A developmental risk society? the politics of genetically modified organisms (GMOs) in China

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Abstract: Over the past years, China has grown to become one of the largest growers of genetically modified crops in the world. At the same time, international and domestic biotechnological corporations are attempting to conquer the domestic seed market. Some Western observers fear that the pressure of food security and increased international competition, coupled with a lack of civil society, might lead to the disregard of risks presented by genetically modified organisms (GMOs). In this paper, we attempt to probe the possibility of whether China might evolve into what we typify as a "developmental risk society" – a society in which government and science confronted with major development issues, disregard technological risks due to the absence of sufficient countervailing forces. We argue that the answer to this question is negative and demonstrate that current biotech politics in China actually features a complex dynamics with various checks and balances, while the State displays a deeply contradictory position towards biosafety management.

Keywords: genetically modified organisms (GMOs); biotechnology; Bt cotton; risk; developmental state.

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1 Global and local importance of China's biotechnology

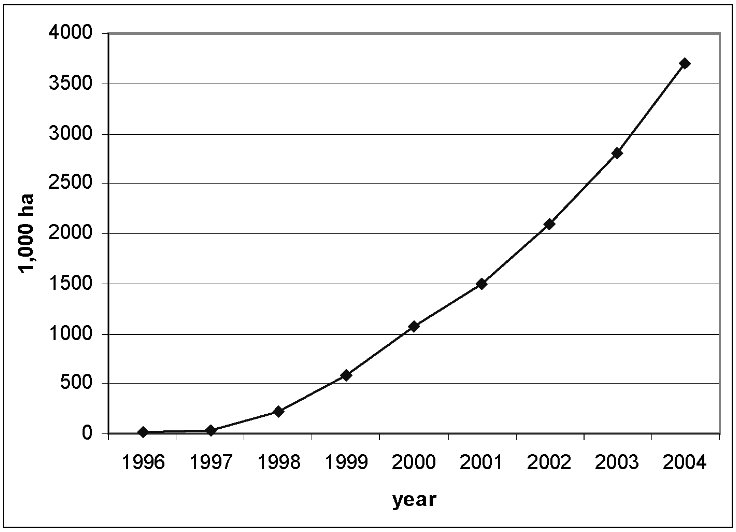
Recombinant DNA techniques have drastically changed life on our planet. Genetically Modified Organisms (GMOs) ranging from genetically engineered bacteria to genetically engineered fruit and fish, herald new technological breakthroughs in a wide variety of economic sectors such as medicine, agriculture and the food industry. Worldwide, public reaction to biotechnology varied from pragmatic acceptance in The Netherlands – "everything is okay as long as it is inexpensive" – to outright social resistance in Brazil. Also governmental response varied. The European Union, Japan, Australia and Switzerland, for example, have maneouvred cautiously in embracing biotechnology and have imposed mandatory labelling systems for GMOs. Contrarily, the USA has aggressively pushed biotechnology and criticised Zambia and Zimbabwe for not accepting biotech food aid, while Europeans were called 'immoral' and 'Luddites' (in the words of US Trade Representative Robert Zoellick) (Taylor, 2003).

There are several arguments as to why biotechnology developments in China merit close, scholarly attention. In 1995, Lester Brown shocked the Chinese government with his prediction that the People's Republic would face critical food shortages in the future (Brown, 1995). Although Brown's analysis has been much criticised after publication, he did touch on a critical issue.[1] Food security has for decades been a source of major concern for the Chinese government. China houses one fifth of the world's population, while the area of farmland per capita is less than half of the world average. According to demographic projections, the Chinese population will reach 1.6 billion by the year 2030. The demand for food production must rise by at least 60% to keep pace with this demographic trend (Zhang, 2000).[2] For these reasons, there is a strong need for raising agricultural productivity. Many experts say that high yielding and disease resistant GM crops may help developing nations such as China and India feed their growing populations. But the relatively weak regulatory and legal institutions, the lack of political transparency and the absence of a pluralist and strong civil society might lead to a hasty adoption of new and uncertain technologies with potential social and environmental risks.

For one thing, a scenario of public concern over GMOs prompting the government into action seems unlikely in the Chinese context. Public angst for biotechnology – derided by US president Bush as "unfounded and unscientific fears" – caused the European Union in 1999 to declare a *de facto* moratorium on the application of GMOs in food products, which was only lifted in July 2003 with the proclamation of new stringent regulations (Buddingh, 2003). A recent study on consumer acceptance found a higher level of resistance against GM foods by consumers in Japan, Norway and Taiwan as compared to their peers in the USA. Whereas The USA, on 3rd May 2000, rejected mandatory biofood labelling on the ground that these foods do not differ from their conventional counterparts from a health and safety standpoint, the Japanese, Norwegian and Taiwanese authorities have stipulated much stricter regulations (Chern and Rickertsen, 2002; Macer and Ng, 2000). Contrarily, GMOs are a nonissue in China; a recent poll of 1,000 respondents found that one third had never heard of GM foods. In addition, those who did not know or were unsure if they would be willing to eat GM food outnumbered those who answered with a clear ‘yes’ or ‘no’ (with almost 25% stating they actually *would* eat it).[3] In another study of college students at one of China’s top academic institutions – the Shanghai Fudan University – the overall majority of interviewees (83%) said that they “had never paid attention to the question whether the food they bought was genetically modified food”, and in fact “did not care about GM products” (54%) (Wu et al., 2002, pp.2, 3).[4]

Another important reason why the Chinese developments in biotechnology should be followed closely is China’s rapidly growing area of GM plants. Seven crops have been approved for, or have already gone into commercial production: two types of GM tomato, disease-resistance green pepper, short-straw morning glory (petunia), GM tobacco (but only commercially grown between 1993–1998) (James, 1997; Keenan, 2002)[5] and two types of cotton modified with genes from the *Bacillis thuringiensis*, so called ‘Bt cotton’ (Wang, 1999, p.8; Qing and Wade, 2000, p.2; Zhao, 2002, p.30). In 2004, China was the fifth largest grower of GM crops after the USA, Argentina, Canada and Brazil, according to the International Service for the Acquisition of Agri-Biotech Applications (ISAAA). For several years in a row, including 2004, China accounted for the world’s largest acreage in pest resistant Bt cotton.[6] In 1996 China cultivated 16,667 hectares of Bt cotton, concentrated in the Hebei and Shandong provinces. Nine years later, this area had sharply risen to 3.7 million hectares accounting for 66% of the national cotton acreage (see Figure 1).

Figure 1 Acreage of Bt cotton in China in 1,000 ha (1996–2004)



Source: China National Bureau of Statistics (2001, p.376) and Provided by Cui Jinjie, Cotton Research Institute of Chinese Academy of Agricultural Sciences,[7] James (2002, 2003, 2004)

Finally, the way in which China will deal with the control of GMOs has possible global implications. With China's recent entry to the World Trade Organization (WTO), it will play a major role in the international community (related to international trade and the environment). China's lead in new issues, such as GMOs will be critical for Asian regional institutions (e.g., Association of South East Asian Nations or ASEAN, Asia Pacific Economic Cooperation or APEC and the Asia Europe Meeting or ASEM) and international organs such as the WTO and the United Nations Convention on Biodiversity. In anticipation, in early 2002, China approved new regulations on the production and use of GM products. Under the new rules, Chinese-foreign joint ventures and foreign owned companies need government approval to research or test GMOs, while sellers of modified seeds, seedlings or animals need official permits. However, the environmental regulations on GMOs in China are still lagging behind countries in the West and need to be reinforced. It is against this backdrop that this paper has been written.

