ers to identify genes that determine important traits. However, he says it won't be long before rice genome research will lead to genetic manipulation of rice plants. Already, parallel research efforts in Japan, the United States, and Europe have used tissue culture to regenerate rice plants and produced fertile plants that contain and express foreign genes, says Toenniessen of the Rockefeller Foundation.

Manipulation of endogenous rice genes is also advancing rapidly. Hiroaki Shimada of Mitsui Toatsu Chemicals' Plant Biotechnology Lab expects the RGP's efforts to eventually boost the company's efforts to breed disease and stress-resistant strains. "Their molecular-based map and molecular markers that link with some important genes involved in rice quality will be very helpful for our rice-breeding process," he says.

Perhaps even more important are the expected benefits for the study of other crops, says Toenniessen. Because it is a small genome—one-sixth the size of wheat—rice is fast becoming the model cereal for studies in molecular biology and molecular breeding.

In a collaboration that began in 1991, Michael Gale, Graham Moore, and their colleagues at the John Innes Centre in Norwich, the largest plant molecular biology facility in Britain, worked with RGP scientists to identify markers that appear in the same relative positions on wheat and rice. Indeed, the correspondence between rice and wheat is so close that, in Gale's words, "wheat is rice." The colinearity observed among barley, wheat, and rye suggests there is colinearity "between markers on rice and all these species," says Moore. The ultimate goal, says Moore, is "a generalized map of the genome of the ancestral grass that gave rise to these cereals some 60 million years ago. Then all the information which has been generated by studying these cereals separately in the last 50 years could be combined."

Thanks to its well-funded and focused approach, Japan's RGP is ideally positioned to help lead this ambitious effort. And that's not all. Buoyed by the success of the project, the agriculture ministry is tapping its racetrack proceeds to start an animal genome project, using a pig model. Researchers hope it, too, will prove to be a winner.

–Jane E. Stevens

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Send In the Clones

When Cornell University geneticists Susan McCouch and Steve Tanksley learned in the late 1980s about the Japanese rice genome–mapping project, they looked forward to a fruitful collaboration. The Cornell team was assembling its own rice genome map, so it proposed integrating the two efforts. Working with Akira Saitoh, then head of the Rice Genome Research Program (RGP) in Tsukuba, they exchanged 70 DNA markers.

But soon after the marker exchange, which occurred in 1990, the Japanese project was abruptly shut down and a new rice genome project was set up with an entirely new staff (see main text). Although a joint map was published in 1992, it took several years for outside groups like the Cornell team to regain access to material from the new project. "The project was absolutely closed, even to researchers in Japan," says McCouch.

Recently, however, McCouch and other researchers say the RGP has begun to open up once more. Last year, for example, 4342 sequences from the RGP's complementary DNA (cDNA) clones were deposited in public data banks, and another 1500 are to be added this fall. And RGP researchers have recently submitted a manuscript for publication that will give the locations of 1383 DNA markers, including 876 of the cDNA sequences already in the data banks. "After acceptance we will be able to release all mapped DNA clones, sequences, and additional information necessary for mapping work," says Takuji Sasaki, who became program director this past spring. And McCouch herself says that her group received a batch of cDNA clones from the RGP early in 1994.

According to Sasaki, there was never a policy against open collaboration. After the 1991 reorganization, the RGP's director, Yuzo Minobe, thought "clones should be widely distributed," says Sasaki, who succeeded Minobe in March of this year. The reason it took until this year to send out clones, he says, was that "we did not have so many clones to distribute" before then.

PETER MORENUS/CORNELL UNIVERSITY

Taking root. Cornell's Susan McCouch tends rice clones sent from Tsukuba.

Masahiro Nakagahra, who directed the initial RGP from 1988 to 1990 and presided over the 1991 reorganization, says the misunderstanding may have stemmed from his concern that an individual researcher might take DNA materials produced by the RGP team and "bring them into his small world," and that the project was reorganized and policies put in place "to avoid an accident." McCouch suggests, however, that RGP administrators feared that too-close collaboration might favor overseas teams.

Such an attitude would be understandable, because the RGP "was designed to make Japan pre-eminent in rice research," observes Gary Toenniessen, head of the agricultural science program at the Rockefeller Foundation in New York, which supports rice genome work at Cornell and a handful of other U.S. labs. Also, he notes, "The idea was to provide a place where corporate-sector scientists could work and then take materials back to their company and develop products. That never materialized," he says, and the project has since become more typical of an international scientific endeavor.

Molecular geneticist Saghai Maroof of the Virginia Polytechnic Institute and State University adds that there's nothing wrong with a research institute wanting to hold its cards close to the vest. "I don't think they are trying to hide [information]," he says, "but they want to make sure everything is right. Since they are calling the shots, it's up to them."

Whatever the reasons for the RGP's seesawing history, overseas researchers welcome the RGP's renewed openness. "We have found them very easy to work with," says British plant molecular biologist Michael Gale of the John Innes Center in Norwich, which has postdocs shuttling back and forth between Britain and Japan. "It's a very fruitful collaboration." Agrees McCouch: "This is a new era of collaboration. The RGP will be a major contribution to the international community."

–J.K. and Jeffrey Mervis