

IDS Working Paper 207

**The biotech developmental state? Investigating the Chinese
gene revolution**

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September 2003

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Summary

China's experience with agricultural biotechnology has been dramatic. Many new technologies have been developed by public sector research institutes that rival the outputs of the major biotech corporations. This has happened in the context of policy processes and priority setting exercises that are articulated in terms of the provision of public goods. In many respects this model contrasts with other parts of the world where the private sector has been dominant. The paper looks at how and why China has so vigorously pursued this biotech path, looking in particular at the role of science-policy networks in promoting a biotechnology discourse. It also looks at the particular challenges associated with developing a domestic biotech industry while managing multinationals such as Monsanto. A central question is to what extent this experience is an example of the state acting "developmentally": steering both the private and public sectors to deliver public goods, and seizing the opportunities presented by a new technology while attempting to ensure that there is some level of social control over it. The paper asks: to what extent is China a biotech developmental state; and what are some of the challenges and limitations associated with this way of looking at the Chinese experience?

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Preface

Biotechnology Policy Series

This IDS Working Paper series emerges from a series of three interlinked projects. They involve collaboration between IDS and the Foundation for International Environmental Law and Development (FIELD) in the UK and partners in China (Center for Chinese Agricultural Policy (CCAP)), India (Centre for the Study of Developing Societies, Delhi; Research and Information Systems for the Non-Aligned and Other Developing Countries (RIS), Delhi; National Law School, Bangalore), Kenya (African Centre for Technology Studies, Nairobi) and Zimbabwe.

Three key questions guide the research programme:

- What influences the dynamics of policy-making in different local and national contexts, and with what implications for the rural poor?
- What role can mechanisms of international governance play in supporting the national efforts of developing countries to address food security concerns?
- How can policy processes become more inclusive and responsive to poor people's perspectives? What methods, processes and procedures are required to "democratise" biotechnology?

The work is funded by the UK Department for International Development (DfID) ('Biotechnology and the Policy Process in Developing Countries' and 'Globalisation and the International Governance of Modern Biotechnology') and the Rockefeller Foundation ('Democratising Biotechnology').

This paper is a product of the 'Biotechnology and the Policy Process in Developing Countries' project. Other papers in the Biotechnology Policy Series are listed inside the back cover.

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Abbreviations

BRI	Biotechnology Research Institute, Chinese Academy of Sciences, Beijing
<i>Bt</i>	<i>Bacillus Thuringiensis</i>
CAAS	Chinese Academy of Agricultural Sciences
CCAP	Centre for Chinese Agricultural Policy
CNCBD	Centre for Chinese Biotechnology Development
CNHRRRI	China National Hybrid Rice Research Institute
CPTI	Cowpea trypsin inhibitor
CRI	Cotton Research Institute
DPL	Delta and Pineland
GM	Genetic modification
IFI	International Financial Institution
IFPRI	International Food Policy Research Institute
ISAAA	International Service for the Acquisition of Agribiotech Applications
JV	Joint venture
MITI	Ministry for International Trade and Industry, Japan
MNC	Multinational corporation
MOA	Ministry of Agriculture
MOST	Ministry of Science and Technology
NIC	Newly Industrialising Country
OPV	Openly-pollinated variety
PVP	Plant Variety Protection
SDRC	State Development and Reform Commission
SEPA	State Environmental Protection Administration
UPOV	International Union for the Protection of New Varieties of Plants
WTO	World Trade Organisation

Solving tomorrow's agricultural problems in the end will come down to biotechnology, to relying on the most sophisticated technologies.

(Deng Xiaoping)¹

China's agricultural problems, grain problems must be solved by the Chinese people themselves. This means that agricultural science and technology must be greatly developed, and we must carry out a new agricultural science and technology revolution.

(Jiang Zemin)²

1 Introduction

The starting point for this paper is that something different has happened in China in relation to biotechnology,³ and that this is a story that needs both telling and analysing. China's experience with biotech has been dramatic, regardless of one's view of the desirability or otherwise of the technology. A lot has been achieved and this has international significance.⁴ Biotechnology is in most places essentially a private sector phenomenon; the public sector has a role, but the real investments and control of technology lie deep within the private sector. For many this is a problem: the social nature of food production, the fundamental importance of secure and safe food supplies, and the value of biodiversity and natural resources mean that a concentration of power in a few large multinationals is a matter of very serious concern. Many argue that technology is not neutral and who controls it is of central relevance to whether it is likely to be a good or bad thing for the poor. This perspective has been an important counterweight in the biotech debate to the strongly-articulated rhetoric that GM crops are essential to feed burgeoning, hungry populations as this century progresses.

China potentially presents a different scenario to this, as biotechnologies have overwhelmingly been developed by the public sector in the context of policy processes and priority setting exercises that are clearly linked in some sense to the provision of public goods such as economic development, food security and poverty reduction. These concerns are not shared by multinationals in the same way, there may in some instances be common interests, but in principle the process of technology development is fundamentally different, motivated by private profit concerns and not primarily with promoting any form of inclusive national development.

This being the case an exploration of the Chinese biotech experience, looking at how China's biotech industry has developed, and through what sort of policy process is critical. A central question is to what extent this apparently unique experience is an example of the state acting "developmentally"; steering both

¹ *Jiānglái nòngyè wèntí de chūlù, zhōngyū yào yǒu shèngwù gōngchéng lái jiējué, yào kào jiānduàn jìshù* (Author's translation).

² *Zhōngguó de nòngyè wèntí, liángshí wèntí, yào kào zhōngguó rén zìjǐ jiējué, zhè jiù yào qǐ wǒmen de nòngyè kējì bǐrán yǒu yìge dà de fāzhǎn, bǐrán yào jìnxíng xīn de nòngyè kējì gémíng.*

³ Biotechnology here refers in the main to agricultural biotechnology and principally to transgenic biotechnology – involving the transfer of genes often from different life forms and their insertion into novel plays in the genome – the complete set and structure of genes that make up any given life form. In the paper biotechnology and biotech are used interchangeably.

⁴ This is illustrated for instance by the great interest in Huang and colleagues paper in Science documenting China's biotech achievements (Huang *et al.* 2002b).

private and public sector to deliver public goods, seizing the opportunities presented by a new technology but attempting to ensure that there is some level of social control over it, and using it to promote development in terms of growth and poverty reduction. A serious concern for many who study the innovations that are happening globally around the production of crops and their transformation into food, and the value chains with which they are associated is that a process of consolidation is taking place. This consolidation means ever greater intensification and industrialisation of agriculture and food production for all but a few niche or small-scale markets. Biotechnology is an integral part of this, it annexes one of the means of production – seed – and moves it from the commons into private hands. In this respect it is feared that it cannot possibly benefit the poor, farmers will lose age-old rights to save seed, through the intellectual property regimes and – eventually – sterile seed technologies associated with GM crops, and will also see the genetic diversity on which their farming systems depend eroded through the monocultures associated with industrial agriculture.

For many commentators biotechnology is inherently exclusive and excluding, with developing countries largely unable to take advantage of biotechnology other than in the form of technologies aimed primarily at northern seed markets. The entry costs for poor nations to develop technology on their own terms are too high, and so they are only able to consume GM technologies produced elsewhere. This paper asks if the Chinese experience of scaling the great heights of this new technological domain in the context of very different institutional forms shows that alternatives exist.⁵ The idea of the developmental state is explored as a conceptual tool to explain this process of focused and rapid change. To what extent is China a biotech developmental state; and what are some of the challenges and limitations associated with this way of looking at the Chinese experience?

This research is based on fieldwork in China between 2000–2003.⁶ Interviews were conducted with over 100 different informants, all of whom can be considered “policy actors” to differing degrees. These included many varieties of scientist (molecular biologists, entomologists, ecologists, geneticists and plant breeders) researchers, bureaucrats, *Bt* cotton farmers and local level agricultural staff, employees in multinational corporations and directors and managers of Chinese private-sector biotech companies, seed

⁵ Biotechnology cannot of course be thought of apart from the issue of risk – environmental, to human health or socio-economic risk. These issues are largely not dealt with in this paper but are considered separately in Keeley (2003). The aim of this paper is to explore how the Chinese state has promoted biotechnology as a precondition for thinking about whether it might be possible to develop technologies with more social control than tends to be felt to be the case in this area. Issues of public participation are not dealt with directly.

⁶ This research was supported by the UK Department for International Development, ESCOR as part of the Biotechnology Policy Processes in Developing Countries project. The support and experience of research partners in China Huang Jikun and Hu Ruifa at the Centre for Chinese Agricultural Policy, Chinese Academy of Sciences, Beijing and Wang Qinfang, Biotechnology Research Institute, Chinese Academy of Agricultural Sciences, Beijing has been greatly appreciated. Thanks also to Bai Junfei at CCAP, and to Li Xiaoyun at the College of Rural Development, China Agricultural University, Beijing. Thanks too to Karen Brock, Peter Newell and Jillian Popkins for comments.

companies and NGOs.⁷ Quotes are not attributed directly in most instances to protect the confidentiality of informants.⁸

The paper is organised as follows. The next section introduces the idea of the developmental state and asks how far this idea might apply to what has been happening in China. The paper then looks at China's biotech achievements, and considers in what sense they are different from experiences elsewhere. The paper then explores different facets of how and why this developmental state has been able to promote strong development of biotechnology in China. Then it looks at some of the challenges facing biotech in China challenges that limit the effectiveness of this developmental state.

2 The developmental state and the policy process

Literature on the policy process suggests that to understand policy-making three broad approaches are possible: one that emphasises political economy and the interactions of state and civil society, and different interest groups; another examining the histories and practices linked to shifting discourses and how these shape and guide policy problems and courses of action; and a third giving primacy to the roles, and agency – or capacity to make a difference – of individual actors. To some extent these different perspectives, rooted in different schools and disciplines, can be integrated: it is possible to look at how actors make and shape discourses and interests whilst at the same time being constrained by them. This is the heart of the policy process and policy change.⁹ Thinking about the role of the state in the policy process is one key part of this – to what extent does the state act coherently, what discourses does it articulate, and what network of actors is it associated with? To what extent can some states be thought of as guiding policy processes developmentally, acting both with a greater level of coherence than states typically in developing countries are usually assumed to display? How do they promote sets of objectives that are developmental, either in the broadest definition of promoting economic growth, or more specifically in terms of reducing poverty?¹⁰

⁷ The research process was conducted in Beijing, Shanghai and the following provinces: Anhui, Fujian, Guangdong, Hebei, Henan, Hunan, Hubei and Jiangsu. Visits to discuss with farmers and county level officials also took place in Xinxiang prefecture and city, Henan, and Susong and Wangjiang counties in Anhui. The interviews were conducted by the author in Chinese and English.

⁸ The paper uses a lot of quotes, the aim as far as possible has been to allow informants to speak. Given the sensitivity of some of the issues discussed, and the fact that some people did not want their comments attributed I have decided to opt for anonymity while indicating the institutional or type of position held by the informant where possible, and when the interview took place.

⁹ For further elaboration see Keeley and Scoones (2003).

¹⁰ This is a tension in the developmental state literature – promoting aggregate GDP growth perhaps through successful industrialisation in key sectors can be an unequalising experience and can have negative effects on poverty reduction. The evidence in the East Asian developmental states literature is that growth – given relatively equal starting points illustrated by low Gini coefficients – proceeds in a more equal fashion than in other places such as Latin America. There is some trickle down, and there are spillovers.

What is the developmental state, and why is it interesting? The idea of a central role for the state in development has a long history and dates back to Gerschenkron and accounts of the Soviet catch-up with the West, through to post-war planning models associated with import-substitution industrialisation and careful economic controls. When transformations predicted in these models failed to materialise for most of the “third world” in the way that had been hoped, a new consensus emerged, articulating in the context of widely perceived crisis – negative economic growth rates, chronic debt and increasing poverty – a different view of the role of the state in development. This narrative, linked primarily to international financial institutions suggested that the state was not – as had been imagined – the solution, but the problem. Development would come through less state not more: less bureaucracy, less intervention, and less regulation. Rather than look closely at the nature of the international capitalist system with its booms and slumps, debt and inequality, the IFIs and governments supporting them chose to argue for longer-term restructuring of economies and short-term solutions to financial constraints through the application of market principles and laissez-faire economics.

While this process of restructuring in the 1980s and 1990s was underway it was noticed that a very small number of poor nations had experienced dramatic shifts, managing to significantly increase their per capita GNPs and industrialise, changing into modern capitalist economies. According to some definitions they had “developed” (World Bank 1993). A glut of studies then followed on how these countries had got it right, concentrating on analysing macroeconomic performance and also the trail-blazing role of particular key industries nuzzling their way into very high-value niches in the world economy.

But were these interpretations correct? Following the initial studies that took the transformation of NICs as clear evidence of the correctness of the prescriptions of the so-called Washington Consensus a series of empirically detailed studies emerged that argued that actually something rather different had been at work, and that the core of it was something by this time very off-topic, namely an interventionist state. But this was not the heavy-handed interventionist state of neo-liberal nightmares, rather it was a state that planned carefully to achieve certain strategic objectives, identifying key sectors for growth and industrialisation, protecting infant industries, channelling investment, actively intervening in the market through tax and interest rate policies and even offering targeted subsidies (Amsden 1989; White 1988; Wade 1990; Blecher and Shue 1996 and 2001).

But how did the state manage to perform the apparently unlikely feat of nurturing economies or particular industries through the use of particular policy levers without falling prey to the corruption, rent-seeking, and straight-forward bad choices that many predict and find ample evidence of in the bureaucratic actors that the state is comprised of? The answer according to Evans (1995) is “embedded autonomy”: effective states are embedded in society, where there are enough links to make state actors

responsible and accountable, but they are also autonomous enough to see the bigger picture and make necessary hard choices, avoiding becoming a prisoner of the interests of a few powerful groups.¹¹

How does this idea of the developmental state work in relation to China? Clearly the Chinese state has sought to control very carefully the process of transition. Crudely, China learnt from the experience of the former USSR and managed its reform process slowly and stealthily: for example, through creation of Special Economic Zones; gradual reform of state-owned enterprises – many are still in the process of change; not having an open capital account as IFI theory would have dictated, meaning China was arguably insulated from the worst effects of the East Asian crisis; state sponsorship of Town and Village Enterprises at the local level as a motor of economic growth and demand; and judiciously paced change in agriculture: while decollectivisation was rapid, other agricultural policy reforms have taken place more slowly.

