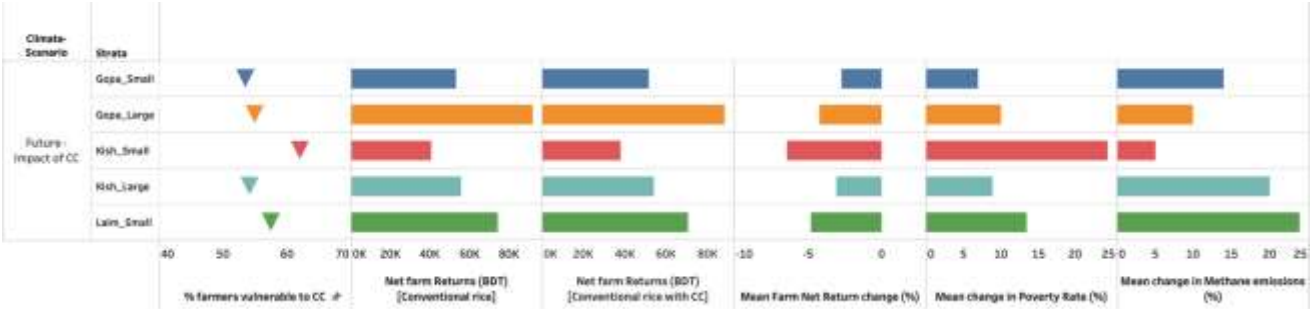

Figure 7. Preliminary results showing climate change impacts on conventional rice production systems in the districts of Gopalganj, Kishoreganj and Lalmonirhat. Data was stratified in Small farms with less than 1 ha with rice and Large farms with more than 1 ha of land under rice.

The socio-economic data used was extracted from a survey collected by BRAC and Monash University (Barrett et al., 2021) which includes both farmers' information on using conventional rice systems and farmers' adoption of SRI/AWD in three districts of Bangladesh (Gopalganj, Lalmonirhat, and Kishoreganj). Outputs from the crop simulation team were used to estimate the relative change in crop yields and GHG emissions due to climate change and due to switching from conventional rice production to SRI/AWD.

The climate change impact results show that:

(1) 50%-60% of the farm population in these three districts risk agricultural loss
(2) Farmers' income is projected to decrease by 3%-6%
(3) Poverty rate is projected to increase between 7% to 25%
(4) Methane emissions on conventional rice system are projected to increase with climate change between 5% to 24%.

The adaptation analysis using the TOA-MD showed that if SRI/AWD technology is introduced, the potential adoption rates range between 36% and 70% across the districts and farm type. Mean farm income increases between 7% and 25% which contribute to reduce poverty rates between 20% to 40%. Adoption of SRI/AWD contributes to reduce GHG (methane) emissions between 25% to 35%. While the results are preliminary, they show the importance of capturing the heterogeneity inherent to these production systems. In this case, the regional differences and farm type indicate that there are gainers and losers with respect to climate change, and some may have larger benefits by adopting SRI/AWD. Further analysis incorporating other regions and more detailed production costs, climate projections will be conducted and presented in the final project report.

