Against the grain

China has long been a keen supporter of transgenic agriculture, and is still pouring money into developing the technology. So why are applications to market new genetically modified crops in limbo? Colin Macilwain investigates.

Last June, the *China Daily* — the English-language mouthpiece of the country's ruling Communist Party — published an article by Greenpeace, describing the alleged ecological risks posed by transgenic crops. It wasn't quite as though Amnesty International had been asked to write a piece on China's treatment of its political dissidents, but for those who are familiar with Beijing's official line on transgenic agriculture, it still marked a dramatic turnaround.

Since the mid-1980s, the Chinese government has ploughed hundreds of millions of dollars into developing the technology, and in the late 1990s it swiftly authorized the commercialization of a handful of transgenic crops. At that time, Chinese agriculture seemed to be on the highway to a genetically modified future. Indeed, at the lab bench, that is still the case: universities and government labs are bursting with ideas, talent and investment. "Plant science is a major activity, because it is so important to China," says Jiayang Li, director of the Chinese Academy of Sciences' Institute of Genetics and Developmental Biology in Beijing.

But in the past couple of years, agricultural biotechnology in the world's most populous nation has taken a detour into a cul-de-sac. No new transgenic food crop has been approved for commercial use since 2000 — although candidate crops continue to move into field trials. And given signals such as the Greenpeace article, the outlook for approvals seems to be worsening. "My personal view is that the current discussion is biased against agricultural biotechnology," says Zhixue Wang, the official in charge of the Ministry of Science and Technology's Rural Technology Development Centre in Beijing.

What's going on? It is hard, in a country that only allows free debate within carefully prescribed bounds, to put your finger on the answer. Chinese agribiotech researchers cite "public concerns" about biosafety, as well as doubts that export markets in Europe and elsewhere will accept genetically modified produce. But circumstances suggest an alternative explanation: that the Chinese government is exploiting the biosafety issue to frustrate the commercial ambitions of Western agribiotech firms, because it realizes that its own research programme needs more time to catch up.

Sowing the seeds: China's farmers (right) currently prefer high-yielding imported transgenic cotton to homegrown varieties. Anxious to avoid a similar situation prevailing for rice (above), the government is now investing heavily in research on the crop.

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The Greenpeace article, like much of the *China Daily*'s contents, carries a coded message. And in this case, that message seems to be: "Monsanto, keep out." The world's leading agribiotech firm, based in St Louis, Missouri, has already carved out a sizeable share of China's market for cotton seed, selling varieties that are engineered to produce an insecticidal toxin. And China's farmers — or at least those who can afford it — are prepared to pay a sizeable premium for the high-yielding Monsanto products, in preference to cheaper homegrown varieties.

Cornering the market

In the circumstances, say some Western observers, it makes sense for Beijing to close the door on new commercial approvals until its domestic products can compete effectively. In the meantime, at least viewed from an American perspective, China is using European public concerns about the safety of transgenic crops to keep imported varieties at bay. "China is trying to make major investments in biotechnology research," says Julia Moore of the Smithsonian Institution's Woodrow Wilson International Center for Scholars in Washington DC, who follows the global trade in transgenic crops. "But it is also taking advantage of biotechnology concerns in Europe and elsewhere to limit its imports of the technology."

Given the scientific effort that is currently under way in Beijing, one would hardly think that this is a country that is putting the brakes on transgenic agriculture. Research laboratories run by the Chinese Academy of Sciences and the Chinese Academy of Agricultural Sciences (CAAS), plus those at Peking University and the China Agricultural University, are well equipped and generously staffed. At Li's institute, for example, some 25 principal investigators and 300 other staff and students are engaged in plant science, mostly related to wheat and rice.

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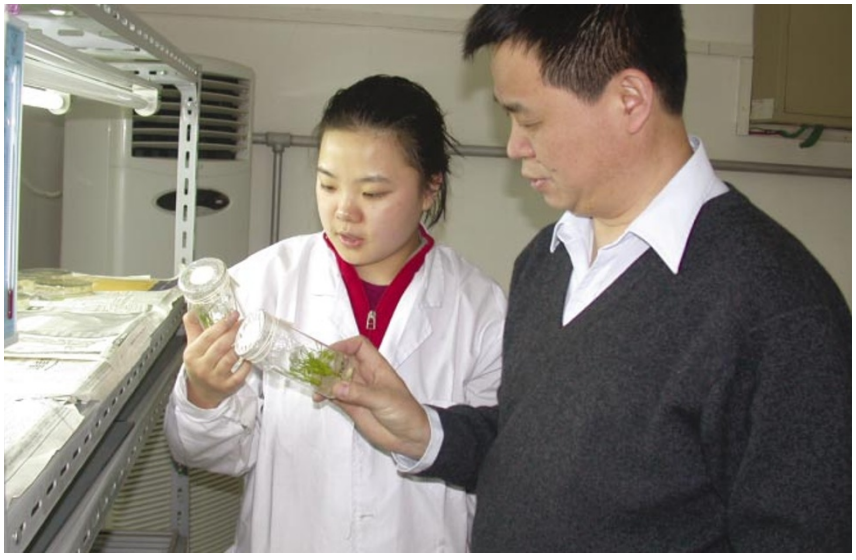

Jiayang Li (right) is unimpressed with agribiotech firms' reluctance to engage with Chinese researchers.