Most writing on the developmental state in China, however, has concentrated on particular localities, looking at why particular county governments have acted effectively as mini-developmental states creating conditions for growth without engaging in business directly (Oi 1999; Blecher and Shue 1996 and 2001). Take the example of Xinji county going into fur and leather goods documented by Blecher and Shue, they argue that local government used ‘the full panoply of developmental state levers to push that sector to prominence’ (2001: 370), including establishing an industrial park, encouraging investment, tax breaks, and using urban planning functions. In other instances the state does actually engage in profit-seeking behaviour directly with particular bureaux taking risks and creating and running companies, for example. Here the state is conceptualised as “entrepreneurial” rather than “developmental” (Duckett 1998: 14–15; Blecher 1991).

Biotechnology in China fits the pattern less of the small locality transforming itself and more of the sectoral strategy, and in this sense there is the echo of the work of MITI in Japan, or the support for automobiles or semi-conductors in South Korea. But there are immediately complications: biotechnology in China is not yet about supporting the large *keiretsu* and *chaebol*, the industrial combines that dominate the industrial landscape in those East Asian countries, and it happens in a context of transition from a centrally-planned economy with almost no private sector only a few decades ago, as opposed to settings where the private sector has always been there, and the big story has been about its transformation.

Furthermore biotechnology is a very different sector to automobiles: most people accept cars, many don’t accept GM crops. The research side of biotechnology is in some ways everything: it can be seen as a frontier of innovation that does not have a clear endpoint, whereas for other sectors this has been less

¹¹ Kang has recently elaborated this idea of different types of balance between interest groups and state capacity in relation to South Korea (2002). He argues that the South Korean experience shows that the idea of ‘Weberian bureaucracies autonomous from political and social interference’ is in fact a myth, and that the state was developmental in this instance *despite* high-levels of corruption (Kang 2002: 78). He notes: ‘A “hard” view of the developmental state – that the state is neutral, picks winners, and provides public goods because the civil service is insulated from social influences – is difficult to sustain empirically.’ (Kang 2002: 178). In relation to China successes have definitely happened alongside widespread and large-scale corruption, indeed misuse of state funds and state authority is one of the most widely acknowledged and serious of contemporary Chinese political problems (see Hu 2001).

obviously the case. A key part of the story in relation to biotechnology is how research becomes practice, and moves from laboratories to commercial products. This part of innovation, alongside the “front-end” process of doing the science, is key to thinking about what a developmental state might mean in this area and what the challenges associated with it might be.

Another concern is that development as conceived in the vision of the developmental state is often a limited concept: it is top-down, it is about economic growth, cutting-edge industrial sectors, and about GNP per capita. It hasn't always been about pro-poor growth, or participation of the poor in defining trajectories and processes of change. This matters in relation to biotechnology and needs to be held in mind. A biotech developmental state needs to be more than one that succeeds in this industrial sector, it has also to be about the provision of public goods which include poverty alleviation and sustainable agricultural development and food security, as defined by the poor themselves.

The Chinese experience that this paper sets out to explain has, then, to be judged by two sets of criteria: is it different in the sense of governing the market and successfully picking a winner, and is it different in the sense of using a technology in a more democratic, pro-poor fashion than dominant private-sector led models?

3 A biotechnology discourse?

3.1 China's biotech achievements

So what exactly has China achieved so far in the biotechnology field? China was the first country to commercialise a GM crop: virus-resistant tobacco in 1988, and has to date four different GM plants in commercial production (cotton, petunias, tomato and sweet peppers). While the overall size of commercialised GM area in China is less than 1 per cent of the total global acreage,¹² it is nevertheless the fourth largest in the world. Genetic modification has been carried out, and field trials or environmental release testing is underway for 16 different plants, including rice, maize, wheat, cotton, soyabeans, peanuts and tomatoes; and for traits such as insect, disease and herbicide resistance, shelf-life improvement, and cold and salt tolerance. Between 1997 and 2000 over 250 applications for field trials, environmental release or commercialisation were approved.

Expenditure on agricultural biotechnology was US \$112 m in 1999 (India by contrast reaches only 20 per cent of this), and the plan is to increase public expenditure on biotech to US \$ 500 m by 2005, topping US government spending (Huang *et al.* 2002; Monsanto 2002a).¹³ This amounts to one fourth of public spending globally (Huang and Wang 2003: 16). More than 150 laboratories are doing agricultural biotechnology research, and there are over 1,600 researchers in 29 key institutes, and as many as 2,000 researchers altogether nationwide (Huang and Wang 2001). For 22 core institutes funding increased by 30

¹² US is 68 per cent.

¹³ According to a report in *Peoples Daily* (26 August 2002), total biotechnology sales (presumably including pharmaceuticals but not specified) in 2000 were worth 20 billion yuan (about US\$2.4 billion), compared with 260 million yuan (about US\$31 million) in 1986.

per cent between 1995–9, from 32.7 m RMB to 92.8 m RMB (US \$ 4m to 11.3m) (Huang 2002a: 162).¹⁴ One of these institutes was the first in the world to decode the rice genome in 2001.¹⁵

The only GM crop commercialised on a wide-scale is *Bt* cotton, which was first approved for sale in 1997. It is now grown over an area of 5.5m *mu*, or 1.5m hectares in 2001, which amounts to 35 per cent of the cotton area, in several different provinces.¹⁶ In the provinces around the Yellow River in the northern part of China take up is as high as 75 per cent according to Xue (2002), and is even reckoned on other estimates to be nearer to 97 per cent in some provinces. There were 5 million farmers using the technology in 2001 (Huang *et al.* 2002c: 2). A significant proportion of this is *Bt* cotton coming from Chinese research institutes, and was developed using the Chinese developed pollen-pathway transformation method. Altogether *Bt* cotton has been approved in nine provinces.¹⁷

Research by Huang Jikun, Hu Ruifa and their team of agricultural economists at the Chinese Centre for Agricultural Policy presents very positive developmental impacts for *Bt* cotton; these include major improvements in production efficiency, environmental benefits, and contributions to poverty reduction. Pesticide sprayings, previously very intensive, have declined from 15–20 to 1–2 sprayings per season (Jia and Peng statement, 2002). Huang *et al.* present data showing that the cost of producing a kilogramme of cotton has reduced by 28 per cent from \$2.23 to \$1.61; that yields have increased by about 10 per cent; that where farmers use *Bt* cotton they are US\$140 per hectare better off, and that deaths of cotton farmers due to pesticide poisoning (a common occurrence in China) have decreased (2002d). This data has aroused considerable international interest. These figures, and the arguments they support, are frequently cited by key figures in the international biotech and food and farming policy networks, such as Clive James (Chairman of the ISAAA) and Per Pinstrup-Anderson (former Director General of IFPRI).¹⁸ Monsanto publicise in a recent newsletter that Chinese *Bt* cotton has ‘cut the use of pesticides by 80 per cent, reducing production costs by a whopping 28 per cent’ (Monsanto 2002a).

China’s biotech programme is presented as having a developmental focus that makes the experience quite different to what is happening elsewhere. ‘China is accelerating investments in agricultural research and is focusing on commodities that have been ignored in the laboratories of industrialized countries. Small farmers have begun to adopt GE crops when permitted to do so.’ (Huang *et al.* 2002b: 674). They argue that ‘the public dominated research system has given China’s researchers a strong incentive to produce crops that increase yields and prevent pest outbreaks’ (2002b: 675). In contrast to the experience

¹⁴ One US dollar equals 8.2 RMB, or Chinese yuan (Y).

¹⁵ A separate research effort by Syngenta also achieved this, and published its results at the same time.

¹⁶ Cotton is an important crop for China with annual production in the region of 450–500 tonnes, 25 per cent of world production (Mo 2001b).

¹⁷ Five transgenic OPV and one hybrid approved by 2002 (Huang 2002c: 6).

¹⁸ ‘[Clive James] said independent studies in 1999 estimated economic advantages from *Bt* crops totalled \$700 million, which had been shared by two million farmers. It included some \$140 million for *Bt* cotton farmers in China.’ (Reuters News Service, Singapore, 17 Dec 2001). For Per Pinstrup Anderson see a talk given at ODI, London (www.odi.org.uk/speeches/pinstrup.html). ISAAA is the International Service for the Acquisition of Agribiotech Applications, a foundation which facilitates the transfer of GM technologies to developing countries. IFPRI is the International Food Policy Research Institute, based in Washington, and the influential agricultural and food policy wing of the Consultative Group on International Agricultural Research.

of industrialised countries, where 45 per cent of the approvals for field trials are for herbicide tolerant or quality improved varieties, and only 19 per cent for insect resistance, in China, 90 per cent of field trials target insect and disease resistance (Huang *et al.* 2002b: 675). Added to this a strong case is made that there are no significant opportunity costs associated with China's biotech programme. Huang and colleagues argue that 'as *Bt* cotton spreads the social benefits from this crop will easily pay for all of China's past biotech expenditures on all crops' (2002b: 676).

A case can also be made that this is a form of pro-poor biotech, though this is of course a notoriously difficult term to define, and for some it can only be an oxymoron (if claims about property rights and risks associated with input costs and genetic erosion are shown to be true). This is one of the things about Chinese developmental state biotech – if that is indeed what it is – that makes it different and interesting. For many, a clear case is made about gains to cotton farmers in terms of reduced costs.¹⁹ According to a Monsanto representative the value created through use of their Bollgard cotton in China was distributed as follows: 60 per cent for the farmer (yield, insecticide and labour); 27 per cent Monsanto; 7 per cent JV partner; and 6 per cent to the distribution channel.²⁰ Another factor is that less farmers experience the negative effects of pesticide use (ill-health, even in some cases death). These arguments suggest that biotech has been developed in way that may offer more to poor farmers than is the case in the dominant agribusiness model.

A central plank of this case is that there is an emphasis on techniques and traits not stressed by MNCs because of low returns, or weak proprietary rights. In line with this, drought resistance and salinity tolerance are being researched at places such as the Chinese National Rice Research Institute, for example. The table below presents some basic information on what traits are being researched in relation to GM rice, and the degree to which they might be considered "pro-poor" (noting of course that many assumptions are involved in making such linkages). According to Huang and Wang stress-tolerance (particularly resistance to drought) are increasing as a priority of MOST and are now accorded as large a share of research resources as disease or insect resistance (Huang and Wang 2003: 8). Other researchers interviewed were more sceptical about this though: 'drought-tolerance is too complicated, no one is doing this. It's disease, insect resistance, protein-enhancement and golden rice.'²¹ Not all flagship efforts to address agronomic challenges involve transgenics: for example, the Super Rice programme to improve yield and quality of hybrid rice, a high-profile programme of the High Tech 863 programme. The basic principle of China's biotechnology research is to concentrate on the five key crops ("*wu da zuomu*": cotton,

¹⁹ Huang argues that *Bt* cotton benefits poor farmers more than rich through larger increases in net income than for larger farms with higher income (Huang 2002a: 177).

²⁰ Interview, Beijing, 2001.

²¹ Researcher working on ecological impact of GM crops, Fudan University, Shanghai, 2003.

maize, rice, wheat and soyabeans). Although these are not the crops in which China has an advantage in international agricultural markets, according to Huang they are priorities in relation to aggregate food security.

Table 3.1 Research on GM rice

GM Rice – different traits	Potentially “pro-poor”?	Priority in China	Results
Herbicide-tolerance	Less	No	?
Insect	Yes/no	Yes	Yes
Disease	Yes/no	Yes	Yes
Quality	Less (aimed at consumers)	Yes	?
Vitamin A + others	Yes	?	?
Salinity	Yes?	Yes	Limited
Drought-tolerant	Yes?	Yes	Limited
Soil-fertility	Yes	??	??

However, Huang *et al.* in an overview study of agricultural research in China note a general concern that changes in research funding policy have led to concentration on areas that offer higher returns, and perhaps under-investment in issues of poverty reduction food security and environmental sustainability (2002a). Also, the 863 programme is now increasingly prioritising more basic research such as genomics and bioinformatics; these fields could lead to successful identification of many new traits, including complex traits for minor crops, although this is far from inevitable.

4 Why biotechnology in China?

4.1 Understanding the appeal of biotechnology

This section will illustrate why a biotechnology policy narrative has been appealing to Chinese policy-makers, and argues that the way it is presented is developmental in the sense of seeking to provide public goods, and in imagining a strong and guiding role for the state in steering the course of innovation. The attraction of biotechnology can be seen to work on a number of levels: biotechnology is a cutting-edge industry, but it also addresses food security, and agricultural productivity concerns; offering bold answers to this combination of objectives is very important. Rural livelihoods and the – to some extent interlinked – question of how to deal with agriculture lie at the heart of contemporary Chinese policy debate. A key question has been: ‘what to do about China’s farmers?’ In fact this was exactly the question posed by the former Premier Zhu Rongji in his 2002 report to the National People’s Congress, a subject he described in frank terms as his “biggest headache”. This level of political prioritisation has meant the so-called three *nongs*: “*nongye, nongchan, nongmin*” (agricultural industry, agricultural production and farmers) has become a key policy slogan, and a focus of state media interest.

An interest in biotechnology also builds on strong traditions of agricultural research in China. Green Revolution narratives have been particularly important. Technology has been a key source of growth alongside institutional and price reforms, although perhaps in recent times it has received less attention by comparison with the emphasis placed on market reforms. It is often forgotten that China was the first nation to extend semi-dwarf rice varieties and drought and pest resistant wheat cultivars in the 1950s (Huang 2002a: 129). These were followed by hybrid maize in the 1960s and the very first hybrid rice cultivars in the 1970s. Hybrids from the prestigious Hunan [now China] Hybrid Rice Research Institute covered half the area of cultivated rice by 1990 (Lin 1991 quoted in Huang 2000a: 4). Nevertheless, strong arguments have been made that, while research has been key to maintaining total factor productivity in agriculture, returns in recent years have been declining. Such a case leads to an emphasis on new, more promising areas of research, given limitations in traditional avenues. Research institutes are also very crop oriented (Huang 2002a: 144). The model of research is one of getting winning new varieties out to farmers, and biotechnology can be seen as an extension of this through yield increases and a variety focused approach. Some fear that one consequence of this is that rather less emphasis is perhaps placed on integrated farming systems or livelihoods-based approaches.

The geopolitics of crops is an increasingly recognised theme in recent social science literature on plant-breeding (Perkins 1997; Richards). The support of the US Ford and Rockefeller Foundations for the Green Revolution India has been presented as a key part of the Cold War. When Richard Nixon visited China in 1972 on his critical détente mission Norman Borlaug also accompanied him, underlying the importance of agricultural science to international relations at that time (ibid.). In more recent years the Rockefeller Rice Biotechnology Programme has played a key role in building Chinese capacity.

