Researchers Score Victory Over Pesticides–and Pests–in Asia

At sundown, hundreds of residents of Pangyingkiran, Indonesia, gather around a rickety bandstand in the village square to watch a "ketoprak," a play put on by the villagers. There are thousands of similar village theaters throughout Indonesia, and traditional subjects include gossip about the village chiefs and cultural myths. But in the past 2 years an unusual act has been showing up in this village's ketopraks, courtesy of the United Nations Food and Agriculture Organization (FAO). The subject is an ecological approach to preserving the region's most precious commodity: rice.

In the village performances devoted to this subject (known in the West as integrated pest management, or IPM), the farmers, their families, and other villagers act out the process of rice farming. They play the roles of rice paddy workers, pesticide distributors, even rice pests like the rice brown planthopper and the spiders that prey on it. This unusual theater is but one component of a drive begun in 1986 by the FAO to introduce large-scale IPM to Indonesia. That effort is paying off handsomely, the FAO claims. While rice production has increased by about 10% since 1986, according to Peter Kenmore, manager of FAO's Inter-country Program for Integrated Pest Control in Rice in South and Southeast Asia, pesticide use is down sharply. "There's little doubt that Peter's work has been widely acclaimed as the premier IPM program ever attempted," concurs Ralph Wright, IPM program chief at the Environmental Protection Agency.

That could be good news for much of Asia, because feeding the increasing number of hungry mouths there without use of additional pesticides, which foul water supplies and, in an agricultural Catch-22, often kill off useful predators that help keep some insects under control, is a key goal for agricultural scientists. The rest of Asia is next on the agenda because the program seems to work best for rice. There is good reason to wonder whether the Indonesian program can be transplanted outside Indonesia, which has a tight village structure and a culture that includes institutions like the ketoprak that provide ideal vehicles for teaching. But a variety of researchers contacted by *Science* agreed that although Indonesian culture is unique, the FAO program has some ingredients for success throughout Asia. But they warn that for it to take hold, other Asian governments may have to take the bold step the Indonesian government did 6 years ago when it eliminated government subsidies for pesticide distribution.

That move was, in a sense, a desperation measure. In 1986, the brown planthopper had become a devastating plague—eating up four times as much rice as in the previous growing season, enough to feed 3 million people. And neither breeding resistant strains nor ladling on tons of pesticide could stop the bug or the plant virus it carries. Researchers concluded that pesticides had actually made things worse by encouraging the development of resistant strains of the pest. The Indonesian government was gripped by a fear that rice production in the country—which reached self-sufficiency levels only in 1984—was on the brink of collapse. So in 1986, Indonesian President Suharto banned 57 of the 63 pesticides used on rice and began diverting millions of dollars from pesticide subsidies to the country's until then largely quiescent IPM program. The key commodity, many scientists say, was the political will to risk enraging farmers who had long depended on pesticides.

FAO

FAO

Rice production. In a village theater, Indonesian farmers stage a play about the trials and tribulations of life in a rice paddy *(right)*. West Javan farmer's sketch of major players in the rice paddy ecosystem *(above)*.

Suharto was given some of that political courage by research results gathered in the early 1980s by Kenmore and his colleagues showing that insecticides often exacerbate brown planthopper outbreaks. The researchers discovered that the brown planthopper provides a classic case of resurgence, in which pesticides kill off predator insects, leading to a rebound in the pest population. In a 1984 paper in the *Journal of Plant Protection in the Tropics*, Kenmore, with researchers at the International Rice Research Institute (IRRI) reported that seven times as many planthopper eggs survive on experimental fields treated with insecticide. "Trying to control population outbreaks with insecticides is like pouring kerosene on a house fire," Kenmore says. It was this message that caught the ear of Indonesia's cabinet ministers—and Suharto. "Kenmore was able to persuade the government to go against its instinct…in a skillful, political way," says Robert Blake, chairman of the World Resources Institute's Committee on Agricultural Sustainability for Developing Countries and a former ambassador to Mali.

