INTERNATIONAL RICE RESEARCH INSTITUTE

CLIMATE CHANGE STRATEGY

2022 - 2027

CGIAR

IRRI

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RICE AND CLIMATE CHANGE

Rice is the world's most important staple food for some 4 billion people, while in Asia, the poorest of the poor derive up to 70% of their calorie intake from rice. The crop is produced by some 144 million farm households, and harvested from 166 million hectares annually. Rice farming is associated with poverty in many areas. About 900 million of the world's poor depend on rice as producers or consumers, and out of these, some 400 million poor and undernourished people are engaged in growing rice.

Because of its geographic expansion and typical manner of wetland cultivation, worldwide rice production contributes about 10% of total greenhouse gas (GHG) emissions from the agricultural sector, mainly because of methane (CH4) emissions from continuously flooded wetland rice fields (Fig. 1). Flooded rice environments account for around 20% of the total global CH4 flux, thus significantly contributing to climate change. Climate change, in its turn, threatens the very production of rice through the effects of higher temperatures and more frequent droughts and flooding, as well as sea-level rise, which imperils rice production in mega-deltas and coastal zones. Reduced global rice production endangers food security and hampers poor consumers and producers emerging out of poverty (Fig. 2).

Figure 1. Methane production from rice fields.

- ~2/3 of total emissions from rice sector are from paddy soil (CH_4)
- Produced by bacteria in flooded conditions
- High Global Warming Potential (28x more harmful than CO_2) → Priority for mitigation
- Other GHG: N_2O (mostly from fertilization, GWP of 265)
- Carbon sequestration

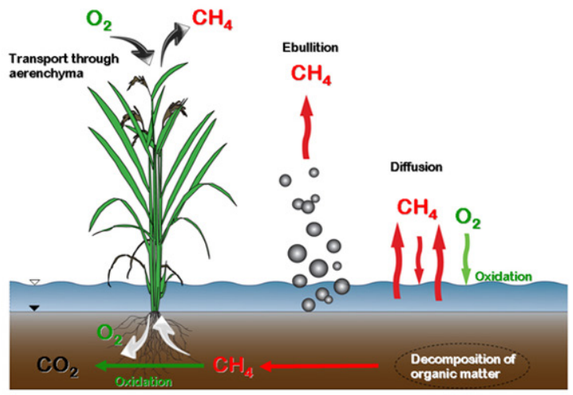
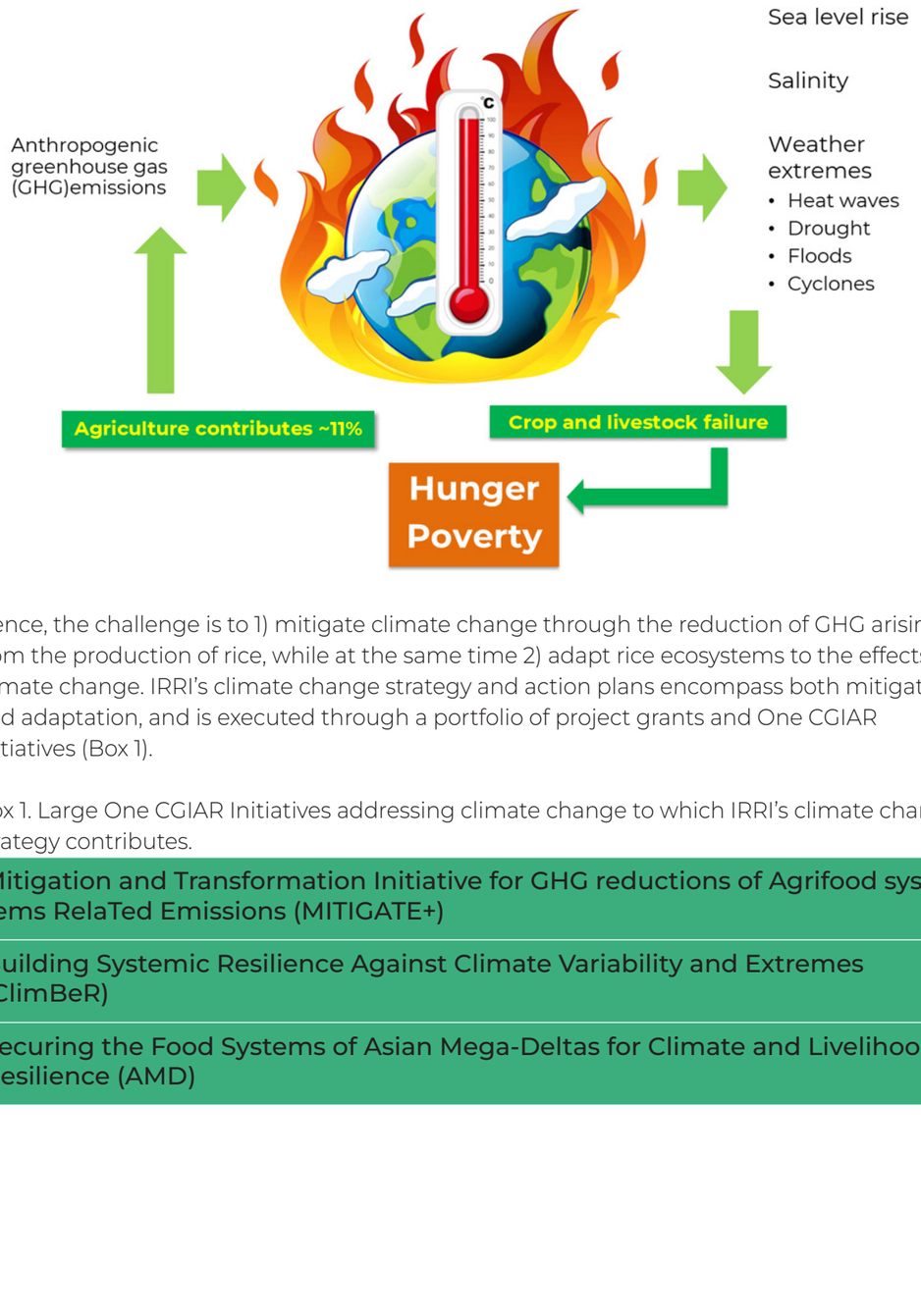