Food security has long been a central policy priority in terms both of availability and stability of supply. The experience of famine is within living memory for many Chinese, and one of the key achievements and planks on which the legitimacy of the Chinese Communist Party rests is the claim to have largely solved the overwhelming chronic food insecurity problem of pre-liberation China.²² Huang *et al.* comment: ‘only when the Chinese people are free from food availability and stability of supply worries can they concentrate on current reforms, and ensure sustained, rapid and healthy development of the economy’ (2002a: 50). In a recent report looking at agricultural research options commenting on policy choices they note that ‘any changes (including trade liberalisation) that might lower the grain self-sufficiency level below 95 per cent in the long-term would get little support from the current leadership.’ (ibid: 180). Complete agricultural trade liberalisation, the same report notes, is predicted to drop grain self-sufficiency to 88.4 per cent by 2005. The only way to meet this policy goal with agricultural liberalisation is

²² For a feel of the of the precarious nature of rural food security in pre-1949 China see P. Buck *The Good Earth* and the writings of the English social historian R.H. Tawney who commented after a visit to China in the 1930s that: ‘the Chinese peasant stands in water up to his head, a single ripple will drown him.’ Famine for instance is widely perceived to be an exclusively African or South Asian phenomena. However, there have been more famine deaths in China in the last 50 years than in all of SE and S Asia and Africa throughout the twentieth century. Four million in Africa, 4 million in South Asia, 5 million SE Asia, and over 20 million in the famine that followed the Great Leap Forward (Buck 1937; Becker 1997; Devereux 2000; Tawney 1932).

to have a 50 per cent increase over expected rise in agricultural research expenditure (ibid: 181). Consequently, ‘China is pinning a lot of its hopes on raising agricultural productivity from breakthroughs in agricultural biotechnology and other modern science fields (State Council 2000)’ (ibid: 212).

An official in the Ministry of Science and Technology in discussion made a similar argument: ‘Many leaders think that biotech is the most important field of high-tech. Because of population size, cultivated area is limited. They worry about how to solve the food problem. Hence the need to industrialise agriculture. But we need to be careful about the environment – so we go for biotechnology.’²³

Arguments are also made about biotechnology using data that claim to show that, under certain sets of assumptions, it is an unquestionably profitable activity, with returns clearly outweighing the costs of investments. The argument is made in relation to commercialisation of GM rice, the crop that China’s biotech advocates hope will be the next to be commercialised: ‘the annual welfare gains amount to an additional income of about 5 billion US\$ by 2010. The estimated welfare gains far outweigh the public biotech research expenditures’ (Huang *et al.* 2002c: 1).

These arguments also have a more urgent edge in the context of WTO entry and the pressures of globalisation. The storyline is that science is needed in order not to lose the race where some of the old tools such as subsidies and trade walls become ineffective or prohibited: ‘WTO will definitely have a big impact; protection will decline, and we will need to rely on science to compete’, argued scientists in the China National Hybrid Rice Research Institute.²⁴

5 How has biotechnology come to prominence?

5.1 The 863 programme

The problems of agriculture shall be solved by science and technology.

(Deng Xiaoping)

Develop high technology and realise industrialisation of agriculture.

(Deng Xiaoping)²⁵

Biotechnology and GM crops have appealed to Chinese policymakers for a number of reasons. How these arguments were made and how this has worked in institutional terms are important questions. The primary role of the public sector in deciding to pursue biotechnology, guiding investment and vigorously promoting the new technology is central to the Chinese story. Responsibility for agricultural biotechnology in China falls across several ministries. The most important of these is the Ministry of Science and Technology (MOST),²⁶ a central ministry equivalent in rank to the Ministry of Finance and

²³ Interview, CNCBD, MOST, 2003.

²⁴ Interview, Hunan, 2002.

²⁵ Han (2001: 2).

²⁶ Before 1998 MOST was the State Science and Technology Commission.

the State Development and Reform Commission. MOST funds scientific research in a number of ways including through support to a series of National Key Laboratories (see Huang and Wang 2003 for more details) and a system of competitive tendering for biotech research grants. It also develops science and technology policy. MOST has always had a key role together with Ministry of Agriculture (MOA) in writing the research part of the five-year plans, the route through which most financial support to agricultural research is allocated (Huang 2002a: 147). At provincial level funds come directly from Provincial Science and Technology Commissions; indeed provincial level Academies of Agricultural Science are under the STCs, rather than agricultural bureaux.²⁷

One of the key bodies through which MOST operates is the 863 programme, also known as the National High-Tech Programme. This programme concentrates on applied science and was started in March 1986 after a group of four scientists persuaded Deng Xiaoping that major investment in science and technology research and development was vital if the Four Modernisations²⁸ were to be realised, and China were not to fall far behind the West.

China's rush to genetic crops is part of a broader effort to co-opt the new science as China's own before it is dominated by the West, as has occurred with other technologies. The initiative dates from the Reagan-era Strategic Defense Initiative, which poured billions of dollars into high-technology research in the 80's with the goal of building a space-based missile-defense system. Startled by the prospect that America would forever dominate the planet because of its superior technology, Deng Xiaoping called for a Chinese response. A result was the 863 Project . . . Beijing called in its top scientists from around the world and set them working on seven broad areas. Genetic engineering was at the top of the list. Since then, the double helix has replaced the atom as the symbol of the modernization drive.

(New York Times 2000)

The importance of this change, and of top level endorsement, cannot be underestimated; while nuclear science and the science underpinning heavy industry were key parts of the ideology of the new Chinese state much as they were for Nehru's India, scientists have not had an easy ride in modern China. Only 15 years before 863 was formed, for instance, scientists were being labelled as class enemies and being sent to the countryside for political re-education. Nevertheless since 1986 a vision of a biotech future has been an integral part of China's plans for modernisation.²⁹ The 863 programme receives substantial coverage

²⁷ The national level Chinese Academy of Agricultural Sciences is under MOA.

²⁸ These are modernisation of agriculture, industry, science and technology and defence. Under the Four Modernisations policy, science would be the route to socialism with Chinese characteristics, not mass movements as in the past.

²⁹ The 863 programme prioritises biotechnology, information technology, aerospace, laser technology, automation, energy and new materials. According to report in *China Daily* 2 September 2002: 'The projects are believed to have significantly narrowed the gap between China and the rest of the world in a wide range of research areas and "in certain areas, (China) has taken the lead," according to a report from MOST.'

through the official media in China, and details of its achievements are only a couple of clicks away on the *People's Daily* homepage.

A Chinese scientist interviewed for this research put the nationalist case very clearly.

We can't have seeds controlled by the US. It's too dangerous, more dangerous than other weapons is the control of the seed industry. It is easy to control the Chinese seed industry. The Chinese government realises this . . . We are not afraid of US missiles, but we are afraid of this. Imported seed could be very expensive and controlled by a few companies. We worry that they won't supply us at a regular price, but we will still have to eat every day! Seeds are not the same as batteries!³⁰

Funds allocated to the 863 programme have been very significant. The first 15 years of the programme coincided with the 7th, 8th and 9th Five Year Plans, during which time 11 billion RMB (US \$ 1.3m) was allocated, with 1.4 billion going on biotechnology. 863 has now been extended to coincide with the 10th Five Year Plan. For this period 15 billion RMB (US \$ 1.8m) has been allocated, with 3 billion RMB going to biotechnology and 50 per cent of that to agriculture.³¹

While the 863 committee is the most prestigious by a long way, a range of other sources of funding for biotechnology are also available, again indicating the strong commitment of the Chinese government to the technology. These include the National Natural Science Foundation, the 973 basic research programme, and the Special Science and Technology Foundation directly under MOST (actually allocated by MOA); there is also the Special Foundation for Transgenic Plants, the Bridge Plan and the Key Engineering Plan (see Huang and Wang 2003). There have also been significant strategic overseas sources of finance, such as the Rockefeller Rice Biotechnology Programme noted earlier, from which China has benefited.

There has been a clear nationalist edge to China's biotech programme, and this can be seen in relation to the pride associated with achievements like decoding of the rice genome, and also in the way that Biocentury – the company promoted by 863 to commercialise *Bt* cotton (discussed below) – and the Biotechnology Research Institute present their biotech achievements; their promotional material, for example, notes that China is the 'second country who successfully obtains transgenic insect-resistant cotton with fully synthesised *Bt* gene . . . The first time in the world successfully synthesised the double-gene transgenic insect-resistant cotton with *Bt* and CPTI genes.'³²

5.2 Science-policy networks: the influence of biotech scientists

In understanding how the Chinese state has promoted biotechnology it is important to emphasise that individuals matter: individuals such as Deng Xiaoping, the scientists who persuaded him of the need for a massive catch-up research endeavour, and the scientists and policymakers today who carry out research

³⁰ Biotechnologist, Zhejiang University, 2002.

³¹ These figures come from discussions with officials in the CNCBD in the MOST, 2003.

³² Biocentury publicity material, 2002.

and make decisions about biotechnology. Networks of actors have clearly been important at all stages in developing biotech in China. The close networks between biotech scientists, funders, regulators and bureaucrats in ministries such as agriculture and biotechnology have been particularly significant.³³

One of the ways of understanding the biotech developmental state in more detail is to look more closely at the science-policy networks that lie at its core. Looking at individual actors carrying out multiple roles, it is possible to see that research, development, commercialisation and regulation of technology overlap in quite fundamental ways, with important implications for the developmental state.

A brief biography of Chen Zhangliang, the scientist quoted earlier expounding on the coming biotech revolution in Chinese agriculture, illustrates the importance of key science-business-policy actors. Chen is President of China Agricultural University (and former Vice President of Beijing University) and Director of the National Laboratory of Genetic Engineering in Beijing. He has been at the heart of the 863 Programme from its earliest days: 'Among the people summoned by Mr Deng was Chen Zhangliang, who was working in a Monsanto-financed laboratory at the University of St. Louis. He was put in charge of developing transgenic plants other than cotton.'³⁴ Chen is the youngest ever professor in China (at the age of 27), he holds a US PhD and is a Global Leader of Tomorrow of the Davos World Economic Forum. He was also responsible for developing GM tobacco, the world's first GM crop, which was later withdrawn because of fear of that China would lose access to international markets. More recently he has developed transgenic peppers.

In addition to managing the biotechnology component of the 863 programme, which channels funding, guides research and supports the commercialisation of research, Chen is the director of seven listed companies in both Hong Kong and Mainland.³⁵ One of these companies developed the first Chinese pharmaceuticals using interferon for treatment of hepatitis.

A description from the website of Keming Bioengineering Company of one of Chen's close colleagues, Pan Aihua, gives more of the flavour of this type of multi-functional scientist-policy actor.

As a business savvy scientist and an entrepreneur of scientific wit, Pan has worked miracles within a few years. In 1992, with the 400,000 yuan he had borrowed from Beijing University, he and Dr Chen Zhangliang founded PKU Weiming Bio-engineering co., in a small office. The company has since become the biggest biological hi-tech company group in China with . . . net assets of hundreds of millions of yuan.³⁶

³³ Key articles by eminent national policy researchers have perhaps also played an important role in encouraging biotechnology: 'our findings suggest that China should continue to promote its GM biotechnology, including commercializing its GM food crops. Policy makers should put less weight on the international dimension in making their decisions on biotechnology' (Huang *et al.* 2002c: 20).

³⁴ *New York Times*, 10 July 2000.

³⁵ These produced revenues for Beijing University of US\$1.68 billion in 2001 (www.china-future.org/docs/people).

³⁶ Du Qingfeng, *China Today*, June 2001.

Another example of scientists playing multiple roles in relation to technology development, business, policy and regulation is Jia Shirong. Jia is a senior scientist at the Biotechnology Research Institute (BRI) at the Chinese Academy of Agricultural Sciences, a National Key Laboratory, officially under the Ministry of Agriculture,³⁷ but with substantial research funding from the Ministry of Science and Technology's 863 and 973 programmes. Jia has carried out research on GM cotton and GM rice, particularly on biosafety in relation to cotton and rice. His colleague at the BRI, Guo Sandui, developed the Chinese *Bt* gene construct. Together they are directors of the Biocentury company which has the patent on that gene, and which is responsible for commercialising Chinese *Bt* cotton; Jia was national coordinator for transgenic *Bt* cotton research and development during 1996–2000. In relation to biosafety regulation, Jia is a key member of the committee in the Ministry of Agriculture that makes recommendations on applications for trials, release and commercialisation of biotech crops. When the so-called Greenpeace report (Xue 2002) emerged in June 2002 he was one of two scientists who made a public statement saying the report was “garbled” and bad science (Monsanto 2002b; Keeley 2003). Added to this, he is also a member of the 863 research committee. When interviewed for this research his approach to biotech development and biosafety management came across quite clearly: ‘I try to encourage policymakers to speed up commercialisation. I see no food safety or environmental impact problems . . . We think that the precautionary principle is not scientific and not practical.’

These networks are in many ways responsible for the success of China's biotech programme. While some worry about a few people having so many responsibilities, others argue that in a developing country this is the best way of making use of limited expertise. They argue that people have integrity, professional reputations to maintain and that there are sufficient checks and balances within the system. People argue that, when X's proposal is being evaluated then Y will not be in the room. Others interviewed for this research – for example, industry representatives – still remain to be convinced, however. One researcher with close links to Chinese biotech policy networks commented

Scientists are influential because there are no farmers organisations and no consumers associations. Zhu Rongji [the Chinese Premier] has said that for agricultural policy the MOA has to listen to scientists. Scientists are lobbying to go on with GM, to get more research funding.³⁸

Another scientist claimed: ‘Scientists just want to get more research money, they say something is good and they get more funds, and they get rich, that's all’. Even the 863 committee comes in for criticism: ‘863 is a few high officials, they think they understand, but there are many complaints’³⁹; ‘The 863 committee – I can't comment; but many things about it are not right’⁴⁰; 863 is ‘a game among a few people’.⁴¹

³⁷ The more prestigious Chinese Academy of Sciences by contrast has ministerial level status.

³⁸ Interview, Beijing, 2002.

³⁹ Interview Ministry of Agriculture, Beijing, 2002.

⁴⁰ Interview with official on 863 committee, Beijing, 2002.

⁴¹ Biotechnologist central Chinese university, 2002.

