Enhancing and stabilizing the productivity of salt-affected areas by incorporating genes for tolerance of abiotic stresses in rice

International Rice Research Institute (IRRI)

Country/Region:	India, Bangladesh, Vietnam
German participation	Max Planck Institute for Developmental Biology, Tübingen; University of Hohenheim
Leading scientist:	Dr Abdelbagi M. Ismail
Duration:	Jan 2008 – Dec 2010

Initial situation

Salt stress is a persistent and escalating problem constraining rice production in vast areas of South and Southeast Asia, currently estimated at over 20 million hectares. Salt-affected areas are predominantly inhabited by impoverished communities with few options for food security and improved livelihoods. In coastal areas, salinity intrusion renders the soil unproductive for rice farming, while in inlands, salinity and alkalinity are progressively expanding because of improper irrigation practices. However, recent opportunities in rice science—specifically in genomics, plant breeding and agronomy—bring significant hope that these lands can be restored to productivity.

Approach of the project

This project has brought advances in molecular genetics to bear on the development of rice varieties that have higher and more stable yield in salt-affected areas. The mapping of quantitative trait loci (QTLs) from salt tolerant landraces has identified novel alleles for tolerance that can be precisely transferred into existing varieties using marker-assisted backcrossing (MABC). Research into the physiological and genetic mechanisms of tolerance will help scientists combine multiple traits into high-yielding cultivars to achieve higher levels of tolerance for stress-prone environments, especially where problems with salinity and submergence coexist.

Major results achieved

The salt-tolerant *Pokkali* allele at the *Saltol* QTL has been transferred using molecular markers into BRRI dhan28, a popular variety for the dry season in Bangladesh, in collaboration with a Generation Challenge Program (GCP) project at IRRI. Progress has also been made to transfer the *Saltol* QTL into the popular variety

IR64, which is widely grown across Southeast Asia. Furthermore, novel QTLs for salt tolerance have been identified at the seedling stage from the landrace *Capsule* from Bangladesh and for the reproductive stage from the landrace *Cheriviruppu* from India, which will be useful for future marker-assisted breeding efforts.

Expected impact

Currently, rice productivity is very low but can be raised by at least 2 tons per hectare, providing food for more than 10 million of the poorest people living off these lands. The tolerant cultivars developed by this project will be tested with partners in the National Agricultural Research and Extension Systems (NARES) in India, Bangladesh and Vietnam for release or for use in their breeding programs, and improved varieties together with their proper management options will then be delivered and outscaled through participatory means.

Specific outputs include:

- Improved salt-tolerant varieties possessing the *Saltol* QTL and breeding lines containing a combination of *Saltol* and *Sub1* for both salinity and submergence tolerance;
- Novel salinity-tolerance QTLs identified and prepared for marker-assisted breeding;
- Genes and alleles associated with salinity tolerance discovered through candidate gene analysis combined with in-depth physiological characterization;
- High-throughput marker genotyping system developed using single-nucleotide polymorphism (SNP) markers for 384-marker multiplexed genotyping to improve the efficiency of QTL mapping and background selection;
- Capacity for marker-assisted breeding, large-scale phenotyping, and participatory research strengthened through degree and nondegree training for our NARES partners from India, Bangladesh and Vietnam.

Collaborating institutions

Central Rice Research Institute, India; Central Soil Salinity Research Institute, India; Narendra Deva University of Agriculture and Technology, India; Bangladesh Rice Research Institute; Cuu Long Delta Rice Research Institute, Vietnam

The Advisory Service on Agricultural Research for Development (BEAF) manages Germany's contribution to international agricultural research. Instruments for implementation are project funding, postdoc funding, small grants and liaising between German and international researchers. BEAF is part of GTZ and acts on behalf of the Federal Ministry for Economic Cooperation and Development (BMZ).

Imprint

Published by:
Deutsche Gesellschaft für technische Zusammenarbeit (GTZ) GmbH
Advisory Service on Agricultural Research for Development (BEAF)

Dag-Hammarskjöld-Weg 1-5
65760 Eschborn, Germany

T +49 61 96 79-3347
F +49 61 96 79-803347
E beaf@gtz.de
I www.gtz.de/agricultural-research

Dahlmannstr. 4
53113 Bonn

T +49 228 24934 231
F +49 228 24934 215
E judith.jansen@gtz.de

Pictures by:
International Rice Research Institute (IRRI) and collaborators from India, Bangladesh, Vietnam

Contact:
Dr Abdelbagi M. Ismail: abdelbagi.ismail@cgiar.org

December 2009