With attention focused on rising prices and fears of food scarcity, scientists in China and the Philippines have collaborated on a new strain of rice — Green Super Rice — that is resistant to drought and pests, does not need high fertilizer inputs and can deliver huge yield increases.

Too good to be true? No, this is for real, writes John Berthelsen, who spoke with the creators of the new grain.

FIFTY YEARS AGO, India was on the verge of mass starvation, a looming famine that was largely stopped by the remarkable efforts of an agronomist named Norman Borlaug, who, with funding from the Rockefeller and Ford Foundations, would later be awarded the 1970 Nobel Peace Prize for the development of a new strain of dwarf rice called IR8.

In the ensuing decades, average global rice production per hectare rose from 1.84 metric tons to about 6 tons, keeping billions of people alive.

But once again, the crunch is on. It is estimated that for every billion people added to the world’s population, 100 million additional metric tons of rice must be produced annually.

The global population, now at 6.87 billion, is due to pass the 7 billion mark later this year — after having reached 6 billion only 12 years ago in 1999. More food will have to be produced on less land and water, with fewer people doing the work due to rapid urbanization. Moreover, agriculture will have to become environmentally friendly to be more resilient to climate change and to contribute less to greenhouse gas emissions.

Rice, which is grown on 142 million hectares in Asia alone and feeds more than 4 billion people, is once more taking center stage, this time because of a remarkable collaboration between thousands of scientists across the world led by the Chinese Academy of Agricultural Sciences and the Philippine-based International Rice Research Institute (IRRI).

The result is called Green Super Rice, and it has the potential to raise rice production to an optimal 14 metric tons per hectare in China from about 6.3 tons today — without fertilizers or pesticides and using considerably less water. It is designed to flourish under the toughest growing conditions in the world.

To show how dramatic that increase is, mechanized rice production in California’s Sacramento Valley is perhaps the most productive in the world, made so through the use of massive amounts of fertilizer and pesticides on land leveled by lasers with mechanized land-planing equipment as big as football pitches. The yield is about 9.4 tons per hectare. By contrast, in Africa yields are about 1 ton per hectare. Researchers believe that Green Super Rice can increase yields in Africa by six-fold, to as much as 6 tons per hectare, says Li Zhikang, senior molecular geneticist and chief scientist with the Institute of Crop Sciences at the Chinese Academy of Agricultural Sciences in Beijing. Dr. Li is the father of Green super rice.

Dr. Jauhar Ali, a senior scientist and regional project coordinator for the development of Green super Rice at IRRI, said the method of producing the new strains is perhaps even more important than the rice itself. That is because it has been produced through a scientific method that also can be applied to other crops, such as wheat, barley, millet or cassava, staples that feed billions of people. It can make these crops harderier and more resistant to disease and insects and cut the use of fertilizers, pesticides and water without resorting to genetic modification.

Importantly, since public institutions developed Green Super Rice, it is not subject to the onerous conditions that major seed companies like Monsanto place on farmers, including the need
to buy new seeds every year. Instead, the Global Rice Science Partnership (GRiSP) will play a crucial role in disseminating both information and research. GRiSP is a network of six international centers with some 900 research, development and other partners worldwide. The roles of the partners vary from upstream research to grass-roots dissemination work and political support at the elemental level.

The project also caught the attention of the Bill and Melinda Gates Foundation, which invited Dr. Li to Seattle to speak to Bill Gates himself. “If you want us to help others, the Gates Foundation should step in,” Li remembers he told them. The result was a three-year grant of $18 million to spread Green Super Rice across the poorest parts of the world.

With the aid of the Gates Foundation, GRiSP is seeking funds to expand into seven countries across Asia and seven in Africa. Some 260 people have been trained from public and private centers, including in Africa, on the use of breeding and seed production technology and now are working to put it into the hands of farmers, much the way Borlaug and his associates did five decades ago. Dr. Li himself embarked on a 40-day trip in early February, first to Shenzhen, where a 100-hectare rice research and testing station is to be established, then to Africa, where he was to visit Mozambique, Senegal, Mali and other countries where poverty, drought, poor farming techniques, burgeoning populations and other problems combine to keep rice yields low and rice farmers at subsistence levels.

