Hybrid Rice Technology

new developments and future prospects

SELECTED PAPERS FROM THE
International Rice Research Conference

Edited by **S. S. Virmani**

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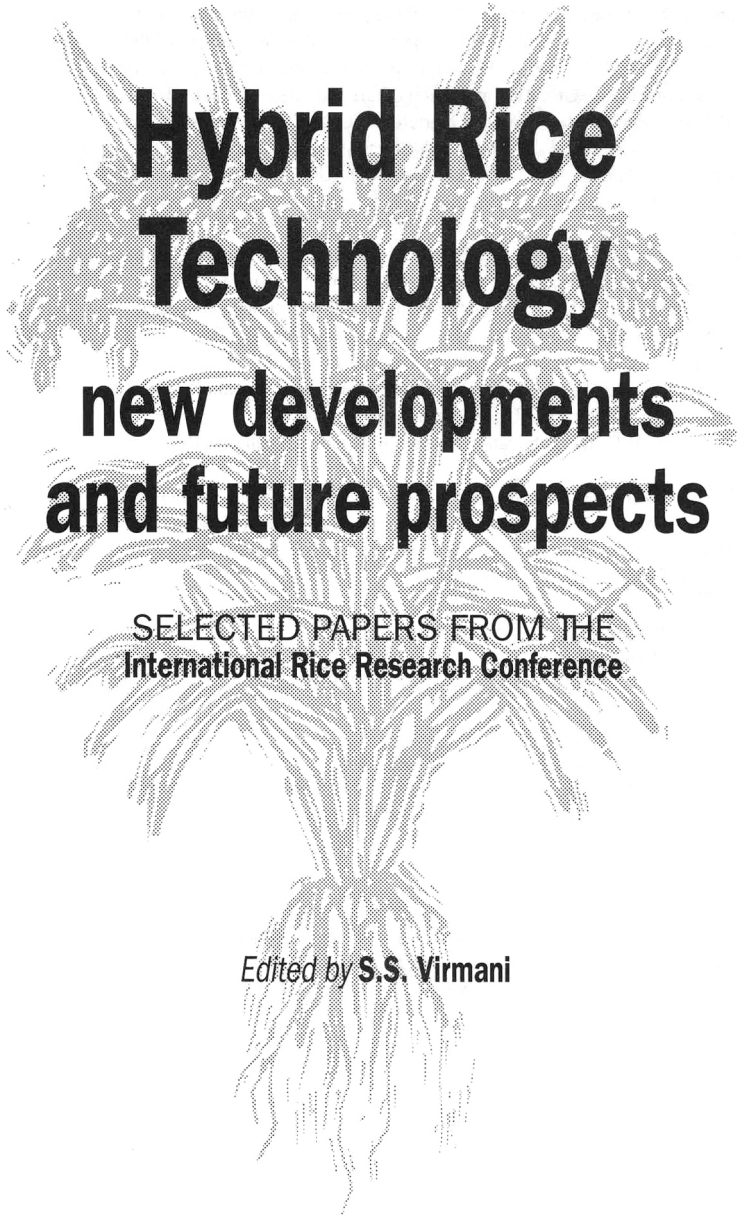

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Hybrid rice research in Brazil

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Hybrid rice has great prospects in Brazil. The first hybrid varieties are intended for release in irrigated areas, where 49% of Brazil's rice is produced. The technological level of the farmers (which results in average yields of 4.8 t/ha), the good infrastructure for seed production and distribution, and the expected improvement in the economical productivity of hybrid rice provide a good basis for developing hybrid varieties. The National Research Center for Rice and Beans is developing a hybrid rice breeding program based on the three-line method, using the wild abortive cytoplasm and the long stigma trait transferred from *O. longistaminata* A. Chev. to improve cross fertilization. The first set of identified maintainer lines are being sterilized, the combining ability tests will be done soon, and hybrid rice varieties probably will be released in the next 5 yr. To improve the available variability for varietal creation in the future, a reciprocal recurrent selection scheme has been started.

The Chinese seed production system is highly labor-intensive, so it is not economical in countries like Brazil, where rice production is fully mechanized. Therefore, an alternative technology must be developed.

Average yield of upland rice in Brazil is low (1.4 t/ha), although the climatic conditions are favorable for this crop. It is possible to increase this yield through suitable cultural practices. Average yield of lowland rice is about 4.8 t/ha. Taillebois and Guimaraes (1987) have observed F_1 hybrids with yield heterosis of about 25% over traditional varieties, so yield potential could be increased through hybrid breeding.