Sometimes, however, top scientists seem equally exasperated at the number of different hats they have to wear and the degree to which they have to play a PR role in relation to biotech. It is as if they feel industry should be doing this and they should get on with the science. A key geneticist commented: ‘We have the job of persuading the media, the European influence in China is very strong. Newspapers are critical. We must do social work! I had never expected this as a scientist! . . . it requires so much energy doing all I have to do.’⁴²

How do the networks work? Many suggest that biotechnologists seem to have particular access to policymakers because of the fundamental earlier endorsement by a key leader like Deng Xiaoping. One such biosafety researcher commented

Personal contacts matter – if you know some important guy he can send a message. X is an academician – he has to give lectures to Zhu Rongji and Jiang Zemin – MOA recommend him to do this. He says that biotechnology is safe and the only way to save a growing population.⁴³

These lectures seem to have had an important role in maintaining support at the very highest levels of support for GM.

These type of connections came across as fundamental in discussions with different researchers. One ecologist laughed at the idea that policy processes were in any sense rational or technical, claiming that everything came down to processes of networking to get ideas across and secure certain interests: “‘*caozuo*’[operating] this is policy-making; policy-making is like a business’.⁴⁴

But of course networks are not only within the Chinese state, they can also link to multinational corporations. Many of the Chinese working in the international seed companies are well known within the Chinese research community and within the relevant bureaucracies in Beijing. While many within multinationals claim they have little influence on government, are seldom invited to meetings or consultations by government and so have little access,⁴⁵ Monsanto nevertheless fund study tours which may play an important role in building a network of useful contacts. A Chinese scientist and Biocentury director claimed: ‘Monsanto do PR well. They invite officials to the US, and they can send them to look at Australian cotton’.⁴⁶ Monsanto, however, claim that Chinese government officials are now prohibited from going on such trips. The company also funds many well-known Chinese researchers, both scientists and social scientists. The key scientist on the Biosafety Committee dealing with assessment of insect resistance has funding from Monsanto for his work. The academic mentioned above, one of China’s key biotech scientists, when interviewed for this research and asked about links with Monsanto commented that, of course, he was in regular contact and then clicked open an email saying: ‘look they sent me some

⁴² Interview researcher in the Institute of Genetics, Chinese Academy of Sciences, Beijing, 2002.

⁴³ Interview, 2003.

⁴⁴ Interview, ecologist, central China, 2003.

⁴⁵ ‘We make suggestions so regulations are more realistic, so that the policy can be implemented. But the officials just ignore us’ (industry representative, Beijing, 2002).

⁴⁶ Interview, Beijing, 2002.

of the rice genome data today' (at this point the sequence was still some way from being published). Chen Zhangliang, discussed above as playing a key role in the creation of the 863 programme, worked in St Louis, home of Monsanto, before he returned to China to make the case to senior leaders.

Some of the actors linked with China's biotechnology programme are situated within global networks which link them up to industry outside of China. These relationships undoubtedly benefit both sides, and up to a point there is a commonality of interest. However, the biotech developmental state needs to think about moving from research to commercialisation, and how this relates to non-domestic sources of biotechnology. Negotiating these two challenges are key to realising the developmental vision.

6 Realising the 863 vision?

The case for a biotech developmental state can be made by looking at the scale and nature of investment in biotechnology research. But the strategic approach to biotechnology does not end with concentrating on biotechnology research and development as a priority. This section explores two different avenues for moving from research and development to commercialisation, emphasising the ways in which the Chinese state has played a strategic role in each of them.⁴⁷ The first is through the creation of a specifically Chinese biotech corporation. The second is through development of joint-ventures with multinationals, transforming the seed industry and introducing technologies from overseas through partnerships with the Chinese public or private sector. In addition to these approaches there are two variants of the more exclusively Chinese theme, these involve either encouraging research institutes to commercialise their technologies, or having Chinese seed companies expand their operations into GM seeds.

6.1 Biocentury – the first Chinese biotech corporation?

The state not only guides research, it has a major role in commercialisation of technologies. There are particular policies through which SDRC and MOST encourage public-private partnership in the application of technologies. Applications to 863 for research funds, for example, now need a private sector player on board. However, to some extent the challenge in China is working out where public and private begin and end. The state often subsidises, maintains a share, or is able to control the private sector in particular areas through regulations and other measures. The actor-networks discussed in the previous section are one important way in which the boundaries of public and private blur. More broadly this has been the hallmark of China's transition from a planned economy to "market socialism": in some areas unfettered free markets, in others tight and careful control by the bureaucracy, with, as we have seen earlier, the bureaucracy either setting out the conditions for entrepreneurship, or actually engaging in that entrepreneurship itself.

⁴⁷ See also Pray (1999).

One factor that helps to explain this blurring of public and private boundaries is the reform of agricultural research in the late 1980s and early 1990s. Research institutes have increasingly been pushed to think commercially. In the biotech field, as we have seen, there are plenty of funds available for those doing the right kind of research, and institutes have been encouraged to compete to capture this funding. Alongside this there have been policies encouraging companies to develop technologies with practical applications and to commercialise those technologies and benefit from commercialisation. One official in the MOST commented: ‘There is a policy of getting scientists to develop companies for the promotion of biotech. You can now form a company and register Intellectual Property (IP) as belonging to a single person. Patents can be used as a basis to create stock companies’.⁴⁸

While strong public sector control remains because of the interest in macro-policy objectives such as food security, the policy is one of ‘focussing resources on the most productive scholars and institutes’, and, ‘encouraging research institutes to commercialize the products of their research, allowing them to retain profits and reinvest’ (Huang 2002a: 205). In this respect research institutes have become something like businesses.

The Special Foundation for Transgenic Plants Research and Commercialisation for example set up by MOST in 1999 requires that proposals submitted by research institutes need to be together with commercial companies and with the objective of commercialising research innovations (see Huang and Wang 2003: 5).

At least one third of the *Bt* cotton in China is marketed by companies that were formed by state research institutes. The most important of these is Biocentury⁴⁹ which markets the varieties with the gene constructs developed by the Biotechnology Research Institute in the Chinese Academy of Agricultural Sciences in Beijing. BRI is one of the most prestigious National Key Laboratories based at the huge Chinese Academy of Agricultural Sciences campus close to the high-tech Zhongguancun area in the north of Beijing. It was founded in 1986 at the same time as 863. While Biocentury is notionally a private company, it has clearly been fostered in its development at all stages by MOST and MOA. BRI retain a major stakeholding, and several senior scientists from the institute who played key roles in developing *Bt* cotton have important positions on the board. It could be argued to be the developmental, or even the entrepreneurial, state in action.

The setting up of Biocentury in 1998 can in many ways be seen as a key achievement of the 863 programme started 12 years earlier, and particularly of the *Bt* cotton programme begun with 863 support in 1991. The company has moved quickly to establish a significant market share, and is soon to be stock-market listed. *Bt* cotton has been at the heart of China’s biotech programme for some time. It is advertised as one of the clearest achievements in promotional material for the 863 programme and in special glossy volumes documenting history, plans and achievements. The case for insect-resistant cotton was made mostly strongly after the extremely severe 1992 bollworm outbreak. This was a key opportunity for

⁴⁸ Interview, MOST, Beijing, 2003.

⁴⁹ *Chuangshiji* in Chinese.

China's biotechnology community. With yield losses of 100,000 tons in the Yangtse cotton zone and 1.5m tons in the Yellow River area, valued at 10 billion RMB (US \$ 1.2 billion) for north China according to Jia and Peng (2002), *Bt* cotton clearly had much to offer (BIDSRG 1999: 86). It became an important priority, however, not only to learn from foreign corporations, but to develop the technology at home and also commercialise it through a Chinese enterprise. In many ways the *Bt* cotton story in China can be read as a nationalistic battle between Biocentury, the Chinese company with Chinese technology, and Monsanto, the US multinational, operating through joint-ventures with foreign technology.

There has been explicit policy support for Biocentury, which echoes the experience elsewhere of nurturing fledgling companies in strategic sectors. A Ministry of Science and Technology official commented: 'We gave them a title, they are a 'National Development Base of the 863 programme', not an ordinary company, a national development base, this helps their business.'⁵⁰ The key form of support, alongside this type of endorsement, is funding. Biocentury was founded with start-up investment of several tens of million RMB from Dongfang Mingzhu, a southern Chinese holding company; this was matched by state investment from MOST through the 863 system, and some investment from the Biotechnology Research Institute who have a one-third share in the company. In 2000 the company got important support from the Technical Innovation Fund for Small and Medium Scientific And Technological Enterprises. Later the same year the company secured State Development and Planning Commission support for a project for commercialisation of *Bt* and CPTI cotton. This form of mixed state and private sector support is described as following the principle of 'sharing the advantages, profits and risks' [*youshi hu bu, liyi tong heng, fengxian gong dan*].

Total investment is now 100m RMB (US \$ 12m), and the company is preparing to be stock-market listed. Profits at present are divided between the key scientist, the state research institute and the larger company, as follows: 13.5 per cent of gross sales go to the institute (shared between Guo Sandui the scientist who developed the Chinese *Bt* gene, the research group in BRI and the rest of the institute); there are also gene license fee payments and variety payments; BRI are guaranteed an annual bottom line payment of half a million RMB, regardless of company performance; and 80 per cent of the profits are retained by the company.

What is clear is that, whatever the profit sharing arrangements, the link to the state and the sense of continuing to be fostered as a national corporation is very strong. As a Biocentury manager in the Shenzhen HQ admitted quite frankly: 'We can still apply for 863 funding, we are a product of 863 in fact.'⁵¹ Others argue that: 'MOA is worried about the market monopoly of Monsanto, so they slow down entry into the market place. Biocentury is not really a private company, it is a state product.'

However, Biocentury is in other respects being encouraged to operate like a private corporation. One aspect of this is the granting of property rights over important technologies, another example of policy support for the company. The company has been granted patents on gene construction modification, and

⁵⁰ Interview, official in CNCBD, MOST, Beijing, 2003.

⁵¹ Interview, Kong Xiangwen, Biocentury manager, Shenzhen, Guangdong.

on their novel plant vector construction technique– the pollen tube pathway. Stock-market listing could also be presented as another example of privatisation.

Biocentury has a number of subsidiary companies, which are also styled as joint ventures, similar to the Monsanto set up described below (on paper at least). These companies are located in Hubei (two separate subsidiaries), Jiangsu, Xinjiang and also in Hebei. Significantly, three of these companies are in the central Yangtse region provinces from which Monsanto is currently excluded. They involve very different forms of partnership with county seed companies, with agricultural research institutes, and with holding companies.⁵² Levels of capitalisation and relative shares vary; sometimes there is one partner, sometimes there are several.

These mixed forms all tell different stories. In some ways Biocentury has to operate in much the same way as Monsanto, building local links and patronage networks. This is a key part of the reality of building a biotech seed industry in China: ‘You have to cooperate with local companies – because of their relations to local officials. They *qiang women de shichang* [snatch our markets], and are critical in that they have good relations from prefecture through to county and village.’⁵³ Constructing the developmental state at the subnational level, particularly the lowest levels, is more complicated than it initially appears at the level of research institutes and government committees in Beijing. It shows that, in some respects, power is decentralised and subject to complicated bargaining and negotiating. National initiatives have to take such realities into account if they are to be at all effective.

Despite the complexity, Biocentury has several advantages over Monsanto. One is that links at the local level, particularly with research institutes, allow them access to well adapted local germplasm, something Monsanto – formally at least – cannot get. According to a BRI scientist and Biocentury director this gives them key market advantage: ‘Our varieties are good – the best local varieties.’⁵⁴

Biocentury has other things in its favour. One key factor is that Biocentury seed is substantially cheaper than that of Jidai or Andai (the two joint-ventures Monsanto operates through). In 2002 Biocentury were selling in Hebei at around 38 RMB per kg, whereas Jidai seed was 45 RMB.⁵⁵ According to the manager of Jidai profit margins between the two companies are very different: ‘Our margins are not high. We have to keep up sales to reach our balance point. Biocentury can be very profitable at sales of 100,000 kg; we need to hit the one million mark.’ He went on: ‘Biocentury has no tech fee, or that’s a

⁵² To give more detail of how some of these companies are constructed: Jingmen is based in Hubei with 51 per cent of the stock owned by Biocentury, 49 per cent is owned by Shayang Nongchang Agricultural Research Institute. The registered capital is 2m RMB (US \$ 0.25m) and the company pays patent fees to Biocentury for use of the *Bt* gene. The company targets the middle and upper reaches of the Yangtse. Another company Nantong is a partnership with a county seed company (Rudong, 49 per cent share) whereas Longfa is a partnership with a private holding company. The company that works in Hebei known as Hebei Apollo involves a partnership between Biocentury, BRI, a city level academy of agricultural sciences and a private rice seed company. Elsewhere Biocentury sells through Fengle (one of China’s largest seed companies based in Hefei, Anhui); they again pay a gene license fee of 2 RMB per kilo. There is also a production base in Sanya, Hainan.

⁵³ Interview, BRI scientist and Biocentury director, Beijing, 2002.

⁵⁴ Interview, Beijing, 2002.

⁵⁵ A Biocentury manager claimed their seeds were nearer to 30 RMB per kg making them one third the price of Monsanto’s.

grey area. Our technical fee is the major constraint on our profitability. We also spend more than Biocentury on quality assurance. Our fixed costs are also high. We don't understand their fixed costs.⁵⁶

According to a manager of Biocentury in the Shenzhen office: 'We can beat them because their costs are too high. 33B [the major Monsanto variety sold in China] is 42 RMB per kg and 18.5 RMB is tech fee! The same applies in India, if we enter we will be more competitive, even if Monsanto have other advantages'.⁵⁷ Biocentury, then, are optimistic about their prospects, and ambitious about their plans.

Our aim is to establish a competent gene-enterprise group based on the mechanism of modern and scientific management. The company is focusing on the integration of technical innovation, product development and market promotion to play a leading role in domestic as well as abroad.⁵⁸

A Biocentury manager interviewed in Shenzhen was equally enthusiastic about what the future would hold.