Figure 2. Vicious cycle between emissions of GHGs from rice fields, their impact on global warming, and the effects of global warming on rice production.



Hence, the challenge is to 1) mitigate climate change through the reduction of GHG arising from the production of rice, while at the same time 2) adapt rice ecosystems to the effects of climate change. IRRI's climate change strategy and action plans encompass both mitigation and adaptation, and is executed through a portfolio of project grants and One CGIAR Initiatives (Box 1).

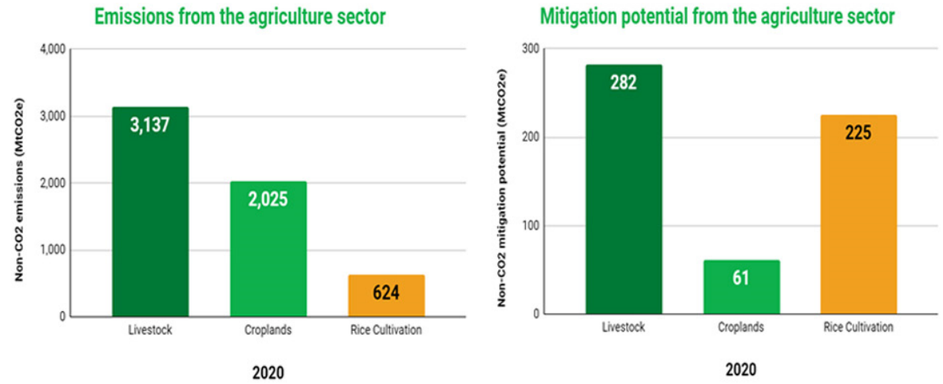
Box 1. Large One CGIAR Initiatives addressing climate change to which IRRI's climate change strategy contributes.

