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PUBLIC AND PRIVATE COLLABORATION ON PLANT BIOTECHNOLOGY IN CHINA

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Public private collaboration in plant biotechnology is unusual in China because the private sector plays a very small role in the Chinese agricultural input industry. There are few public private collaborations and also some examples of collaboration between state-owned research institutes and state-owned commercial enterprises. Both types of collaborations are likely to grow in the future – particularly if the government allows private firms to play a larger role in the input industries, intellectual property rights on biotechnology are strengthened, and regulations on biotechnology are rationalized.

Key words: biotechnology; China; regulations; collaboration; private sector; state-owned enterprise; seed industry; research; Monsanto

One of the strengths of agricultural biotechnology in the United States (U.S.) and Europe has been the close collaboration between public and private institutions that conduct research and that are starting to commercialize biotechnology products. Many of the new biotechnology companies that have spun off from universities continue to work closely with them through individual contacts with former colleagues and through contract research. The large seed and chemical firms that work on agricultural biotechnology also have close links with U.S. universities and with the U.S. Department of Agriculture (USDA) research institutes through joint research programs, contract research, consulting by university scientists, and research consortia.

In the Chinese agricultural biotechnology industry collaboration is also important, but it takes a different form than in the United States. In China, which is in transition from a socialist to a market economy, private enterprise still plays a limited role.[1] Cooperatively owned enterprises, which operate much like private firms, make up the largest share of industrial production. State owned enterprises (SOEs) make up the next largest share of the economy. The SOEs are being pushed to be more "commercial" and some of them operate very much like private firms. In the agricultural sector private firms that conduct biotechnology research and commercialize new technology are almost all foreign. Foreign firms typically collaborate with local firms as Chinese law requires them to have a local joint venture partner and only certain types of SOEs can sell the seed of the major crops. Within the state sector agricultural research institutes are developing commercial enterprises,

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which are still state-owned, or are joining with existing SOEs to market agricultural inputs. In the future some of these inputs will be genetically engineered seed.

The objective of this paper is to review private and public collaborations in agricultural biotechnology in China, identify types of collaborations that have been successful to date, and policy changes that could make research collaborations more effective in the future. The paper starts with a review of the current state of agricultural biotechnology in China.

Commercial Plant Biotechnology In China

In 1988, China was the first country in the world to grow a genetically engineered crop commercially. A variety of tobacco which had resistance to tobacco mosaic virus was released in Liaoning province. Since then, tobacco varieties PK863 and PK893, which have virus resistance and the *Bacillus thuringiensis* (Bt) toxin gene, were released in Liaoning in 1992 (Ming *et al.*, 1997). These varieties used genes from the Beijing University. James (1997) reports that genetically engineered tobacco covered 1.6 million hectares in 1996. The transgenic tobacco yields 5 to 7 percent more leaves than older varieties and saves 2 to 3 sprays of insecticide (James, 1997).

The most high profile foreign biotechnology sold commercially in China is Monsanto and Delta and Pine Land's (MDP) cotton. An American cotton variety was genetically modified to contain the Bt gene that confers resistance to bollworms. It was planted commercially for the first time in 1998 on about 200,000 acres in Hebei Province. Yields of lint in 1997 on the 10,000 acres grown for seed were 1,125 kgs of lint per hectare compared to the provincial average of 825 kgs per hectare (Monsanto Far East Limited, July 24, 1998). Not only are yields higher but insecticide applications are reduced from at least 12 applications to just one, and the fiber is superior in strength and color to the local varieties.

As of June 1998 six transgenic varieties had been approved for commercial production. These include MDP's Bt cotton in Hebei Province and the Chinese Academy of Agricultural Sciences' (CAAS) Bt cotton. The Beijing University's virus resistant tomatoes, sweet peppers, and petunia with Chalcome Synthase have also been approved. The transgenic tobacco varieties, which have been in the field for many years, were not approved. A delayed ripening tomato from Huazhong Agricultural University is also approved for commercialization.

