

Rice: From genes to farmers' fields

November 21 2008

"Waterproof" versions of popular varieties of rice, which can withstand 2 weeks of complete submergence, have passed tests in farmers' fields with flying colors. Several of these varieties are now close to official release by national and state seed certification agencies in Bangladesh and India, where farmers suffer major crop losses because of flooding of up to 4 million tons of rice per year. This is enough rice to feed 30 million people.

The flood-tolerant versions of the "mega-varieties"—high-yielding varieties popular with both farmers and consumers that are grown over huge areas across Asia—are effectively identical to their susceptible counterparts, but recover after severe flooding to yield well.

A 1-9 November tour of research stations and farms in Bangladesh and India led by David Mackill, senior rice breeder at the International Rice Research Institute (IRRI), marked the successful completion of a project, From genes to farmers' fields: enhancing and stabilizing productivity of rice in submergence-prone environments, funded for the past 5 years by Germany's German Federal Ministry for Economic Cooperation and Development (BMZ).

The new varieties were made possible following the identification of a single gene that is responsible for most of the submergence tolerance. Thirteen years ago, Dr. Mackill, then at the University of California (UC) at Davis, and Kenong Xu, his graduate student, pinpointed the gene in a low-yielding traditional Indian rice variety known to withstand flooding. Xu subsequently worked as a postdoctoral fellow in the lab of

Pamela Ronald, a UC Davis professor, and they isolated the specific gene—called Sub1A—and demonstrated that it confers tolerance to normally intolerant rice plants. Dr. Ronald's team showed that the gene is switched on when the plants are submerged.

A geneticist from UC Riverside, Julia Bailey-Serres, is leading the work to determine exactly how Sub1A confers flood tolerance.

"Sub1A effectively makes the plant dormant during submergence, allowing it to conserve energy until the floodwaters recede," said Dr. Bailey-Serres.

Typically, rice plants will extend the length of their leaves and stem in an attempt to escape submergence. The Sub1A gene is an evolutionarily new gene in rice found in only a small proportion of the rice varieties originating from eastern India and Sri Lanka. The activation of this gene under submergence counteracts the escape strategy.

"This project has been a great success, not only in its results but also in the truly international collaboration that made the project possible," said Dr. Mackill, referring to the several national organizations, including the Bangladesh Rice Research Institute, India's Central Rice Research Institute and Narendra Dev University of Agriculture and Technology.

"The potential for impact is huge," he said. "In Bangladesh, for example, 20% of the rice land is flood prone and the country typically suffers several major floods each year. Submergence-tolerant varieties could make major inroads into Bangladesh's annual rice shortfall and substantially reduce its import needs."

Using modern techniques that allow breeders to do much of their work in the lab rather than the field, Dr. Mackill and his team at IRRI were able to precisely transfer Sub1A into high-yielding varieties without

affecting the characteristics—such as high yield, good grain quality, and pest and disease resistance—that made the varieties popular in the first place.

"The impact is evident for farm families as well as at a national production level," said Dr. Ronald. "To be part of this project as it has moved from a lab in California to rice fields in Asia has been inspiring and underscores the power of science to improve people's lives."

Because plants developed through this "precision breeding," known as marker-assisted selection, are not genetically modified organisms (GMOs), the new Sub1 varieties are not subject to the regulatory testing that can delay release of GMOs for several years.

Once Sub1 varieties are officially released within the next 2 years, the key will be dissemination to smallholder farmers in flood-prone areas. IRRI is leading this initiative through a grant from the Bill & Melinda Gates Foundation and Japan's Ministry of Foreign Affairs.

Source: International Rice Research Institute

Citation: Rice: From genes to farmers' fields (2008, November 21) retrieved 23 April 2024 from <https://phys.org/news/2008-11-rice-genes-farmers-fields.html>

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