Mitigation and Transformation Initiative for GHG reductions of Agrifood systems RelaTed Emissions (MITIGATE+)
Building Systemic Resilience Against Climate Variability and Extremes (ClimBeR)
Securing the Food Systems of Asian Mega-Deltas for Climate and Livelihood Resilience (AMD)

MITIGATION

Globally rice cultivation is the third-largest source of non-CO2 greenhouse gas emissions in agriculture, next to livestock and all croplands, mainly because of methane (CH4) emissions from continuously flooded wetland rice fields (EPA, 2021). However, the relative mitigation potential for rice (36%) is much higher than that of livestock (9%), and croplands (3%) (Roe et al., 2021; EPA, 2021; Fig. 3). This presents immense opportunities for reductions of methane and other greenhouse gases, and for channeling climate funding to rural communities and smallholder rice farmers.

Figure 3. GHG emissions and mitigation potential in the agricultural sector. From: Roe et al., 2021.



To capitalize on these opportunities, IRRI established a virtual Center of Excellence for GHG mitigation in rice. Together with relevant local and global partners from the public and private sectors, IRRI provides global leadership in R&D on low-emission rice-based farming systems and value chains. Research stretches across the whole impact pathway continuum, from upstream research to adoption enablers to reaching impact at scale in terms of reduced GHG emissions and increased carbon sequestration (Figs. 4, 5).

Figure 4. Impact pathway of IRRI's climate change mitigation strategy.'

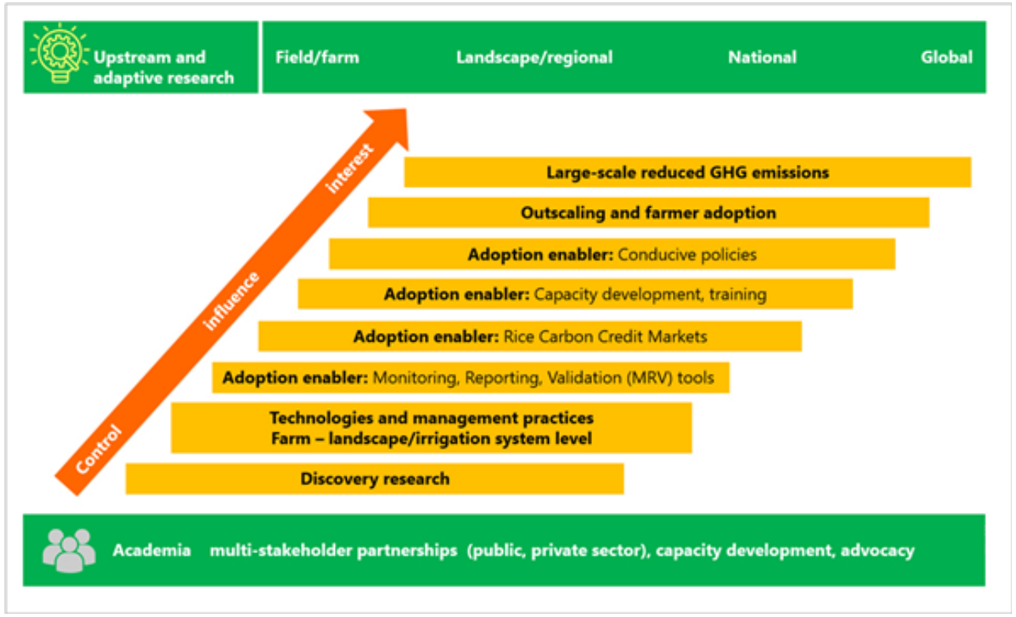
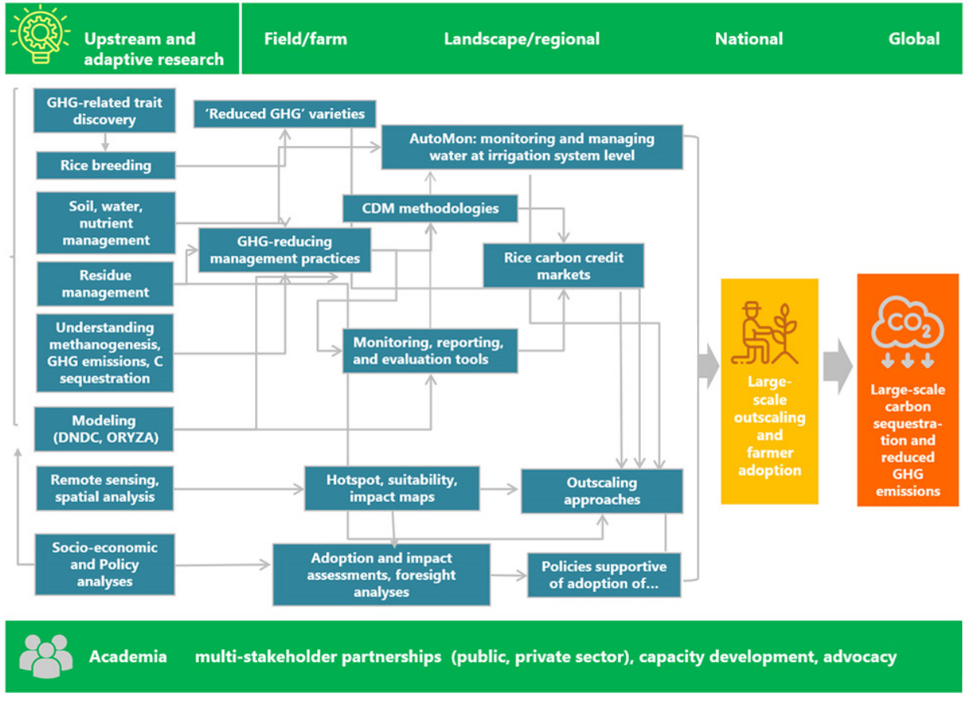


