Breeding for Climate-Ready Rice: Needs, Strategies, and Progress

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Climate change is expected to significantly affect the abiotic and biotic environments where rice is grown. Changes in temperature and availability of water in quantity (too much or too little) and in quality (salinity) will directly impact rice productivity. Such climatic conditions are in fact prevalent in regions of the world where food security is a major concern. Consequently, many rice breeding programs for the unfavorable ecosystems have included tolerance to drought, salinity, submergence, and high temperature as important breeding targets. Major genes and large-effect QTL have been identified for addressing submergence, salinity, and drought conditions. Examples include the submergence tolerance gene (Sub1), salt tolerance gene (Saltol1), and several QTL for sustaining yield under drought stress. Heat tolerance research is still at its infancy but useful genetic variation in germplasm has been identified. Due to the dynamic nature of pathogen and insect populations, it is more difficult to predict the impact of climate change on the biotic environment. We are interested in establishing "bio-stations" in diverse environments to gather empirical data on the influence of climatic extremes on pest-pathogen-host interactions. Such endeavor should be a priority for international collaboration. On the germplasm side, we are exploring the approach of creating a gene pool enriched for resistance to multiple biotic stresses. This involves intermating parental lines with disease and insect resistance to create highly recombined populations with adaptability and resilience to multiple biotic stresses. As a foundation for all breeding work, we are building a genetic diversity research platform to enable efficient use of the rice Genebank. This involves a) the use of 2,000 diverse rice lines in genome-wide association studies to discover gene-phenotype relationships, and b) sequencing 10,000 germplasm accessions (10% of the IRRI Genebank) to identify rare alleles for use in breeding. For the long-term, we are exploring the engineering of C4-photosynthetic machinery into rice to make it more efficient in capturing radiation energy and using nutrients and water. The newly established Global Rice Science Partnership (GRiSP, http://irri.org/our-science/global-rice-science-partnership-grisp) can provide a mechanism to promote collaboration in genetic research and breeding to help sustain rice productivity in new climatic regimes and to reduce impact of rice production to the environment.