2 Dangerous developments: questions, concepts and methodology

In *Risk Society*, the sociologist Ulrich Beck envisioned a bleak future for human development. He regarded current environmental problems such as global warming, nuclear waste and biodiversity loss as a grim challenge which late modern society might not be up against. Earlier risks of nineteenth century industrial society, such as industrial accidents and natural hazards were discrete, statistically describable and thus 'predictable' and subject to "supra-individual and political rules of recognition, compensation and avoidance" (Beck, 1992b, p.99). In contrast, modernisation has unleashed a novel generation of incalculable hazards which Erikson dubbed a 'new species of trouble' (Erikson, 1994). These hazards are increasingly undetectable by direct human sensory perception, can cause irreversible harm, and are capable of transcending generations and the boundaries of nation states. Beck believed that the political, social, and economic institutions of contemporary society are unable to effectively deal with this new category of risks (Beck, 1992a, pp.22, 29).[8] This incapacity in turn leads to a situation in which "the institutions of developed industrial society – politics, law, engineering sciences, industrial concerns – accordingly command a broad arsenal for 'normalising' noncalculable hazards" (Beck, 1992b, p.105). In other words, late modern society creates a sense of false security based on the institutionalisation of technobureaucratic norms and regulations, which forms an intractable logic of self destruction, steering towards a global environmental crisis; it is the logic of the 'risk society'.[9]

Whereas in nineteenth century industrial society, social cleavages and class differences were determined by the distribution of wealth, the risk society comes to be increasingly determined by the distribution of risks. People become gripped by the hazards and potential threats unleashed by the exponentially growing productive forces of modernisation, while their thoughts and actions become pivoted on risk avoidance rather than wealth accumulation (Beck, 1992a, p.49).[10] The feeling of public unease and incertitude over chemical, nuclear and genetic problems causes a polarisation between those who profit from risks and those who are afflicted by risks. In the risk society, state and science face a rising problem of legitimacy, which will eventually mobilise antagonising forces that fundamentally question the direction of societal development

(Beck, 1992a, p.10; Lundqvist, 2000).[11] In Beck's apocalyptic vision these 'subpolitical activities' might mark the way out of the impasse, as they topple the monopoly of expertise held by elite academic and political institutions, and affect the democratisation of science.

Whereas Beck was writing with a Western perspective in mind – with particular reference to the welfare states of industrialised nations (Marshall, 1999, p.267)[12] – the question of state legitimacy in the face of environmental risks, to a great extent, also applies to developing countries. In this respect, one might wonder how well equipped nations in the South would be in dealing with issues of biosafety and social risks of GMOs. In fact, in developing countries where the state has a strong grip over society and 'subpolitical activities' are severely restrained, yet, serious socioeconomic problems still await solutions, there might be a greater danger to disregard the risks of new technologies. Kydd et al. remarked that "regulatory arrangements may be weaker in less developed countries, more difficult to manage or more easily subverted, leading to lower standards for food safety and environmental protection" and even a 'genetic Bhopal' (Kydd et al., 2000, p.1137). The People's Republic of China might just fit such a picture: similar to other East Asian states, China features a strong, developmental state that actively intervenes in economy and society (Chan, 1993, p.59),[13] but still allows little input from civil society (Ho, 2001). Diamond and Myers classified China under the ideal-type category of an "authoritarian state, which rules out formal political opposition of any kind" (Diamond and Myers, 2000, p.368; Cho, 2002; Li, 2002).[14] With its large population and limited natural resources, the central state is eagerly looking for ready, and sometimes drastic, solutions to imminent problems ranging from energy supply to social stability and food security.

In this paper, we examine the question whether the Chinese context might constitute what we term a 'developmental risk society'. In our understanding, this implies a society in which government and science are incapable of dealing with technological risks in the absence of an effective system of checks and balances, and in the face of large scale 'dilemmas of development', such as food security vs. population pressure; economic growth vs. environmental degradation; and rural poverty vs. agricultural modernisation.[15] We argue that the answer to the question above is negative, and will demonstrate that although China lacks a vibrant civil society and democratic polity, biotech politics are actually characterised by an intricate dynamics in which various countervailing forces in society balance the different – and at times, conflicting – interests of social and political actors. A vital role is played by the central state, which seems strongly divided over the biosafety issue; on the one hand, it heavily promotes biotechnological development, yet, on the other hand, it also intensively tries to regulate the international and national flows of GMOs in the food chain and the environment.

In order to substantiate our argument, we review the role, risk perceptions, and vested interests of three groups of social actors involved in the politics of GMOs in China: the central state, international biotechnology companies, and NGOs and independent experts. Several critical considerations precede these choices. First, in the Chinese context with a highly centralised state that reaches deeply into society, the promotion or control of GM crops could not be accomplished *without* support from the central state. Second, a strong incentive to increase the area of GM crops in China presently comes from international companies, such as the Monsanto Company. Third, within the limited framework of this paper, we have chosen to exclude farmers from the analysis. In fact, farmers' risk perception, and the effects that GM crops have on rural livelihood, market integration, and indigenous knowledge of traditional crops are such substantive issues that they warrant separate study. Lastly, this research takes into account nonstate actors, but leaves the perspective of consumers aside. As we have seen in the preceding section, the power of Chinese consumers is relatively weak. To date, there are no clear indications for a 'green consumerism' (Sanders, 2000),[16] let alone, strong public demands for GM free food. On the other hand, despite that the overall majority of consumers showed little understanding of the potential risks of GM food, one study found that the willingness to buy GM food dropped sharply once they obtained neutrally worded information about it. This might point to future scenarios of consumer resistance against GM food as also happened in European Union member states (Ho et al., forthcoming).[17]

One might say that there are as many different scholarly approaches to risk, as there are risk studies themselves (Renn, 1992, pp.70, 71; Krimsky, 1992).[18] In our view, risk is in part an objective threat of harm to people and in part a product of politics, culture and social experience. Hence, hazardous events are 'real': gene flow involves transformations of the physical environment with potential negative consequences for biodiversity and human health, while simultaneously triggering shifts in social and value structures. These events, however, remain constrained within the social context unless they are observed by human beings and communicated to others. In turn, these social interactions may lead to other physical transformations such as institutional change, technological innovation and shifts in governance styles. The experience of risk is therefore both an experience of physical injury and damage, as well as the resultant of political, cultural and social processes by which individuals or groups interpret hazards.

Within the broader domain of biotechnology, this paper will narrow down on genetic engineering or genetic modification (GM) technology. GM methods are distinguished from other biotechnological techniques by allowing the transfer of genes between different organisms. It involves isolation, cloning, recombination and insertion of genetic material through various molecular biological techniques. So called GMOs refer to animals, plants and microorganisms whose genome has been altered through genetic engineering techniques. We will pay particular attention to two types of GMOs (in fact, GM crops) that featured most prominently in China's political and academic debates: pest resistant cotton or Bt cotton, and GM soybean or Roundup Ready soybean. The remainder of this paper is organised into three sections. The first part provides a short review of the benefits and risks of GM crops and foods. The following part, divided into three separate subsections, examines the risk perception and role of the main stakeholders in shaping biotech politics: the national government, transnational biotech corporations, and NGOs and scientific experts. The conclusion provides an outlook on the future perspectives of biosafety governance in China.

