
GENE HETTEL (3)

"Rock" and Rice:
The Rockefeller-IRRI biotechnology saga

Next year, 2010, marks not only the International Rice Research Institute's (IRRI) 50th anniversary but also a half century of collaboration between the Institute and its co-founder, the Rockefeller Foundation. This includes an alliance that started a quarter century ago to help create the new discipline of rice biotechnology. When that effort began in 1984, Gary Toenniessen, currently a managing director of the Foundation, led the charge to bring the new developments in molecular and cellular biology to rice. In this interview, he shows what can be accomplished with around US$120 million of funding and a cornucopia of ideas.

A career with the Rockefeller Foundation

After graduating from the State University of New York at Buffalo, I received a fellowship from the U.S. Public Health Service that sent me to the University of North Carolina at Chapel Hill, where I spent 5 years getting my PhD degree in microbiology. When I was looking around for a job at the end of that training period, the Rockefeller Foundation (RF) contacted me about a new type of postdoctoral fellowship they had, for which one worked with the Foundation while also pursuing some research at a nearby research institute. I received one of those fellowships and, within a year, I was made a program officer of the Rockefeller Foundation. So, for almost my entire career, which is now 38 years, I have been a program officer in the New York office of the Rockefeller Foundation.

In my opinion, IRRI is one of the Rockefeller Foundation's great success stories. The whole idea for IRRI came out of the Foundation. It was based on what Nobel Peace Prize Laureate Norman Borlaug had accomplished with wheat. The thinking was, if you could breed for wheat in Mexico and have those varieties adopted over the vast areas of South Asia, maybe you could breed for rice in a single location and have those varieties, or at least those breeding lines, be used across the vast areas of Asia where rice is grown. So, the Rockefeller Foundation convinced the Ford Foundation to partner with it to create IRRI. Within 3 or 4 years, IRRI's first variety, IR8, came out and had a huge impact throughout South Asia and other regions. But, many more fruits were to come from the Rockefeller-IRRI association over the next four and a half decades.

I was trained as a microbiologist and that meant molecular biology as well. So, when the Foundation, in the late 1970s to early 1980s, decided to move into applying the new tools of molecular and cellular biology to crop improvement, I was one of the people on the staff who knew something about molecular biology and I assumed more responsibility for the Foundation's investments in that area. Once the Rice Biotechnology Program began in 1984, I, more or less, ran that program from the New York office. We also had John O'Toole, a former IRRI agronomist and rice physiologist [1974-84], working in the program, initially from India and then from Bangkok; and Tosh Murashige helping in China, Korea, and the Philippines.

In recent years, we are working more in Africa. So, I spend a lot of time on the African Program today. But, I have to say that the most rewarding work I have done with the Foundation was from 1984 to 2002, when we invested about US$120 million in the Rice Biotechnology Program. I worked very closely with IRRI during that whole period.

The RF changes course—from doing to funding

In 1980, Dr. Richard W. Lyman became the president of the Foundation. His feeling was that foundations really should not be operational. They should be organizations that provide funds to others who get the job done. In the case of agriculture, he congratulated us for helping establish IRRI, the International Maize and Wheat Improvement Center (CIMMYT), the International Center

In October 1995 on the IRRI farm during the Foundation's Rice Biotechnology Meeting held in conjunction with Rice Genetics III, Dr. Toenniessen (*3rd from left*) confers with (*from left*) Gurdev Khush, IRRI rice breeder and principal scientist, 1967-2001; Ken Fischer, IRRI deputy director general for research, 1991-99; Darshan Brar, IRRI rice breeder and currently head of the Plant Breeding, Genetics, and Biotechnology Division (PBGB); John O'Toole, IRRI agronomist and rice physiologist, 1974-84, and later Foundation associate director; Zhikang Li, IRRI molecular geneticist and currently coordinator of the International Network for Molecular Breeding, Beijing; Robert Herdt, IRRI economist, 1973-83, head, IRRI Economics Department, 1978-83, and later Foundation director, agricultural sciences, and vice president; and Swapan Datta, IRRI senior scientist in PBGB, 1993-2005, and currently deputy director general for crop science, Indian Council of Agricultural Research.

