a problem [in the environment]."

Opponents aren't convinced. In particular, they argue that results from the Asgrow-funded survey are inconclusive. "That's like identifying 14 humans without malaria and saying malaria isn't a problem," says ecological geneticist Norman Ellstrand of the University of California, Riverside. But federal regulators are siding with Asgrow. Last May, the U.S. Department of Agriculture's (USDA's) regulatory arm—the Animal and Plant Health Inspection Service (APHIS)—issued a preliminary ruling that growing the transgenic squash would have "no significant environmental impact." APHIS is expected to make the ruling final by the end of the year, which would allow Asgrow to market the squash.

Many scientists would be more comfortable with such rulings if questions about genetic exchange had first been resolved in closely monitored large-scale field tests. "It's crucially important that large field tests are done to pick up early signs of problems," says entomologist Gary Fitt, program leader at the CSIRO cotton research unit in Narrabri, Australia. But Cornell University plant pathologist Denis Gonsalves, who is developing a transgenic papaya for Hawaii's struggling papaya industry, notes that safety concerns "can be tested as transgenic plants are commercialized."

There is, however, one place where data from large-scale trials might already be available: China. Chinese scientists have recently launched massive field trials of transgenic tobacco, tomatoes, and rice on thousands of hectares (*Science*, 11 November, p. 966). "China will provide us with a large-scale opportunity to see what is going on," says University of Bristol biologist John Beringer. Indeed, geneticist Chen Zhangliang, head of the college of life sciences at Beijing University, told researchers attending the conference here that China would welcome U.S. and European scientists to monitor the fieldwork. However, Fang Rong-Xiang, deputy director of the Beijing Plant Biotechnology Laboratory of the Chinese Academy of Sciences, told *Science* after the presentation that Chen was speaking on his own behalf and that the Chinese authorities have not yet discussed the possibility of outside monitoring. In the meantime, says Fang, "we haven't seen any serious problems in our large-scale tests."

For many scientists in developing countries, that is reassurance enough, for environmental safety issues are secondary to the demands for increased production. "We are prepared to take more risks to tackle problems," says Ariel Alvarez-Morales, biotech director at the National Polytechnic Institute in Irapuato, Mexico.

Indeed, top government officials in the United States and elsewhere appear ready to usher in a new age of agriculture. Says conference co-organizer Alvin Young, director of the USDA's office of biotechnology: "The door to commercialization is about to really open wide." Just how wide, however, may depend on data from large-scale field trials in China and from environmental monitoring of the first batch of transgenic crops to hit the market.

–Richard Stone

JAPANESE UNIVERSITIES

Leo Esaki: An Outsider Brings A Culture Change to Tsukuba

TSUKUBA—Like most other doctoral students studying materials science at the University of Tsukuba, Toshiki Komatsu spends his days doing experimental work. But, in a rare breach of the inward-looking culture typical of Japanese universities, he conducts his experiments not on campus but across town at the National Institute of Materials and Chemical Research, funded by the Ministry of International Trade and Industry. There, under the direction of Fusae Nakanishi, who heads the institute's Molecular Systems Laboratory and serves as a visiting research adviser at the university, Komatsu studies polymers that harden or change when exposed to light.

"Revitalizing creative activity is the main reason I was invited to become president."

—Leo Esaki

TSUKUBA UNIVERSITY

Komatsu is in the vanguard of a wave of reforms set in motion by Nobel laureate Leo Esaki, who was tapped as Tsukuba's president in 1992. Esaki spent 30 years at IBM in the United States, but his research roots are in Japan: His 1973 Nobel Prize in physics for demonstrating the electron tunneling effect in semiconducting materials, for example, was done in the 1950s at a forerunner to Sony Corp.

Esaki's status as an outsider committed to changing the system—he is the first person without an academic background to lead a national university in Japan, and he had no previous ties to Tsukuba—was one of the reasons the Tsukuba faculty elected him. And he's moved quickly to establish a reputation as a reformer. One of Esaki's first moves was to encourage industry to play a bigger role in graduate education through a new program that enables doctoral candidates to work in 31 participating corporate and government labs located in the surrounding Tsukuba Science City.

For Komatsu, having the choice was crucial to his scientific progress. "There's no group at the university working on this specialty," he says. "So my professors introduced me to Nakanishi."

Such interactions were expected to be routine when Tsukuba was founded, in 1973, as a new type of national university in the midst of Japan's first high-tech city. But the flame of reform had long since died out when Esaki was brought in. Indeed, "revitalizing creative activity at University of Tsukuba is the main reason I was invited to become president," Esaki told a recent symposium he convened on the role of Japanese universities in a global society. His goal, he says, is to turn Tsukuba "into a first-rate research university" and to create a model university for the 21st century.

The cooperative graduate school program is just one of many ideas he has brought with him from the corporate world. Last spring, a university reform committee that he established recommended fundamental changes in the way Tsukuba does business, including a greater emphasis on graduate education, with a more interdisciplinary focus; increased use of outside peer review of existing programs; greater diversity of faculty and students; and increased spending on facilities both for graduate and undergraduate students (see table on p. 1474). It's a tall order, and to succeed Esaki must overcome institutional inertia, budgetary constraints, and national laws that limit what a university can do.