The trend is towards larger seed companies – as a stock-listed company we will spread. We need to do other crops, only one is risky. And we need to master other parts of the value chain – marketing, purchasing and processing, to textile sales. We will dominate our rivals, we have the technology, no-one can compete with us! Aphids, virus resistant are all to come. Also better fibre quality and length!⁵⁹

Biocentury has set its sights beyond China. It has been in negotiation with Nath Seeds to market its products in India, and also looked at markets in Vietnam and elsewhere. Clearly, in the minds of Chinese policy-makers, the company should develop to become an internationally important life sciences company. Even its rivals see this as a possibility. John Killmer, vice president of Monsanto Far East Ltd. in Beijing, comments: 'In less than 10 years, we'll be accessing technology from China.'⁶⁰

But will this happen? Is Biocentury really developing as the first Chinese biotech corporation to rival Monsanto? To answer this it is necessary to look at how Monsanto and others are working in China, and to look at how the developmental state concept can be seen as, not only about promoting local talent, but about making sure that rivals are carefully managed, either openly or covertly.

⁵⁶ Manager, Jidai, Shijiazhuang, Hebei, 2002.

⁵⁷ Interview, Biocentury manager, Shenzhen, 2002.

⁵⁸ Biocentury company brochure, p8.

⁵⁹ Interview, Biocentury manager, Shenzhen, 2003.

⁶⁰ AgBiotechNet, 2000, Biotech Crops prevent Pesticide Deaths in China. October. www.agbiotechnet.com

6.2 The joint-venture route: managing Monsanto

The biotech multinational with the most significant presence in China is Monsanto: they have the biggest public profile, and they are the only multinational actually selling GM seed to Chinese farmers.⁶¹ To some extent, as has often appeared to be the case elsewhere, it seems that the other multinationals are happy with this situation and are prepared to let Monsanto make the running, possibly get their fingers burned and come in behind, as and when that looks possible. One manager in another multinational commented: 'Let Monsanto go ahead, we just wait and see; Monsanto can take the risks. They get into head-to-head fights with the government, so it is better for us just to keep out of the way and watch.'⁶²

Monsanto focus on cotton and maize in China, and also the import of soyabeans through their Cargill subsidiary. The maize programme has concentrated on developing insect resistant maize together with an institute in Jilin province. They have applied for biosafety approval for maize several times since 1996 but have consistently been refused. For cotton Monsanto first approached the Cotton Research Institute in Anyang, Henan, and began a joint research programme to look at cooperating to produce *Bt* cotton. According to one informant in the company, Monsanto carried out 100 trials at CRI in 1995, but these talks in the end came to nothing.⁶³ In 1996 it began a partnership with Hebei Provincial Seed Company to produce seed in Hebei province. The result was a joint-venture known as Jidai. The joint-venture was approved by the provincial governor which led to accusations that Monsanto was operating in China ignoring the central Ministry of Agriculture, even though at that time there were no restrictions on provinces forming joint-ventures under US \$ 30 m.⁶⁴ Following this new regulations were issued in 1997 requiring central permission for new joint-ventures. Monsanto and Delta and Pineland initially had a 66 per cent share of Jidai, this was also restricted to 49 per cent in the 1997 regulations. According to the MOA this was because the Chinese partners were not seeing enough of the benefits of the partnership. A director of Biocentury argued, however, that because of Monsanto's high technical fee and the fact they get the majority of this, they still get most of the profit from the joint-venture.⁶⁵ The Chinese arguments around the technical fee interestingly echo the international discourse against biotechnology that argues the central problem is one of control and risk of dependence on expensive technologies. A Delta and Pineland technical manager put the counter argument as follows: 'If it is advanced technology then we

⁶¹ Several multinational corporations with interests in the seed industry and biotechnology capacity operate in China. These include Monsanto, Syngenta, Pioneer and Bayer. Syngenta have done some research on GM rice, and are looking to enter the GM cotton market in the future, but the bulk of their business in China is in non-GM vegetables and agrochemicals, where they have annual sales of 1 billion RMB (US \$ 120m), the latter through ownership of Aventis who have built up a large share of the Chinese pesticide market [Interview with Syngenta sales manager, Beijing, 2003]. Pioneer Hi-Bred, owned by Du Pont, have been in China since 1997. They established a partnership at the end of 2002 with Denghai Seed Group called Shandong Denghai Pioneer Seeds Co to produce hybrid maize seed for the summer maize market. Pioneer has been breeding and testing hybrids since 1997 in Liaoning province. Hybrid maize has historically been a restricted sector, so they are relying on changes in the wake of WTO entry and implementation of the Seed Law to be able to release these to farmers. Pioneer has also been testing *Bt* corn in partnership with China Agricultural University.

⁶² Syngenta manager, Beijing, 2002.

⁶³ Interview with a Monsanto manager.

⁶⁴ Monsanto's total investment was \$8.4 m (Interview with Monsanto staff member).

⁶⁵ The technical fee comprises a fee for use of Monsanto's *Bt* construct and a germplasm fee which goes to Delta and Pineland.

should pay a technical fee if it is good. Our price is high, we cannot say to farmers you must buy from us (because we are a company), but they still buy.⁶⁶

Jidai has gradually become the base for Monsanto's operations across the north China cotton zone, in the Yellow River watershed, concentrating on Shandong province in addition to Hebei, and presumably for Henan province where Monsanto was finally granted permission to sell after many failed attempts to get biosafety approval. Following the success of Jidai a second joint-venture followed, based in Hefei in Anhui province, together with Anhui Provincial Seed Company, again Monsanto own 49 per cent. This joint-venture known as Andai at the moment only sells in Anhui, but it would be the base for the wider Yangtse River cotton zone, were permission to be granted for Jiangsu and Hubei provinces.

Breakdown of cotton sales is notoriously complicated. Monsanto, for example, complain that they are presented as having sales in official statistics in provinces where they are not formally even allowed to sell. In Hebei province – Monsanto's biggest success story and a province where *Bt* cotton may be as much as 99 per cent – one Monsanto manager put the breakdown for of the cotton grown as: '15 per cent Monsanto, 15 per cent Biocentury, 30 per cent farmer saved seed, 30 per cent counterfeit, 10 per cent others.' He went on: 'In Shandong the share of the market is smaller. In Anhui it's higher at 15 or 20 per cent. In Henan the market is dominated by the Cotton Research Institute.'⁶⁷

Grain and biotech seed production are deemed to be strategically significant policy areas, hence the picture is altogether different to the vegetable production sector where multinationals can freely set up provincial joint-ventures. Chinese regulations limit the operation of multinational corporations in the grain and biotech sectors. Production of hybrid seed has been illegal until recently, and since 2002 it has been impossible to set up new joint-ventures to market GM seed.⁶⁸ Monsanto were turned down when they tried to set up a joint-venture in Henan province in 2002⁶⁹. It is unclear whether the new regulations would prevent extension of existing joint ventures into new provinces if and when biosafety approval is granted.

There are then several ways in which the Chinese state can be seen to manage multinationals – by not allowing them to buy up Chinese seed companies in key sectors, by restricting them to a joint-venture model, and by not allowing the foreign partner to have a majority share. There are other ways in which MNCs can be seen to be controlled; these include strategic use of biosafety regulations, limiting breeding programmes, and granting plant variety protection on a strategic basis.

⁶⁶ Delta and Pineland, manager, Beijing, 2002.

⁶⁷ Interview, Beijing, 2003; another employee gave a different estimate: 'Market share is hard to say. For commercialised seed we have 80 per cent and Biocentury only 10 per cent in Hebei; for planted seed as a whole we may be 20–30 per cent'

⁶⁸ The 'Guidance list on foreign investment' issued April 2002 by SDPC, State Economic and Trade Commission and MOFTEC (Huang and Wang 2003: 18).

⁶⁹ There are three categories specified in the regulation on foreign investment – GM seed is banned, general seed allows limited investment, and for "high-tech" investment is encouraged – it is not completely clear however what that is. Local governments have powers to make joint ventures with certain capital restrictions, so long as don't infringe regulations. There are currently 60 joint ventures in China in the seed industry all approved by local governments, and only one approved by MOFTEC (Ma 2001: 99).

Regulation, and particularly risk assessment processes, have been one way that the expansion of Monsanto in China has been contained; certainly company employees will state this, though Chinese officials or researchers will not – unsurprisingly – acknowledge it (see Keeley 2003). The important thing about the Chinese risk assessment system is that it concentrates considerable power in the hands of risk assessors and regulators without any obligations to be transparent about what choices are being made and on what basis. Since 1999 the MOA (who currently house the Biosafety Committee which undertakes risk assessments and the Biosafety Office which makes decisions based upon scientific recommendations) has not published details of what applications for biosafety approval have been made, which trials are being carried out, where, and on what basis decisions are approved or rejected. Further to this applications are on a province by province basis, and there are four individual stages of assessment that need to be passed before commercialisation approval can be given (see Keeley 2003). In practice this has meant that, for provinces such as Hubei, Jiangsu and Henan, approval has been given to companies marketing Chinese *Bt* cotton, while Monsanto has been turned down.

Monsanto employees have strong opinions about this: ‘They find an excuse to delay entry. The policy is that there is no *Bt* cotton in the Yangtse provinces. But last year this regulation was deleted. Local *Bt* cotton has been approved in Yangtse for one year. They deliberately slow you down to let locals take the market first.’⁷⁰ A Delta and Pineland employee also commented: ‘From field trials to approval can be eight years – but four years for Chinese. Our stuff is being sold before it’s been approved. Chinese are being ripped off on quality.’⁷¹

Monsanto have also submitted *Bt* maize for commercialisation. An employee claimed:

We have done field trials and environmental release since 1996/7 and applied for commercialisation – we are just blocked, they ask for more data, and it’s always different. One reason is local competition – local products are not so good. This worries the MOA – they know that farmers like the products. Policy comes from the State Council, they decide that MOA have to think about competition in the market place.⁷²

The other area where Monsanto claim that regulations restrict them in an unfair way is the import of soyabeans through their Cargill subsidiary. China temporarily put a moratorium on GM soyabean imports (the bulk coming from the US) but suspended this as a result of high-level pressure during trade negotiations. China then partly backed down issuing interim approval to import pending further safety assessment, but not declaring whether GM soyabeans were safe or unsafe, effectively leaving the door open for a change in policy at a later date.

At the same time Monsanto claim – as in other settings – that they make great efforts to be transparent and even undertake voluntary initiatives to build trust. For example, a Monsanto manager

⁷⁰ Monsanto employee, Shijiazhuang, 2002.

⁷¹ Delta and Pineland employee, Beijing, 2002.

⁷² Monsanto employee, Beijing, 2002.

claimed: ‘We began doing the work on resistance assessment voluntarily as we had in the US in anticipation of future requests, but does Guo Sandui do this? I doubt it.’⁷³ The cynical view of course would be that having accurate information on resistance is also in Monsanto’s interest in terms of guiding their decisions on introduction of new technologies, and not being caught in a situation where they can be shown to be selling a product that already has reduced effectiveness against bollworm.

Even in provinces where Monsanto is approved, the limitation on setting up joint-ventures puts specific limits on how they can operate, largely because they do not have the critical local “*guanxi*” (relationships) to get a foothold in critical prefecture and county seed marketing networks. Compare Hebei with neighbouring Shandong province, for example. In Hebei, because of the links facilitated by the joint-venture, Monsanto is in a strong position; they used to sell locally through seed companies, now they operate through a network of 140 dealers in the province. But: ‘In Shandong we have difficulties, and only 2 to 3 per cent of the market; there is a lot of fake seed and it is hard to work through the local marketing networks. Hebei we may have more like a 25/30 per cent share’.⁷⁴ Another Monsanto employee commented that if Bollgard were approved for other southern provinces it would be hard to make inroads: ‘There is local cotton in Jiangsu and Hubei – it is hard to sell there from Anhui [home of Andai] – the business model is difficult – we need a local partner, because there is natural resistance to an outsider coming into the market.’⁷⁵ These difficulties aside it would appear that in provinces such as Hebei, where Monsanto is very effective, they have been able to build up considerable *guanxi*. This relates to the earlier point about Biocentury: the policy process happens at a number of levels and the central state cannot simply dictate its vision to localities. As the case of the Hebei officials keen to work with Monsanto without the formal approval of the MOA in the mid-90s illustrates, the state is in many ways quite fragmented and this challenges its capacity to act developmentally.

Nevertheless there are regulations which do clearly limit what Monsanto can do. Another big problem for Monsanto is the prohibition on breeding and the way that others, as they would see it, are facilitated to use Monsanto materials. Monsanto are restricted by not being allowed a breeding programme in China; this means they cannot access local germplasm and have to rely on marketing varieties developed in the US.⁷⁶ This can be another way of tying Monsanto’s hands, as on occasions, if germplasm is not well-adapted, this may lead to poor agronomic performance which results in the variety failing biosafety approval. This is because plant variety approval can shade into the terrain of biosafety assessment, as a variety can be deemed unsuitable when for some it may not be the transgenic aspects that are most salient (see Keeley 2003 for a discussion of the blurring of agronomic and biosafety questions). Significantly, Chinese farmers and plant breeders are allowed to use Monsanto or Delta and Pineland seed

⁷³ Interview, Monsanto employee, Shijiazhuang, Hebei, 2002.

⁷⁴ Monsanto technical manager, 2002.

⁷⁵ Monsanto employee, 2003.