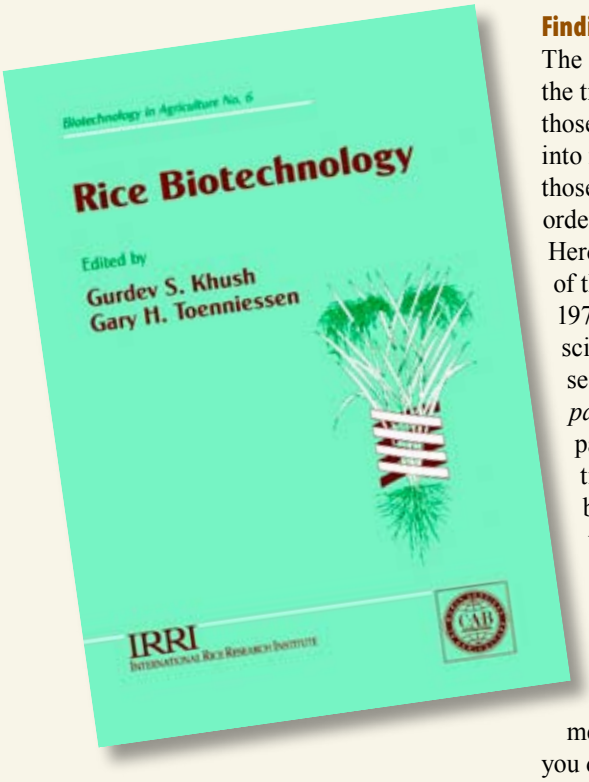
for Tropical Agriculture (CIAT), the International Institute of Tropical Agriculture (IITA), and a number of the other international centers, and also for creating mechanisms, such as the Consultative Group on International Agricultural Research (CGIAR), to fund those centers.

At about that time, a team of external advisors agreed with Dr. Lyman that it was now possible for the Foundation to bring its field operations to a close. In fact, I can remember their report stating that, in many ways, the era in which expatriate scientists go out and actually do research was coming to a close, and what the Foundation should really do is to find ways of supporting international centers and strengthening existing national programs. So, the advisors recommended that the Foundation work in two principal areas. One was to make sure that the new advances that were occurring in cellular and molecular biology were applied to tropical crops important in developing countries and the staple foods of the poor in those countries. Second, the Foundation should develop a strategy for Africa, where the food situation was deteriorating.

Creating rice biotechnology

So, we then moved quite quickly to implement the first recommendation, which was to apply the new developments in molecular and cellular biology to tropical crops. Dr. Alva App, a new RF director of agriculture, came in. Al had actually spent about 6 years [1976-82] at IRRI as a visiting scientist, seconded to IRRI as an employee of the Boyce Thompson Institute for Plant Research to lead the work on the *Azolla* [a tiny nitrogen-fixing fern]–rice combination. So, it's clear to me that, from the time Al arrived, we were going to work on rice because he quite correctly recognized its importance. But, I still conducted a very systematic process of looking at the eight most important crops in determining whether or not the breeding programs were strong enough in those crops to make it reasonable to introduce a biotechnology program and what the impact would be if the Foundation did do that. When we compared all of the results, rice was clearly at the top. We could build on what were already strong breeding programs. IRRI was there, so we had a strong partner to work with and, of course, rice fed more people than any other crop.

First of all, we received approval from our trustees to make a major long-term commitment. So, the initial document that went to the Foundation's trustees in December 1984 informed



them that this was likely to be a 15-year-long program, or longer, and, at that time, we said that the Foundation was likely to commit US$80 million or more. If you actually adjust $80 million for inflation over that period of time, it comes out to about $120 million.

