Mitigation and Adaptation Co-Benefits in Agriculture
~ MAC-B ~

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To promote climate change action and the SDGs, there is growing attention by policy-makers, stakeholders, and researchers on interventions* that contribute to both mitigation and adaptation co-benefits, trade-offs, and synergies

*e.g., soil carbon sequestration, sustainable intensification, crop-livestock systems
MAC-B Assessment Framework

- Stakeholder Engagement
- Representative Agricultural Pathways
- Climate Scenarios
- Emissions and Mitigation Models
  - Biophysical and Socio-Economic Process
  - Impacts and Adaptation Models
- Synergies, Trade-offs, and Co-benefits
- Policies and Programs

Gender
Nutrition
Food
Security
MAC-B project aims to increase in-country capacity to co-develop information products of value to stakeholders. This involves continuing training and experiences using ‘best practices’ in both modeling and stakeholder engagement.
• Directly integrate stakeholder feedback into MAC-B assessment process and co-develop feasible interventions (focused on sustainable rice management and intensification) for mitigation and adaptation co-benefits.

• Evaluate effects of interventions in current farming systems using measures of mitigation, adaptation and development benefits, including greenhouse gas emissions, resilience to climate variability, farmer livelihoods, gender, and nutrition.

• Evaluate effects of interventions on measures of benefits under future climate scenarios.

• Support policy development by convening policy-makers round table to communicate findings and discuss policy implications for mitigation and adaptation programs and NDCs.

• Strengthen capacity in all partners in using and applying GRA/AgMIP MAC-B methods
• **GHG emissions**
  - Model: DNDC
  - \( \text{N}_2\text{O}, \text{CO}_2, \text{and CH}_4 \) flux rate (kg C/ha, kg N/ha)

• **Yields**
  - Models: ORYZA, APSIM
  - Yield per hectare (kg/ha)

• **Stability of yields**
  - Models: ORYZA, APSIM
  - Coefficient of variation of crop model outputs

• **Economic performance**
  - Model: TOA-MD model
  - Sensitivity to costs for aspects of production that contribute strongly to GHGs, such as N management and water management

• **Farmer income and percent poverty**
  - Model: TOA-MD
  - By strata
## Data Sources

<table>
<thead>
<tr>
<th>Data Type</th>
<th>Source 1</th>
<th>Source 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate information</td>
<td>Bangladesh Meterological Department</td>
<td>AgMERRA, AgMIP archives</td>
</tr>
<tr>
<td>Economic data</td>
<td>Primary surveys and data maintained by CIMMYT</td>
<td>Bangladesh Bureau of Statistics (BBS) data</td>
</tr>
<tr>
<td>Crop practice data</td>
<td>Primary surveys and data maintained by CIMMYT</td>
<td>Bangladesh Rice Research Institute</td>
</tr>
</tbody>
</table>
Mitigation/Adaptation
Rice Modules/Linkages

ORYZA rice module
- Phenology
- Photosynthesis
- Evapotranspiration
- Respiration
- Allocation & growth
- Root growth & senescence
- Yield formation
- N & W up taking
- Abiotic stress

Central Interface Module
- Simulation configuration
- Daily calculation management
- Nutrient and water transfers
- Management of cropping status

Management Module
- Water (irrigation)
- Fertilizer
- Tillage
- Residue

Environmental Driver Module
- Soil physic, chemical & hydraulic characters
- Daily weather

DNDC Soil Module (C, N, P life cycling)
- Mineralization
- Nitrification
- Denitrification
- Hydrolysis
- Absorption
- Desorption
- Decomposition
- Fermentation
- …..

DNDC-Art/Applied GeoSolutions coupled rice-soil process-based model that analyzes biophysical processes of rice systems for mitigation and adaptation
Crop: Variety, Seedling age, Direct-seeding/Transplanting, Density, Rotation

Management: Tillage, Nutrients and Residues, Water

Land: Soil type/fertility, Slope, Groundwater level


Scale: Spatial – Meters → Field → Region → Nation → Continent → Global
     Temporal – Day → Season → Year → Decade → Century

Interventions: Characterized by changes in parameters

Parameters: Configured as simulation input files

Simulations: Interventions, baseline and climate change

Mitigation: GHG emissions

Adaptation → Food Security: Yield and yield stability; Farmer livelihoods

Evidence Base for Policies: Co-Benefits for Farmers and Development of Mitigation & Adaptation

Sustainable rice management represented by parameters

DNDC-ORYZA simulation

Sustainable rice evaluation using DNDC-ORYZA outputs and outcome

+ Economic TOA-MD Simulations
• Expand MAC-B projects to additional GRA countries

• Create set of protocols that can be used and modified by each country

• National stakeholder/policy-maker engagement

• Engage with other GRA research groups
Some Scoping Discussions

Bangladesh
Conduct seed project on sustainable rice intensification management options to test mitigation and adaptation co-benefits.

Dominican Republic
Assess co-benefits, trade-offs and synergies for adaptation/mitigation in current NDCs for Caribbean Central America using representative farming systems to identify gaps and needs.

Peru
Perform *ex-ante* impact assessment analysis of potential adoption rates of Alternate Wetting/Drying to evaluate sustainable rice intensification in coastal and Amazon regions.

Vietnam
Conduct a sustainable rice intensification regional integrated assessment in the Red River Delta and Mekong River Delta rice-growing regions.

Zimbabwe
Characterize trade-offs in mixed crop-livestock systems and co-design mitigation and adaptation options for mixed crop-livestock systems under future challenges.
Co-Benefits and Tradeoffs to Food Security from Mitigation and Adaptation in Agriculture

This thematic series will publish in *CABI Agriculture and Bioscience*.

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**Submission Deadline:** 31 October 2021

**Aims and scope:** Research at the *nexus* of climate mitigation and climate adaptation in agriculture remains challenging, owing to both data and modeling limitations, as well as the
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