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Rice Genome Fully Mapped

First DNA Map for a Crop Expected to Boost Modification Efforts

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Scientists have completed a genetic map of the rice plant, a scientific milestone that they hope will accelerate efforts to feed the hungry by improving the world's most important food.

Rice is the first crop plant whose complete genetic sequence, or genome, has been compiled and placed in computer data banks around the world. It will be a key tool for researchers working on improved strains of rice and other grains as they struggle to stay ahead of human population growth. A paper describing the genome is being published today in the journal Nature, and the sequence will be freely available to researchers worldwide.

"You could equate this to being as important as the Human Genome Project," which recently compiled a human genetic map, said Rod Wing, a scientist at the University of Arizona who was a key participant in the rice project. "This is really a project that can lead to important discoveries and findings that can help the condition of the poor. The poorest of the poor are the ones that depend on rice the most."

The number of people in the world is expected to increase 50 percent, to 9 billion, by the middle of this century. Much of that growth will come in Asian countries where rice is the dietary staple.

The new map will make it possible, in theory, to perform sophisticated genetic manipulations of the rice plant, including introducing genes from other species to create desirable traits. For example, one project introduced a daffodil gene into rice to turn the plant into a source of vitamin A, which it normally lacks. But that kind of work has been controversial, and how many countries will embrace it remains to be seen.

More important in the short term, completion of the rice genome is expected to speed conventional breeding programs, allowing researchers to produce rice strains that resist drought and disease and that grow in colder climates and at higher elevations. Those are critical needs as Asia's rapid urbanization reduces the land available for rice cultivation.

Cheaper, more abundant rice is seen as one of the keys to reducing hunger worldwide. Rice is the principal source of calories for about half the world's population, and the United Nations Food and Agriculture Organization projects that demand will rise sharply in coming decades.

Rice is a minor component of most diets in the developed world but it supplies most daily calories for people in Asia who remain in poverty. It is critically important to poor people in Latin America, and its importance is rising rapidly in urban Africa, where it is being embraced as easier to prepare than many traditional African foods.

The International Rice Genome Sequencing Project began in 1998. It was led by scientists in Japan but involved teams from the United States, China, France, Taiwan, India, Thailand, Korea, Brazil and Britain. A lot of the work was done in Rockville at the Institute for Genomic Research, an independent genetics laboratory founded by maverick scientist J. Craig Venter. The Rockefeller Foundation of New York, which for decades has funded research aimed at feeding the world, helped get the project off the ground. It cost more than $100 million.

Two Western agricultural companies, Monsanto Co. of St. Louis and Syngenta AG of Basel, Switzerland, contributed genetic information that moved up completion of the project by at least a year, scientists said.

Seed rice is not a major product for companies like Monsanto and Syngenta, but the plant is vitally important to them nonetheless. The great cereals whose cultivation made human civilization possible -- rice, wheat and corn are the most important -- descended from a common ancestor, a wild grass, that lived more than 50 million years ago. That makes the cereals close genetic relatives, and rice, with the smallest genome, proved to be the easiest to analyze. It is a crucial model for understanding the biology of all cereals.

Building on their success with rice, scientists are about to tackle the far larger genome of corn, the most important commodity in U.S. agriculture.

Companies like Syngenta and Monsanto have brought genetically modified strains of corn and other crops to market. They have been embraced by U.S. farmers, but vociferously rejected by consumers in Europe, Japan and other places. Availability of the rice genome will make such genetic manipulation easier in all the cereals -- but, by giving scientists more precise knowledge of how the plants work, it may also help to reduce some of the theoretical risks that have led to controversy.

The paper coming out today reports details and analysis of the rice genome, but it does not contain all of it. The rice genome is a sequence of chemicals represented by symbols looking like this: ATTGTGTAGCTTCTT. That goes on for 389 million letters, so computers are the only practical way to store and analyze it.

The letters stand for adenine, thymine, cytosine and guanine, chemical units arranged like beads along strands of deoxyribonucleic acid, or DNA. The exact order of the units is a message that tells the rice plant how to build its proteins, the fundamental working parts of all living organisms.

Scientists now have a rice genome with but a few gaps. It is a map of the Nipponbare strain of white rice grown in Japan, though the many other strains of rice -- red rice, basmati rice, brown rice, purple rice -- are expected to be similar.

While the map is an important achievement, it also means that an immense new task opens before the world's plant biologists. They need to learn to read the genetic messages and understand how the proteins in rice interact with one another, which is likely to take decades.

Already, researchers in Japan, using the new map, are hot on the trail of genetic variations that might allow rice to grow in colder climates, while the Rockefeller Foundation is funding work in the Philippines and other countries on strains that could yield enough even in drought years to keep a farm family from starving.

"Our work is not over," said Takuji Sasaki, vice president of the National Institute of Agrobiological

Sciences in Tsukuba, Japan, and principal leader of the rice genome project. "It's just starting."