The National Research Center for Rice and Beans (CNPAF/EMBRAPA) is developing a research program for irrigated lowland areas with the objective of developing improved male sterile parental lines with long stigmas to increase outcrossing rate and permit hybrid seed production at a lower cost.

Irrigated and rainfed lowland rice cultivation systems in Brazil

Total rice production in Brazil averaged 10.2 million t/yr over the last 5 yr. Irrigated rice contributed about 49% of this. Approximately 5% of total production came from rainfed lowland conditions. About 23% of the total rice area in Brazil is under these two systems, the rest is under upland conditions.

The irrigated lowland cultivation system covers about 1.07 million ha, concentrated mainly in the southern region of the country. Direct mechanized seeding is practiced in 90% of this area. In the states of Rio Grande do Sul, about 766,000 ha are planted, and the most commonly planted cultivars are IRGA409, IRGA410, IRGA412, and IRGA414. Seeding is done with pregerminated seeds in the 104,000 ha of the state of Santa Catarina, where Cica8 is the prevailing cultivar. The other important areas for irrigated rice are the west-central and northern regions, with about 102,000 ha, mostly planted with cultivar Metica 1. Rainfed lowland areas are concentrated in the southeast, where Cica8 is the prevailing cultivar on an area of about 120,000 ha.

The climatic conditions vary from region to region, but this variation is less in areas where the irrigated lowland system dominates. This explains the broad geographic distribution of some cultivars. The exception is the state of Rio Grande do Sul, where the low temperatures in the autumn season favor cultivars with short cycles.

Based on the importance of irrigated rice in Brazil, the technological level in this system, and the prospect of greater economic returns through hybrid rice technology, the CNPAF gave top priority to the hybrid rice program.

There is good infrastructure for seed production and distribution in irrigated lowland regions of Brazil. In these regions, several national and international enterprises are now working with hybrid maize. Some of them are also working with vegetable hybrids. This kind of experience will be useful for hybrid rice development.

Research program for the development of hybrid rice at CNPAF

The CNPAF began its research on hybrid rice technology in 1984, concentrating on the irrigated lowland system. The work involves improving parental lines based on the three-line (A, B, and R) hybrid breeding system using short- and long-term breeding strategies.

Short-term strategy of hybrid rice breeding

The A, B, and R lines are being obtained through the identification of maintainer and restorer plants among existing Brazilian cultivars or fixed lines proceeding from the conventional breeding program.

All available purelines are crossed with a restoration tester carrying wild abortive (WA) male sterile cytoplasm. Maintainers and restorers are identified by F_1 fertility rate and anther characteristics. The A/B lines are being produced by backcrossing the long stigma trait transferred from *Oryza longistaminata* A. Chev. and the WA male sterile cytoplasm in the maintainer plants. Some indica lines are at the first cross cycle for WA male sterile cytoplasm, following introduction of the long stigma trait.

The combining ability of A and R lines will be tested for yield and other traits of economic importance. Good combining A and R lines will be used to develop heterotic rice hybrids.

Long-term strategy for hybrid rice breeding

CNPAF will apply a recurrent selection scheme to broaden the genetic variability among parental lines of the hybrids. The recurrent selection has already been applied by using genetic male sterile mutants of IR36 (developed at IRRI by Singh and Ikehashi [1981]) to develop composite breeding populations. Two populations, CNA-IRAT4 M and CNA-IRAT4 R, were formed after identifying and intercrossing maintainer and restorer plants from the CNA-IRAT4 population into the two respective groups (Taillebois and Neves 1989). To broaden the genetic bases of these male and female populations, a collection of maintainer and restorer lines was introduced. The long stigma trait was introduced into the female parent. Average intercrossing rate is 34% in the CNA-IRAT4 population after four recombining cycles, and observations show that it is possible to select for this character.

The reciprocal recurrent selection scheme used in half sib families (Neves et al 1990) will help improve the combining ability among the two populations. The allogamy characters will be improved in the maintainer population and restoration ability will be tested and selected in the restorer one.

Four generations, or 2 yr, are necessary to complete one cycle of recurrent selection. Hybrid parental lines will be created at each cycle by pedigree selection on the "per se" performance. The long stigma trait will be selected in early generations. Restoration ability will be tested on inbred lines and maintainer plants sterilized by WA cytoplasm. The tests of combining ability and restoration will be done during the normal cropping season.

Considering the progress of research, we expect that the first set of rice hybrids for Brazil will be released by 1997.

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Notes

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