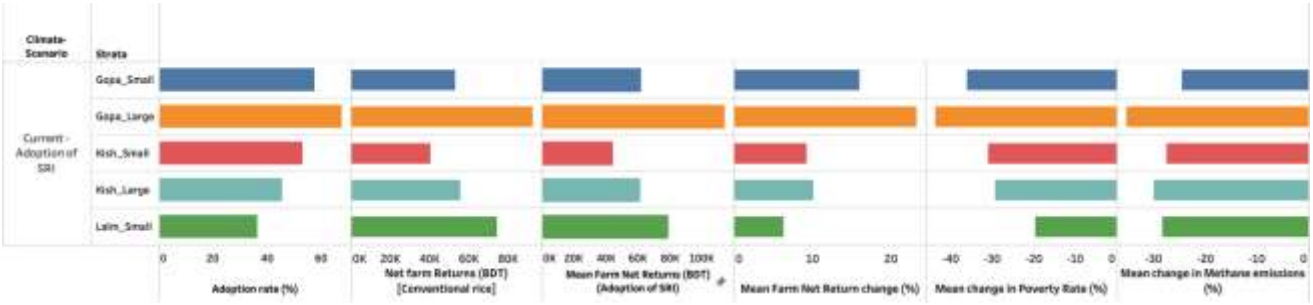

Figure 8. Preliminary results showing benefits of adopting SRI/AWD under current climate in the districts of Gopalganj, Kishoreganj and Lalmonirhat. Data was stratified in Small farms with less than 1 ha with rice and Large farms with more than 1 ha of land under rice.

Presentation 4 (12:00–12:20): Stakeholder Engagement by Dr. Sk. Ghulam Hussain (CIMMYT–BD)

Dr. Sk. Ghulam Hussain started by explaining stakeholder engagement as a systematic process of identifying, analysing, planning, prioritizing, and implementing actions intended to engage and influence, and that engagement is essential because of its goals to simplify stakeholder communications and ensure that communication resources are used efficiently and effectively.

Dr. Hussain stated that engaging appropriate stakeholders will provide an improved understanding of the MAC-B integrated assessment modelling system and possible MAC-B interventions. The

stakeholder engagement process will enable stakeholders to identify additional interventions for the MAC-B modelers to test in current and future conditions. Stakeholders will then understand the MAC-B framework and advocate for its use in national planning documents such as the National Adaptation Plan (NAP), Nationally Determined Contributions, etc. Bangladesh's researchers are encouraged to learn how to improve and test ideas generated by MAC-B modelling efforts. Stakeholders and regional researchers will then be more likely to adopt the MAC-B framework and create practices to achieve development impacts. The goal is for MAC-B to enhance regional capacity for implementation of mitigation and adaptation practices.

Potential stakeholders include Bangladesh Meteorological Department, Bangladesh Agricultural Research Council, Bangladesh Agricultural Research Institute, Bangladesh Rice Research Institute, Bangladesh Livestock Research Institute, Krishi Gobeshona Foundation, Jahangirnagar University, London School of Economics, University of Eastern Finland. Based on the stakeholders' importance and their influence on research, they were grouped as Informing, Collaborating, Consulting, and Monitoring Groups. After conducting a participatory mapping exercise with a range of experts and institutional groups, a stakeholder analysis matrix was developed (Fig. 9).