3 Reconsidering the gene revolution: pros and cons of GMOs

Similar to the Green Revolution, at the time heralded as the 'end to world hunger', companies and experts now hold out numerous promises about the wonders of GM technology. However, GMOs might not only affect farmers' livelihood, but – as many critics maintain – also involve unanticipated environmental and health risks. Therefore, it is imperative to be conscious of the various benefits and risks of GM crops. The potential benefits of GM crops include input characteristics, such as higher yields, wider growing conditions (better tolerance to different temperatures, soil conditions, and so forth) and increased resistance to pests and diseases (McGarity and Hansen, 2001, p.8). The potential benefits in terms of output characteristics refer to higher nutritional content, improved food quality, and added medicinal properties (through the development of 'agriceuticals' such as vaccine containing food (McGarity and Hansen, 2001, p.10).

The potential risks of GMOs can be divided into risks to human health, and risks to the environment and public welfare. The risks to human health can be caused by the unintentional production of toxic or allergenic proteins in the GM crop,[19] reduced levels of nutrients (Teitel and Wilson, 1992) and pathogens' resistance to certain antibiotics (notably kanamycin) due to the use of 'marker' genes (Food and Drug Administration, 1992, p.22). Many scientists acknowledge that the present expertise on the interaction between GM plants and the human digestive system is insufficient. In addition, the tools for assessing the health risks of GM plants are relatively undeveloped. On the other hand, environmentalists' alarmist reports on the pandemics caused by GM foods have not materialised either. Although millions of people daily consume foods derived from GM crops, no single confirmed case of a disease attributable to GMOs has appeared in the scientific literatures.

The socioeconomic risks of GM crops lie in various areas. In developing countries where income disparities are large, markets are noncompetitive and the rural populace is reliant on subsistence agriculture, there is a greater risk that biotechnology will lead to the widening of social inequality (Kloppenburg, 1998, p.55). The use of the new technologies might also lead to greater market integration and dependency of farmers on agricultural corporations. The monopolisation of the market can be used to extract from farmers and consumers, the profits attributable to increased efficiencies.

Also disquieting are the potential environmental risks: pest resistant GM crops that do not distinguish between harmful and beneficial insects (for example, honeybees and pollen-spreading butterflies), while 'gene flow' of herbicide or disease resistant genes from GM crops might create undesirable weed species (Quist and Chapela, 2001; Metz and Fütterer, 2002).[20] For the purpose of this paper, we should note that the debate on the environmental risks has also turned to Bt cotton. As we will see below, this particularly pertains to Bt cotton's potential ecological effects: the development of resistance against Bt toxin by cotton's primary pest – the bollworm; the possible rise of secondary pests – such as aphids, lygus bugs, and red mite; the decrease of the bollworm's natural predators – such as spiders and parasitic wasps. Another issue that has divided scholarly opinions is the claimed effect of the reduction in pesticide use through Bt cotton. Qaim (2003) and Huang et al. (2003) have reported a clear decrease in pesticide use. Yet, these results have recently been contested by Men et al. (2004, p. 1) and Pemsl et al. (forthcoming). Men et al. (2004) stated that "the total number of insecticide applications for Bt cotton was no less than the total applied on nontransgenic cotton, because additional applications were required against sucking pests". Moreover, they also reported that "pesticide applications decreased numbers of aphids, acarids and predatory spiders significantly on both transgenic and nontransgenic cotton".

Scientists may provide comprehensive risk analyses from a technical, social or economic perspective. Yet, the particular design of the regulatory regime of GMOs that is eventually adopted by individual nation states critically depends on such factors as the risk perception by involved parties and what may be socially and culturally acceptable. Also crucial, is the commitment of national authorities to take on responsibilities in biosafety policy. In 2001, the vast majority of developing nations, such as Mali, Ethiopia, Nicaragua and Pakistan had not developed a national legal framework for the regulation of biosafety yet (Wakhusama, 2001, p.10).[21] China conveys a rather mixed picture; the country has undoubtedly embarked on a biotechnological 'Great Leap Forward', yet simultaneously, the government has also been relatively quick in responding to the advent of biotechnology and its potential hazards. We will see that this situation is the resultant of an intricate interplay between the different stakeholders.

4 Biotech politics: conflicts, debates and a lack of public participation?

4.1 The state wavering between public and private interests

Over the past decade, China has dramatically stepped up its efforts in biotechnology. In addition, the national research budget for plant biotechnology has strongly expanded: over the period 1986–1999 it increased 14 times from US$ 8 million to US$ 112 million. China already accounts for more than half of the developing world's expenditures on plant biotechnology. In 2001, Chinese officials announced plans to raise the research budgets by 400% before 2005. If this goal is achieved, China will take up nearly one third of the world's public spending on plant biotechnology. (Huang et al., 2002, p.675). With one fifth of the world's population living off less than half of the world's per capita average of arable land, it is certain that the Chinese state is facing the pressures of development, such as safeguarding food security, agricultural modernisation and keeping up with increased international competition.

For the reasons above, the international media have portrayed China's biotech sector as balancing on the brink of an environmental crisis (Kirkby, 2002, p.1).[22] However, the situation is more complex than the critics want us to believe. In fact, the central state is actually performing an arduous juggling act in balancing the contradictory benefits and risks of GM crops.

While embracing biotechnology and substantially investing in its development, the Chinese government has also been proactive in biosafety and risk management – internationally and domestically. As a Party to the United Nations Convention on Biological Diversity, China has taken actively part in the drafting and negotiations of the Cartagena Biosafety Protocol (CBP).[23] On 8th August 2000, China signed (but until today, has not ratified) the CBP joining another 71 signatories including the UK, France, Germany and New Zealand (Stilwell and van Dyke, 1999).[24] In addition, China was also among the 18 other countries that joined an international pilot project for the development of a National Biosafety Framework. The project established by the United Nations Environment Program and funded by the Global Environment Facility was meant to build and improve capacity on biosafety management in developing countries. This project has supported and stimulated China to establish an impressive regulatory framework that covers most relevant areas including risk assessment, labelling, production, use, storage, import and export and release of GMOs into the environment. China has not yet included specific regulations for the implementation of the CBP's 'Precautionary Principle' and the 'Advance Informed Agreement' (Meyer, 2000),[25] but a drafting group is currently engaged in harmonising national laws and regulations with the CBP.

In terms of domestic policy making on biosafety, China's central authorities have demonstrated considerable caution and restraint in their choice which GMOs to allow for entry to the domestic market (China Daily, 2002, p.1).[26] Chinese scientists have been active in the development of a wide variety of GMOs, including rice, wheat, Chinese cabbage, cauliflower, carp, pig and sheep (Wang, 1999, p.7). Yet, to date the Chinese government has not granted permits for the commercial production of most GM products that could enter the food chain although Bt rice is expected to be commercialised soon (see Table 1).

