TRANSGENIC CROPS

China Takes a Bumpy Road From the Lab to the Field

China's rejection of applications to sell GM crops and a ban on foreign investment coexist with an expanding research portfolio

BEIJING—The Chinese government has long maintained that transgenic crops are the key to feeding and clothing the country's huge population in the 21st century. And it is backing that conviction with rapid increases in research budgets. But although it once enthusiastically embraced efforts to get genetically modified (GM) seeds into the hands of farmers and welcomed foreign investment in developing GM crops, the government is now proceeding with extreme caution. Officials point to growing concerns about biosafety as the reason for the shift, whereas others see trade policy as the driving force.

The latest example of this dichotomy between supporting research and postponing the harvest of its commercial fruits came last month, when the government's biosafety committee turned down an application for the commercial distribution of a domestically developed, herbicide-resistant variety of rice. It wasn't a big surprise: Although China has approved commercial cultivation of five species of GM crops, most notably Bt cotton in 1997, no staple food crop has ever passed muster. Earlier this year, the government drew the line around GM crops a little tighter by announcing a ban on new foreign investment in agbiotechnology ventures. The rules, issued in March, are part of a series of edicts governing the importation and labeling of GM crops.

Although the two actions are independent, together they emphasize the prevailing attitude toward GM crops. Chinese officials say their cautious approach is needed to make sure all GM crops are safe. The restriction on foreign investment, they argue, simply adds another protective layer by ensuring that overseas companies don't unleash varieties that could threaten local strains. "Our government is not trying to ban foreign investment from the domestic market," insists Duan Wude, deputy director of the Department of Science, Technology, and Education at the Ministry of Agriculture. "It is only being careful with the introduction of foreign technology."

That explanation sounds to many observers like a smokescreen for a tougher trade policy, however. "By trying to protect its own research-based industries, China is creating a situation in which the real losers are the farmers," contends Scott Rozelle, a professor of agricultural and resource economics at the University of California, Davis. "I favor a go-slow system for approving new releases, but I am against the ban on foreign investment."

Cultivating a taste. This Bt cotton (*above*) is part of a short list of genetically modified plants that China has approved for commercial sale. None has gotten the nod since 1998, although 10 varieties have been approved for controlled environmental testing.

The ban on foreign investment "is more of a trade issue than a scientific issue," says Xing-Wang Deng, director of the new Center for Plant Molecular Genetics and Agribiotechnology, which involves scientists at Yale and Beijing universities. Deng and others say that China is worried that other countries might impose restrictions on its agricultural exports if farmers begin harvesting large amounts of transgenic crops, along with traditional varieties, and they fail to segregate the two types. That has happened in the past with Chinese-made soy sauce, derived in large part from GM soybeans grown in the United States. The ban, he says, is seen as a way to limit the amount of land planted with GM crops and thus make oversight easier.

U.S.-based Monsanto is by all accounts the company most affected by the restrictions on foreign investment. It's the biggest foreign source of GM crops in China; its Bollgard Bt cotton seeds, for example, are growing in a majority of the 350,000 hectares of GM cotton cultivated this year. John Killmer, president of Monsanto China, says the new rules exacerbate an already difficult situation for the company, which has repeatedly failed to win approval for Bt corn and has abandoned an earlier collaboration with Huang Danian of the National Rice Research Institute in Hangzhou on a herbicide-resistant rice variety that is also awaiting government approval.

"The current process is so onerous that it can take 7 to 9 years to win approval," says Killmer, noting that Monsanto has tried unsuccessfully for 6 years to introduce the same Bt corn that is now growing in the United States. "And some corn hybrids have a life of only 3 to 4 years." Killmer says companies such as Monsanto currently have little incentive to push ahead with GM crops in China, in view of the almost-certain rejection of any application for a commercial license. He also dismisses the official explanation for the ban on new foreign investment: "The idea that it's for safety considerations doesn't wash," he says, because those considerations should apply equally to domestic activities.

GM CROPS THAT HAVE PASSED MUSTER

Approved in 1997

- Bt cotton (Monsanto)
- Bt cotton (Chinese Academy of Agricultural Sciences)
- Delayed-ripening tomato (Central China Agriculture University)
- Color-altered petunia (Beijing University)

Approved in 1998

- CMV-resistant sweet pepper (Beijing University)
- Tomato (Beijing University)

China's Bt cotton crop is the fourth largest in the world and the most successful of five species under cultivation (see table). Two species of GM rice—one herbicide tolerant and the other blast resistant—have been approved for field trials and environmental release, but Duan says the review for a commercial license could take quite a long time because of concerns about whether genes from the transgenic plants could spread to wild species.

While these debates play out, plant scientists are benefiting from the government's growing investment in research. The current Five-Year Plan projects a fivefold rise in spending on agbiotech research, to perhaps $500 million by the end of 2005, and some three dozen Chinese institutes are working on transgenic plant research. The

CREDITS: PHOTO BY ZHANG RUI/*CHINA FEATURES*; SOURCE: CHINA AGRICULTURAL UNIVERSITY

Beijing-Yale center, which officially opened 18 months ago, is riding that wave of support, says Deng: "We try to understand basic biology. And we focus on *Arabidopsis* and rice because it's a good model system as well as an important economic crop."

The recent ban on foreign investment doesn't affect Yale's participation in the center, Deng says, nor did it stop Monsanto this summer from pledging approximately $750,000 over 5 years to support the center's programs. "It's not considered an investment by a foreign company," notes Deng about the contribution, which he says will "strengthen an exchange program and lessen our dependence on university funds."

Despite the current impasse, both Deng and Killmer believe that properly licensed GM crops will one day be commonplace among China's 350 million peasant farmers. But they offer different reasons for their optimism. "They are facing a use-it-or-lose-it situation," says Killmer, referring to work by Chinese scientists, including discoveries based on the sequencing of the *indica* rice genome, that could wind up in the hands of foreign competitors. "And that may be the thing that breaks the logjam."