Graduate gains. Esaki believes that the key to raising the overall quality of research at the university is to shift Tsukuba's educational sights from undergraduate to graduate-level education—not just for science and engineering, but also for the humanities and

social sciences. The school now enrolls 9000 undergraduate and 3000 graduate students, and Tomoo Ishida, vice president for reform, says he hopes to reverse that proportion by the end of the decade.

The drive to emphasize graduate programs dovetails nicely with demographic trends. Japan's college-age population will drop sharply over the next decade—from a peak of 2 million in 1992 to 1.5 million in 2000. At the same time, there is increasing recognition that the proportion of students pursuing advanced degrees is one of the lowest among industrialized nations and must be raised.

Reform efforts at Tsukuba and other universities are being supported by the Ministry of Education, Science, and Culture (Monbusho), which earlier this year established an office for university reform. Monbusho officials hope to replace past heavy-handed directives with policies that give more autonomy to Japan's universities, for example, by relaxing regulations on curricula. The ministry has also set aside money for one-time expenses involved in reform efforts. And it has funded 14 new permanent faculty positions at Tsukuba that are part of another bold effort by Esaki to redefine university research and cooperation with the private sector.

That program, called the Tsukuba Advanced Research Alliance (TARA), is trying to erase the barriers that separate research disciplines and those between university, government, and industry labs. TARA research will be conducted under one of seven loosely defined "research aspects," such as biological sciences, materials science, and the effects of human activity on the environment. All research, which is to be proposed by Tsukuba faculty, will be subjected to reviews by outside experts.

This year the alliance launched the first six of what eventually will be more than 20 research projects. A typical team will consist of about 10 scientists, half of them from other university, government, or industry labs. Although the government is expected to help with funding, TARA's director, Kazuo Murakami, says success will hinge on a team's ability to attract industrial contributions. The current recession, he notes, isn't helping: "At the moment what we need is more corporate support."

TSUKUBA UNIVERSITY

Center of attention. The University of Tsukuba sits in the heart of the sprawling Tsukuba Science City.

A broader challenge facing Esaki's efforts to overhaul Tsukuba's culture will be to reach a consensus on precisely what should be changed. Reform committee member Yasuo Kitahara, a professor in the Institute of Literature and Linguistics, wonders what will happen to purely disciplinary research if interdisciplinary research is promoted, and to undergraduate education if graduate education is emphasized. "It is easy to talk about reform and restructuring," he says, expressing the concerns of many faculty members, "but to foresee all the consequences is really difficult."

Fixing fixes. Several features that Esaki would like to change are actually unintended consequences of previous reforms. A prime example is the existing academic structure. Instead of traditional university departments, Tsukuba planners set up "colleges," centered on a traditional academic specialty—like natural sciences or comparative culture—but supposedly broader and more flexible. Related colleges were grouped into three "clusters." Research was functionally separated by assigning professors to "research institutes" even though they have teaching duties in the colleges.

The system "is really difficult to explain," Ishida says, adding that it is less efficient and more rigid than planners had hoped. At least two of the colleges offer competing courses in basic English language, he says, a situation that "is really confusing for students." Unfortunately, the structure is part of the national law that created the university; any changes must be approved by the Japanese Diet, a lengthy process at best.

For those reasons, Ishida says officials will exploit a loophole in the law to reshuffle graduate divisions while keeping the undergraduate school intact. But Ishida declined to give details of the plan, which is due out next spring, until the reform committee completes its review.

Funding is another area where compromise will be necessary. As the reform committee noted last spring, graduate-level research and education are more expensive than undergraduate programs. That means Esaki's changes will require bigger university budgets and more financial aid and graduate student fellowships. Even so, Ishida says, Monbusho's unusual decision to provide new slots for TARA bodes well for additional funding. "Monbusho is willing to support universities making such efforts," he says.

However, Naoki Murata, head of Monbusho's new reform office, points out that the Ministry of Finance has the final word on any permanent increases, and he predicts that "it will be difficult [for Tsukuba] to get 100% of what it would probably hope for." No discussions will take place, he adds, until university officials draw up detailed plans and requirements.

None of this fazes Esaki. Despite the inevitable compromises in administrative structure, funding, and curriculum, Esaki has set high standards by which to judge the results of his reform efforts. One day, he says, he would like Toshiki Komatsu and others like him to experience what he enjoyed in Stockholm. "We're expecting this university to turn out great numbers of future Nobel laureates," he says.

–Dennis Normile

ESAKI'S AGENDA FOR REFORM

Major points of the University of Tsukuba's proposed reform plan include:

- Focusing the graduate school curriculum on basic rather than applied science;
- Introducing outside reviews of all research and education programs;
- Upgrading research facilities and space;
- Easing course requirements to allow students to sample a wider range of disciplines;
- Encouraging master's degree students to seek doctorates;
- Increasing student financial assistance and improving student housing and other facilities;
- Raising the number of foreign students;
- Making it easier for adults in the work force to return to graduate school;
- Limiting the number of faculty members who have graduated from the same university; and
- Setting targets for recruiting non-Japanese and women faculty members, establishing open employment and promotion standards, and simplifying administrative procedures.