Japan Academy Prize to:

Kazuyoshi TAKEDA
Professor Emeritus, Okayama University

for "Establishment of the Cereal Bioresource Genetics and Contribution to Its Application"

Outline of the work:

Crop production has been greatly increased over the last century owing to remarkable improvements in cropping and breeding technologies. Due to rapid population increase and aggravated environmental deterioration, food shortages, nevertheless, as a serious unsolved problem in the 21st century. One promising approach to solving this problem is the creation of new gene sources by collecting evaluating and developing genetic resources, combined with new breeding strategies, including molecular breeding technology. Dr. Takeda conducted a large-scale collection and evaluation of the cereal germplasm, of barley in particular. He investigated its variations and the genetic basis of its agronomic traits. Discovering and creating new gene sources, he was successful in devising practical uses for some of them. Thus, he has contributed to the establishment of Cereal Bioresource Genetics and its practical application.

1. Collection, evaluation and development of barley germplasm

Over the past 20 years, Dr. Takeda has been responsible for managing the Barley Germplasm Center, Okayama University, which is the core institution for barley germplasm conservation in Japan. During this period, the Center added about 6,000 new barley accessions to the previous collection of about 4,000.

Dr. Takeda investigated the various characters of those accessions, including semi-dwarfism ("uzu" character), sensitivity to the insecticide diazinon, thermostability of β-amylase, and presence/absence of polyphenol oxidase and lipoxygenase (abbrev. LOX), and he clarified the chromosomal locations and geographical distributions of the genes for those characters. Two noteworthy achievements are his elucidation of the nature of the *uzu* gene and the discovery of lipoxygenase 1-deficient mutants, leading to success in breeding a LOX-less malting barley cultivar.

2. Studies on genetic mechanisms controlling agronomic traits of cereals

Dr. Takeda investigated genetic mechanisms that control various agronomic traits of cereals, mainly by statistical methods in the earlier period of his research and by QTL (quantitative trait locus) methods in the later period. His main achievements are as follows: (1) Studying six different short-straw mutants of rice, he found that the use of a semi-dwarf gene reducing the lower than higher internode length is preferable for breeding a high-yielding semi-dwarf cultivar. (2) By screening about 4,000 to 7,000 barley accessions, he found new genetic resources for Fusarium head blight resistance (23 accessions), salt tolerance (202 accessions), and deep-seeding tolerance (11 accessions), valuable for future barley breeding. Using the resistant and sensitive accessions for QTL analysis, he determined the number, chromosomal locations and closely linked molecular markers of the QTL loci that are responsible for those stress responses. (3) In his investigation conducted at Ames, Iowa, he

analyzed the genetic relationships between grain yield, biomass, harvest index, and the growth rate of 80 backcross populations of hybrids between wild and cultivated oats and demonstrated that the growth rate is more important than the harvest index for yield increase. This finding gave rise to a controversy on the contemporary dogma of the supreme importance of harvest index to yield increase.

3. Breeding barley and wheat lines adapted to strong acidic soils in the lower reaches of Yellow River, China

From 1988–1999, Dr. Takeda engaged in a project to breed wheat and barley lines adapted to the semi-arid Loess Plateau, in collaboration with the Northwest Institute of Soil and Water Conservation, Academia Sinica. In this work, he employed about 1,100 accessions of barley, wheat, and their relatives, but ended with no promising results. From 1990–2000, he couducted another project to breed wheat and barley adapted to the strong acidic soils of the Sanhe Plain in the lower reaches of the Yellow, Huaihe, and Haihe Rivers, in collaboration with the Shijiazhuang Institute for Agricultural Modernization, Academia Sinica.

Bulding upon his experiences in the Loess Plateau, Dr. Takeda decided to start this work with ten times more genetic resources (1,548 wheat and 8,704 barley accessions) than in the previous one. Also, the selection method was modified to “block unit selection,” taking into account the great variation in soil conditions. Namely, the selection field was partitioned into small blocks, in each of which seeds of different accessions were mix-planted and the well-performing individuals selected from each block in the first two cycles of the selection. As the results, three promising barley lines and three wheat lines (A115 with high stress resistance, A132 with high yield, and A69 with high baking quality) were obtained. Of those, the wheat line A115 out-yielded the check cultivar at all salt concentrations up to 0.8 % salt in the soil. After two years of yield trials, this line was approved as a commercial wheat cultivar by Hebei Province in 2000. This cultivar provided a 10–18 % yield increase in five years after its release in Nanpi County, Hebei Province. The Shijiazhung Institute for Agricultural Modernization honored Dr. Takeda for his contribution with the title of Honorary Professor in 2000.