Figure 5. Activity-framework of IRRI's climate change mitigation strategy.



IRRI invests in the following solutions that form part of an integrated action-framework along the impact pathway:

At plant level

- Identification of traits and underlying genes that control fluxes of O2, CO2, and methane within the plant-root system, and of production of root exudates that feed the methane-producing microbes in the soil; and
- Screening and development of low-methane-emitting rice cultivars.

At the plant-soil-atmosphere interface, at field and farm level

- Understanding of the process of methanogenesis and the identification of entry points to manipulate the system to reduce methane emissions; capturing improved understanding in process-based simulation models such as an integrated ORYZA-DNDC model;
- Identification of potential methane inhibitors and/or soil amendments;
- Identification and development of soil-water-nutrient management practices, including residue management, at field level to reduce methane emissions (Box 2);
- Development of low-methane emission post-harvest practices for managing and processing crop residues, such as composting, bio-char production, and alternative uses such as mushroom production (Box 2); and
- Promotion of novel methodologies for certifying integrated emission reduction actions through accepted approaches, such as the rice carbon credit market.

At landscape and regional scales

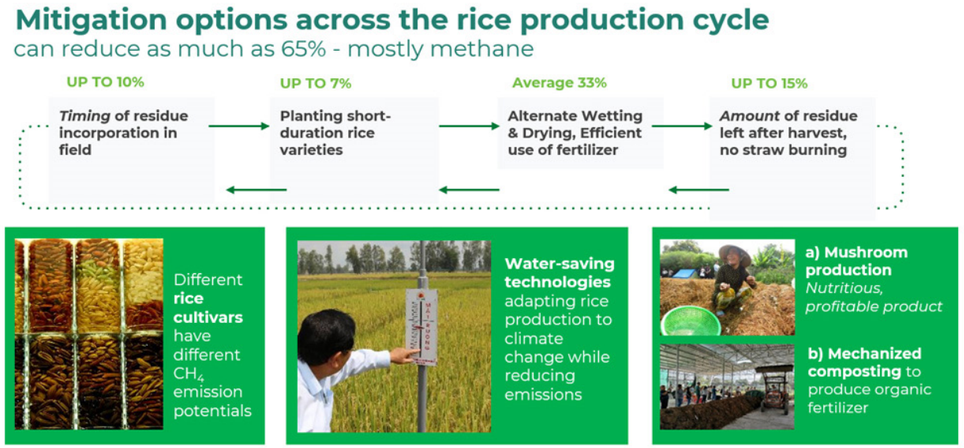
- Development of suitability indicators and maps for spatial-explicit targeting of innovations;
- Development of spatial monitoring tools based on remote sensing, in-field sensors, simulation modeling, geographic information systems, and ground-truthing; and
- Training and capacity development of implementation partners, including farmers, extension agents and advisory services, NGOs, and private sector partners.

