access to PGR. Whilst free-flow of germplasm has benefited agriculture for all countries, apprehensions about such unrestricted access have risen due to major advances in molecular biology, biotechnology and information technology along with the use of intellectual property regimes in these fields. Nevertheless, the search for new genes is an endless effort. In view of ever-changing world scenario, a country like India needs to have a balanced approach to harness the benefit of rich global agro-biodiversity through its technological competence in the larger interest of the nation. Recognising this, concerted efforts are needed on introduction of trait and crop specific germplasm, such as better malting quality germplasm in barley, better wine quality germplasm in grapes, resistant root stocks in fruits, diverse and wild germplasm in oil palm and temperate fruits, and sources of resistance to biotic and abiotic stresses and genetic stocks with specific desirable traits in various agricultural and horticultural crops.

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## INVITED PAPERS

# Plant Introduction and Rice Improvement for South Asia

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Rice is the single most important food crop and 90 percent of it is grown and consumed in Asia. During 1960s there were widespread concerns about the impending food crisis in Asia as rice yields were stagnant and population growth rates were accelerating. International Rice Research Institute (IRRI) was established in 1960 to apply science to problems of rice production. Germplasm conservation, evaluation and utilization received top priority from the beginning of the institute's research programmes.

Rice germplasm bank was established in 1961 through contacting national and international agencies in major rice producing countries. The international conferences held at IRRI and at Hyderabad, India in 1970 led the start of International Rice Collection and Evaluation Project (IRCEP). The outcome of these conferences was the agreement to coordinate and strengthen national efforts on field collection, evaluation and conservation on a systematic and international basis. By early 1980s the number of accessions in IRRI genebank rose to 49,027. The Assam Rice Collection from the Indian programme was a valuable addition to the IRRI genebank. Germplasm in IRRI genebank was continuously augmented and it has now 85,997 accessions of which 27,861 accessions are from South Asia. During 1980s IRRI undertook several exploration missions in Asia, Africa and Papua New Guinea to collect wild relatives of rice. IRRI genebank now contains 3,696 accessions of 21 wild species of *Oryza* besides 1,333 accessions of African cultivated rice *O. glabberima*.

Systematic characterisation of rice germplasm for a range of morphological and agronomic traits including resistance/ tolerance to biotic/ abiotic stresses was undertaken at IRRI. Similarly, the wild species have also been characterised and evaluated. IRRI germplasm is freely accessible and no IPR protection applies to germplasm held in the genebank in trust. A Material Transfer Agreement is used for exchange of germplasm from the collection under which recipients must also certify that they will not apply IPR to the germplasm accessions. Major resources have been devoted to develop improved germplasm with high yield potential, superior grain quality, disease and insect resistance and abiotic stress tolerance. Many donors from South Asia have been utilized in the genetic enhancement programme. Major improvement in the genetic yield potential of rice occurred through reduction in plant height by incorporation of a gene of short nature. The improved varieties are lodging resistant and responsive to fertilizers and have maximum yield potential of 9-9.5 tons per ha. Photoperiod insensitivity was the other important trait inherited mainly from Indian variety TKM6 that contributed in increasing the adaptability and yield stability in new varieties developed at IRRI. These short duration varieties have led to increased cropping intensity.

In the wet and humid tropics, the rice plant is subject to attack by diseases such as blast, bacterial blight, tungro and grassy stunt viruses. Several donor sources used in breeding programme resulted in development of breeding materials with multiple resistance. Many sources for disease resistance such as Ram Tulsi (India) for blast; TKM 6 (India), DZ 192 (Bangladesh) for bacterial blight; *O. nivara* (India) for grassy stunt, and Adday selection (India) and Habigang DW 8 (Bangladesh) for resistance to tungro came from Indian subcontinent. Similarly excellent sources of resistance to insect-pests like stem borers, plant hoppers, leafhoppers and gall midge have been identified and varieties with multiple resistance have been developed. Most of the sources of insect-pest resistance were from India, TKM 6 for striped borer resistance; Mudgo, MTU 15, ASD 7, Ptb 18 and Co 22 for brown planthopper resistance; Pankhari 203, ASD 7, ASD 8 and Ptb 8 for green hopper resistance, and Ptb 10, Ptb 18, Eswarakora and ARC 1368 for gall midge resistance. Several donors for brown plant hopper resistance such as Rathu Heenati and Babawee came from Sri Lanka. Improved germplasm with moderate level of tolerance to salinity has also been developed at IRRI using donors from India such as Pokkali, Getu and Nona Bokra, and some of the lines with salinity tolerance has been released in the Philippines As most of the donors for disease and insect-pest resistance from India used in breeding programme had high amylose, the improved varieties developed at IRRI have high amylose and long slender and translucent grains. These varieties are highly acceptable in Indian subcontinent. There is considerable emphasis for developing improved germplasm with aroma. Basmati rices and Pankhari 203 from India are the main donors for this trait in the breeding programme at IRRI.

IRRI germplasm has been extensively shared with the national rice improvement programmes. Seeds of donor varieties, early generation breeding materials, fixed elite lines and named varieties are sent to national programme scientists at their request and through international nurseries. The breeding materials have been sent to 87 countries irrespective of geographical location or ideology. These were evaluated for local adaptation and subsequently released as varieties and also used as parents in national rice breeding programmes. More than 300 IRRI bred lines have been released as national varieties in Asia, Africa and Latin America. About 80 varieties have been released in Indian subcontinent alone. The gradual replacement of traditional varieties by improved ones has had a dramatic effect on the growth of rice output in Asia. Since 1966 when the first high yielding variety of rice was released, the rice area harvested has increased marginally, from 126 to 152 million hectares (20%), while the average rice yield has increased from 2.1 to 3.9 tons per ha. (86%). The total rice production increased from 257 million tons to 600 million tons (133%). The increase in per capita availability of rice and a decline in the cost of production per ton of output contributed to a decline in the real price of rice both in international and domestic markets. The decline in food prices has, therefore, benefited the urban poor and the rural landless, who are not directly involved in food production but who spend more than half their income on food grains.

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# Achievements and Opportunities of Plant Introduction in India–The Case of Wheat

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The wheat and wheat types originated in Middle Eastern region. Modern wheat types such as bread wheat and durum wheat are now grown worldwide on about 200 million hectare area with an annual production of 590 million metric tons. There has been continuous movement and introduction of original landraces across the globe during the last 500 years. India's modern wheat breeding programme is based on large germplasm introductions from CIMMYT since early 1960s to date. A number of lines and sets of international trials have been