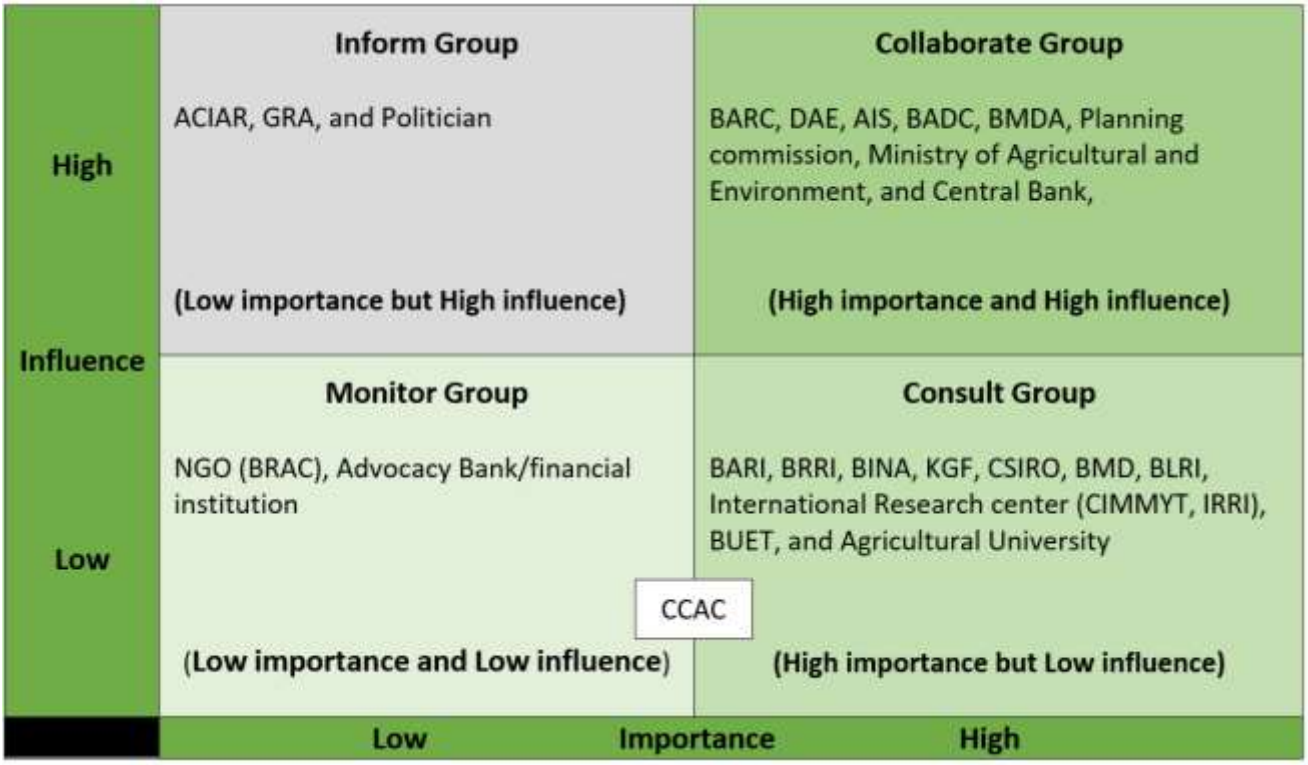

Figure 9. Stakeholder analysis matrix

Presentation 5 (12:00–12:20): Social Aspects by Dr. Hom Gartaula (CIMMYT-India)

Dr. Hom Gartaula discussed evaluating interventions to improve farmers' livelihoods and nutrition, and described how the vulnerability context and benefits structures are different for men, women, and youth. Interventions that result in equal access and benefits will impact livelihoods overall. He offered

a framework for gender-informed modelling (Fig. 10), including the key social variables that should be part of the analysis such as age, education, land ownership, household headship, gender roles, gendered decision making, migration, ethnicity and language, and intra-household consumption pattern, which are not necessarily considered in the existing frameworks. He also presented some variables selected for integrating gender and social inclusion in the analysis leading to more equitable outcomes and highlighted the challenges for an effective integration due to data availability, scale issues, and translating gender-data into policy language, especially the one generated through non-numerical means.