Table 1 Varieties of GM crops approved for environmental release up to 2003

Crop	*Introduced trait*[a]	*Contained use*[b]	*Deliberate release*[b] *(Bergmans, 1999)*[27]	*Commercial production*[b]
Cotton	Insect/disease resistance	1	7	2
Tomato	Virus resistance	0	4	2
	Shelf-life altered			
	Cold tolerance			
Sweet pepper	Virus resistance	0	2	1
Petunia	Colour altered	0	0	1
Tobacco	Insect resistance	2	5	0
Rice	Insect/disease/herbicide resistance	3	6	0
Soybean	Herbicide resistance	0	1	0
Potato	Disease resistance	0	7	0
	Quality improvement			
Wheat	Virus resistance	1	0	0
Papaya	Virus resistance	0	1	0

[a]Huang et al. (2002, p.675).

[b]Wang (1999, p.8).

Permission has been granted to two varieties of GM tomatoes and green pepper, but these crops have not gone into commercial production yet, because of concerns over domestic food safety regulations on the part of investors. In addition, the commercial cultivation of GM tobacco was stopped in 1998 (Qing and Wade, 2000, p.2). In fact, the overall majority of commercially cultivated GM crops consists of the nonfood crop, Bt cotton, which is grown within strictly contained areas approved by the Ministry of Agriculture or MOA (CSTN, 2002a, p.2). Furthermore, under rules promulgated by the MOA effective since spring 2002, seventeen different species of agricultural GM products divided over five classes in the so called MOA Identification Catalogue must be labelled before sale on the domestic market. This is different than in, for example, the European Union, Japan or Switzerland, where labelling is compulsory above a certain percentage threshold of transgenic material.[28] Also for GM products that are already available on the shop shelves, labelling is required (CSTN, 2002a, p.3).

A critical and potential destabilising factor in China's biotechnological governance is the fragmentation of authority, which results partly from the novelty of the issue and partly from the restructuring of the central and local state bureaucracy since the Ninth National People's Congress in 1998. The novelty of biosafety and GMOs as political issues implies that newly created state institutions, or newly accorded responsibilities need to be defended against older, established agencies with vested interests. On top of this, China has engaged in a major restructuring of the state's bureaucracy which affected two important institutions concerned with biosafety: the State Science and Technology Commission (SSTC) and the National Environmental Protection Agency (NEPA). During the restructuring, the SSTC was downgraded to ministerial level and renamed the Ministry of Science and Technology (MOST). In addition, the NEPA was elevated to half a rank below ministerial level and renamed the State Environmental Protection Agency (SEPA).

Initially, the state institution in charge of the nationwide control of biosafety was the MOST. In the early 1990s, a National GMO Biosafety Committee was established under MOST for the supervision, administration and approval of activities in biotechnology. For years, the most important national rules on biotechnology were the "1993 Safety Administration Regulations on Genetic Engineering" issued by the predecessor of MOST, the former SSTC.[29] In addition to MOST, there are four other state institutions with overlapping duties in lawmaking, control and supervision of biosafety and GMOs:

- the MOA notably its Office for Security Management of Agricultural Genetically Modified Bioproducts and the Experts Committee on Agricultural Genetic Engineering Safety
- the SEPA, in particular its subordinate Department of Nature and Ecology Conservation
- the Ministry of Public Health (MPH), namely its Center of GMO Food Safety Evaluation and the State Human Genetic Resources Administration jointly set up with MOST and lastly
- the State Administration for Entry–Exit Inspection and Quarantine.

At present, the MOA, one of the oldest, and thus, more powerful ministries, has allegedly assumed the coordinating role in national biosafety control. The MOA (particularly the Biosafety Office and its subordinate Biosafety Committee) is responsible for biosafety management and control of GM crops and products, including the drafting and implementation of biosafety policies, regulations on labelling, and the review of risk assessment applications (CSTN, 2002b, p.2).[30] The current coordinating role of the MOA is contended by those who believe that the State Environmental Protection Agency (SEPA) should play a greater role (which it might get under the new Biosafety Law that the Ministry of Science and Technology and SEPA are currently drafting)[31] as well as those who favor a greater role for the Food Industry Bureaux. In addition, critics have also pointed to the potential conflict of interests as a state institution with responsibilities in the governance of agricultural production is simultaneously charged with tasks in environmental protection. As the former Deputy Director General responsible for biosafety in SEPA stated: "Granting the MOA this responsibility, is like allowing a soccer player to referee his own match" (Wang Dehui, oral communication, 9th September 2003). Traditionally the SEPA has been concerned with (agro)industrial pollution issues, but since the signing of the Cartagena Biosafety Protocol in 2000 (ratified by the National People's Congress on 19 May 2005), it is also concerned with the conservation of biodiversity. Under the Cartagena protocol, the SEPA is also the executing agency for the drafting of the National Biosafety Framework. The SEPA maintains that it will continue to build a national system for the inspection and technological support of biosafety in accordance with this framework. Although the Ministry of Public Health has left most biosafety concerns to the MOA, this institution is also active in the testing, approval, labelling, and industrial standards for new foods. In fact, it is in the midst of drafting new GMO Food Safety Regulations that in some areas might overlap with MOA rules.

At present, it is unclear how the different responsibilities in biosafety of the various ministries and state departments relate to each other. Wang Canfa, a member of the NPC drafting group for new comprehensive legislation on biosafety, stated:

> "With regard to China's laws and regulations on biosafety, a few ministries have stipulated some rules, yet only from the angle of their own ministry. There is no ministry that has systematically stipulated comprehensive rules on biosafety and its administration from the national perspective. As a result, there is no coordinated and uniform administration (...) which has already influenced China's management of biosafety, and at the same time the coordination of biosafety administration with the international community."[32]

Promulgating laws and regulations is one thing, but their effective and efficient implementation is another. In this respect, the coordination and integration of biosafety policies between the MOST, SEPA, MOA, MPH and the State Administration for Entry–Exit Inspection and Quarantine will prove essential. However, whether Chinese society might or might not develop into a developmental risk society not only hinges on how the central state balances conflicting interests of environmental protection, food security and biotech development; it also depends on the input of other social actors: NGOs and independent experts, and companies, particularly transnational corporations.

4.2 Biotech companies

Monsanto is one of the most important players in GM crops – internationally, as well as on the Chinese market (Keenan, 2002, p.1).[33] The products that Monsanto attempts to market in China, include GM soybean known as Roundup Ready® soybean, and Bt cotton sold under the name BollGard® cotton. Roundup Ready soybean contains an enzyme capable of neutralising the herbicide's active ingredient, glyphosphate. This gives it a comparative advantage over nonresistant weeds. BollGard cotton has been modified with genes from *Bacillis thuringiensis*, as a result of which it produces biotoxins that kill its main pest – the boll worm. Monsanto claims its GM crops are environmentally friendly, cost and labour efficient, and help in solving food security. In their words:

> "Why are farmers adopting biotech crops at a rate that some compare to the rate at which tractors replaced horses during the early 20th century? The reasons are simple: With no change in safety or quality of the harvested products, these crops are easier and cheaper to grow than their counterparts without herbicide or insect resistance. In addition, the environmental bonuses represent, arguably, the greatest benefits to resource conservation and environmental quality of any technology introduced since the beginning of agriculture." (James R. Cook quoted by Monsanto, 2002, p.1).