⁷⁶ As with many things around biotechnology and seed in China there are different opinions as to what is actually allowed and what isn’t. In this case the head of extension in the Ministry of Agriculture commented ‘the joint venture structure may in the future extend to breeding – at the moment US seed can only be multiplied’ (Interview with head of extension, MOA, Beijing, 2002).

for breeding as China joined UPOV under the terms of the 1978 convention and was able to draw up a list specifying which crops would be subject to Plant Variety Protection and which not: ‘This year China joined UPOV, but there is no variety protection for cotton. This is MOA policy. We can do nothing. Farmers can save seed, but companies use our material to produce and sell. This happens at county level, at province and even in research institutes.’⁷⁷ This is clearly used quite strategically as one researcher noted: ‘If GM rice were coming into China it wouldn’t be on the UPOV list’.⁷⁸

Monsanto say that the current situation benefits no-one, as the existing IP situation in China discourages companies from bringing their best technologies into the country: ‘We won’t introduce best varieties, the new generation of Bollgard, the best technology and the best germplasm, because it walks. Our gene is better, stronger, and it has clearer expression.’ Even the ill-fated attempt to cooperate with the Cotton Research Institute resulted in “losses”: ‘We cooperated with CRI between 1995 and 1996. But we were being ripped off. We have agronomists – they can see, they know the sources.’⁷⁹

According to another employee: ‘Bollgard 2 has just appeared, but because of the IP issue we don’t want to bring it to China, because the seed market is in chaos. Everyone can use the seed and there is no right to prosecute. I can use your seed, bulk it in 1 to 100 ratio. And the quality is similar.’⁸⁰

This is clearly a problem for Monsanto in some provinces than others, and appears to be a clearer problem where they have permission to sell, but no joint-venture: ‘They are either copying our seed; or selling their seed under our name. In Shandong there is more of that. But in Hebei it’s a smaller problem.’ The Monsanto employee continues, again echoing the argument of those who are worried about farmers’ rights and corporate control in relation to biotechnology: ‘The key issue is saved seed. Farmers when they buy seed want to buy the best. They can buy 1 kg a year and then harvest and use it next year.’⁸¹

To others the constraint on breeding is unfair as high-quality commercial cotton (*Gossypium hirsutum*) is really a relatively new crop to China introduced by Delta and Pineland in the 1950s and then developed by the central Cotton Research Institute using those materials: ‘Chinese breeding work over the last 20 years has given varieties that have good yield and are tolerant to disease. But the lint is not so good. The parents of this material come from DPL. DPL has a good bank. But we have no breeding programme in China, and it is hard for us if we cannot experiment.’⁸²

Sometimes Monsanto staff will say that the breeding issue is not a huge problem as most of the climates and soil types in China have similar matches in the US, but more reflectively some will acknowledge that the restriction places agronomic challenges in front of the company: ‘Breeding is still

⁷⁷ Rules for Plant Protection issued by the State Council 1997, and comprehensive Plant Breeders Rights Law in 2000 allows exceptions for scientific research and farmers rights to use material for production and reproduction (Mo 2001b: 892). 1999 China joined UPOV (1978 Convention). Patent Law 1984 (amended 1992 and 2000) excludes patents on plants or animals. 2000 amendment to the Patent Law allows that a patent may be granted for the “process for production” where it means a non-biological process or method, so some biotechnology leading to new plants and animals is protected (ibid.: 891).

⁷⁸ Researcher, Beijing, 2002.

⁷⁹ Interview, Beijing, 2002.

⁸⁰ Interview, Beijing, 2003.

⁸¹ Interview, Shijiazhuang, Hebei, 2002.

⁸² Interview Delta and Pine, Beijing, 2002.

important for disease resistance this can vary quickly (both fungi and bacteria) – so it is best to select in China. But no breeding stations are allowed in China. We can only test.⁸³

Of course, some argue that Monsanto ignore the rules and access local breeding materials; indeed the company may well have accessed local materials through its testing programmes with CRI, but this is of course only speculation. One Biocentury manager commented

Of course Monsanto use local varieties but say they are American! They just don't admit that they have bought local ones. They tried to cooperate with Jimeng [An agricultural research institute in Hubei]. Later it didn't happen. Neither will admit formally that there has been an exchange, but their breeders tell us informally what happened.⁸⁴

Other multinationals argue that they wouldn't take such risks: 'Syngenta wants to use local germplasm and it is willing to pay. It is better if these things are done above board. You have to be very careful; you don't want to give government excuses.' In any case the policy argument is clear as articulated by one researcher: 'Local varieties are a public good, so for Monsanto to do breeding is an IPR issue.'⁸⁵

But Monsanto claim that for the most part the system works against them. However, while Monsanto may not like farmers saving seed and exchanging it locally, or institutes using varieties as breeding materials, this is at least legal under the Chinese system. A more serious problem is the issue of producing seed of whatever quality or provenance, putting it in a bag and claiming it is Monsanto 32B, 33B or 99B. Monsanto claim to have collected over 100 different packets of fake 33B (and this author was shown a few samples). Not only is the system unfair, it shows – they argue – that there is considerable grassroots demand for their products.

In Shanxi, Shaanxi and Henan we have never sold one seed but are products are popular – why is this? The MOA should answer this! The farmer information system is good now, they know what is good. There are 100 examples of fake seed, they pay no technology fee. According to MOA data there are 16m *mu* of 33B – but we know we didn't sell that! We only have 2 m *mu* in Hebei and Shandong.⁸⁶

The other area of questionable legality is the use of patented gene constructs which are protected where varieties aren't. The most notorious example is a very popular hybrid variety emanating from CRI called Zhongmian 29, using the best CRI germplasm and a *Bt* gene. Probably this was the actual fruit of the doomed collaboration between CRI and Monsanto (along with, according to some, the drift of some germplasm into the corporation's collection). According to one Monsanto employee: 'Who knows where the CRI gene is from; they crossed into Zhongmian 29 and 39. It's Monsanto Crylac. We are told it was

⁸³ Interview, Monsanto, Beijing, 2002.

⁸⁴ Interview Biocentury manager, Beijing, 2002.

⁸⁵ Interview with CAS researcher, 2002.

⁸⁶ Interview with Delta and Pine technical manager, Beijing, 2002. 15 mu = one hectare.

stolen from Monsanto; this is an open secret, but we don't sue or do anything about it. CRI was given approval directly by the MOA with no biosafety regulation only variety registration. This is not fair play.⁸⁷ Monsanto also had early discussions with the Biotechnology Research Institute in Beijing, and of course predictable allegations are made about some of that institute's early *Bt* constructs. The key difference here with CRI, however, is that BRI is a biotech lab and clearly has pioneered new GM techniques, whereas while CRI has some facilities (PCR machines etc.), it is unlikely that they have – or had then – the capacity to isolate gene constructs.

So what is Monsanto's response? Interestingly the view seems to be that marketing, branding and technical support will win out: 'We don't rely on government, we rely on education. Farmers care more about seed than pesticide, it's the most important means of production if you ask the farmer.'⁸⁸ In the post-WTO world many in the industry hope that markets will eventually open and quality products will win out: 'DPL has done a lot to develop cotton in China. We get aeroplanes and shampoo from overseas: why shouldn't agriculture benefit from the best foreign technology?'⁸⁹

Monsanto seem to be taking the long view, and arguably Chinese policy-makers realise that because of the importance of the Chinese market companies are willing to tolerate what they see as lax IP situations in order to maintain a presence and build their profile for the longer term when perhaps there is more domestic demand for IP protection, or it is more feasible to enforce demands through the international system. The Monsanto China manager argued in a presentation to the first international conference on the seed industry that: 'The key is IPR and PVP, an ordered market. Foreign investment should be open [but] agriculture is a restricted industry . . . telecoms was too [i.e. only 49 per cent foreign ownership] but recently Alcatel bought 50 per cent of Shanghai Bell.'⁹⁰

But of course the alternative view expressed from the Chinese side is that what is critical is useful competition not monopoly: 'Monsanto actually went to Anyang, to BRI, to Hebei, but their conditions are too tight so they aren't acceptable. They want to own everything.'⁹¹ While of course there are factions in the MOA close to Biocentury who might prefer to have no Monsanto in China, the dominant MOA view seems to be that Monsanto is a useful presence, but it should be on Chinese terms, and in the context of responsible expansion and meaningful competition rather than monopoly. And meaningful competition has to be constructed using whatever levers are available, it doesn't just happen.

But Monsanto and Biocentury are not the only ways in which GM crops can be commercialised in China. Other routes include research institutes commercialising their research not necessarily with the high level support experienced by Biocentury, or the seed industry moving more strategically into biotechnology partnerships or research.

⁸⁷ Interview, Monsanto, 2002.

⁸⁸ Interview, manager Andai, Hefei, Anhui, 2002.

⁸⁹ Delta and Pine, Beijing, 2002.

⁹⁰ John Killmer, presentation to The First International Forum on the Globalisation of China's Seed Industry, Beijing, 26–8 November 2001.

⁹¹ Biocentury manager, Beijing, 2002.

6.3 Other approaches

6.3.1 Commercialising research: the Cotton Research Institute, Anyang

The Cotton Research Institute is the nationwide institute for cotton research. Founded in 1957 in Anyang in Henan province the institute has been the key player in adapting the Delta and Pineland germplasm introduced to China in the 1950s (before then China had essentially only used lower-yielding indigenous cotton varieties), surmounting agronomic challenges and increasing aggregate cotton production. Key CRI varieties, such as the prize-winning Zhongmian 12, for long periods held sway as the backbone of Chinese cotton production. Indeed, until as recently as the late 1980s and early 1990s CRI cultivars covered over 50 per cent of the national cotton area.

However, things have begun to change with the break-up of the state system of clearly demarcated research, extension and marketing. These days the institute concentrates more on the northern Yellow and Huai river cotton areas and pursues a “one institute, two systems” approach of concentrating on both research and marketing. Indeed, following the liberalisation of marketing, as with other institutes, the CRI has developed several regional cotton companies geared at marketing its varieties.⁹²

But the ending of the old monopoly position and the changes in the cotton seed market, linked with globalisation and technical change have proved a challenge for CRI. CRI publicity materials present a vision of the central company in Anyang becoming ‘an internationally competitive cotton company promoting the industrialisation (sic) of transgenic cotton.’ But, in reality, other research institutes and other companies are now producing and marketing varieties that rival the outputs of CRI: ‘CRI used to control everything; now even [the provincial level] Henan Academy of Agricultural Sciences has caught up with them.’⁹³

One response was, as noted above, to try and form a partnership with Monsanto. While this didn’t work out, one output was the contested Zhongmian 29, the ‘first Chinese transgenic cotton variety’.⁹⁴ This hybrid variety has been popular with farmers as it is very high yielding, despite costing twice as much as Monsanto’s 33B. Other products have not been so successful, and in 2001 CRI were fined 2m yuan for selling unapproved products to farmers: ‘CRI have been selling unstable products, they register things as conventional varieties when they are not.’⁹⁵ Indeed, according to one informant, it was only their strong links with the MOA in Beijing that prevented them getting in more trouble.

The former director of CRI is now head of extension in MOA saw these squabbles as temporary, part of the teething pains of getting used to new technologies and marketing situations. More recently CRI has licensed technologies from BRI and has developed new transgenic varieties such as Zhongmian 38 where the intellectual property issues are more clearly managed: ‘Zhongmian 29 is now too old. The gene may have come from the US – it’s hard to say, some people have said some things, but now we have

⁹² Two of these are in Xinjiang, two in Henan and one in Shandong.

⁹³ Monsanto employee, Beijing, 2002.

⁹⁴ CRI publicity materials, 2002.

⁹⁵ Chinese biotechnologist, CAAS, Beijing, 2002.

forgotten about it.⁹⁶ He has a clear vision that if China is to compete with companies such as Monsanto what is necessary is for BRI and CRI to join in a more systematic way.

For breeding, research and extension we lack one very big company. If everything were done together this would be better . . . CRI and BRI, and extension coming together: this is my dream. I hope for this one day. The issue is to get the gene inserted in the best material. CRI have the best varieties, and lots of germplasm. CRI has a history of 43 years, it has made a great contribution to cotton in this country. They have the germplasm but now they need high-tech, and the link to BRI.⁹⁷

While this sounds almost like trying to reconfigure the old state controlled system, the vision is more of the developmental state bringing competing parts together that perhaps do individual things very well to encourage them to function as a more coherent integrated unit: doing everything from research and breeding to marketing, along the lines of the life science corporations. But the government's touch should be light and facilitating: 'Government should withdraw eventually; having many things under control is a problem, you start, let people do it, and withdraw.'⁹⁸

For others, however, this vision is more of a pipedream. One Chinese person in one of the multinationals commented: 'One has one bit, one the other. CRI has germplasm, but no gene research. Guo Sandui has a biotech lab but no breeding programme— he can't do downstream work. They can't get together – this is the real Chinese system. It's like wives and girlfriends.'⁹⁹

6.3.2 Transforming Chinese seed companies into biotech firms?

This section has looked at some of the ways that China has sought to realise the 863 vision of developing a strong and competitive biotech industry. One route has been through joint-ventures with multinationals, another has been through fostering the development of a biotech corporation, other strategies have been for Chinese research institutes to develop biotech applications and market them through newly set up companies. A final tack is for established seed companies themselves to take an interest in biotech and either invest to develop new GM products or to go into partnerships with others.

In some ways hoping domestic seed companies develop an interest in GM might seem the most obvious route for China. However, this has for many reasons been the least successful path so far. The key reason for this is that the Chinese seed industry is still in the process of reform, and comprises many small and poorly integrated companies.

One prestigious Chinese biotechnologist lamented the difficulty of engaging Chinese seed companies in biotech: 'There is no research in companies. There is no R only D. I find they have no idea; I am

⁹⁶ Extension director, MOA, Beijing, 2002.

⁹⁷ Extension director, MOA, Beijing, 2002.

⁹⁸ Extension director, MOA, Beijing, 2002.

⁹⁹ Delta and Pineland employee, Beijing, 2002.

Box 6.1 Two Chinese seed companies

Longping Gaoke

Longping Gaoke is one of China's largest seed companies. Founded by Yuan Longping, one of China's most famous scientists and "father of China's green revolution"¹⁰⁰ and the China National Hybrid Rice Research Institute in Changsha, Hunan, this company specialises in hybrid rice in particular, as well as a range of other horticultural crops.¹⁰¹ The company has overall annual sales of rice seed of 150m RMB (US \$ 18m) and has 15 subsidiary companies, with companies operating as far afield as the Philippines, Uruguay and Pakistan. While the company has had discussions with Monsanto and Pioneer, as yet it does not have any major plans to invest in biotechnology, or think about developing varieties of GM rice. According to the managing director the most likely direction for innovation appears to be "super-rice" the new 863-funded non-GM high-yielding varieties currently being developed by CNHRRI. He also expressed anxiety at trends in the seed industry: 'All our companies put together are not big enough compared to the US',¹⁰² and noted that the unfavourable seed-to-grain price ratio – grain prices still partially being controlled by the government – was a key constraint to farmers investing in more expensive seed, and, in turn, a disincentive for companies looking to develop new technologies.

Delong

Delong, meanwhile, is a company with a very different background. The company was set up in 2000. By 2002, in terms of marketing, it became China's largest seed company, selling hybrid corn – over half its income –, hybrid rice – a quarter –, melons and cotton. Delong is essentially a holding company with no background in the seed industry; it has a controlling share in seven companies and a smaller share in others, but is large with registered capital of 100m RMB and 800 staff. With a range of breeding bases throughout China, Delong aims to be China's leading seed company within a few years and to join the international top ten.¹⁰³ Not everyone is so optimistic about this, however. A technical manager at Delta and Pineland commented: 'Delong has money and no technology. None of their own varieties. They buy things up, and operate as if it's the old system. Breeding programmes take time to develop: it needs time, money and germplasm'.¹⁰⁴

Whether the company, by spending money, is able to really understand the seed industry is a moot point. The company does, however, appear to be more reflective about the possibilities of biotechnology than other seed companies. A senior manager commented: 'We think that biotech in agriculture is an inevitable trend. There are two key issues for us – quality (particularly high protein) and resistance traits.' However, he went on to note that the appeal of biotech was still not so clear for all crops: 'For cotton the attractions of *Bt* are clear because pests are so serious. But for rice or corn this might be a different story; it is harder to find a single trait or variety that will work across large areas. Corn, for example, is grown from Heilongjiang to Guizhou, and these are very different locations'.¹⁰⁵ Problems of seed markets were also raised, with markets for good and bad seed presented as poorly separated.