Since Suharto opened the door to agriculture without pesticides, Indonesia's FAO-run program has taught IPM techniques to nearly 200,000 farmers, most of them in the past 2 years. According to Wright, Kenmore's concepts aren't particularly new—they're "textbook IPM" concepts that have been kicking around for 30 years—but they've been assembled and packaged in a particularly successful way. FAO field experts train Indonesian farmers to recognize insects, such as the spiders that prey on brown planthoppers, and plant diseases, such as a particular yellowing of rice plants, indicating a bacterial infection that's neither treatable with insecticides nor economically harmful to rice production. "What's taught is how to look at the rice paddy as an ecosystem," says Kenmore.

This philosophy is implemented in "Farmer Field School," where 25 farmers meet for 5 hours once a week for 10 weeks. There they observe plants and insects, then come to a consensus on how best to manage the rice based on their observations, experiences, and weather forecasts. Instead of relying on pesticides as a magic bullet to cure ailing crops, the farmers learn, among other things, how to add the right amount of fertilizers and how to manage water supplies. In addition, the farmers are trained as amateur economists—they learn how to forecast the amount of pest-induced damage that's tolerable before

opting for pesticides. IPM strategy for rice boils down to a simple axiom: Pesticides usually do more harm than good because they kill beneficial insects.

This kind of training isn't particularly expensive by the standards of international aid. The Indonesian government pays for the program's annual cost—$6 million—half of which comes from aid provided to Indonesia by the U.S. Agency for International Development. The World Bank will start footing part of the tab on 1 June. Agricultural experts hope that this kind of international funding will provide a lever for getting Indonesian-style programs adopted elsewhere. "We're trying to get IPM as a basic condition for World Bank loans," says Peter Weber, an agricultural analyst at the Worldwatch Institute, a Washington, D.C., environmental think tank.

The numbers depicting increased food production and decreased chemical use aren't the only measures of the Indonesian program's success. In addition, there's the fact that it has already survived one potential major calamity. In 1990, a sporadic rice pest in Southeast Asia—the white rice stemborer—began infesting paddies in West Java. Despite desperate calls from the villages for a massive distribution of pesticides, local governments stuck by IPM. According to the FAO, field trainers that summer rallied 300,000 people to pick the stemborer's pinhead-sized white eggs off the rice plants. Last year, stemborers infested only a handful of hectares of rice paddies, says Kenmore. Furthermore, FAO scientists maintain that the rice paddies most damaged by the stemborers were in areas treated heavily with carbofuran, one of the few rice insecticides currently allowed on the Indonesian market.

Kenmore argues that the commitment of local officials, who stood firm and rallied the villagers on behalf of IPM, indicates that the Indonesian program has long-term sustainability. That's great for Indonesia, but for the rest of Asia it simply poses the key question of whether the preconditions of the program's success can be duplicated elsewhere. Some analysts think, somewhat gloomily, that it will take the same kind of threatened catastrophe in other rice-growing Asian nations that it took in Indonesia to launch the program. "Unfortunately, too often it happens that only when systems break down do people do sensible things," says Andrew Gutierrez, an entomologist at the University of California at Berkeley.

It may or may not take catastrophes in other countries in Asia for them to get IPM under way, but, in the opinion of many agricultural experts, it will require that the governments of those countries follow Suharto's lead and steer farmers away from pesticides. "The reason farmers use more chemicals is because that's what the paradigm is," says Weber. "And you need to change the paradigm from the top."