Monsanto's rationale to enter the Chinese market is obvious: both in cotton and in soybean China belongs to the world's four largest producers. With an annual production of over 4.5 million tons, China ranked first in cotton output in 1998, while in the same year it ranked fourth with more than 15 million tons of soybean. The research and development of Bt cotton belongs to China's and, in fact, the world's sole and largest undertaking in the commercial production of Bt cotton to date. In the early 1980s, the Institute of Biotechnology of the Chinese Academy of Agricultural Sciences and the Monsanto company independently engaged in research to render cotton resistant to the boll worm, a major insect pest. This resulted in two types of Bt cotton: Monsanto's BollGard® cotton and the Chinese variant of Bt cotton developed by the Institute of Biotechnology. Chinese authorities allowed commercial use of the two Bt cotton types in 1997, after the domestic cotton harvest was heavily affected by pests, while field experiments with Bt cotton had proven successful (He, 2000, p.1).

China's major cotton producing regions are located along the fluvial plains of the Yellow and Yangtze rivers, stretching from the military farms (*bingtuan*) of Xinjiang in the northwest to the coastal provinces of Shandong and Zhejiang. The regions most suffering from boll worm are the Yellow and Yangtze river areas. Today the production of Bt cotton is concentrated in the Yellow river region – the provinces of Shandong, Henan, Hebei, Shanxi, Shaanxi – with a limited area in the Yangtze area – the provinces of Hubei, Hunan, Anhui and Jiangsu (see Table 2).

Table 2 Characteristics of China's major cotton growing regions including Bt cotton

Characteristic	*Region*		
	Yellow river	*Yangtze river*	*Northwest*
Major provinces	Shandong, Henan, Hebei, Shanxi, Shaanxi	Jiangsu, Anhui, Hubei,Hunan, Jiangxi, Sichuan, Zhejiang	Xinjiang[b], Gansu
Bt cotton in ha	16,667 (1997) – 8,07,000 (2000)[c]	Limited area in Anhui (1997) – 258,200 in Hubei, Hunan, Anhui, and Jiangsu (2000)[c]	None (1997) – 10,760 in Xinjiang (2000)[c]
Seed use, 1998[a]	74.4 kg/hectare	33.2 kg/hectare	110.7 kg/hectare
Production, 2000[a]	1.69 million tons	1.21 million tons	1.51 million tons
Average production, 1996–2000[a]	7.49 million tons	7.52 million tons	6.52 million tons
Yield, average 1995–1999[a]	810 kg/hectare	947 kg/hectare	1,393 kg/hectare
Pests	Bollworm, aphids	Pink bollworm, mites	Aphids, spider mites
Diseases	Fusarium wilt (Damping off), root rot, anthracnose	Boll rot	Blight, leaf-spot

[a]Only major cotton-producing provinces are included in the classification, i.e., with an annual production exceeding 20,000 tons.

[b]Cotton production in the hands of the Xinjiang Military Production and Construction Corps (or *bingtuan*). This organisation was set up for reclamation of the frontier zones and belongs to the Chinese People's Liberation Army. During peacetime, the *bingtuan* members primarily engage in farming, mining and industrial production.

[c]From (Xue, 2002, p.5). All remaining data – including Bt cotton acreage in 1997 – from (USDA Economic Research Service, 2001).

Since Monsanto has obtained a license for commercial promotion, it has made considerable investments in promoting its BollGard cottonseeds in China. And not without success, over the first five years since the introduction of Bt cotton from 1996 to 2000, Monsanto's share in the total acreage of Bt cotton rose from zero to 65.9% (see Table 3). In addition, by cooperating with local seed companies, Monsanto took away a lion's market share in Hebei Province. Monsanto and the Delta and Pine Land company established a joint venture with the Hebei Provincial Seed Company for the sale of Bt cottonseeds (He, 2000, p.2). Although Monsanto's application for Hubei province was rejected, it did receive approval in 2000 to sell Bt cotton seeds in Shandong Province (Smith, 2000).

Over the past few years, however, Monsanto's market share in China has dropped as domestically developed Bt cotton seeds and (pirated) hybrid seed varieties increasingly start to flood the market. According to a technical representative in the Monsanto Beijing Office, its market share for Bt cotton had decreased to 15% in 2004 (Oral communication, 4th May 2004). One of Monsanto's main commercial rivals on the domestic market is Biocentury, a company set up by the Chinese researcher Guo Sandui and his colleagues, who developed a 'Chinese' (according to Monsanto 'pirated') version of Bt cotton. Biocentury is jointly owned by Guo Sandui, a Guangdong-based holding company, and the Biotechnology Research Institute of the Chinese Academy of Agricultural Sciences.

Table 3 Acreage of domestic and Monsanto Bt cotton in China (1996–2000) in ha

Year	*Domestic Bt cotton*	*Monsanto Bt cotton*	*Monsanto Bt cotton* (*% of total*)
1996	16,667	0	0
1997	21,333	12,667	37.3
1998	45,333	1,82,667	80.1
1999	1,84,667	3,93,333	68.1
2000	3,66,667	7,09,333	65.9

Source: Provided by Cui Jinjie, Cotton Research Institute of Chinese Academy of Agricultural Sciences

The operations of transnational biotech companies in mainland China are confined within the boundaries set out by the central state. Unlike most industrialised nations where biotech research is privately financed, the Chinese government funds almost all plant biotechnology research. In 1998, 50% of the total expenditures of 461 billion RMB[34] in the natural sciences and technology came from the government (China National Bureau of Statistics, 1999, p.678). It was estimated that in the periods before 1995 and between 1995 and 1999, private investments in biotechnology only accounted for respectively 5% and 10% (Huang et al., 2002, p.675). In their attempt to govern the biotechnological arena, the Chinese authorities have not feared to risk a trade war with one of their largest trading partners: the USA. In January 2002, the Chinese Ministry of Agriculture promulgated national regulations with far reaching implications for biosafety and foreign trade (CSTN, 2002b, p.3).[35] Under these rules, Chinese-foreign joint ventures and foreign owned companies need government approval to research or test GMOs, while the sale of modified seeds, seedlings or animals is restricted through official permits. The regulations stirred up concern with the USA, which produces 70% of the world's GMOs, most of which modified soybean. China is the largest export market for modified soybean and the US industry ship approximately an estimated US$ 1 billion worth per year. In 2004, 20.74 million tons of soybeans were exported from the USA to China (Zhao, 2004). Confusion over the rules brought a virtual halt to new orders of USA cargoes of soybeans – 70% of which are bioengineered – as Chinese buyers that worried cargoes might not be approved. By September 2001 – a half year before the regulations' official proclamation – the USA and China reached a formal agreement over GM products, and soybean sales have since resumed.[36]

John Killmer, Monsanto's Greater China President felt frustrated over the government's conflicting stance on biotech development:

> "China has imposed the most restrictive regulations on the production, research and importation of GMO crops in the world. The ban is specifically designed to shut foreign companies out of the world's largest government funded biotechnology development programs. They have one foot on the accelerator, which is funding biotech research and development, and they have the other foot on the regulatory brake." (Killmer cited in Kyne, 2002, p.1)

As we have already seen above, the central state's motives for stepping up control over biosafety are not driven by environmental concerns alone. Wang Weirong, a researcher at Fudan Xinyang Biotech commented on the new rules:

> "most GM-related products in China are currently made from imported material. (...) The regulation is thus likely to form trade barriers to foreign competition, but when China's own biotechnologies become mature, the labelling rule might be loosened." (Wang cited in Jia, 2003, p.836)

In fact, one of the underlying reasons of the Chinese leadership's to allow the presence of transnational biotech companies might be to facilitate field trial experiences and gain expertise through technology transfer (perhaps at times, even involving pirating). It seems highly implausible that the government would allow the monopolisation of the domestic market by transnational corporations.