At regional and national scales

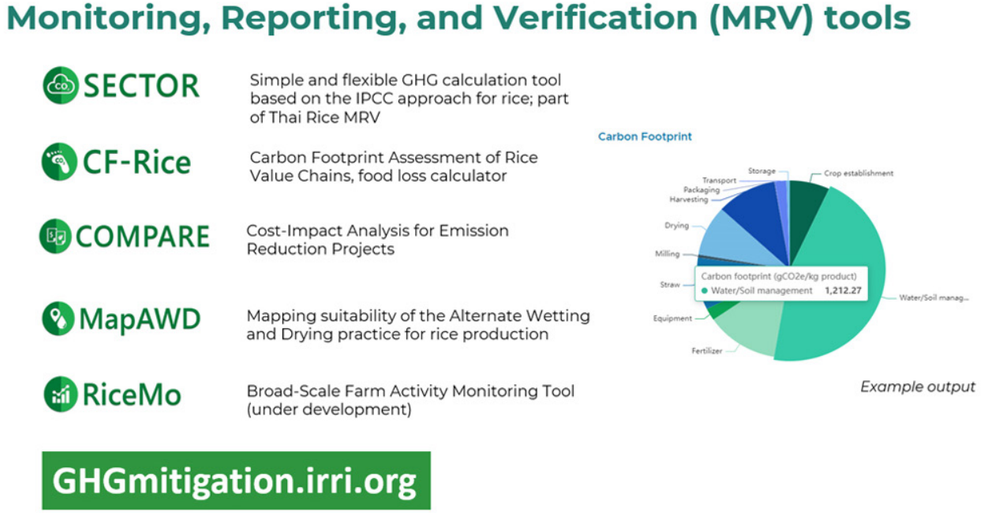
- Development of a suite of integrated Monitoring, Verification, and Reporting tools and facilitation of carbon credit markets for rice (Box 3);
- Conduct adoption and impact assessment studies of technology adoption;
- Providing support to the development of policies and interventions that are conducive to adoption of mitigation technologies, processes and procedures, and to the establishment and smooth functioning of rice carbon credit markets;
- Supporting and advising governments to repurpose the price policy, public expenditures, and other forms of support to rice production in favor of suitable innovation bundles for mitigation; and

- Engaging in multistakeholder platforms and mechanisms for transformative and sustainable outscaling of climate change mitigating practices and mechanisms in the rice sector.

Box 2. Opportunities for the reduction of methane during rice production and postharvest.



Box 3. IRRI's monitoring, reporting, and verification toolbox for rice.



ADAPTATION

Of all crop species, rice has the most genetic potential for adaptation to climate change as it is grown in environments that range from drought-prone uplands, through puddled wetlands, to flood-prone deepwater systems (Box 4).
Hence, an important component of IRRI's climate change adaptation strategy revolves around the development and deployment of novel rice varieties with enhanced tolerance to drought, flooding, salinity, heat, and even low temperatures.
Like in IRRI's mitigation strategy, the adaptation strategy stretches across the whole impact pathway continuum, from upstream research to adoption enablers to reaching impact at scale in terms of increased resilience to climate change and climatic shocks (Figs 6, 7).

Box 4. Diverse rice ecologies from drought-prone uplands to deepwater rice.

Figure 6. Impact pathway of IRRI's climate change adaptation strategy.