We designed the program to have three major components. The first was to "create" rice biotechnology. Molecular biology was a brand new discipline in the early 1980s and there was nobody in the world except for a few Japanese who were doing serious work on rice molecular biology. IRRI had no biotechnology program. There were no rice molecular biology programs in the United States. So, it was a wide-open opportunity for the Foundation to lead the effort to really create a significant biotechnology research program for the most important food crop in the world.

Creating the technology meant creating a molecular genetic map of rice and then creating the tools that would allow the genetic engineering of rice. It meant understanding the way the rice genome is structured, and understanding at the molecular level the relationship between rice and rice pathogens. There was a lot of investment in those basic tools that make up the set of technologies that we call biotechnology.

Finding relevant traits

The second component was to work on the traits for which one would want to use those tools, once available, to introduce into rice. But, we needed to understand those traits at the molecular level in order to use those tools. We hired Bob Herdt [IRRI economist, 1973-83; head of the IRRI Economics Department, 1978-83; later, director for agricultural sciences at RF and vice president; see his tribute to Norman Borlaug, *passion, persistence, and persuasion,* pages 32-34] as our colleague at that time. Previously, his job at IRRI had been to prioritize traits that IRRI was going to work on so he had already developed the methodology for prioritizing traits. He did the same thing for the Foundation's rice biotechnology program.

It is basically a technique that measures the yield forgone because you do not have that trait. For example, at that particular time, there were no known genes for resistance to the rice tungro virus, which, at that time, was causing a lot of problems in the Philippines and other countries in Southeast Asia. So, that turned out to be very high on his list of priorities. There were reasons to believe that biotechnology would work as a way of addressing the tungro virus. Bob outlined our research priorities for rice biotechnology in the 1991 book Rice Biotechnology, which IRRI breeder Gurdev Khush and I edited [see http://snipurl.com/qv0uh].

Building molecular biology capacity in Asia

The third component was capacity building in Asian rice research institutions. In countries such as India, China, Thailand, and the Philippines, we tried to link the more fundamental research programs with the rice research institutions within those countries. That involved a lot of training. During that 17- to 18-year period, the Foundation supported about 400 fellowships for Asian scientists. Many went to advanced laboratories in the U.S., Europe, Australia, and Japan, where we were funding the work on tool development. Most of the actual work that led to important discoveries was done by Asian scientists in a laboratory in the U.S. or somewhere else. Since they were really the "inventors" of the tools, they had the real sense of ownership. When they went back home, there was a real sense of pride and desire to use those tools within their home countries and the Foundation supported them when they went home.

Over time, the funds that were going into tool development and into work on the traits shifted from the West—the U.S. and Europe—to Asian countries, particularly China, India, and Thailand, where they began developing real capacity. By about 2000, when we would have meetings of our rice biotechnology network, we had scientists from the major companies working in biotechnology asking to come to those meetings.

We also had scientists from laboratories that we were not supporting around the world asking to come to those meetings because they would learn, not only the most recent results in rice biotechnology but also in biotechnology in general, from some of the Asian programs that we were supporting. That is when we realized that we had achieved our goal, when the Asian scientists were at the forefront of doing the research on tool development and working on the traits. We recognized that we had accomplished our goal of making sure that the new tools on molecular biology would be applied to rice and that has certainly proven to be the case. We see Asian countries continuing to make major advances in the development and application of rice biotechnology. China and India, for example, now have as much capability as Monsanto or Syngenta or any of the major corporations. So, that's an overview of the Foundation's Rice Biotechnology Program.

Go to www.irri.org/publications/today/Toenniessen.asp for the complete transcript with links of Dr. Toenniessen's pioneer interview, in which he tells little-known facts about the fascinating Golden Rice story, the ardent competition among scientists to develop the molecular map for rice, and the challenges that are being encountered to take the Green Revolution to Africa.