Plant Biotechnology Research In China

China has made a major investment in plant biotechnology research. Almost all biotechnology research in China has been conducted by public sector research organizations. These include institutes of the Chinese Academy of Science (CAS), the CAAS, provincial academies of agricultural sciences, general universities and agricultural universities. The only biotechnology research by private firms that we were able to identify in the summer of 1998 was by Monsanto on corn and soybeans, and MDP on cotton. The Chinese Academy of Science, CAAS and some universities are involved in basic research. Six institutes and universities have been working on a rice genome mapping project since the early 1990s. Both the universities and the academies are also involved in applied research targeting development of commercial transgenic crop varieties.

Data on field trials of transgenic crops provide insights on the type of applied research conducted in China.[2] In 1997, the first year of operation, the Chinese biosafety committee received 53 applications for trials or commercial releases of transgenic plants or plant related microbes.[3] The largest number of

trials approved were by institutes under the CAS, Beijing University, and the CAAS institutes (table 1). Monsanto was the only private international company that had field trials or commercial use approved. Notably, none of the provincial academies of science, which have the largest number of agricultural scientists, have made any applications for trials or commercialization. The field trials of five major field crops – rice, maize, soybean, cotton, and tobacco – and five horticultural crops – tomato, potato, green pepper, chili pepper, and a tropical fruit (table 2).

Table 1. Plant & Plant-related Bio-safety Applications, 1997.

Types of Institution	Pilot Experiments	Field Trials	Commercial Production
Private firm	2 (rejected)	4	1 (approved) 1 (rejected)
CAS	2	11	--
CAAS	3	8	1
Beijing University	--	9	1 (approved) 2 (rejected)
Other Universities	1 (approved) 1 (rejected)	1 (rejected)	1 (approved) 1 (rejected)
Other Academies	1	2	--
Total Applications	10 (3 rejected)	35 (1 rejected)	8 (4 rejected)

Note. Dashes indicate that no application was made. Chinese Biosafety Committee. Unpublished raw data.

Collaborations Between Public And Private Enterprises

The earliest public-commercial collaboration in biotechnology was between the University of Beijing and the government tobacco companies that led to the commercialization of transgenic tobacco. The university labs transformed standard tobacco varieties into varieties with virus and pest resistance, while government tobacco companies distributed seed to their growers.

The foreign seed companies and chemical companies that are now the international leaders in plant biotechnology entered China first with conventional products. The seed firms usually started working with public research institutes in the late 1980s and early 1990s. Pioneer conducted maize trials in collaboration with the Cereals Breeding Institute at CAAS. Delta and Pine Land had a collaborative research program with the Cotton Research Institute of CAAS, and Pacific Seeds (now part of Advanta) which worked on rapeseed and canola in a joint program with the provincial academy of agricultural sciences in Wuhan and also with the Australian government. None of these efforts produced varieties that were released either by the center or by provincial governments.

The second wave of entry by foreign firms into the seed business was in the form of joint ventures with provincial seed companies, with the China National Seed Industry Group, or with the provincial seed testing stations. Monsanto and Delta and Pine Land established a joint venture with the Hebei

Provincial Seed Company to sell transgenic cotton seed. DeKalb, Cargill, and Chai Tai (Charoan Pokphand) are all using this model to enter the conventional seed industry. Pioneer has set up a 100 percent owned research company, but will have to join with one or more government seed companies once it is ready to commercialize its products. Foreign companies continue to conduct contract research and varietal testing with public sector research institutes.

Table 2. Applications Approved for Field Testing or Commercialization of Transgenic Plants, 1997.

	Field Trials	Commercialization
Rice	6	--
Maize	2	--
Soybean	2	--
Cotton	7	2
Tobacco	4	--
Potato	6	--
Tomato	3	1
Green Pepper	1	--
Chili Pepper	1	--
Tropical fruit	1	--
Flower	--	1
Poplar tree	1	--
Total	34	4

Note. Dashes indicate that no application was made. Chinese Biosafety Committee. Unpublished raw data.