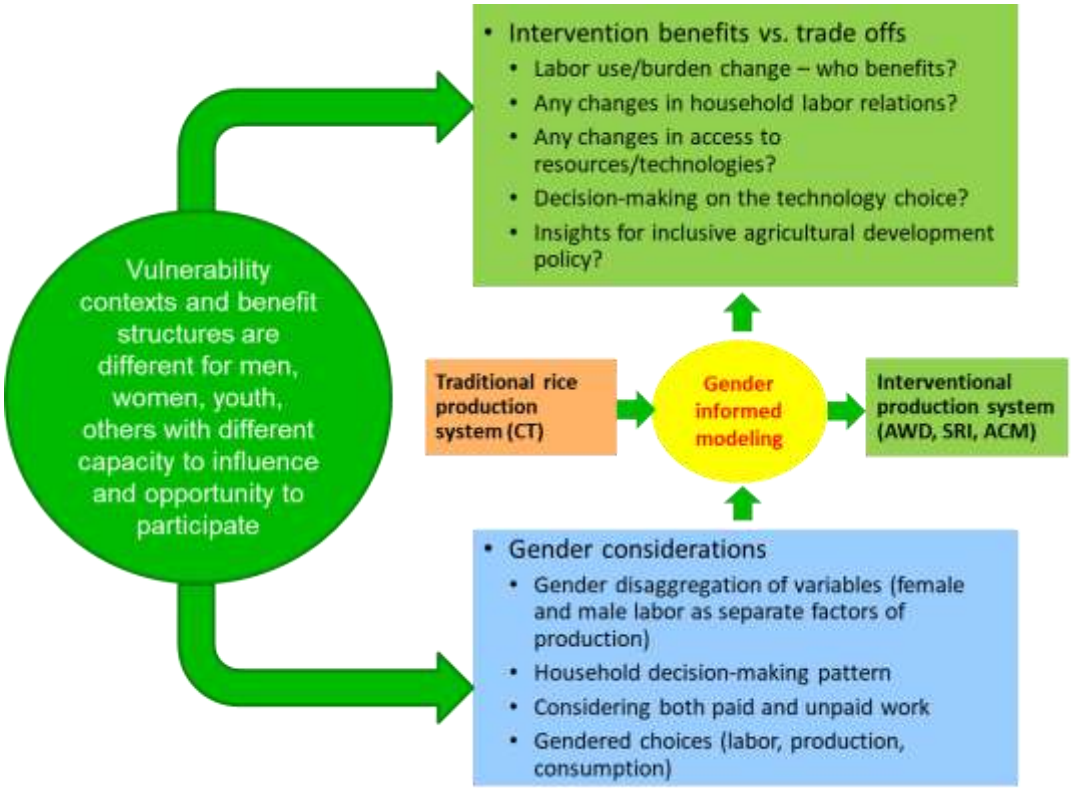

Figure 10. Framework for gender-informed modelling.

Remarks by the Session Chair, Dr. Debasish Sarker, Director-General, Bangladesh Agricultural Research Institute (BARI) **(12:50–13:00):**

Dr. Debasish Sarker, Director-General, BARI first expressed his gratitude and then provided his valuable observations on the five presentations.

Dr. Sarker believes that partnerships between national and international stakeholders will open new windows to fight and minimize climate change risk, and develop mitigation and adaptation measures for Bangladesh's agriculture sector. The research findings will expose new options.

He drew attention to the increasing incidence of floods, droughts, and cyclones that have caused extensive economic damage to agriculture livelihoods in Bangladesh. Agriculture accounts for 20% of the GDP and impacts 65% of the workforce. Mitigation and adaptation are therefore the key strategies by which to combat the impacts of climate change and ensure and food security.

Dr. Sarker also expressed his firm hope that the separate strands of the MAC-B project can work together closely to formulate initiatives or create a platform for long-term collaboration with advanced technologies, leading to the establishment of artificial intelligence in agriculture and the digital transformation of data.

Panel Discussion: Mitigation and Adaptation Co-Benefits (14:00-15:00 pm)

Panellist 1: Dr. Md. Abdur Rashid Sarker, Professor, Department of Economics, University of Rajshahi

Dr. Md. Abdur Rashid Sarker asked the presenters whether the 'co-benefit' mentioned in the MAC-B project is qualitative or quantitative, whether it involves only private or social benefits, and how farmers and stakeholders perceive the co-benefits of the project.

He believes that a district level model is needed because different areas of Bangladesh are impacted differently. He explained that in Bangladesh coastal areas are affected by cyclones, the north of the country by droughts, and the Sylhet area by flash floods. As a result, the same model may not be applicable to each district or area, making area-specific modelling a pre-requisite.