4.3 Cotton controversies

The complexity of biotech politics in shaping China's stance on risk management is also visible in public debate. At present, Chinese nongovernmental institutions are still weak and incapable of providing sufficient countervailing power against the proponents of biotechnology – be they state or business actors (Ho, 2001).

As Chinese politics is gradually opening up for pressure group intervention and public participation, the environmental arena has sprung up as one of the most active sectors in civil society. However, green NGOs still face many political and institutional constraints, while their impact on society is extremely limited (Wu, 2002). In a recent survey among 10,495 households, only four percent of the respondents believed that environmental protection should be enhanced through the role of green NGOs (while almost 57% opted for other measures such as strengthening environmental education, environmental laws and regulations, and increased investments in the environment) (SEPA, 1999, pp.22, 29).[37] In another survey, it was found that less than 3% of 1,000 respondents had heard of GM food through environmental NGOs.[38] Most significant is the fact that there *is* no domestic NGO that has made biotechnology its field of activity in Chinese society today.[39]

Most China watchers and reporters are wary that the lack of civil society will lead to the neglect of the environmental and socioeconomic risks of biotechnology. For instance, *The New York Times* wrote:

> "Enthusiasm for the new science abounds. There is no public debate to stir up the opposition that has brought the development of genetically modified crops to a near standstill in India." and "with no independent news coverage (...), consumers are unaware that they are eating modified food." (Smith, 2000, p.1)

Although there is a kernel of truth in these reports, there is also no reason to assume that biotechnological risks in China 'are underestimated, compared out of existence or made anonymous causally and legally' as Beck assumed would happen in the risk society (Beck, 1992b, p.105). In fact, unknown to most foreign – and probably also domestic – observers, the Chinese authorities actually tried to evoke a societal debate on biosafety.

The first scientist who critically wrote about the safety of GM crops in China was Mang Keqiang, professor at the Institute of Microbiology of the CAS. However, he did not write on a personal title, but had been *invited* by the central authorities to do so (Mang, oral communication, 2002). The high priority that had been accorded to this issue was shown by its publication in 1996 in China's authoritative government newspaper: the *People's Daily* (*Renmin Ribao*). Mang Keqiang warned that

> "once agricultural transgenic plants and microorganisms are released and spread into the environment, they might be difficult to control (*yi shifang tuiguang, ze nanyi kongzhi*)' and hoped that the 'involvement of other concerned experts in the discussion, will bring these questions to the attention of governmental policy makers and the administrative departments in charge of research funds." (Mang, 1996)

Unfortunately, the state's attempt to start a national debate on biosafety did not materialise at the time.

In order for a modest debate to materialise, the input of a transnational actor proved necessary. In 2002 Greenpeace supported the publication of Chinese experiences with Bt cotton cultivation (Greenpeace, 2002). The report, written by Xue Dayuan, deputy chief of the biosafety management office of the State Environmental Protection Agency, focused on the environmental impact of Bt cotton. The study was based on a scientific review of Chinese research conducted by four academic institutes: the National Institute of Plant Protection and the Cotton Research Institute in Anyang, both of the Chinese Academy of Agricultural Sciences; the Department of Plant Protection of the China Agricultural University; and the Department of Plant Protection of the Nanjing Agricultural University.

Xue drew several important conclusions (Xue, 2002, p.3). First, "although in the Chinese studies there are no significant impacts on predatory natural enemies associated with Bt cotton, there are associated adverse impacts on parasitic natural enemies of cotton boll worm". Second, "Bt cotton is not effective in controlling many secondary pests, especially sucking pests (...) such as cotton aphids, cotton spider mites and thrips". Third, "cotton bollworm can develop resistance to Bt cotton". In fact, laboratory tests indicated that "susceptibility of bollworm to Bt cotton fell to 30% after 17 generations" while the resistance index "increased 1,000 times when the selection was continued to the 40th generation". Fourth, "farmers must use chemicals two to three times to control bollworm, particularly from mid July to the end of August" because "the resistance of Bt cotton to bollworm decreases over time, and control is not complete in the third and fourth generations". In other words, the cultivation of Bt cotton results in an increased, rather than a decreased pesticide use as Monsanto and other researchers (Huang et al., 2003; Qaim, 2003) have claimed. Xue's last conclusion is supported by other studies (Men et al., 2004; Pemsl et al., forthcoming). As there are no effective measures to resolve the resistance problem, Xue maintained that Bt cotton is released into the environment prematurely.

Immediately after publication, the report came under heavy attack. According to Monsanto's scientific director Eric Sachs, the Greenpeace report was 'misleading and flawed'. He added that "there is no evidence of resistance to Bt crops (...) and while this purports to be a review of the relevant information, it doesn't present all information available, even that which contradicts it" (Sachs quoted in Reuters, 2002, 4th June). The report was also fiercely criticised by two prominent scientists at the Chinese Academy of Agricultural Sciences. Jia Shirong and Peng Yufa wrote: "The context of many research data is garbled in accordance with the author's own interest and will". They added that "the greatest environmental impact of Bt cotton was its benefit to the environment that was a significant reduction (70–80%) of the chemical pesticide use" while "risks to beneficial insects and the environment are negligible" (UNIDO-BINAS, 2002, pp.1, 2). However, the question whether Xue Dayuan was right or not is secondary to the fact that a Chinese debate on the risks of GMOs – albeit confined to scholarly and commercial circles – was initiated by an international NGO.

5 Concluding observations: the future dynamics of biotech politics

Over the past decade, China has embarked on nothing less than a biotechnological 'Great Leap Forward' With an area of approximately 2 million ha in 2002, China has become the fourth largest grower of GM crops in the world. Among Western observers there is a fear that the lack of civil society, independent news coverage, and the traditional command and control fashion of Chinese politics, might lead to a hasty adoption of GM technologies with scant regard for environmental and social risks.

Partly drawing on social theories of risk, this paper examined the question whether the particular constellation of the Chinese polity and society does indeed constitute a 'developmental risk society' conceived here as: "a society in which government and science are incapable of dealing with technological risks in the absence of an effective system of checks-and-balances, and in the face of the large-scale 'dilemmas of development". Through a review of the main social actors in biotech politics – the state, transnational biotech corporations, and NGOs and academics – we may conclude that the answer to this question is in fact, negative.