Two firms that are owned by leading plant breeding institutes also have the potential to evolve into plant biotechnology programs. Mr. Li Denghai, a nationally known government maize breeder at the LaiZhou Academy of Agricultural Sciences, which is a prefecture level research institute, has established a commercial hybrid seed firm in Shandong Province. It is owned by the LaiZhou Academy, and two county seed companies. Mr. Li already has a track record of producing commercial hybrids that are successful throughout northern China. The Hunan Hybrid Rice Research Center (HHRRC) also established a joint venture with the U.S. firm, Ricetec, in the late 1980s to developed markets for their hybrid rice in the Americas. This joint venture is now starting to develop Chinese markets. The HHRRC is using biotechnology to improve their rice hybrids. Other research institutes have also started seed firms with commercialization in mind but they have been hobbled by regulations and a lack of capital.

Monsanto had proposed a joint CAAS – Monsanto rice biotechnology research institute. However, CAAS could not obtain money to provide its share of the needed capital, and there were unresolved concerns about intellectual property rights (Director of Planning, CAAS, personal communication, June 2, 1997).

Which Collaborations Work Best?

There are only two collaborations that have successfully spread transgenic plants into farmers' fields. These are the Beijing University - National Tobacco Company program for mosaic and pest resistant tobacco and the MDP - Hebei government program on transgenic cotton. The Beijing University and MDP conducted the research and, in turn, the tobacco company and the Hebei seed company sold the product. There was little true collaborative research involved. In the case of cotton, the political power of the Vice-Governor of the province was important in helping the genetically engineered varieties through the regulatory process and into the field.

The local collaborations which appear to have some possibility of success in the future in developing and pushing transgenic varieties are the HHRRC – Ricetec collaboration and those between research institutes and seed companies, such as the one in Shandong.

Policy Changes Might Further Collaboration

Three policy changes might create a more productive environment for public and private collaboration in plant biotechnology. First, allowing the private sector to play a larger role in seed and chemical distribution would foster more private public collaboration, as there would be more private research and more seed firms for universities and public research institutes to collaborate with. At present only state-owned seed companies are allowed to sell seeds of the major field crops, and 80 percent of the pesticide industry is restricted to Chinese firms. Second, stronger intellectual property rights, such as including plants in patents and enforcement of existing plant breeders rights legislation, could also help increase collaboration. At present private firms are reluctant to work with public scientists and SOEs for fear they will lose control of proprietary technology. Government research institutes are hesitant to contract with SOEs to sell new plant varieties because in the past SOEs have stopped paying royalties. Thus, rather than collaborate, research institutes try to set up their own seed firms (Pray, Rozelle, & Huang, 1998). Finally, the Chinese regulatory system is susceptible to political and economic pressure especially since regulators now have to earn part of their income through commercial activities. Decisions to approve or disapprove new plant varieties and transgenic plants are not transparent and seem to be arbitrary or biased. Regulators need enough government financing so that they do not need to be involved in commercial enterprises with the firms they are supposed to regulate. A more transparent process, with safeguards against regulators who support special interests, might lead to collaborations based on science and economic efficiency rather than political connections.

Endnotes

[1] In 1994, private firms produced 12% of industrial output (if only individual owned firms are included) or 26% of industrial output if "other ownership" (which includes joint ownership, share holding ownership, and foreign ownership) is counted (State Statistical Bureau [SSB], 1995).

[2] According to new guidelines introduced in 1996, trials of transgenic plants in confinement and in the field must be approved by a national biosafety committee. Commercial release must also be approved by the biosafety committee.

[3] Before national guidelines and committees on biosafety were established, field trials were conducted and managed by each institution, and new genetically engineered varieties were released through the regular varietal release procedures. Field trials were conducted on wheat, rice, soybeans, cotton, corn, tobacco, potato, tomato, sweet peppers, papaya, cabbage, alfalfa, and potatoes (Jia, 1997). Transgenic varieties of tobacco and tomato were grown commercially before there were national guidelines.

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