Physiology, genomics and molecular approaches for lmproving abiotic stress tolerance in rice and impacts on poor farmers

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Abstract

Unfavorable weather and soil conditions reduce rice yield and land and water productivity, aggravating existing encounters of poverty and food insecurity. These conditions are foreseen to worsen with climate change and with the unceasing irrational human practices that progressively debilitate productivity despite global appeals for more food. Our understanding of plant responses to abiotic stresses is advancing and is complex, involving numerous critical processes - each controlled by several genetic factors. Knowledge of the physiological and molecular mechanisms involved in signaling, response and adaptation, and in some cases the genes involved, is advancing. Moreover, the genetic diversity being unveiled within cultivated rice and its wild relatives is providing ample resources for trait and gene discovery, and this is being scouted for rice improvement using modern genomics and molecular tools. Development of stress tolerant varieties is now being fast-tracked through the use of DNA markers and advanced breeding strategies. Large numbers of drought, submergence and salt tolerant varieties were commercialized over recent years in South and Southeast Asia and more recently in Africa. These varieties are making significant changes in less favorable areas, transforming lives of smallholder farmers - progress considered incredulous in the past. The stress tolerant varieties are providing assurance to farmers to invest in better management of their crops and the ability to adjust their cropping systems for even higher productivity and more income, sparking changes analogous to that of the first green revolution, which previously benefited only favorable irrigated and rainfed areas. New breeding tools using markers for multiple stresses made it possible to develop more resilient, higher yielding varieties to replace the aging and obsolete varieties still dominating these areas. Varieties with multiple stress tolerances are now becoming available, providing even better security for farmers and lessening their production risks even in areas affected by complex and overlapping stresses. The progress made in these less favorable areas triggered numerous favorable changes at the national and regional levels in several countries in Asia, including adjusting breeding and dissemination strategies to accelerate outreach and enabling changes at higher policy levels, creating a positive environment for faster progress. Exploiting the potential of these less productive areas for food production is inevitable, to meet the escalating global needs for more food and sustained production systems, at times when national resources are shrinking while demand for food is mounting. However, the success in these areas requires concerted efforts to make use of existing genetic resources for crop improvement and establishing effective evaluation networks, seed production systems, and seed delivery systems to ensure faster outreach and transformation.

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