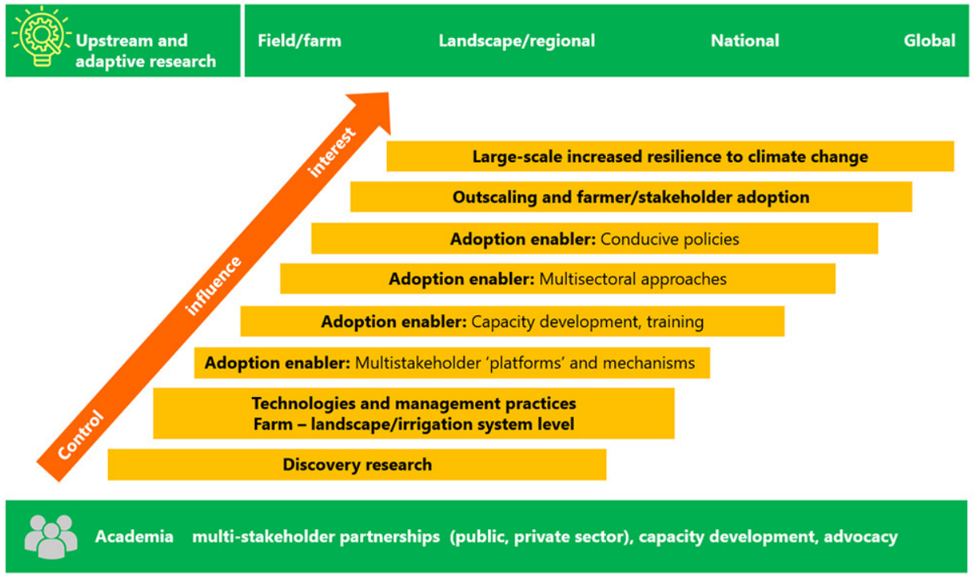
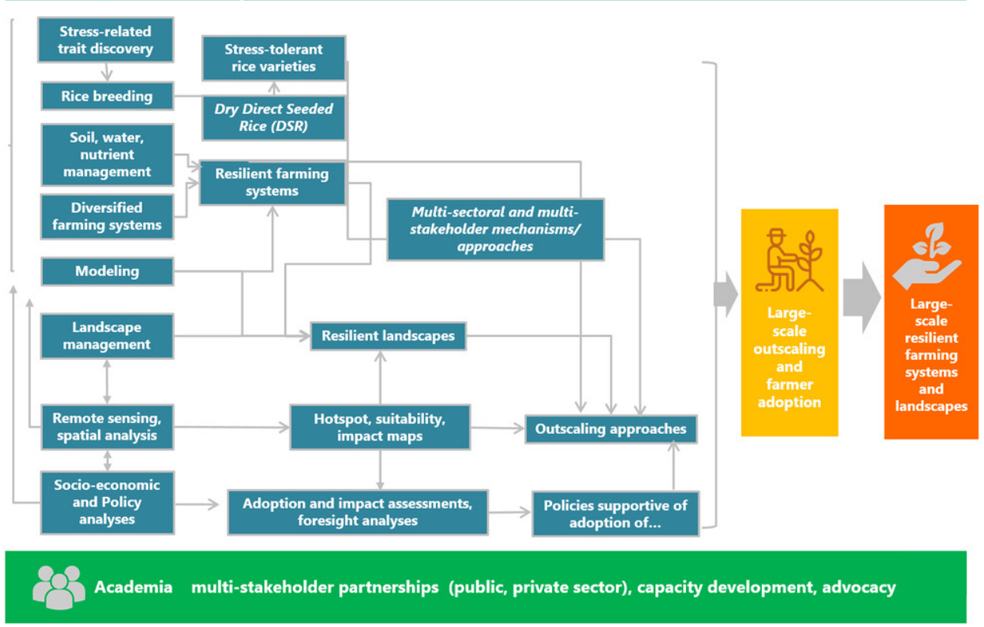


Figure 7. Activity-framework of IRRI's climate change adaptation strategy.