He reported having found that the adoption rate of alternate wetting and drying (AWD) irrigation – which is cost-saving, water-saving and helps to reduce GHG – is very low in Bangladesh, because (1) most farmers are unaware of AWD technology, and (2) those who do know about AWD technology do not use it because there is no financial incentive to save water when farmers do not pay for water volumetrically. Farmers thus pay the same whether they use AWD technology or not. Because of a lack of good governance, poor coordination among farmers and stakeholders in the field, and a lack of proper policy and policy application, the AWD adaptation rate is not increasing in Bangladesh, in contrast to the Philippines and India where it is very successful. Dr. Sarker requested the presenters and participants to investigate why AWD is not working in Bangladesh. His research reveals that the net revenue of production by using AWD does not decrease; sometimes it is the same or a little higher,

making AWD profitable. Farmers should therefore use AWD technology and it is our duty as scientists and policymakers to work out how to make AWD successful in Bangladesh.

Panellists discussing Mitigation and Adaptation Co-Benefits

Next, Dr. Sarker mentioned agroforestry technology and that it should be considered as part of the MAC-B project. According to him, agroforestry technology can avoid damage and be one of the adaptation strategies to be analysed in the MAC-B project. Agroforestry has the potential to absorb carbon, increase farm income, provide fruits and wood, and also protect the soil from erosion.

He also thinks that conservation agriculture should be considered as it can bring no or minimum tillage for non-rice crops and is also an environment-friendly and climate-smart technology.

He stated that rice yield and productivity have not increased in the last five years compared to China and India, and that new technology should therefore be introduced. Farmers are shifting from *boro* rice to maize production, not because of climatic reasons but because of economic reasons, as maize involves less cost and less water, making the net return high.

Finally, he mentioned that in this time of energy crisis, solar irrigation should be awarded greater emphasis as it is environment friendly, and Bangladesh has no sunlight problem.

Panellist 2: Dr. S.M. Mofijul Islam, Senior Scientific Officer, Soil Science Division, BRRI, Joydebpur, Gazipur

Dr. Mofijul discussed the significant global increase of about 33% in carbon dioxide, methane and nitrogen oxide since the pre-industrial era, and the main focus of the Paris Agreement of keeping the global temperature rise to 1.5 degrees Celsius. He also highlighted the COP26 Summit on Food Security in Glasgow.

The Bangladesh Nationally Determined Contribution (NDC) highlights both conditional and unconditional projections based on which Bangladesh expects to reduce 100 million tons of carbon dioxide.

To reduce methane emissions from rice fields there are technologies such as fertilizer management, water management, conservation agriculture, improved cropping patterns and nanotechnologies. AWD is an excellent technology, with effective impacts on greenhouse gas emissions, significantly decreasing global warming potential.

Panellist 3: Dr. Sohela Akhter, Director (TCRC), BARI

Dr. Akter provided the following suggestions:

- MAC-B can be used to gather views from stakeholders focusing on sustainable rice management.
- Modern technologies can be used in model verification.
- To mitigate the vulnerability of the country to temperature and rainfall extremes, heat tolerant varieties, among others, can be used.
- Conservation agriculture and climate-smart agriculture need to be adopted. Cover crops and crop rotation can be used.
- Integrated plant nutrition systems can be upgraded.
- Rainwater harvesting can be extended.

In regard to the impact of the climate crisis on current agricultural conditions, if the gradual drifting of the rice season due to drought and delayed production continues, this will hamper rice and wheat production.

Panellist 4: Mr. Malik Fida A. Khan, Executive Director, Centre for Environmental and Geographic Information Services (CEGIS).

Mr. Khan first stated that a quick assessment using models indicates that Bangladesh's agricultural sector can be changed and co-benefited by adopting mitigation and adaptation measures.

The Bangladesh NDC and National Adaptation Plan are his current prominent project. In national adaptation, the plan has six goals and one of them is food, nutrition, and livelihood security with interventions of water, agriculture, and fisheries. Of the 47 interventions that provide mitigation co-benefits, twelve or thirteen are climate-smart agriculture interventions. He asked that the MAC-B project check with this assessment for the climate-smart agriculture interventions and how the project could contribute to interventions that provide both mitigation as well as adaptation co-benefits.