“There are huge areas of Africa that are unexplored,” Dr. Li says. “They have all the gold in their hands and they don’t know how to use it.” Green Super Rice itself is the result of a massive effort mostly by the Chinese government, which has poured $50 million into its development since 1998 and which involves the painstaking cross-breeding of more than 250 different potential varieties and rice hybrids with the help of rice scientists from around the planet. It is the brainchild of Dr. Li, who holds a dual position with IRRI as a molecular geneticist.

“In China, the rural areas are under tremendous strain,” Dr. Li says. “We are running out of people. They are all moving to the cities. China is undergoing a tremendous transformation in the rural areas. We anticipate huge change. But China cannot continue to depend on any other country to provide food. We have to be self-sufficient.”

For China, loss of agricultural land is an acute issue, Dr. Li says. Between 1979 and 2005, rice-planting area shrank in China from 32.4 million hectares to 28.8 million as burgeoning cities ate up the land. China’s premier Pearl River Delta alone lost half of its rice land to industrialization, an average decrease of 85,000 hectares a year over the six-year period ending in 2005. Rice farming moved north and east, to areas like Heilongjiang, where weather wasn’t nearly as hospitable for a semi-aquatic plant species that originated in tropical swamps and typically consumes two to three times as much water as do other cereal grains.

“China utilizes about a third of the world’s fertilizers on 7 percent of the world’s land,” Dr. Li says. “This created a tremendous problem — surface water pollution, soil degradation. It was not going to be sustainable. Land is shrinking because of city expansion. A group of Chinese scientists said we have to reverse the trend. We proposed a new idea — high productivity and low inputs.”

It was while working on a research project in the United States that Li began to ponder the idea of how to improve many of the traits and tolerances of rice without damaging productivity. “We tried for 10 years, with great success,” Dr. Li added. “I got great support from the government.” As many as 2,000 Chinese scientists were assigned to what Dr. Li calls “the first and largest research project ever created by Chinese agricultural science. It was a vast group of scientists.”

As the team developed the improved strains, Dr. Li says, they began to think of how they would perform in the rest of Asia and Africa, where production methods are often far more primitive than they are in China, let alone the developed world. “Now we continue to improve. It is a continuous project,” Dr. Li says. “You cannot develop a product that will last forever because the environment changes.”
The ultimate product is a tough, strong plant that can resist both drought and submergence. It can resist all known variants of blast and bacterial leaf blight, two funguses that attack rice, and thus doesn’t require fungicides or pesticides.

As an indication of the complexity of the project, in one study alone, over six years, researchers backcross bred three recurrent elite rice lines and 203 diverse donors, representing a significant portion of the entire genetic diversity of the primary gene pool of rice to improve tolerances to salinity, submergence, zinc deficiency, resistance to brown plant hopper and other problems.

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The famed IR8, which triggered the Green Revolution of the 1960s, could produce 5 tons per hectare under optimum growing conditions. With fertilizer and pesticides, the yield could go as high as 10 tons. But, as Dr. Li points out, so much fertilizer and pesticide was being used in China’s agricultural areas that it was wrecking the environment. IR8 was also subject to kernel breakage and initially had problems with texture, so-called mouth feel, before the problems were bred out of its successors. Green Super Rice, Dr. Li says, has the texture and taste that people want.

“Our future goal is to work together with African science people to transfer the technology. In the second phase we will work together to develop a new type of rice there,” he added. “What we have done is against nature,” he muses. “The key point is that in those poor areas, without irrigation, those varieties don’t perform well. We already improved tolerance to drought, etc., but there are limitations.”

One string of research, he says, is to go back to the original strains, before the first Green Revolution, and start over with pre-IR8 plants, to see what functions they may have had. “It is an alternative strategy. We have found some evidence that it could be productive. We will start over. Nobody can be sure that one strategy alone can work.”

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