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Climate Smart Rice: Approach towards Climate Changing Global Scenario

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Climate change is affecting crop distribution and output, as well as posing new agricultural threats. Crop productivity has already experienced detrimental impacts, underlining the necessity of taking adaptive measures. Although, in few regions (mainly in temperate latitudes) may experience improved conditions for production. Globally, climate change is expected to reduce cereal production by 1% to 7% by 2060. Both the changing climate and growing population has been increasing the pressure on our food resources. The sustainability of feed able resources is looking difficult in present changing scenario of climate. Almost, more than half of the world's population that is near about 4 billion people eating rice as their staple food (Mohanty, 2014). But on another hand, the changing climate is making it tenacious for rice growing communities to maintain the productivity. Hence, there is an urgent need to make climate suitable genotypes to resist changing climate. CGIAR scientists from the International Rice Research Institute (IRRI) and Africa Rice, together with national research and agricultural extension system partners, have long tackled the problem through breeding to develop new, climate-smart varieties of rice. Their drought-, flood- and salt tolerant rice varieties are designed to adapt rapidly changing climatic conditions. Adoption of CGIAR's climate-smart varieties of rice, together with adjusted management practices, has led to significant increases in yield and sustenance of production in climate change stress-affected areas, including those inhabited by the most impoverished farming communities.

Conventional and marker-assisted breeding is used to incorporate specific desirable traits into rice plants, resulting in improved varieties that are more resilient to stresses and can survive unfavorable conditions made more intense and frequent by climate change. The breeding lines are then tested in several different locations and countries, including direct trials in farmers' fields. The selected lines- those proved to withstand stress and retain desirable grain qualities -are finally either released directly, or bred into widely grown and popular local varieties.

Drought-tolerant Rice

Drought is the most widespread and damaging of all environmental stresses, affecting 23 million hectares of rainfed rice in South and Southeast Asia. In some states of India, severe drought can cause as much as 40% yield loss, amounting to $800 million. IRRI has developed drought-tolerant varieties which have been released in several countries and are now being planted by farmers. These include Sahbhagi Dhan in India, the Sahod Ulan in the Philippines, and the Sookha (Sukkha) Dhan varieties in Nepal. Across these varieties, the average yield advantage of drought-tolerant varieties over drought-susceptible ones is 0.8-1.2

tons per hectare under drought. The scientists have identified several key regions of the rice genome called quantitative trait loci (QTLs) that give the rice drought tolerance and improve rice grain yield under such conditions.

Flood-tolerant Rice

Floods cause farmers in Bangladesh and India to lose up to 4 million tons of rice per year. CGIAR-released varieties carrying the SUB1 gene which makes rice plants better able to withstand complete submergence in water have shown an average yield advantage of 1-3 tons over original varieties, after floods lasting for 10-18 days. Some examples include the Swarna-Sub1 variety in India, Samba Mahsuri-Sub1 in Bangladesh, IR64-Sub1 in the Philippines, and Ciherang-Sub1 in Indonesia and Nepal, and FARO 66 and 67 in Nigeria.

Salt-tolerant Rice

Saltwater encroachment due to rising sea levels and lower rainfall threatens rice crops in coastal farming areas. In Bangladesh, salinity affects about one million hectares of arable land. CGIAR researchers at IRRI and AfricaRice have developed and released more than 20 salt-tolerant varieties, and have incorporated salt tolerance into popular rice varieties such as BRRI Dhan11, 28, and 29 in Bangladesh, as well as various varieties in India and West Africa. These salt-tolerant varieties have resulted in considerable increase and stability of productivity in salt-affected areas and, in some cases, led to expansion into areas previously abandoned because of high salinity.

Heat-tolerant Rice

Global warming has a significant effect on rice production. Though rice originates from the tropics, high temperatures of more than 35°C during the reproductive stage reduces rice production. Especially high temperature occurs when the rice plant flowers cause low seed setting and low yield production because rice plants are most sensitive at the flowering and ripening stages. The scientists are looking for rice that can tolerate high temperatures by screening of improved and traditional rice varieties. These donors are used in a crossing program to incorporate tolerance of high temperature into elite rice lines that are then tested for heat tolerance in 'hot and dry' and 'hot and humid' countries. Another mechanism for rice heat tolerance is early-morning flowering, which escapes the high temperature at midday. It was found that *O. glaberrima*, a wild species of rice, is a useful genetic source since it has a habit of early-morning flowering and high transpiration with sufficient water, both of which are convenient traits for avoiding heat stress.

Cold-tolerant Rice

Frequently occurring low temperature causes more than 50% yield loss. Cold tolerance is a complex trait controlled by many genes. The scientists have identified three regions of the rice genome that have a direct link to cold tolerance at the plant's reproductive stage. Cold stress at critical times of reproduction hinders the formation of fertile pollen that is crucial for fertilization and consequently the rice plant may fail to produce grains. IRRI's collaboration with South Korea's Rural Development Administration paved the discovery of a cold-tolerant breeding line called IR66160-121-4-4-2 that inherited cold tolerance genes from Indonesia's tropical japonica variety Jimbrug and northern China's temperate japonica variety Shen-Nung89-366. Using this line, crossed cold-tolerant and cold-sensitive rice lines and evaluated the progeny under two separate stress conditions - cold water in the field and cool air temperature in the greenhouse. After the experiment, they selected some promising cold tolerant lines that also have desirable spikelet fertility and early maturity traits.

Rice that Can Tolerate Poor Soils

Nutritional imbalances such as potassium and zinc deficiency and iron and aluminum toxicity are widespread in most rice production areas in Asia, Latin America, and Africa. Genetic donors for tolerance of these soil problems are being identified and used in breeding. Iron toxicity is a widespread growth constraint in lowland rice in Africa. IRRI has identified highly tolerant varieties or lines such as Suakoko 8 (*O. sativa*) and CG 14 (*O. glaberrima*). The Africa Rice Center (Africa Rice), IRRI's partner in the region, has facilitated the release of some improved varieties that are tolerant to iron toxicity.

"Cultivating climate smart rice varieties in unfavorable environments could boost local rice production. Recently, a new climate-smart practice is being developed, called "Climate Informed Rice Crop Low Emission" (CIRCLE). This can allow the RCM (Rice Crop Manager, a decision-making tool that can be accessed *via* smart phone or computer with an internet connection developed by IRRI) to collect information on climate adjusted crop yields, climate and environmental risks and low emission options for rice cultivation practices. Climate-smart practices unite numerous issues related to agricultural production in changing and adverse climatic conditions in the rapid era of development. Achieving the food security by proper adaptable climate smart practices pull the production system towards sustainability and improve the livelihood of marginal farmers across the world."

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