



Hybrid rice – the next generation

Bayer CropScience's hybrid rice is known for its especially high yield potential. A new variety from the Arize product range also has an important, additional characteristic: Arize Dhani is resistant to bacterial leaf blight.

In 2008, Indian rice farmers were able to benefit for the first time from a new option for protecting their crops against attack by the bacterial pathogen *Xanthomonas oryzae*. Arize® Dhani is the name of the new variety that Bayer CropScience has just brought onto the market in five Indian States. This is the world's first hybrid rice with greater than 95 percent

resistance against all known races of bacterial leaf blight.

Bacterial leaf blight is a particular problem in the eastern Indian states, especially Chhattisgarh, West Bengal and Orissa. "A total area of about six to seven million hectares is affected here", explains Arun Mittal, rice-product manager of Bioscience in India. BioScience is the Bayer Crop-

Science Business Unit that specializes in the development and production of varietal seed.

The rice-growing area affected by bacterial leaf blight corresponds to about 15 percent of the total Indian crop. Depending on the severity and timing of infection, harvest losses of between 20 and 60 percent can occur, according to Mittal. In fact,



A technician at the Bioscience site in Ghent, Belgium, removes seeds from a rice plant.

ance genes from the naturally-occurring varieties together into the optimal combination. They did this through advanced breeding, using molecular markers. The comprehensive resistance thus achieved was then brought together with a strong yield potential using well-proven hybridization technology. Like Bayer CropScience's other hybrid rice varieties, Arize Dhani has a yield potential that is 20 to 30 percent higher than that of conventional rice varieties.

Its yield advantage over conventional varieties is even greater under conditions of infection by bacterial leaf blight. "When the disease hits, farmers who use Arize Dhani can produce up to 80 percent more yield than their neighbours using classical varieties", says Arun Mittal. Arize Dhani will therefore help farmers operating in areas threatened by the disease to achieve greater income security. It's no coincidence that the product is called "Dhani": this Hindi word is used to describe a "rich person".

Market leader in hybrid rice

Arize Dhani is already the eighth hybrid rice variety that Bayer CropScience has introduced in India. All of these products are characterized by an especially high yield potential. The availability of such a large

bactericidal agents are available for use against bacterial leaf blight – but none of them has proven effective enough to date. In developing Arize Dhani, Bayer CropScience has taken advantage of the fact that nature already presents us with rice varieties that are partially resistant to bacterial leaf blight. Breeders tested the resistance properties of such varieties against

various isolates of *Xanthomonas oryzae* that had been collected for the purpose from locations throughout India. Their investigations showed that none of these varieties possessed resistance that was effective against the entire spectrum of bacterial leaf blight isolates occurring in India.

In order to create a variety that achieved just this, the breeders brought the resist-

number of different products can be explained in terms of differences in the properties they possess, such as the rice's grain shape and size, and aroma; it also has to do with adaptability to local climatic conditions.

Arize Dhani is the first hybrid rice that offers the additional benefit of broad resistance to bacterial leaf blight. As a global leader, Bayer CropScience plans to continue to bring further second-generation hybrid rice varieties of this type onto the market. These varieties deliver a double benefit: high yield potential combined with, for example, resistance to a particular pest or to other types of stress.

Bayer CropScience is market leader in the hybrid rice market in India. However, hybrid rice currently accounts for only two percent of the Indian rice cultivated area.

Increasing this proportion would be a way of increasing the productivity of Indian rice cultivation, which is clearly lower than in other countries "India is only in 16th place in terms of rice productivity", says Frédéric Arboucalot, Global Manager of Bayer CropScience's rice seed business. The comparison with the People's Republic of China – the other country confronted with the need to feed a population of more than a billion – is telling. With 44 Million hectares, India's area under cultivation is one and a half times bigger than that of China; nevertheless, Chinese farmers harvest considerably more rice. In 2006, the figure was 184.1 million tonnes for China, compared with only 136.5 million tonnes for India. Productivity in China equated to more than six tonnes of rice a hectare, compared with just over three tonnes a

hectare in India. Hybrid rice was introduced into China as early as the 1970s, and it is now grown on more than half of the area under rice cultivation.

Increasing demand for rice

In an article for Rice Today – the house magazine of the International Rice Research Institute (IRRI) in the Philippines – at the beginning of 2008, the IRRI researcher Dr. Sushil Pandey predicted that the demand for rice will continue to rise in coming years. In fact, an additional 50 million tonnes will be needed by 2015; Asia alone will account for 38 million tonnes of this. For comparison: the total global rice harvest in 2006 was around 635 million tonnes, according to FAO-figures.

The main reason for the anticipated increase in demand is strong population growth. In India, the population has been increasing by 1.7 percent a year on average. The UN forecasts that it could climb from 1.10 billion (2005) to 1.26 billion by 2015. A further increase is also expected in China – despite the "one child policy" – to 1.39 billion people by 2015. According to the demographers' forecasts, the whole of Asia could have a population of 4.35 billion inhabitants by then; in 2005, the figure lay at 3.91 billion. In other words, an eleven percent increase in ten years.