China has a long-standing relationship with transgenic technology: as far back as 1993, its farmers were growing genetically modified tobacco that was resistant to insect attack. But when Philip Morris, the US tobacco company, heard farmers boasting about the crop, they barred its purchase for use in their cigarettes. That episode, several researchers say, led to establishment of a formal approval system for genetically modified crops.

Under the system, transgenic crops that have been approved for sale include a tomato modified for increased shelf-life, and sweet peppers resistant to cauliflower mosaic virus. But in economic terms, by far the most important are several varieties of '*Bt*' cotton, which produce an insecticidal toxin derived from the bacterium *Bacillus thuringiensis*.

In the early 1990s, almost one-third of China's vast cotton crop was being lost to bollworm, the voracious caterpillar of the moth *Helicoverpa armigera*. In 1997, the government approved commercial planting of a variety of *Bt* cotton developed by Monsanto and designed to combat the pest. Since then, more *Bt* varieties, some from Monsanto, others produced by the CAAS and other domestic labs, have also won approval.

According to one survey published last year, farmers growing *Bt* varieties in 1999 reported yields that were 6% higher and production costs some 28% lower than farmers cultivating conventional cotton. Most strikingly, the transgenic farmers had slashed their use of synthetic pesticides by more than 80% (J. Huang, S. Rozelle, C. Pray and Q. Wang *Science* **295,** 674–676; 2002).

China's own *Bt* cotton varieties are subtly different from Monsanto's versions. Most *Bt* crops contain only one of two related *B. thuringiensis* genes, called *cry1Ab* and *cry1Ac*, but the Chinese varieties include both. The genes were also introduced using a different method. Like most transgenic crops, Monsanto's *Bt* cotton was made by bombarding plant tissue cultures with tiny particles of tungsten or gold coated with DNA containing the transgenes — a process patented by the seed company Pioneer Hi-Bred of Des Moines, Iowa. But the Chinese varieties were created using a different technique, which has not been published in the international literature but was patented in 1998. The method involves injecting DNA into the seed embryo in the plant ovary — through the tube created by the pollen that fertilized the ovum — within 24 hours of the cotton flowering.

Homegrown talent

This go-it-alone approach is a source of considerable pride for Chinese researchers. "China was the second country in the world to develop a genetically modified crop and get intellectual property rights to it," boasts Dafang Huang, director of the CAAS's Biotechnology Research Institute in Beijing. Today, 0.6 million hectares of the total Chinese crop of 4 million hectares consists of the homespun transgenic cotton.

Monsanto's products, however, account for a similar cultivated area — even though its seed is up to ten times costlier. The reason that farmers are prepared to pay a premium for the imported varieties, Chinese researchers admit, is their superior quality.

One solution would be for Chinese researchers to collaborate with Monsanto to address the country's agricultural needs. "In 1999 I held talks with the president of Monsanto in the Far East," recalls Wang, "and we hoped to use their expertise to develop crop varieties here in China." But neither Monsanto nor the Beijing government is a shrinking violet in the field of intellectual property negotiations, and the talks reached deadlock — leaving the company with near-pariah status among Chinese scientists. "Monsanto seems to want its products in China, but not its research," sniffs Li.

Li and other institute heads speak more warmly of Swiss-based Syngenta and Pioneer Hi-Bred, both of which have set up several collaborations with individual research groups. Even still, no Western firm has yet established a broad-based collaborative research agreement with a Chinese institution.

Most observers agree that the current hiatus in commercial approvals for transgenic crops is likely to deter Western agribiotech companies from broadening their links with Chinese labs. Such approvals are the responsibility of a subcommittee of the National Biosafety Committee, which meets twice a year. Its meetings are closed, and no account of its workings has been published since the brakes were put on new approvals. "At the moment it is difficult to get approved," says Guoying Wang, head of the molecular-biology department at the China Agricultural University and a member of the subcommittee, rather vaguely. "Most scientists support biotechnology but some scientists are opposed, including some senior scientists."

The subcommittee's decisions, at least in theory, are underpinned by a biosafety research programme that was launched in 2001. According to Yufa Peng, a plant pathologist at the Institute of Plant Protection in Beijing and the CAAS's chief scientist on the biosafety programme, the effort involves 125 researchers at 23 laboratories. It includes research into the ecological impact of transgene flow to crops' wild relatives, and the effects of transgenic agriculture on biodiversity.

Beijing's official policy, meanwhile, is deliberately equivocal. As Liu Xu, vice-president of the CAAS, puts it: "China will abide by the precautionary principle and substantial equivalence." The former is usually invoked to reject transgenic technology on grounds of caution; the latter implies acceptance on the grounds that transgenic crops are not significantly different to those produced by conventional breeding.

Conveniently enough, this ambiguity leaves China free to embrace the commercialization of transgenic crops once more, when it feels that its own technology can compete with Western imports. If this is the real reason for Beijing's current position, then the progress of China's research on rice may be the crucial factor. Already, Chinese researchers have published a draft genome sequence for the *indica* subspecies of rice (J. Yu *et al. Science* **296,** 79–92; 2002). The government is now investing heavily in rice functional genomics and in efforts to genetically engineer the crop. "Chinese institutions still have a lot to learn," says Huang. "But hopefully the situation with rice will be better than it was with cotton." ■

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