Conclusion by Dr. Mohammed Asaduzzaman, Professorial Fellow, Bangladesh Institute of Development Studies (BIDS):

The conclusion of the presentations of preliminary findings of research on mitigation and adaptation co-benefits was presented by Dr. Mohammed Asaduzzaman. He said:

"The sum of the presentation is that there is no magic bullet; conditions, sites, and situations are important for bringing a change. Actual implementation in the field is the real problem because a farmer is managing many factors. A few key issues need to be considered always. How water is supplied, how water is used, net income, etc. Payment for ecosystem services must be done in this country but has not started yet. Again, there is no magic bullet, the conditions of the farmer need to be understood. Science needs to be feasible technically, socially, and economically."

Breakout sessions on the MAC-B focus areas (15:00–15:50 pm):

Group 1: Biophysical Impacts (Crop, GHG, Soils)

Climate-smart soil, water and fertilizer management

Biophysical Impacts (Crop, GHG, Soils) break-out group

Important note: In ensuring food security, the group agreed not to sacrifice rice yield.

Suggestions included the use of:

- Short instead of long-duration crop varieties in the *aman* season
- Minimum tillage with crop residue management
- AWD during the *boro* season (according to soil type)
- Satellite-based irrigation system to ensure precise water management
- Solar irrigation system
- Proper management of irrigation channels to prevent water loss
- Deep placement of urea
- Sulphur/neem costed-urea
- Biochar
- Biofertilizer
- Nano fertilizer
- Compound fertilizer
- Real-time N application

- Machine transplanters with deep placement of fertilizer
- Crop rotation
- Direct seeded rice where applicable
- Early warning system for disease and pest management to reduce pesticide use

Group 2: Economic Impacts

The economic group outlined why the MAC-B project uses the TOA-MD model and SRI/AWD. The TOA-MD Model is a unique simulation tool for a multi-dimensional impact assessment that uses a statistical description of a heterogeneous farm population to simulate the adoption and impacts of a new technology or a change in environmental conditions and poverty. The MAC-B research team aims to investigate AWD when all the activities under changing climate and environmental conditions were considered.

For the team, selecting a comprehensive data set was a major challenge, as the aim was to analyse impact assessment on specific issues.

The group discussion identified the following prospects for the economic aspect of the project:

- Evaluate the effects of interventions related to climate change on the current farming system using multiple measures of adaptation, mitigation and development co-benefits.
- Evaluate the effects of the interventions related to climate change on the current farming system considering the future climate scenario in advance.
- Utilize TOA-MD because this economic model can be run using currently available data, resulting in lower costs compared to other models.
- Discussed options for future research (e.g., a second phase of this project) to involve other partners to have access to additional data to represent other management options for rice systems and possibly, expanding the analysis to other systems, like maize-based systems

The Economic Impacts Breakout Group found that the workshop had been useful in finalizing their analysis and that it had provided them with new ideas about the technologies that they could include in the future.

Group 3: Gender and Social Aspects

One of today's most pressing challenges which emerged from the discussion is the link between gender and nutrition. Men, women, and children come under distinct categories of vulnerability, meaning that gender inequality impedes progress and impacts on both household and national food and nutrition security. In addition, risk factors are growing every day. MAC-B focuses on mitigation and adaptation to reduce vulnerability. The danger factors will inevitably decline if climate change is reduced. The technology tested in this project is AWD. Children suffer the most throughout puberty, and it has a long-term impact on them. A lack of nutrient-rich food will lead to problems for the country in the future.

The group pointed out the impossibility of imagining a healthy, ecologically friendly world without agriculture, and that it is impossible to improve agriculture and agricultural products without considering the contribution of women to the industry. Female workers are primarily involved in post-

harvest activities, a crucial aspect of farming. They also contribute to pre-mechanization procedures, and the fact that they are not fully acknowledged is regrettable.