The type of governance that the Chinese state has adopted today is characterised by a relatively strict regulation of biotechnological risk and biosafety. Different than most developing nations, China has been proactive in drafting and promulgating rules for the national, as well as the international control of GMOs. China signed the Cartagena Biosafety Protocol in 2000 and two years later, proclaimed a comprehensive and stringent set of regulations on the risk assessment, labelling, research and environmental release of GMOs. In addition, even though a limited number of GM foods, such as tomato and green pepper, have been allowed for commercial production, the only GM crop that is cultivated on a large scale is a non food crop: Bt cotton. Some would argue that this points to the government's caution in allowing GMOs into the food chain.

On the other hand, even if the main implementation of agricultural biotechnology to date has been primarily limited to nonfood crops, this does not exclude the possibility that food products might soon get approval for commercial release. In particular, this counts for Bt rice, which is expected to be released for commercial production in a short term. Substantial investments have been done in the research and development of transgenic varieties of major staple crops, such as rice, wheat and potato. Sooner or later the domestic and international biotech companies will want to see the returns of these investments. Moreover, despite the fact that the Chinese government did not shrink back from a near trade war over the import of GM soybean with the USA in 2001, Sino-American trade was resumed before rules on labelling had reached the shop shelves. Even at this writing, the regulations on labelling and risk assessment have generally not been implemented, which implies that China continues to allow large quantities of nontraceable and unregulated GM material to enter its food processing and beef industries.

Why is the Chinese state so ambiguous in its stance towards biosafety? For one thing, the underlying motives that determine the sort of biotechnological governance adopted by the central leadership are clearly not given in by environmental concerns only. In the biotechnological arena, the Chinese state is facing various developmental pressures, such as securing food for its immense and ever growing population, agricultural modernisation without harming small scale subsistence farmers – the current mainstay of rural society; and keeping up with international competition. Internationally the USA is the largest producer and exporter of GMOs. To harness its own emerging biotech sector against international competition, the government heavily stimulates research and protects the domestic market when necessary.

Adding to the complexity of Chinese biotech politics is the absence of sufficient countervailing forces from civil society. However, the alarmist reports by Western media of a complete neglect of the risks of the new technologies fail to identify the many positive developments in biosafety in China. As early as 1996, years before the public discussions took off in selected member states of the European Union, the Chinese government made an attempt to trigger a public discussion over GMOs. A prominent researcher of the CAS was invited to write and publish a paper about biotechnological risks in the *People's Daily*, the nation's leading government newspaper. Unfortunately, the public debate failed to materialise at the time. The debate that *did* take off was the controversy over Monsanto's genetically modified cotton or Bt cotton, which can kill its main pest: the boll worm. According to a Greenpeace publication – based on an extensive review of Chinese research – there is substantial empirical evidence that point to the pest's resistance to Bt cotton. The publication's conclusions were heavily debated in commercial and Chinese academic circles.

The above demonstrates three essential features of Chinese society and the complexity of biotech politics. First, the central state is, to a great extent, committed to stimulating societal debate over GMOs, and will remain an important actor in balancing the various conflicting interests over biotechnology. Second, even though the discussion over environmental effects is important in its own right, many things have been left unsaid, in particular, the socioeconomic effects of GMOs on the rural populace. Third, in the absence of domestic NGOs that are active in the biotechnological arena, a public discussion over the risks of genetic engineering needed the backing of a transnational NGO to materialise. In spite of the relative indifference of the Chinese public to issues of biosafety as shown in several surveys, there is clearly a new field open for domestic

NGOs to exploit. A poll of 1,000 urban residents cited earlier in this paper came up with a few remarkable findings: 87% of the respondents found that food producers and supermarkets had the obligation to let consumers know which foods contain transgenic material, and 83% deemed a labelling system necessary for this (Green Community Research Center, 2002, p.2).

Chinese society differs from Western societies in critical ways, if not for the contradictory and complex trends in policy making over genetic engineering. Although China today most certainly can not be deemed a developmental risk society, there are potentially dangerous countercurrents in the longer run, such as the fragmentation of state authority over biosafety; the inertia of domestic nongovernmental groups in picking up biotech as an activists' issue; and the pressures by domestic and international biotech companies. What is certain, however, is that the way in which China will deal with biosafety, is going to have a crucial impact on the future dynamics of biotech politics in the South *and* in the North.

List of acronyms	
CAS	Chinese Academy of Sciences
CBP	Cartagena Biosafety Protocol
CSTN	China Science and Technology Newsletter
GMO	Genetically Modified Organism
ISAAA	International Service for the Acquisition of Agri-Biotech Applications
MOA	Ministry of Agriculture
MOST	Ministry of Science and Technology
MPH	Ministry of Public Health
NEPA	National Environmental Protection Agency
NGO	Non-Governmental Organization
RMB	Renminbi
SEPA	State Environmental Protection Agency
SSTC	State Science and Technology Commission
UNIDO-BINAS	United Nations Industrial Development Organization Biosafety Information Network and Advisory Service
USDA	US Department of Agriculture
WTO	World Trade Organization

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Notes

[1]Brown has been much criticised by Western and Chinese scholars over the past years for neglecting the role of agricultural intensification and making no specifications for the quality of land resources in his analysis. In addition, recent surveys of the area of arable land have shown that there has been significant underreporting in the land statistics (up to 25%).

[2]In addition, the rapid urbanisation and structural changes in the agricultural sector have also led to great losses in arable land. It was estimated that over the period 1985–1996, the total losses in arable land due to construction activities amounted to 1.3 million hectares (Ministry of Agriculture, 1997, p.100).

[3]In answer to the question 'if you knew that a certain food product contained GM ingredients, would you still eat it?' a total of 49% answered that they did not know or found it hard to tell. Those who could answer with 'yes' or 'no' added up to 48%. The survey was carried out under among 1,000 respondents in October–November 2002 in Guangzhou City with a response rate of 83% (Green Community Research Center, 2002).

[4]The survey was conducted in 2002 under among 500 students, response rate was 93%. Note that the students represent the echelon of best educated people in Chinese society.

[5]GM tobacco was not officially approved for commercial production by the Chinese Ministry of Agriculture, as it went into commercial production in 1993 well before the MOA's safety administration regulations were issued. According to the ISAAA, the acreage of transgenic tobacco was more than 1 million ha (60% of the total tobacco area) in 1996 and 1997. However, in 1998 the cultivation of GM tobacco was stopped in response to stricter regulations on biosafety (James, 1997; Keenan, 2002).

[6]In 2004 China occupied 82% of the total world acreage in Bt cotton (4.5 million hectares). This is not GM cotton as there are other types of genetically modified cotton.

[7]Estimates by Huang et al. are lower: 2,000 hectares of Bt cotton in 1997 and 7,00,000 hectares in 2000. It appears that they only accounted for the share of Bt cotton by the Monsanto company, see also Table 3 (Huang et al., 2002, p.676).

[8]As he wrote

> "The calculation of risk as it has been established so far by science and legal institutions collapses' and 'science's rationality claim to be able to investigate objectively the hazardousness of risk permanently refutes itself. It is based, on a house of cards of speculative assumptions and moves exclusively within a framework of probability statements, whose prognosis of safety cannot even be refuted by actual accidents." (Beck, 1992a, pp.22, 29)

[9]For more information on Beck's concept of the risk society, (see Cohen, 2000; Barry, 1999).

