

Stress-tolerant rice for South Asia

Rice is a staple for the majority of the 1.7 billion South Asian population and a source of livelihood for more than 50 million households. The region cultivates rice on 60 million hectares and produces over 225 million tons of paddy.

Current paddy production in South Asia is more than 300% of what it was at the start of the Green Revolution. The majority of this production increase in the past five decades came from yield growth, with harvested area growing by only 20% from 50 million hectares in the late 1960s to 60 million hectares now.

However, rice production in the region is threatened by climate change. Climate change estimates predict the intensity and frequency of drought and floods will have a huge impact on rice production in the region. Some climate experts also believe that sea-level rise will increase the salinity of more rice lands along coastal areas of India and Bangladesh.

IRRI and its partners are developing rice varieties that can withstand severe weather conditions that are forecasted to be more frequent and intense with climate change.

Drought

Drought is the most widespread and damaging of all environmental stresses, affecting 23 million hectares of rainfed rice in South and Southeast Asia alone. In the eastern Indian states of Jharkhand, Orissa, and Chattisgarh, severe droughts occur about once in five years causing losses estimated at USD 800 million.

IRRI scientists have identified several key regions of the rice genome that give the rice drought tolerance and improve rice grain yield under drought. Field trials suggest that the average yield of drought-tolerant varieties over drought-sensitive ones is 0.8–1.2 tons per hectare in farmers' fields under drought conditions. These varieties are making drought-prone areas more productive and contribute to the food and income security for poor rural communities.

IRRI has developed and released 42 drought-tolerant varieties that are now being planted by farmers in several countries. These include Sahbhagi dhan, CR dhan 204 and 205, and DRR dhan 42, 43 and 44 in India; Sukkha dhan 4, 5, and 6 and Hardinath 3 in Nepal; and two BRRI dhan varieties in Bangladesh.

IRRI is currently developing varieties that combine drought and flooding tolerance, a few of which were released in India and Nepal.

Flooding

Flooding poses a grave threat to rice production in South Asia. Every year, around 6 million hectares of farmland in India, Nepal, and Bangladesh are flooded over a week, severely reducing productivity. Because rice plants die within days of being underwater, farmers in these areas, who mostly belong to the poorest of the poor, often suffer from total crop loss. In India and Bangladesh, flooding causes annual crop losses of up to 4 million tons of rice—enough to feed 30 million people.

IRRI and its collaborators developed rice varieties that carry the *SUB1* gene. The gene originated from a low-yielding traditional variety grown in limited areas in Odisha and enables rice to survive 14–18 days of complete submergence. Yields of 1–3 tons per hectare have been achieved with flood-tolerant varieties under flash flood conditions where farmers could not harvest other varieties. A recent study indicated that most marginal farmers





living in these flood-affected areas are benefiting from flood-tolerant varieties.

IRRI and other partners have introduced the *SUB1* gene into eight “mega varieties” grown in several rice-growing countries in South Asia. These include Swarna-Sub1, Samba Mahsuri-Sub1, and Ciherang-Sub1 in India and Nepal and BRRI dhan 51 and 52 and BINA dhan 11 and 12 in Bangladesh.

The use of these varieties are spreading fast over the last few years and are currently grown by more than 5 million farmers in Asia. In South Asia, seed multiplication and distribution of new flood-tolerant varieties is proceeding in Nepal, Bangladesh, and India in partnership with national agricultural research and extension systems.

Salinity

Rice productivity in salt-affected areas is very low, mostly at less than 1.5 tons per hectare.

Over 20 million hectares of land suited to rice production in Asia are currently either under exploited or unexploited because of excess salt and other related soil problems. The area is increasing because of rising sea levels and decreased flow in rivers caused by climate change.

Field trials of salt-tolerant varieties suggest a yield advantage of at least 2 tons per hectare compared with non-tolerant varieties in salt-affected areas. Salt-tolerant rice varieties also offer great potential to grow rice on marginal lands, which are usually left fallow particularly during the dry season because of high salinity. The area under this type of land is quite substantial—approximately 0.83 million hectares in Bangladesh and over 6 million hectares in India.

Salt-tolerance is being incorporated into popular rice varieties and released in countries across Asia. From 2009 to 2016, four salt-tolerant rice (CSR 43, CR dhan 405 and 406, and Gosaba 5) have been released in India. During the same period, nine varieties tolerant of salinity rice, including BINA dhan 8 and 10 and BRRI dhan 78, were released in Bangladesh.

Stress-tolerant varieties are being disseminated in India, Bangladesh, Nepal, Kenya, Tanzania, Mozambique, Nigeria, and Madagascar, and others through the Stress-Tolerant Rice for Africa and South Asia (STRASA) project. The stress-tolerant varieties are also anticipated to have significant spillover effects for non-participating countries like the Philippines, Cambodia, Lao, Indonesia, and Myanmar.

STRASA aims to raise yields in stress affected areas by 50% over ten years through improved cultivars and management, benefiting an estimated 18 million households in target countries.

For more information about flood-tolerant rice varieties, you may visit www.strasa.irri.org.



International Rice Research Institute

IRRI aims to improve livelihoods and nutrition, abolishing poverty, hunger, and malnutrition among those who depend on rice-based agri-food systems. In doing so, IRRI's work protects the health of rice farmers and consumers, and the environmental sustainability of rice farming in a world challenged by climate change. IRRI's work promotes the empowerment of women and supports opportunities for youth in an equitable agri-food system.

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