IRRI invests in the following solutions that form part of an integrated action-framework along the impact pathway:

At plant level

- Trait and gene discovery related to climate extremes (abiotic stresses); continuous biotic stress trait discovery for Blast, Bacterial Leaf Blight, Brown Plant Hopper, Rice Yellow Mottle Virus, and nematodes;
- Development of new high-yielding rice varieties tolerant to multiple climate-change induced stresses, such as heat, drought, flooding, cold, and new emerging pests and diseases; and
- Varieties suitable for mechanized direct dry seeding (DSR).

At field and farm level

- Mechanized Dry Direct Seeded Rice (DSR);
- Diversified cropping and farming systems, including fish/shrimp-rice farming; climate-adjusted cropping calendars; and
- Tools for identification, mapping, and forecasting of biotic stress - pathogens (interface with landscape level);

At landscape and regional scales

- Mapping of climate risks (i.e., drought, floods, salinity, heat, cold, biotic stresses), real-time extreme weather events and weather-related disasters such as flooding and typhoon damage, and damages to rice crops;
- Development of suitability indicators and maps for spatial-explicit targeting of innovations; and
- Training and capacity development of implementation partners, including farmers, extension agents and advisory services, NGOs, and private sector partners.

At regional and national scales

- Conduct of adoption and impact assessment studies of technology adoption;
- Providing support to the development of policies that are conducive to adoption of adaptation technologies, processes, and procedures;
- Building capacity for policies that bring together local needs and available tools to enable governance for resilience, working across levels, scales, and sectors and drawing out "champions of change" who can advocate for local investment and empowerment;
- Supporting and advising governments to repurpose the price policy, public expenditures, and other forms of support to rice production in favor of suitable innovation bundles for adaptation;
- Improved seed delivery systems (of climate-resilient varieties – see above);

- Engaging in multistakeholder platforms and mechanisms for transformative and sustainable outscaling of climate-change adaptation practices and mechanisms in the rice sector; and
- Ensuring gender and social equity, because a climate-resilient, nutrition-secure future will require gender sensitive policy, ensuring grassroots voices are heard and women, youth, and marginalized groups are included.

GENDER

Women contribute significantly to rice production. Within rice value chains, female family members participate in rice production and in postharvest, processing, and marketing operations. Through farming, they significantly contribute to food security in the household, nationally, and globally. However, women's contribution in the rice sector is often overlooked and undervalued, and many impediments hinder women realizing their full potential. Women face barriers and inequalities in terms of access to and control over such resources as land, capital, and credit as well as access to agricultural inputs and technology. Moreover, women and marginalized groups in society often suffer relatively most from adverse impacts of climate change.

Besides participating in the production, processing, and marketing of rice, women are also instrumental in development. Women work as a catalyst for change and are a major driver of growth and development. Empowerment of women by ensuring their equal access to resources, inputs, and technologies and allowing them to have greater control over income and assets can accelerate the pace of mitigation of – and adaptation to – climate change, ultimately contributing to household food security, health and nutrition, and poverty reduction. Hence, IRRI's climate change strategy explicitly recognizes the important role women play both as participants in rice value chains and as catalysts of transformative change. In developing and disseminating solutions, IRRI will pay particular attention to women's needs, involve them in targeted capacity development, and strengthen their role in participation and outreach programs.

NEXT STEPS

IRRI operationalizes the strategy through a well-balanced portfolio of upstream-to-downstream bilateral and OneCGIAR projects. Capitalizing on current strengths, IRRI will invest in novel research areas – and develop new partnerships – to develop next-generation solutions such as low-carbon farming, rice carbon credit markets, and policy support and analyses. At the same time, IRRI will collaborate with local, national, and international partners to co-create and disseminate solutions 'at scale' and to support the development and implementation of national development plans to reduce GHG emissions and adapt to climate change.

IRRI aims to improve livelihoods and nutrition, abolishing poverty, hunger and malnutrition among those who depend on rice-based agri-food systems. In doing so, IRRI's work protects the health of rice farmers and consumers, and the environmental sustainability of rice farming in a world challenged by climate change. IRRI's work promotes the empowerment of women and supports opportunities for youth in an equitable agri-food system.

IRRI is a member of the One CGIAR.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