¹⁰⁰ Through his discovery of the male sterile line for hybrid rice production

¹⁰¹ 10–15 per cent of all rice varieties are based on Yuan Longping's hybrid rice lines. Longping Gaoke has overall annual sales of 100–150 m RMB (US \$ 12–18m). The company is owned 5 per cent by Yuan Longping, 25 per cent by CNHRRI and 49 per cent by a group of other agricultural research institutes.

¹⁰² Interview, Beijing, 2002.

¹⁰³ It is looking at sales of 2bn RMB by 2005 (US \$ 240m).

¹⁰⁴ Interview, Beijing, 2002.

¹⁰⁵ Interview, Beijing, 2002.

surprised that they take no interest. It's like the Chinese idiom: 'with no long term view, you get trouble in the short term'.¹⁰⁶

To some analysts the problem is a lack of capitalisation combined with too many small companies¹⁰⁷. A Syngenta employee complained: 'The problem with the seed industry is that it lacks capital. Foreign companies can't buy; and local seed companies don't see, or can't act, they are not good on finance, so holding companies like Delong are filling the gap. I say great go ahead, you have two or most three years in which you can do this. It doesn't matter that they know nothing about seed with money you can buy anything'.¹⁰⁸ Chinese scientists also argue that, despite the large budgets for biotech research, funding is not really enough to build a serious biotech industry: '100m RMB (US \$ 12m) committed in the 9th FYP is too small – we need private capital. We lack planning; the scale is too small. TNCs are well linked to the market, but Chinese enterprises don't invest in GM products or basic research. We need preferential treatment from government. Stock market listings'.¹⁰⁹

How do particular companies interviewed for this research view the current state of affairs? Box 6.1 presents the case of two large seed companies.

At present, then, Biocentury seems to be the only contender to multinationals if the Chinese state is to pursue a developmental biotech that involves a state-supported corporation dominating local markets and moving to be a key competitor in international markets. Other research or seed enterprises don't seem to be too far on with responding to the challenge of biotechnology in a commercial sense. This is, of course, in part explained by the effective moratorium on commercialisations of any of the major GM food crops, the situation may change were this to alter. The other way the developmental state might work, of course, to promote a public-good oriented and pro-poor biotech would be to only concentrate on carefully setting the terms of access for the international private sector. This is not the situation at present, but the challenges for the development of biotech industry in China are great, both in terms of overcoming domestic obstacles, and dealing with changing international contexts, as the next section elaborates.

¹⁰⁶ Biotechnologist, Institute of Genetics, Beijing, 2002.

¹⁰⁷ At the time of writing only for publicly listed Chinese seed companies: Longping, Yahua, Fenge and Qinfang (Carl Pray, pers. comm.).

¹⁰⁸ Interview, Beijing, 2001.

¹⁰⁹ Biotechnologist, Institute of Genetics, Beijing, 2002.

7 Challenges for the development of biotechnology in China

Companies in China are far too short-termist: it's hard to get them interested in biotech; they don't think of the longer-term national interest. Monsanto has been running for 100 years, but the quality (suzhi) of Chinese companies is too low.

(Senior scientist, Institute of Genetics, Chinese Academy of Sciences, Beijing, 2002)

The paper so far has looked at how China's biotech strategy can be understood as characteristic of a developmental state: reflecting a capacity to engage with a new technology and innovate in a way that goes beyond what experience might predict, and in the process attempting to impose more social control of the technology than is the norm elsewhere. The previous section looked at how China has sought to engage with biotechnology in a commercial sense, either in terms of interactions with multinational corporations, or in terms of developing its own biotech industry. Much has arguably been achieved, but nevertheless serious challenges remain and these may yet prove to be fundamental obstacles.

7.1 The seed industry

One issue is that while national R and D capacity is strong and many products have been developed, the routes for commercialisation – if this is deemed desirable – are weak; indeed some argue that the weakness of the Chinese biotech seed industry is one reason why China has been slow to grant market approval to any new genetically modified crops, despite some new traits and varieties having passed other stages of risk assessment.

This section explores in more detail some of the reasons for these challenges and looks at what they mean for understandings of China's biotech developmental state. It begins by looking at the seed industry. Huang *et al.* describe the Chinese seed industry as 'the agricultural sector's last bastion of state planning' (2000: 3). With the introduction of the Seed Law in 2000 seed marketing has begun to change, but it still remains a sector characterised by numerous small companies and small protected markets. Under the planned economy each county had its own seed company and they generally had monopoly rights in their area.¹¹⁰ While there are now many more large companies with national reach, many local markets are still hard to access. Policy in practice in this area appears to be different from policy on paper.

There are over 10,000 companies in China. Often local extension agents sell seed despite being prevented from doing this officially, and in the process they promote particular varieties and hinder the progress of others depending on who they are tied in with. The basis of the seed industry in the past was local production for local markets. Companies were not allowed to sell beyond a certain area, and this continues to some extent under the new Seed Law, where there are different entitlements to produce and sell seed depending on levels of capitalisation. However, while policies say any non-hybrid can be sold anywhere with a license, in practice the conditions for a license in some places are tough. Seed companies are commercialised to different degrees; some have severed ties to local agricultural bureaux, but often

¹¹⁰ There were also prefectural and provincial seed companies. Foundation seed would come to companies from prefectural or provincial level research institutes.

they are independent in name only. Huang *et al.* (ibid.) note that: ‘Seed administrators collect money from seed companies; they are often members of seed companies this needs reform’. They go on to argue that the policy functions and business functions of seed companies need separating: ‘the biggest problem for all the multinationals is not IPRs, but market access’ (ibid.).

Another characteristic of the Chinese seed sector is that only 30 per cent of seed used is produced by the organised seed sector (Huang *et al.* 2000: 6). Obviously a lot of seed is saved and exchanged by farmers locally, but much is also so-called “fake” seed, unregistered and often packaged as if it were Monsanto or some other recognised brand. From one point of view this may not necessarily be a bad thing, farmers get cheap seed which may be crosses of generic good varieties and well-adapted local seed. But, on the other hand, the quality is often low, with varieties insufficiently backcrossed, for example. Cotton officials in Wangjiang county, Anhui province complained that this was a particular problem: ‘The opening up of the market is not really a good thing. There are too many varieties and quality control is lost.’¹¹¹ An Andai manager commented: ‘The Seed Law of 2000 was important but implementation is a problem, there is fake seed and this is often protected by local authorities.’¹¹² Not only are there problems of fake seed this also means that varieties that have been approved for sale in one place cross provincial borders and end up being sold in places where they have been officially rejected (see Keeley 2003). One scientist on the Biosafety Committee in the MOA argued: ‘Companies in fact carry cotton everywhere— the government has no way of controlling this, it’s a reality.’¹¹³

This situation is problematic for those trying to sell GM seeds for both Monsanto and Biocentury. According to the Andai manager

There are 120 fake varieties. MOA say there are not enough people to take care. MOA has to order the province, then the province orders the prefecture, the order goes down level by level to the grassroots then has no effect. That is how bureaucracy is: they have strong relations with local authorities.¹¹⁴

Of course officials are optimistic that these phenomena are all problems associated with transition and that the situation is improving. An official in the extension department in the MOA argued that

As you move from a planned to a market economy there are problems. But the seed law is now powerful, and the systems of certification. Not all cotton companies can sell seed, there are restrictions on capital, they need registration, and certificates for quality. Government monitors the quality of seeds.¹¹⁵

¹¹¹ Under the Seed Law it is actually the job of local agricultural bureaux to punish those selling fake or poor quality seed (Article 59). However, in situations where the networks between companies, traders and local officials are close regulations may in practice not be enforced.

¹¹² Interview, Hefei, 2002.

¹¹³ Interview, Beijing, 2002.

¹¹⁴ Interview, Hefei, 2002.

¹¹⁵ Interview, MOA, Beijing, 2002.

Indeed, many of these general problems were recognised in a presentation by an MOA official at the first international China seed conference – he put the case that the government would interfere less in the future in the seed industry and put more effort into concentrating on ensuring quality standards are maintained.¹¹⁶

7.2 Agricultural research

As part of China's biotech strategy considerable funds are allocated to biotech research and these are accessible through a range of different programmes such as 863, 973, Foundation for Transgenic Plants and the Bridge plan. There is also a system of National Key Laboratories prioritising key institutes. These funding and priority setting structures can be argued to be part of the very focused way that the Chinese biotech developmental state works. While plans go to MOA and then to MOST for consistency with policy directives and priorities, in practice agricultural research is not really as coherently organised as it at first appears. A lot of evidence appears to suggest not, and that this is not the only challenge for the Chinese state in terms of what it is expecting research to deliver as part of its biotech vision.

Huang *et al.*, in a comprehensive review of agricultural research in China, argue that the decentralised research system presents particular problems.

While the institutional framework of agricultural research is comprehensive in the way it is laid out, lack of coordination among various players has led to a large overlapped agricultural research in China. Inefficient resource allocation is often created from similarity of research priority settings or duplication of efforts between the central and local governments, among various ministries, and among local research institutes in the same regions.'

(Huang *et al.* 2002a: 115)¹¹⁷

Scientists were often quite scathing about the highly publicised and prestigious research funding bodies.

Research is not very prioritised – it depends on what gene you have developed. There is no good strategic planning. 863 people just get funds for what they can do. 863 and 973 is a group of people in Beijing, and the best people don't necessarily get the money. Its politics not science, you have to build up your networks. *Bt* is available so lots of people do *Bt* rice, for example.¹¹⁸

Another researcher observed that: 'Prioritisation is very poorly done. Institutes have are no board members or trusts as overseas. If you get money you'll do research on that; the cotton institute will

¹¹⁶ Presentation by Ma Ju (Ma 2001).

¹¹⁷ Private sector research in China is 1.7 per cent of agricultural research expenditure, 75 per cent of this is from 20 MNCs and the rest from 30 domestic private research institutes. But private sector research is emerging, for example Li Denghai, set up the private Laizhou Academy of Agricultural Sciences, with public sector support. Maize from LAAS accounted for one third of the total sown area in 1999 (Huang *et al.* 2002a: 142). The Chinese research system is also very decentralised research system with 86 per cent of the agricultural research budget spent at provincial or prefectural levels (*ibid.*: 143).

¹¹⁸ Interview, scientist, central China, 2003.

research rice if someone will pay for it!¹¹⁹ Others argue that: ‘No one knows what is going on’, and that there is an urgent need for a clear accessible inventory of what projects and themes are being undertaken and addressed by different institutes under different auspices. Even a key official in the MOST suggested that there was a certain haphazardness: ‘Together with MOA we define which crops are most important for R and D. To some extent guided by what researchers can do’.¹²⁰

Another aspect is that, not only is the system perhaps not as coordinated as it might be, it is also hard to bring scientists together to work strategically. Much as the bureaucrats on the 863 committee might like people to get together and pool knowledge, in reality it seems that institutes are quite secretive and territorial about what they are doing; each wants to make some breakthrough that will attract critical acclaim, or patent something significant or experience the kudos of winning a key prize. One sceptical scientist argued that: ‘Cooperation between institutes in China depends on scientists, administrators can do nothing.’¹²¹

Research institutes are also under pressure, with core funding cut-backs, to generate their own funds, commercialise their research and effectively go into business, identifying market demands and attempting to meet them. Incentives to commercialise their own technologies, offer advantages, but, as Huang argues, ‘skilled research staff could be taken away from research activities to perform business tasks for which they are not trained. Research could suffer while enterprises run by non professional managers perform badly’ (2002a: 130). Furthermore new companies may also have problems competing in the market place where they lack authority to restructure and have to carry lots of staff, including retired staff associated with the institute (Huang *et al.* *ibid.*: 222). This was an argument heard in relation to Longping Gaoke, for instance. The challenges for companies emerging from research institutes are many and do not always bring the best results as the next section discusses.

7.3 Are companies like Biocentury really up to competing?

Bureaucrats don't understand agricultural sciences. I went to the US and came back and said you can't compete with Dupont or Monsanto. St Louis is unbelievable, having a plant is only the beginning, you have to reach all the way from the seed to the field.'

(Senior Chinese agricultural scientist, China Agricultural University, 2002)

Are companies like Biocentury the mechanism for Chinese biotechnology to reach all the way from the lab to the field? Biocentury as a company is in some respects in an enviable position – it has access to technologies from the close network associated with the substantial investments linked to the 863 programme. It is supported in developing its markets through its close links to the public sector in a way that its rival Monsanto is not. Yet, in some respects, the company faces difficulties. Indeed, symptomatic

¹¹⁹ Interview, researcher, Beijing, 2002.

¹²⁰ Interview, MOST, Beijing, 2003.

¹²¹ Environmental scientist, Shanghai, 2003.

of the problem is the fact that some in foreign companies don't even refer to Biocentury as a company, calling Chinese cotton "MOA cotton". Biocentury, for some, is not seen as a serious rival despite its network of companies and its lower seed prices. Even within the policy networks close to the company rumours are that the holding company is not happy with the state of the books and particularly the way profits are divided.

For Biocentury to really challenge Monsanto and for the Chinese developmental state to really realise its goals of developing a Chinese biotech industry some things will need to change. One problem with the company is the reliance on senior scientists doubling up as business people spending their time flying between labs in Beijing and offices in Guangdong, or going off to India to negotiate business deals. A key scientist at Biocentury and BRI noted: 'Property rights are not well thought about by scientists. Chinese scientists offer things to everyone. They are not businessmen'.¹²² Another commentator noted that the attempted deal with Nath Seeds in India seems to have come to a halt: 'who knows the Indians probably ran off with the seeds and said thank you very much'.¹²³

In many ways the Biocentury problem reflects a more general problem with the market oriented approach that now characterises Chinese research. As Huang *et al.* note

many serious researchers, frequently the renowned ones, bitterly complain that being forced to concentrate on starting up and running businesses diverts precious human capital from serious research by encouraging those not trained in economics or business practices to enter complex, emerging marketplaces in China's transforming economy . . . in some cases success in business has led to promotion in the research hierarchy, while those who have not fared so well, despite research credentials, have found promotion blocked.'