However, women's requirements vary according to area; for example, natural catastrophes affect many regions, where women's needs should be considered accordingly.

The group emphasized that to achieve equality for all genders in society including under-represented women, opportunities should to be made available based on need. They also highlighted the importance of a healthy diet, and that women should be encouraged to work in agriculture, which should be a primary focus.

Synthesis, reflections and next steps by Dr. Timothy Krupnik (CIMMYT):

Dr. Krupnik said he had found the workshop interesting and useful. He pointed out that seeing colleagues and stakeholders face-to-face is remarkably important, and that the debate about SRI was also important.

He reflected that not only SRI is projectable: other approaches are also relevant. The data set on SRI is impressive; however, the focus does not have to be on SRI as the only adaptation measure.

In response to the biophysical group, he identified two interesting findings:

(1) Scientist are very focused on approaching interventions in a package, speaking of best management practices such as soil and water. Models can be used for some but not all interventions;
(2) Farmers rarely employ the entire package of recommended practices; this is an idea for scientists not farmers. How farmers are using AWD and other components of SRI should be examined.

Dr. Krupnik added "We need to identify socio-economic and adoption patterns, where we can look at models of adaptation in terms of components rather than as technical packages. There needs to be adaptation in addition to adoption. Farmers rarely, if ever, use the same package approach season after season." Dr. Krupnik asked participants to challenge themselves in this regard.

He stated that the socio-economic group had raised some important queries. Although the project might have utilized rich data about rice production, it might not have enough national or global data linked to fisheries and livestock production. He said, "We shouldn't use these concepts to ask for more funding. But I think there are some advantages to collecting this new data, which will help us in the next phase of this research. It can help to link rice with multiple other crops or livestock. Rice will always be king and will always be the most important thing that will ever be considered for modelling context."

On gender inclusion, Dr. Krupnik said, "We don't often count women in the agricultural system, or how they are working regarding seed maintenance, in post-harvesting activities. But if you look at the livestock sector, the role of women is increasing, which is why I think we need to collect some additional primary data. We would like to create a more advanced data set on gender roles, and present it in the next 6 months and use it with secondary data sets".

Wrap-up and closing by Professor Dr. Ainun Nishat, Professor Emeritus, BRAC University, Bangladesh

Professor Dr. Ainun Nishat stated that the impact of climate change on the agricultural sector is highly significant, even though Bangladesh produces only 0.3% of global GHG. This needs to be recognized. Scientists assume that total global rainfall will increase, resulting in more frequent short-duration, very heavy rain, as well increases in the number of extreme events such as cyclones, storms and flash flooding. Crops react to these changes, with just one degree increase in the temperature having a significant impact. Livestock and fisheries are other important areas most affected by climate change. A main goal of the Paris Agreement, agreed upon by 197 countries, is to ensure food security.

Professor Dr. Nishat said he was very glad that the MAC-B project considers both mitigation and adaptation: to ensure food security, a link must be established between the two. Government policy should be developed in such a way that the adaptation rate and food production are increased and GHG emissions reduced. He also referred to AWD as the best technology for mitigating methane emissions. To ensure adaptation, Bangladesh needs rice varieties that are tolerant to stress (from salt, drought, and submergence) and short-duration varieties. Professor Dr. Nishat also said that maize can be a potential crop to include in the climate change adaptation strategy in Bangladesh as it can tolerate high temperature levels compared to other crops. He indicated that the Bangladesh National Adaptation Plan has mainly focused on the agriculture sector in order to secure food security. He encouraged scientists, policymakers, and stakeholders to come up with an effective combination of adaptation and mitigation strategies, and work on these to save agriculture in Bangladesh.

Finally, **Dr. Ghulam Hussain** thanked everyone for their enthusiastic participation and for providing their valuable feedback, which would help to improve and modify the integrated assessment approach and the MAC-B project.

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