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Increasing productivity of direct-seeded rice areas by incorporating genes for tolerance of anaerobic conditions during germination

International Rice Research Institute (IRRI)

The challenge

Direct-seeded rice (DSR) is becoming increasingly popular in rainfed and irrigated ecosystems, mainly due to labour and water scarcities and the high costs involved in transplanting rice. Often, yields are low and unstable – especially in environments where erratic rainfall and poor water control lead to flooded conditions during and shortly after germination – given that modern rice varieties cannot survive complete submergence at this stage. The problem of poor crop emergence and establishment is further compounded by the invasion of weeds, especially weedy rice and red rice, as the young rice plants grow.

Our approach

The project has three main components which inclusively considered training, capacity building and gender diversity in all aspects:

a) Develop rice varieties that are tolerant of anaerobic conditions (AG) during germination by introducing single and pyramided QTLs for this trait into popular varieties.

b) Mapping additional QTLs from novel donors, functionally characterize selected major QTL(s), and develop molecular markers for more precise marker-assisted breeding.

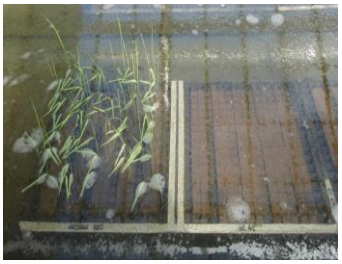
c) Improve crop establishment and weed control practices for direct seeded rice systems.

Project name	Increasing productivity of direct-seeded rice areas by incorporating genes for tolerance of anaerobic conditions during germination
Commissioned by	Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (BMZ)
Project region	Philippines, Sri Lanka
Lead executing agency	International Rice Research Institute (IRRI) Contact person: Endang M. Septiningsih e.septiningsih@irri.org
German cooperation	Max Planck Institute for Developmental Biology, Tuebingen
Duration	05.2013 – 04.2016

The benefits

a) Two varieties that tolerate anaerobic germination stress developed by pyramiding two major QTLs in two selected Sub1 lines (lines with tolerance to submergence during the vegetative phase).

b) One additional variety from each from the two partners (i.e. the Philippines and Sri Lanka), introgressed with two


L. to r.: The performance of IR64-AG1, NIL with a major QTL of AG tolerant coming from Khao Hlan On in the background of IR64, compared to its original variety, IR64 under AG stress field condition, The performance of a tolerant landrace Ma-Zhan Red compared to IR42 under AG stress green house condition, Rice flatsedge (Cyperus iria L.) infestation in irrigated dry-seeded rice fields in Killinochi, Sri Lanka

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anaerobic germination QTLs to enhance their performance under direct seeding.

c) Candidate genes for selected major QTL validated and gene-based markers generated.

d) New QTLs for flooding tolerance during germination identified and near isogenic lines (NILs) developed for future molecular breeding.

e) Improved crop establishment and weed control practices for lines that tolerate anaerobic germination stress tested at IRRI and the partner sites.

f) Two PhD students and personnel at two partner institutes – the Philippine Rice Research Institute (PhilRice) and the Rice Research and Development Institute (RRDI) in Sri Lanka – trained in advanced molecular breeding and the management of direct-seeded rice.

Expected impact

Expected outputs include: varieties tolerant to anaerobic germination stress; a deeper understanding of the molecular mechanisms controlling the tolerance of AG stress; additional QTLs from novel donors for additional breeding targets; sets of gene-based and flanking single nucleotide polymorphism (SNP) markers for highly precise marker-assisted breeding; optimal sowing densities and water control practices in combination with reduced herbicide application rates that will lead to high and stable yields; proper weed and crop management practices for the new tolerant rice lines; and management recommendations to enable maximum yields under direct seeding.

An expected long-term impact is that project outputs will be passed to farmers through the networks that our NARES partners maintain with IRRI and will help small farmers ensure food security and improved livelihoods through higher and more stable rice yields in stress-prone direct-seeded rice growing areas.

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