PLANT BREEDING

Hopes Grow for Hybrid Rice To Feed Developing World

U.S. company builds on successes in China as improved techniques and better management deliver higher yields

LOS BAÑOS, THE PHILIPPINES—Sant Virmani, who heads hybrid rice–breeding efforts at the International Rice Research Institute (IRRI) here, remembers when the number of scientists interested in the subject could fit into his living room. But this month, organizers of an international conference marking the 40th anniversary of IRRI* had to fold back a room divider and bring in more chairs to handle the throng that gathered to hear his talk.

That heightened interest reflects the growing number of researchers who hope that hybrid rice will help feed the billions of people who rely on the crop. "Hybrid rice is really the only [technique] at hand that has proven to boost yields in farmers' fields," Virmani says.

Although rice breeders have created improved, higher producing rice varieties, they haven't been able to take advantage of a natural phenomenon that jacks up the yields of grains such as corn. Thanks to an imperfectly understood effect called heterosis, the first generation, or F1, hybrid of a cross of two different varieties grows more vigorously and produces from 15% to 30% more grain than either parent. But because rice is self-pollinating, with each plant producing its own fertilizing pollen, producing hybrid rice was commercially impractical. Now, 3 decades of effort has produced hybrid rice varieties and commercially viable methods of producing the hybrid seed. "Finally, hybrid rice is ready to take off," Virmani says.

Such a jump is needed because increases in rice yields have leveled off in the 1990s, while the population continues to grow. But others counsel caution. They warn that the quality of the hybrid rice hasn't yet matched that of current varieties and that growing hybrid rice requires changes in farming practices, in particular, the purchase of new seeds for every growing season. "Hybrid rice is not a success story—yet," says Wayne Freeman, a retired agronomist who formerly oversaw The Rockefeller Foundation's food programs in India.

The road to the current progress has been long and arduous. In the late 1960s, Chinese researchers discovered a wild male sterile rice variety. Because male sterile plants don't produce pollen of their own, that allowed researchers to fertilize the plants with pollen from other varieties. Not all crosses work, however. Some produce lots of vegetation but little grain. Yuan Longping, director of China's National Hybrid Rice Research and Development Center in Changsha, Hunan Province, has spent 2 decades working on breeding this male sterility trait into the indica rice varieties grown in China and improving seed-production techniques. Hybrid rice now covers about 50% of China's rice acreage and accounts for 60% of production.

Tech transfer. RiceTec's Robin Andrews, left, has adapted the hybrid rice techniques pioneered by China's Yuan Longping, far left. Hybrids can yield 30% more rice.

For a long time, however, China was the exception. Its success rested on its vast pool of cheap labor and heavy government subsidies. Producing hybrid seed requires growing the male sterile line together with a second parental line, which provides the pollen. Large teams of Chinese workers spray the male sterile plants with a growth hormone that induces the panicles, or grain clusters, to emerge from the rice leaf sheath to catch pollen more easily. The pollen has to be shaken loose from the second line by workers dragging ropes or sticks over the plants. In a separate area, the male sterile line must be grown alongside a third line, which provides pollen to reproduce the male sterile line for the next seed-growing season.

However, the lure of potential payoffs has proven irresistible. A hybrid rice project launched by the Indian Council of Agricultural Research has boosted yields from less than 100 kilograms per hectare to about 1.5 metric tons through a painstaking trial-and-error breeding effort that involved more than 1000 experimental hybrid lines. Commercial cultivation began in 1994, and some 150,000 hectares are now planted in hybrid rice. Hybrid rice is also being grown in Vietnam and the Philippines, and scientists in Bangladesh, Sri Lanka, and Indonesia are developing hybrid rice varieties for farmers.

In the United States, an effort in the 1980s by a subsidiary of Occidental Petroleum Corp. fell flat. But in the early 1990s a company controlled by the prince of Liechtenstein picked up the rights to use the Chinese hybrid techniques and plant materials and underwrote a research program by RiceTec Inc. of Alvin, Texas, to commercialize the technology. In addition to transferring the male sterility trait into varieties suitable for the United States, RiceTec has mechanized the seed-production process to eliminate the hand labor used in China. "We are doing with just two workers what the Chinese are doing with 100," boasts Robin Andrews, company president, who says that the details are proprietary. Last year, field trials in Arkansas and Missouri produced hybrid plots with an average yield 33% greater than a variety of the farmers' choice. As a result, says Andrews, "every one of the farmers who participated in our trials has bought seed to plant this year."

Farmers in other parts of the world remain to be convinced that hybrid rice is better, however. A small study in India by Aldas Janaiah, an agricultural sociologist at IRRI, found that actual harvests often fell short of projected yields and that most farmers do not plan to plant hybrid rice again. And Virmani admits that hybrids require farmers to monitor fertilizer applications more closely and take greater care of the transplanted seedlings. Breeders also need to improve the quality and taste of hybrid rice.

Still, Virmani believes that the growing cadre of researchers around the world will eventually solve those problems. "Ten years ago you couldn't get even 20 people interested in talking about hybrid rice," he says. "Hybrid [rice] research efforts are really just getting started." **–DENNIS NORMILE**

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* Rice Research for Food Security and Poverty Alleviation, 31 March to 3 April.