(Huang *et al.* 2002a: 209)

Biocentury in many respects also faces some of the same problems of Monsanto. For example, CRI benefiting from BRI research – if that is what happened – can be presented as consistent with a developmental state strategy, but for the commercial managers of the company who increasingly want to think in terms of exclusive control of technology such an easy-going approach increasingly grates. 'CRI have used our gene – it's a complicated relationship, this issue is still not resolved, since BRI and CRI are all under the Academy of Agricultural Sciences access issues are complicated, we are all part of the same system (*yige xitong*)'.¹²⁴ Indeed a general comment is that seed companies are happy to pay the license fee once for technologies coming from research institutes but after when they have the seed they reproduce themselves and refuse to pay any royalties, according to many viewing research outputs as essentially public property in the first place.

¹²² Biotechnologist, BRI, Beijing, 2002.

¹²³ Researcher, BRI, Beijing, 2002.

¹²⁴ Biotechnologist, BRI, Beijing, 2002.

These problems are in some respects one of the Janus faces of the multifaceted networks of scientists that lie at the core of China's development of biotech, and which have, in many ways, enabled it to do so much so quickly. As with many phenomena noted more generally to really succeed in particular areas there may need to be a teasing apart, a clarification of functions. This in some ways may mean at the same time, however, that some of the advantages of the Chinese public-private networks around biotech are lost and with them some of the instruments of control relied upon by the state.

Some would also argue that the scope for pursuing novel Chinese approaches to developing biotech will be weakened as integration with the norms, standards and obligations associated with WTO increasingly kicks in over the next few years. To what extent is this true?

7.4 Challenges following WTO accession

Chinese are keen to go on study tours. Chinese want to go and study the EU to learn technical barriers from them!

(Monsanto employee, Beijing, 2002)

Analysis of exactly how China's recent WTO entry will affect the capacity of the state to at least attempt to behave developmentally in relation to biotechnology is beyond the scope of this paper. But it should be noted that changes associated with WTO such as new intellectual property regimes or greater rights of multinationals to invest and market could potentially limit some of the room for manoeuvre and strategic approaches that this paper has identified as critical to the development of China's biotech industry to date (Mo 2001a). It may be much harder for China to use biosafety in a strategic way to restrict the expansion of multinational corporations while being more permissive towards its own companies. Pressures to be consistent or face challenges on the basis of erratic application of sound science criteria are a possible consequence (see Newell 2003). The developmental state certainly needs to become literate in the use of "neutral" scientific technical criteria to advance particular policy objectives, while remaining SPS and TBT compliant.¹²⁵ These issues clearly worry many in China who claim that agriculture was "sacrificed" in the WTO agreement.¹²⁶

Companies such as Jidai clearly feel that they will benefit from WTO: 'Jidai follows the laws and regulations. In the long run the development of the seed industry is positive and clear, WTO will support this.'¹²⁷ Multinationals argue that they behave transparently and that WTO enforces this and that eventually there will be a big enough constituency in China seeing the benefits of this: 'It's all about lowering unit costs and with WTO people will figure this out'.¹²⁸ There is an expectation that restrictions on foreign investment in the seed industry may not last more than three years, though not everyone is in

¹²⁵ See, for example, recent disputes with the EU on residues on spinach, or the US on chicken breast exports from China for example, and Chinese imports of chickens feet.

¹²⁶ Huang and Rozelle (2002) disagree with this interpretation arguing that the agreement only reinforces existing trends.

¹²⁷ Manager, Jidai, Shijiazhuang, 2002.

¹²⁸ Manager, Delta and Pineland, Beijing, 2002.

agreement on this point. Some researchers claim that not everyone in MOA supports the new restrictions on MNC investment as they see Monsanto as having a positive role in terms of stimulating competition¹²⁹. It may also be that, if foreign investment becomes more possible and local level protectionism becomes of the type described above, there may be some consolidation in the seed industry and drastic change from the situation that prevails at present. One Syngenta manager argued: 'Many in China feel WTO is a big threat. Everyone is yelling that the wolf is coming in the seed industry.'¹³⁰

In relation to intellectual property it is less clear that there will be substantive changes in the short-term. China claims that under the terms of the Agreement on Agriculture and food security provisions it is WTO compliant. TRIPS will be implemented from January 2005; as yet the government's position in relation to 27.3b is unclear. Other areas where China may face challenge in relation to WTO are the system of using Lists to limit plant variety protection on the basis of the UPOV 1978 Convention (Mo: 898); some argue there is a lack of transparency of what is on and off, and insufficiently rigorous application of novelty, distinctiveness, uniformity and stability criteria. At the moment some researchers use capacity arguments to justify the ad hoc nature of the list, this may be harder to justify in the future: 'PVP doesn't include cotton. One reason is that the sequences are the same and so it's hard to test different varieties. When there is a proper gene library then we will be able to check.'¹³¹

On the other hand parts of the Chinese government such as SEPA appear to be increasingly sympathetic to arguments about genetic erosion and biodiversity loss. Some SEPA-based researchers argue that strong IPR regimes in agriculture could exacerbate trends towards seed monopolies and monocultures.¹³² There are other areas where, if China can master the arguments – property rights and risk assessment are two examples – it may be possible to limit attempts to force imports of GM agricultural products on China: 'We have PVP and biosafety, because otherwise GM will come, Chinese agriculture could be smashed by WTO. We will just follow Europe.'¹³³ Labelling is another such area, with many in China arguing that China's tight labelling laws are actually more WTO compliant than those of the US.

8 Is the developmental state delivering pro-poor biotech?

One key argument in relation to China's biotech programme is that, because of the public sector role in priority setting, guiding investment, controlling multinationals, and formulating strong policies, a type of biotechnology is being developed that is fundamentally different to the dominant vision associated with private-sector led research and commercialisation.

¹²⁹ Though the regulation was originally submitted to the State Council around 1999 by the MOA Seed Division. After this opinions changed, nevertheless the State Council still made the ruling.

¹³⁰ Manager, Syngenta, Beijing, 2001.

¹³¹ Interview researcher BRI, Beijing, 2002. Another researcher argued: 'IPRs– there will be endless court cases – they have to be realistic. There is no capacity to implement. And we want to respect the rights of farmers to save' (CAS researcher, Beijing).

¹³² Discussions at Policy Research Centre for Environment and Economy, SEPA.

¹³³ Interview, Manager, Syngenta, Beijing, 2001.

The paper has presented some of the arguments for seeing the Chinese state as acting as a developmental state in relation to biotechnology; it has clearly strategised to support the development of a high-tech industry which it sees as offering a range of different benefits. However, the evidence for a pro-poor focus is mixed. Some work is done on more pro-poor traits, but the crop focus for China's biotech programme is geared at key crops in relation to food security conceived in the broadest sense. Also, the pressure to concentrate on productivity gains and optimum returns to research mean that some are openly sceptical of the benefits of a pro-poor focus. The director of one agricultural research institute commented: 'You get much better returns to research in rich provinces. If you invest in poor regions, it gets lost all over the place. Our resources are limited. There are less incentives for scientists. We have to think about market utilisation efficiency.' He went on to argue that the need to concentrate explicitly on food security as in the past was now over: 'China's number one problem was hunger. 7 per cent of the land; 23 per cent of the population; this is solved! Now the issue is quality. Too much rice is imported from Thailand.'¹³⁴

Further to this China's vision of agricultural development, to which biotechnology is linked, is arguably not particularly pro-poor; rather it places heavy emphasis on high-potential areas and improving agricultural productivity in order to be more competitive in markets for key crops (generally in relation to imports). Discourses of agricultural development tend to focus on high-tech rather than low-tech solutions to problems and these tend to be linked to assumptions about increasing farm size to improve efficiency; at the same time, in many instances rural poverty alleviation is often primarily conceived in terms of moving people out of marginal areas either through employment creation via the successful town and village enterprise model, or through resettlement policies.

There are other considerations. The emphasis on biotech as a national priority area means that, from one point of view, MOST dominates agricultural research. It provides a major source of funding for agricultural research institutes; in some instances more significant than the MOA which formally oversees these institutes, and, through this, it is able to push for the realisation of biotech policy. One aspect of this is that problems are defined by scientists (molecular biologists, geneticists and so on) and not by agricultural specialists. One scientist interviewed at the prestigious National Hybrid Rice Research Institute in Hunan, the institute which developed the first varieties of hybrid rice in China, complained that it was hard to get funding for the type of non-transgenic approaches he was using; they were "a small stream" in the wider context of genetic engineering dominated agricultural research institutes. An official in the MOA commented: 'The MOST has money and power, they invite people in for priority setting, but they don't get MOA in to discuss.'¹³⁵ These kind of trends are borne out in figures presented by Huang *et al.* who note that China biotechnology research got 9.2 per cent of the national crop research budget in 1999, an increase from 1.2 per cent in 1986. This compares with levels of between 2 and 5 per cent in other developing countries (2002a: 675).

¹³⁴ Director, China National Rice Research Institute, Hangzhou, 2002.

¹³⁵ Interview, MOA, 2002.

Some researchers are quite critical of this trend, arguing that money is diverted from other approaches: 'too much attention is paid to biotech; lots of money is wasted. We are blindly following biotechnology. There is lots of low level duplication. Too many people go into biotechnology, the balance is not good.'¹³⁶ Even within the multinational corporations people can be found who are openly critical of the possibilities of pro-poor biotechnology.

Biotech will never help solve poverty, it will make it worse; this technology is only for those that can afford it, if you are growing cotton you are not very poor, maybe for some this is there main crop and so the technology helps lift them up, but mostly it is farmers who are doing well can pay for water and fertilisers and so on.¹³⁷

Another researcher argued

Many talk about this. They don't like the diversion of funds, but the powerful people can decide. They argue that biotech is the new technology for a new century. People think biotech is our future and they look down upon traditional technology. It's a pity. They neglect traditional science. 90 per cent of what is on the market are traditional varieties, but officials put money into biotech. Some researchers complain that, if biotech is not mentioned in a proposal, they will not get money, if you put it in you will get more.¹³⁸

This, then, is another challenge in relation to the developmental state fostering a form of biotechnology that can in any way be thought of as developmental.

9 Conclusion

This paper has shown that analysis of Chinese discourses and practice of agricultural biotechnology casts light on several important dynamics in modern China. This narrative of the life-sciences applied to agriculture has a particular appeal because it kills several birds with one stone: it speaks to the long-standing problem of food security, it is potentially a very important niche to occupy in the global knowledge economy, and it appeals to a particularly Chinese commitment to modernisation and faith in the power of science and technology to affect this transformation. Biotechnology has been particularly effectively promoted by small but well-connected science-policy-business networks. This tells us something new about change and continuity in policy processes in a country that is metamorphosing rapidly. The paper has shown that China has concentrated on biotechnology and produced results that in many ways mirror the activity of developmental states in other settings. The state has in some respects picked a winner.

¹³⁶ Scientist, China Agricultural University, Beijing, 2002.

¹³⁷ Manager, Syngenta, Beijing, 2001.

¹³⁸ Environmental scientist, Beijing, 2003.

But in terms of this *first* definition of the developmental state -governing the market and rapidly industrialising- serious questions still need to be asked. Research outputs may be impressive for a developing country, and China may have successfully engaged with Monsanto on its own terms, but, as was illustrated, attempts to commercialise research or evolve larger seed companies into GM agribusinesses have had limited effect. This is an often overlooked factor that may also explain some of the reasons for China's slow down in commercialisation of new GM technologies beyond the much publicised *Bt* cotton. The likelihood of Biocentury, China's prototype biotech corporation, becoming a global industry leader at the moment is small. In this sense of being a successful developmental state China is still only half-way there.

In terms of the *second* definition of the developmental state -- applying technology to address poverty and food security concerns -- again there are many unanswered questions. One criticism of biotechnology is that it presents one limited solution to a narrowly defined problem. Agricultural productivity gains and specifically crop improvement are the goals and biotechnology is the major way to achieve them. While these are undoubtedly important concerns they are only one aspect of debates about agricultural production and its relationship to food security and rural livelihoods. An important set of prior assumptions underlie a policy commitment to biotechnology, and in China it appears that at present a wide-ranging debate about these problem-solution framings has not been had publicly. Scientists critical of very strong public policy commitments to biotech appear to feel that they only have a remit to engage in the particulars of specific biosafety debates, rather than address wider questions about the need for biotechnology. Within civil society Greenpeace is the most prominent example of an organisation trying to recast the debate, though the means for them to do this has been through supporting biosafety research on key under-examined themes, rather than straightforward advocacy as elsewhere. One of their project officers defined what they are trying to do as follows

Our aim is to locate technological discussion in a social context. Food safety, sustainable agriculture and organic farming. We are asking what should be the future of agriculture in China? Agriculture is the most pressing problem in China and the question is should genetic engineering be the solution?¹³⁹

These kind of concerns chime with related debates about the widely-accepted rural crisis which biotechnology is implicitly conceived as addressing. Importantly the principal problem of many farmers is well-recognised as agricultural fees and taxes, in the case of the often-cited soyabean farmers of the Chinese northeast, for example, it could be that they could be substantially more competitive if they were not facing such a fiscal burden. Is technology really what the developmental state needs to concentrate on? Equally importantly, to what extent do the rural poor and rural farmers themselves have the chance to define their problems and deliberate over different solutions? Just as not all farmers regard GM cotton as an unqualified success, so there are likely to be many perspectives on the role of technology in this aspect

¹³⁹ Greenpeace researcher, Beijing, 2003.

of rural development, and the challenge for policymakers is to find ways to handle this complexity and open up official science-policy discourses to a greater range of voices and perspectives.

Drawing these two strands together it appears that on both counts the concept of a biotech developmental state works only up to a point. The state is doing something in China that for the most part it is not doing in other places and in some ways it does it very effectively, as China's many high-profile research breakthroughs illustrate. Complementing this, some of its motives and patterns of investment in engaging with biotechnology are very different to the corporate sector dominated picture elsewhere; in this sense there might be more hope of the technology being used in a way that contributes to development. But finally, just as agricultural biotech stands at the apex of many different policy concerns, so it is difficult to tell one simple story about biotechnology; the biotech developmental state concept offers certain insights but in relation to both definitions there are still important limitations at present.

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