To some observers, awareness at the top of the dangers of commonly used pesticides is long overdue—and sorely lacking in Asia. "There's an intimate interface between agriculture and people" in Asia, says Richard Harwood, an agronomist at Michigan State University and former director of the Asian division at the Winrock International Institute for Agricultural Development, based in Morrilton, Arkansas. "The rice paddies surround the villages...there's no way of isolating the rice paddy from village water supplies," he says. A review of health studies compiled by IRRI researchers and sponsored by the Rockefeller Foundation in 1990 found that prolonged exposure to pesticides in Asia can lead to maladies ranging from skin disorders to heart problems. "We need to paint the current scenario," says K.L. Heong, an entomologist at IRRI, meaning that the other countries must be shown that IPM can work as well as, or better than, pesticides.

Kenmore, meanwhile, hasn't altered his IPM strategy—in fact, the Indonesian program is serving as a prototype, he says, for revamping programs supported by the Dutch and Australian governments in Bangladesh, China, India, Korea, Malaysia, the Philippines, Vietnam, Sri Lanka, and Thailand. And they have had some successes. Farmers in Bangladesh who received IPM training spent 75% less money on pesticides in 1991 than did their untrained counterparts—and produced 13.5% more rice. And in the Philippines, where environmental organizations and farmers' cooperatives are campaigning against pesticides, the agriculture secretary last month banned four pesticides. Those are encouraging signs, but it will take much more time to tell whether the hopeful results from Indonesia can, like a hardy hybrid strain of rice, thrive in foreign soil.

–Richard Stone

GENE PATENTS

Scientists Voice Their Opposition

An interagency working group set up to resolve the sticky questions surrounding the patenting of gene sequences held a town meeting at the National Academy of Sciences last week, where the public was invited to speak its mind. The committee got an earful as representatives of 16 or so different scientific and biotech groups took to the podium, largely to denounce or question efforts by the National Institutes of Health (NIH) to patent gene fragments of unknown function (*Science*, 11 October 1991, p. 184). If nothing else, the group established by the White House Office of Science and Technology Policy (OSTP) and chaired by Mary Clutter of the National Science Foundation,* got a strong message that the U.S. and international genetics community is still vehemently opposed to NIH's moves. Industry, too, is leery, said Richard Godown of the Industrial Biotechnology Associations, though it believes that NIH had no choice but to file the applications.

NIH Director Bernadine Healy, a member of the working group, showed no signs of backing off yet, however. She said the agency's goal in filing for patents on thousands of gene fragments identified by NIH researcher Craig Venter is not to get rich but simply to ensure, as is required by law, that its discoveries are translated into new therapies and drugs. She reiterated that NIH staked its claim "to protect its options—and those of the taxpayer," while the issue of whether gene fragments could—or should—be patented is sorted out. And, contrary to widespread opinion, she said NIH is not committed to patenting: "If, after thorough evaluation, it is decided that these cDNA [complementary DNA] sequences should not be patented, NIH could withdraw its patents or dedicate them to the public."

That didn't wash with most of the researchers who testified, however. One by one, representatives from the American Society of Human Genetics (ASHG), the American Institute of Biological Sciences, INSERM in Paris, the European Community, and others argued that if NIH is allowed to go ahead, it will start a patent stampede that will destroy international collaboration and hinder product development. "This sort of approach does not build a road to further advances, it just builds a toll booth along the way," said Michael Roth, a patent attorney at Pioneer Hybrid. Even Venter told *Science* that patenting thousands upon thousands of gene fragments simply won't work. "The patent system wasn't designed to give me and a small group of people ownership of half the genome," he added.

What's more, warned David Galas, another working group member who also oversees the Department of Energy's genome project as head of health and environmental research, the NIH claim could be just the "tip of the iceberg." He noted that if that approach holds sway, patent claims might be filed on all sorts of mapping data such as the giant YAC (yeast artificial chromosome) clones being used to piece together the chromosomes. Walton Nance of ASHG, agreed, saying it raised the specter of unending litigation over competing claims, say, from one group that patented a YAC and another that patented a gene fragment within that YAC.

Galas urged the government to give careful consideration to a policy that would allow the

* Genome Patent Working Group of the Committee on Life Sciences and Health, under the Federal Coordinating Council for Science, Engineering, and Technology.