The major part of the required increase in production must come from an improvement in the yield per hectare, points out Dr. Pandey in his Rice Today article, because there is no capacity for extending the area under cultivation. In China, the rice-growing area actually declined by three million hectares between 1997 and 2006. The reason: rice farming is increasingly in competition with other forms of land use.

This increase in productivity will be achievable primarily through the development and distribution of improved technologies, according to Dr. Pandey. This is, at the same time, the only possibility of avoiding a further, rapid increase in the price of rice.

New Rice Research Laboratory in Singapore

Among these technical solutions will be new possibilities for crop protection, as well as seed with improved yield potential. In order to bring forward this type of development, Bayer CropScience is investing five million Euros in its new Rice Research Laboratory in Singapore. The Institute began its work in June 2008, and it



What is hybrid rice?

Hybrids are produced by crossing two different parental plant lines. Under this approach, one of the lines is deliberately sterilized to prevent the usual process of self-pollination. The plants, which are then purely female, receive pollen exclusively from plants of the second parental line growing in the immediate vicinity. In this way, the genetic material of the two lines is combined, and the female plants produce the hybrid seed.

Targeted choice of the two parental lines allows to produce hybrids with specific, desirable properties: for example, a particularly high yield potential. In fact, finding suitable parental lines is an expensive and protracted process. Bayer CropScience develops the lines it needs in India, Brazil, USA and soon in Thailand.

Thanks to the modern molecular biology techniques used at its Rice Research Laboratory in Singapore, Bayer CropScience is now able to accelerate the development of new hybrid varieties. The company is a world leader in hybrid technology; besides rice, Bayer CropScience also develops oilseed rape and cotton seed using the hybrid approach.

will contribute a significant extension in breeding capacity for hybrid rice, among other things. Here, the use of modern biochemical methodology will accelerate the otherwise prolonged process of developing new varieties.

One example is DNA marker technology, through which certain genes can be detected in the genetic material – thus allowing scientists to determine to what extent the genes have been retained during crossing and appear in the progeny. Indeed, Bayer CropScience's researchers used DNA marker technology to follow the fate of individual resistance genes during the crossing process that led to the development of the bacterial leaf blight-resistant Arize Dhani. DNA marker analysis is an integral tool in molecular breeding, which in turn helps to accelerate the development of new varieties significantly.

Bayer CropScience had good reason to choose Singapore as the location for its research laboratory. "This is the best place for the Institute, because 90 percent of global rice cultivation takes place in Asia", explained Dr. Joachim Schneider, who leads Bayer CropScience's BioScience Business Unit, at the laboratory's inauguration ceremony in June. "With this laboratory, we want to be able to develop new, highly-efficient rice hybrids more rapidly, so that rice farmers throughout Asia can then benefit from them", declared Dr. Schneider.

Bayer CropScience's hybrid rice is now on the market in six Asian countries. Besides India, these are Bangladesh, Indonesia, Pakistan, the Philippines and Vietnam. Arize-Products are also available in Brazil, and further market introductions are planned in several other countries, including Thailand and the USA.

The product portfolio will also continue to expand. Just as Arize Dhani combines high yield potential with resistance to bacterial leaf blight, other products will bring different supplementary characteristics. "Examples of the characteristics we are currently working into hybrid rice varieties include resistance to Brown Plant Hopper, and significantly-increased tolerance to salinity or submergence", explains BioScience's Frédéric Arboucalot. In the meanwhile, plans for Arize Dhani in 2009 include further expansion into the Indian market, and introduction in Bangladesh. ■

Karl Hübner



Bacterial leaf blight (*Xanthomonas oryzae*) lesions on the leaves and ear of rice plants.

Bacterial leaf blight

The most characteristic symptoms of bacterial leaf blight are light-coloured, longitudinal stripes on the leaf lamina. Badly-infected plants first wilt, then quickly dry out. Diagnosis of the disease can be confirmed by cutting off the leaf at the lower end of a lesion and dipping the cut end into water: masses of bacteria can be seen against the light, streaming into the water, which eventually becomes cloudy.

Warm temperatures and high humidity favour the development of bacterial leaf blight. Damp areas, strong winds that damage the rice plants, and over-fertilising are further factors that encourage the disease. Moreover, the presence of weeds or infected rice stubble ensures the survival of the pathogen between crops, such that a new outbreak of the disease can occur as soon as the following crop is sown.

The younger the plants are at the time of infection, the greater the resulting harvest loss. In some regions, local losses of up to 60 percent are recorded. Asian countries are particularly badly affected: besides threatening millions of hectares in India, the disease is also a problem in other Asian countries such as Bangladesh, Myanmar, Japan and Indonesia.



Touring the new Bayer CropScience Rice Breeding Support Laboratory are Dr. Joachim Schneider, Head of BioScience (far left), Mr. Julian Ho of the Singapore Economic Development Board (second from right), and Mr. Marcus Yim of Bayer South East Asia (far right).