For Deng, it's a simple matter of waiting until the government decides the time is right: "In the long term, these GM crops will be approved [for commercial sale]. All of the scientists I know are optimistic. But I don't know how long it will take."

–DING YIMIN AND JEFFREY MERVIS

Ding Yimin writes for *China Features* in Beijing.

ARCHAEOLOGY

Armenia Uncovers a Bronze Age Treasure Trove

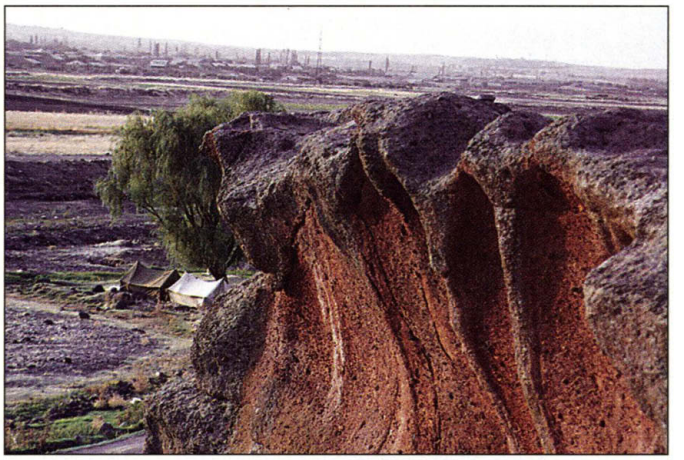
With the help of private money, Armenian researchers are unraveling a site full of impressive stonework and ritual artifacts

AGARAK, ARMENIA—From a distance, the cliff face and its curling overhang look like a giant wave about to break over the central Armenian plain. Up close, something more spellbinding comes into view: The lip of the 15-meter bluff sports what seems to be a meter-long, v-shaped ram's head, complete with coiling horns, chiseled from the volcanic rock. Farther along the edge, in eroded bas relief, are what looks like the nostrils and horns of a bull. A third, more deeply eroded feature might have been a dragon's head.

"Just look at it, it's beautiful," says Boris Gasparyan of the Institute of Archaeology and Ethnography (IAE) in Yerevan. In just two field seasons since excavations began here in Agarak, an Armenian team has uncovered a prodigious number of artifacts and mysterious carvings that promise to shed new light on the peoples of the Caucasus from the Early Bronze Age some 5000 years ago right up to the Middle Ages. "It's an incredibly important site," says Adam T. Smith, an archaeologist at the University of Chicago and one of the few Western experts to have visited Agarak. "A comparatively small portion of the site has been excavated, and yet the results are quite fantastic."

A few years ago, the site was on the verge of being lost forever. Just before the excavations started, a nearby quarry was planning to expand onto the site and extract the rock, known as tuff, a popular building material in the Caucasus. Fortuitously, Gasparyan had befriended Michael Gfoeller, then an official at the U.S. Embassy in Yerevan who also happens to be an archaeology buff. Gasparyan showed him around a number of Armenia's rich historical sites. "I realized that Armenia today is like Egypt in the 1820s: an undiscovered country of immense cultural wealth," Gfoeller recalls. Gasparyan similarly wowed Gfoeller's brother Joachim, a wealthy businessperson, during a visit. Joachim Gfoeller was so enthralled that he set up a foundation to support archaeological research in the impoverished nation.

Agarak was an obvious first project, says Gasparyan, now the foundation's local director. The cliff is hard to miss: Part of it was blasted away during construction of a road that passes within feet of the site, and fragments of Bronze Age pottery had also been found there. But once excavations started, even Gasparyan and his colleagues were astonished by the extent of the remains. In 2001, the dig team swelled to 100 at the height of the summer season. That many workers "is unheard of in this day and age," says anthropologist Philip Kohl, an expert on the Caucasus at Wellesley College in Massachusetts, who says the operation's scale is reminiscent of archaeology's golden age in the colonial era before World War II.



Spot the ram's head? Armenian archaeologists claim that this volcanic outcrop was worked by Early Bronze Age sculptors.

CREDIT: DMITRI ARKAKELYAN AND ARTHUR GYULGAZIAN

By the end of last summer, the huge team, led by IAE's Pavel Avetisyan, had peeled away the surface soil from nearly 5000 square meters of the site—still only a fraction of its claimed 200-hectare extent. "Agarak is notable for its sheer size," says Smith, who is co-leader of an excavation of Late Bronze Age fortresses in Armenia. If it is truly that large, says Kohl, who has not yet seen it, then "understanding and evaluating the significance of the site may take decades."

The Armenian team has found traces of intensive stone working: steps leading to niches carved into the cliffs, horseshoe-shaped cavities connected by channels cut into the tuff, and trapezoidal blocks. "The total expanse appears to have been carved, shaped, and molded to human life," says Smith, who adds that such features "suggest some sort of ritual installations, such as altars or other monuments."

The Armenian team has also begun unearthing the remains of stone houses clustered along a street, along with a bounty of terra cotta statuettes and ceramic artifacts linking the site to the Kuro-Araxes, a culture widespread in the Caucasus in the 29th to 27th centuries B.C. The researchers suggest that the bluff was an open-air temple, complete with housing for the priests. According to Smith, that's "an entirely reasonable starting hypothesis that will undoubtedly be subject to intense questioning as the research proceeds."

Although it might take decades to fix Agarak's position in the Kuro-Araxes culture, the site has already begun to spark vigorous debate. Some experts doubt, for instance, whether the bas relief heads along the cliff edge were carved by human hand. "I would have some reservations about the anthropic