Never Ending Race for Genetic Variants

Rice yields have improved markedly through the use of novel varieties. New variants are now needed to avoid disaster sown in past successes

The International Rice Research Institute (IRRI) received notification at the end of October that its newest rice variety, IR58, has been recommended for release in the Philippines, the institute's host country. Like its predecessors, IR58 has been bred for high yield, resistance to diseases and pests, and tolerance to a range of hostile growing conditions. In addition, the new variety has the clear benefit of maturing in 95 to 100 days, which is 10 days faster than its most successful forerunner, IR36.

Although the accelerated growth rate is undeniably important, because under favorable circumstances it can allow multiple cropping, the chief advantage of IR58 is the novel makeup of the genetic package that confers disease and pest resistance. "It is difficult to develop a variety which has a useful life of more than 5 to 6 years in the tropical environments," says Monkombu Sambasivan Swaminathan, who recently took over from Nyle Brady as IRRI's director general. "Because of the year-round cultivation of the rice crop, disease and insect organisms occur in overlapping generations. There is therefore a greater likelihood of the origin of new races or biotypes." IR58, in common with a number of new varieties developed recently at IRRI, derives its resistance characteristics from a set of genes different from those in IR36. Its use will therefore expand further the genetic diversity of the high-yielding strains that now form so important a part of this major world food crop.

"Expansion of genetic diversity is now a crucial part of our efforts," explains Swaminathan. "Since its introduction in the late 1970's, IR36 has become extremely important. This year in Asia it is planted in an estimated 11 million hectares out of a total rice planting of about 150 million hectares. Because of its high yield, IR36 represents an even greater proportion of crop produced. Although IR36's resistance to pests and diseases has held up until now, there are signs that it is being threatened. A new virus disease, ragged stunt, and another unknown virus, provisionally referred to as wilted stunt, appear to be affecting IR36 in some areas. The race between the pathogen and the plant breeder is a continuous one."

Swaminathan was in Washington, D.C., for a meeting at the World Bank of the Consultative Group for International Agricultural Research (see this issue, page 866), of which IRRI is part. The institute was presented with the consultative group's first King Baudouin International Agricultural Research Award for its development of IR36, "the most widely grown rice in the world." Commenting on the importance of the international nature of the work, Swaminathan said, "There would have been no IR36 had there been no IRRI. Equally, there would have been no IR36 had there not been a collaborative network of rice scientists working in different countries as members of a well-knit family."

IR36 has an extensive pedigree and was derived from crossbreeding 13 parents from six countries—India, Indonesia, China, Vietnam, the Philippines and the U.S. Not only does IR36 have an international mix of genes, but its development also depended upon exposure to major diseases and pests in several different countries where the challenge would be most severe. "This approach has opened up new frontiers in crop improvement research," says Swaminathan. (See also this issue, p. 847.)

IRRI began its work in 1962 and four years later released its first semi-dwarf, high-yielding variety, IR8, which provided inspiration for the much vaunted "green revolution." The revolution with IR8 proved to be premature, partly because it was susceptible to a wide range of diseases and pests and partly because of the poor quality of the grain. The breeding, which involved a simple two-parent cross, had concentrated on quantity, not quality. Serious setbacks in the form of bacterial blight outbreaks in 1968 and 1969 and tungro in 1970 and 1971 inspired further the search for resistant varieties.

Starting with IR8, extensive crossbreeding and intensive selection eventually led to IR36, the first improved rice variety to have multiple resistance to all the major diseases and insect pests. On the way to IR36 a series of intermediates was produced and released, each with a greater spectrum of resistance than its predecessors. IR36 can now withstand assault from bacterial blight, blast, grassy stunt, tungro, green leafhopper, brown leafhopper, stem borer, and gall midge. Resistance to each of these was acquired through selective breeding with proved varieties and the screening of tens of thousands of progeny. Interestingly, one of the parents was a species of wild rice, *Oryza nivara*, from India which turned out to be the best source of resistance to grassy stunt.

Since its first introduction into farmers' fields in 1977, IR36 has become exceedingly successful and popular, so much so that in many areas it represents a virtual monoculture. Hence the danger of disaster when resistance breaks down, as it inevitably will. With a crossing rate now running at around 5000 per year, IRRI has been able to generate potential replacements for IR36. For instance, the Philippine Seed Board recommended IR50, 52, and 54 for release in 1980 and IR56 in June this year. The release last month of IR58 is the latest in this production line of essential genetic variants.

Without a wide range of genetic stock upon which to draw, IRRI would be unable to pursue its continuous search for variability underlying resistance to the major diseases and pests. Currently there are an estimated 120,000 rice strains throughout the world, of which IRRI has representatives of 60,000 in its germ-plasm bank. The institute plans to have all 120,000 strains in its possession by 1985. "This is essential for preserving for posterity the fruits of thousands of years of natural and human selection," says Swaminathan. "In research there is no time to relax. Eternal vigilance is the price of good and stable agriculture."

—ROGER LEWIN

Edwin G. Huffman/World Bank

Use of rice variants spreads

A quarter of Asia's rice derives from variants developed at IRRI.

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