Importance of Rice Genetic Resources and Current Status of Rice Breeding and Cultivation in Korea

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Abstract The use and conservation of biodiversity are increasingly important concerns for society. We focus on the genetic diversity aspects of biodiversity as they pertain to the rice gene pool and its contribution to agriculture and our food supply. We review that the need and threats of biodiversity. There are two basic approaches such as ex-situ and in-situ for conservation strategies of genetic diversity of the rice gene pool. The main concern of breeders regarding rice genetic resources for plant breeding in future is to develop promising varieties with high yielding, functional performance, and sustainability over a range of environments by using genetic resources and widening gene pool through biotechnological approaches. Rice breeding in Korea during last three decades has made the tremendous progress in genetic yield potential and grain quality as well as stability of rice variety. Research on rice cultivation in Korea focuses on labor saving technology and production of high quality rice and environment-friendly technologies of low production cost.

Key word : Genetic Resources, Biodiversity, Rice Breeding, Korea

Introduction

Rice is the primary food grain consumed by almost half of the world's population. Rice yields have risen more rapidly than demand arising out of population and income growth. These gains have resulted from the development of new and more productive rice varieties based on the wide utilization of promising germplasms in the breeding program. The drastic increase of rice productivity was made possible by the genetic improvement of varieties and intensive cultural practices and the basic targets defined by rice breeding researches have been the yielding potential, high grain quality, and tolerance to biotic and abiotic stresses. However, research priorities have changed and new challenges emerged to meet the needs of farmers and consumers and to respond to socioeconomic and cultural changes.

The Importance of Rice Genetic Resources and Gene Pool

Rice is an economically important cereal crop, providing food for more than half of the world's population. There are two cultivated species of rice in the world, which are members of a group of more than 20 grass species included in the genus *Oryza* of the family Poaceae. Asian rice (*Oryza sativa*) had its origin in south and southeast Asia and is now cultivated worldwide, whereas African rice (*O. glaberrima*) was domesticated in parts of west Africa and remains locally important in some farming systems in those areas. In the thousands of years of selection by farmers to meet their widely diverse needs and in the process of dispersal since domestication, rice has formed a tremendously broad range of genetic diversity as reflected in the large number of varieties existing today. *O. sativa* is estimated to have more than 140,000 varieties, including primitive ones (landraces) and improved ones (Jackson 1995). These make up an important component of primary rice gene pool, which is necessary for further improvement of rice cultivars.

<The Need and Threats for Biodiversity>

The use and conservation of biodiversity have become a focus of concern for human society in recent decades. Biodiversity can be defined as the total diversity and variability among systems and organisms at the bioregional, landscape, ecosystem and habitat levels, at the various organismic levels down to species, populations and individuals, and at the level of the population and genes (Heywood 1995). Crop genetic diversity is the basis of our food supply and therefore the basis of our survival. This is true of an agricultural subsistence-based society or market-integrated, technologically advanced one. Genetic diversity allows farmers and plant breeders to adopt a crop to heterogeneous and changing environments and to provide it with resistance to pests and diseases. Large areas planted to a single variety or a few cultivars with a similar genetic background can be especially vulnerable to pests, diseases and severe weather (NRC 1993). The development of new modern rice varieties has depended on the continued availability of genetic diversity. The main source of this diversity is the traditional varieties that have been grown and selected for generation by rice farmers of the world. All modern varieties can be traced back to landraces. Wild species also represent a rich pool of diversity particularly for their ability to withstand pests and diseases. They have made an important contribution to rice improvement. New biotechnology tools promise to increase the usefulness of genes of wild relatives for rice improvement (Khush et al. 1994). In addition, wild rice species are useful in basic research. The widespread adoption of modern rice varieties, together with modern input such as fertilizers, pesticides and the development of irrigation have contributed to an increased food supply and a decline in real rice prices (Hossain 1995). But these changes have also contributed to the loss of genetic diversity. This loss, also known as genetic erosion, has been recognized as a problem since 1960s. It has been more formally defined as the loss of genes from a gene pool attributed to the elimination of populations caused by factors such as the adoption of high-yielding varieties, farmers' increased integration into the market, and land clearing, urbanization and cultural change. The reduction of genetic diversity on farm may increase the vulnerability of rice to major disease or pest outbreaks. This vulnerability may be enhanced by double cropping large tracts of modern varieties in the tropics and subtropics. Threats to rice genetic diversity are related not only to the adoption of modern varieties but also to the loss of farming systems where some of this diversity has evolved.

Conservation Strategies

The need to conserve the diversity of the rice gene pool has been recognized as important for many decades, particularly given that genetic erosion has occurred and continues to take place. There are two basic approaches such as ex-situ and in-situ conservations. Ex-situ conservation includes activities of collecting seed samples of cultivated or wild species from the original sites and then storing the samples in gene banks. This conservation is a safe and efficient way of conserving rice genetic resources and has the advantage of making the germ plasm readily available for use by breeders and for study by researchers. The main activities of national genetic resources program are the collection, conservation, characterization, evaluation, and distribution of rice varieties and wild species. Seeds placed under ex-situ conservation in a gene bank become isolated from the natural environment where they originated. In evolutionary terms, ex-situ conservation is static. Concerns have been raised regarding the observation that static conservation may decrease the adaptive potential of crops and wild species populations in the future. Thus, ex-situ conservation cannot be considered as the only approach for conserving genetic diversity of the rice gene pool. Therefore, dynamic approach such as in-situ conservation is also necessary. According to Frankel *et al*. (1995), in-situ conservation should meet three criteria such as survival of species/population, maintenance of the evolutionary potential and, for wild relatives, of the primary gene pool and the development of new genotypes. If the annual *O. rufipogon* and *O. nivara* grow close to cultivated *O. sativa*, they can exchange genes, spontaneous hybrids between wild and cultivated species will be occurred, and natural introgression is likely.

Current Status of Rice Breeding and Cultivation in Korea

Rice breeding in Korea during last three decades has made the tremendous progress in genetic yield potential and grain quality as well as stability of rice variety. Through incorporation of the semi-dwarf genes for short stature by remote-cross between indica and japonica, short stature contributed to improvement in harvest index which was the single most significant architectural changes in the rice varieties, which led to the green revolution in Korea. Yield potential of latest rice cultivars increased to about 41-43% in both japonica and Tongil type rices as compared with those of earlier developed japonica and Tongil varieties. Several other traits such as photo-insensitivity, disease and insect resistance and tolerance to some abiotic stresses such as cold damage, resulted in the increased adaptability and yield stability of domestic rice varieties. Especially japonica rice cultivars were largely improved in canopy architecture, lodging tolerance, resistance to major pests and environmental stresses. Varietal improvement for adaptability to different ecosystem also showed considerable progresses. There was also a significant progress in breeding system and selection technologies especially on the following areas : the modified conventional breeding system with rapid generation advancement, establishment of the efficient screening system for resistance to major disease and insect pests and evaluation of grain quality. Successful application of another culture techniques greatly contributed to rice breeding program through shortening breeding period from 10-12 to 5-6 years of a rice variety. Interspecific hybridization and molecular breeding system utilizing DNA markers has been pursued with some progress.

Research on rice cropping in Korea focuses on labor saving technology and production of high quality rice, and environment-friendly technologies of low production cost. Changes of rice plant cultivation technology are manual transplanting at 1960-1970's, mechanical transplanting of 30-day seedlings at 1980's, mechanical transplanting of infant seedlings at early 1990's, direct seeding at middle late 1990's, environment-friendly cultivation at 2000's. Rice is mainly transplanted by human hand up to 1970's in Korea. However, machine transplanting was introduced in 1977 and the proportion increased rapidly year by year. Finally, machine transplanting became common cultural practice nowadays in Korea. Actually, almost all rice farmers have adopted the machine transplanting except those favoring direct seeding. Harvesting rice plants and threshing panicles are really hard works to do with human power. For the agricultural works, sickle and man power thresher were mainly used up to 1970's in Korea. However, several kinds of implements such as binder, power thresher and combine were developed and nowadays combine is widely used for harvest in Korea.

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