[10]As Beck wrote:

> "The dream of class society is that everyone wants and ought to have a share of the pie. The Utopia of risk society is that everyone should be spared from poisoning." (Beck 1992a, p.49)

[11]It is what Beck and other sociologists such as Anthony Giddens and Joseph Huber called 'reflexive modernization', because it is only when social and political actors are reflexive on the externalities of development that institutional and social change can be brought about (Beck, 1992a, p.10). For more information on reflexive modernisation, (see also Lundqvist, 2000).

[12]As Brent Marshall wrote

> "the explanatory power of the risk society is strongest when applied to 'welfare states' where the material needs of most of its citizens are met via wealth redistribution through taxation and social security." (Marshall, 1999, p.267)

[13]In political science, scholars have classified states into such types as regulatory, predatory or developmental states. Although there is no strict dividing line in state typology, countries like Japan, South Korea, Taiwan and Singapore have been generally regarded as developmental states (Chan, 1993, p.59).

[14]Yet, on the other hand, ample studies have examined and described the various arenas in which modest political reforms are taking place in China: the village elections since the mid 1980s; the growing power of the national and provincial people's congresses; and the nation's first experiment with democratic elections at the township level since 1949. (See, for example, Cho, 2002; Li, 2002).

[15]Note that this is different from Beck's idea of the Western risk society in which the distribution of wealth as the main driving force around which social cleavages and class distinction centres has been replaced by the distribution of risks. In fact, although wealth distribution still features prominently in developing nations, this does not preclude the emergence of risks.

[16]Although green products are already on sale in Chinese supermarkets, the current market is limited. (see Sanders, 2000).

[17]This study is based on a poll of 1,000 respondents. A draft version of this article is available at www.rug.nl/cds (Ho et al., forthcoming).

[18]In an attempt to classify the various approaches in the social risk studies, Renn (1992) put forward an exhaustive, yet, overwhelming description ranging from organisational theoretical perspectives to cultural theory-inspired studies. However, rather than classifying oneself into a particular school of thought or adding to the existing stack of approaches, notions and ideas on risk, we opt to highlight the main assumptions underlying our study. One of the main dichotomies that has split the various social theories on risk is the 'realist' vs. the 'constructivist' approach. In other words, are risks an objective reality or a social construct determined by structural forces in society? (see also Renn, 1992, pp.70, 71; Krimsky, 1992).

[19]For example, the toxic proteins produced by *Bacillis thuringiensis* (Bt toxins) which genes are currently inserted into most pest-resistant GM crops. Although Bt toxins are biodegradable, scientists have speculated on the possible toxic and allergenic effects for human beings – particularly so for those with weakened immune systems.

[20]The issue of gene flow caused a great controversy with the publication of Quist and Chapela's paper on transgenic DNA constructs of Bt corn in native Mexican maize. The academic row got so fierce that *Nature*, which had published the paper, rescinded its support for the original paper. It was an unprecedented move: for the first time in the journal's 133 year history it withdrew support for an paper without first calling for a retraction. Note that the discussion did not focus on the *eventuality* of gene flow, because most scientists surprisingly agree that transgenic DNA constructs will flow into the environment sooner or later. The discussion actually focused on the question whether transgenic DNA constructs are likely to change or fragment during the gene flow (See Quist and Chapela, 2001). Some of the reactions to Quist and Chapela were published as letters to *Nature*, see for example, (Metz and Fütterer, 2002).

[21]See Wakhusama (2001, p.10).

[22]See for example, Kirkby (2002, p.1).

[23]The CBP developed from the Convention on Biological Diversity of the United Nations Conference on Environment and Development held in 1992 in Rio de Janeiro.

[24]Apart from the Cartagena Protocol, there are two other binding international agreements that touch on biosafety issues: the Agreement on Sanitary and Phytosanitary Measures formulated within the framework of the WTO, and the International Plant Protection Convention developed by the Food and Agriculture Organization (FAO) of the United Nations (See Stilwell and van Dyke, 1999).

[25]The CBP sets safety standards for the international transfer of living modified organisms (LMOs) through:

- the use of the 'precautionary principle', which states that in the absence of scientific evidence or certainty on risks, decision-makers should be free to refrain from approval for the use and production of LMOs and the products thereof

- the requirement of Advance Informed Agreement for export to prevent developing countries from becoming dumping grounds for LMOs. The nation receiving LMOs or products thereof must be notified by the exporting party in written communication, while export can only proceed when approval from the receiving country has been given
- risk assessment which includes an appropriate period of observation of LMOs commensurate with their life-cycle or generation time, before they are put to their intended use
- the labeling of GM products, and obligatory documentation for living modified organisms meant for food or feed processing. However, the CBP regulations on this aspect are less stringent than most national biosafety laws (See also Meyer, 2000).

[26]China has also firmly opposed any experiments in the area of human cloning. This was expressed by the national delegate to the UN *ad hoc* Meeting for the International Convention against Reproductive Cloning of Human Beings (China Daily, 2002, p.1).

[27]In terms of regulation all activities with GMOs are subject to either the regulations for 'contained use', based on the European Directive 90/219/EEC, or regulations for 'deliberate release' of GMOs, based on the European Directive 90/2220/EEC (Bergmans, 1999)

[28]For the EU this is 0.9%, Australia 1%, Brazil 4%, Japan 5% and Switzerland 5%. See (Jia, 2003, p.835) and also www.isaaa.org/kc/issues/labeling/labeling.htm, which provides a comprehensive list of labeling legislation for different countries.

[29]The regulations also stipulate that "the SSTC is responsible for the nationwide genetic engineering safety work", see Order 17 of the State Science and Technology Commission, 24th December 1993.

[30]In addition, over the past few years there has been an increase in applications for biosafety assessment. By the end of 2001, the Chinese Ministry of Agriculture had received over 700 applications for security-oriented assessment of GM agricultural products from 52 domestic and four foreign biotech companies (CSTN, 2002b, p.2).

[31]Recently a statement on the new Biosafety Law was made on the government Biodiversity website, "Our country will implement a GMO biosafety law", 19th May, 2005. ("Wo guo jiang zhiding: Zhuan jiyin shengwu anquan fa"), available at http://www.biodiv.gov.cn/swdyx/144398862075822080/20050520/7840.shtml.

[32]Wang Canfa, oral communication (2003).

[33]World-wide only three companies account for virtually all GM crops that are commercially grown: Monsanto, Syngenta and Aventis CropScience (acquired by Bayer). Of these three, Monsanto products alone accounted for 91% of the total area sown to GMOs (Keenan, 2002, p.1).

[34]US$ is around 8 Rmb.

[35]These are:

- the methods on security evaluation and management of genetically modified agriculture bioproducts
- the methods on security management of imported genetically modified agriculture bioproducts
- the methods on identification management of genetically modified agriculture bioproducts (CSTN, 2002b, p.3).

[36]On 11th March 2002, China extended its trade agreement on GM soybean with the USA until April 2004. At the time, the issue even caught the attention of US President George W. Bush, who discussed the problem with Chinese leaders during a meeting in October 2001 in Shanghai.

[37]The survey was conducted between July 1998 and 1999 in all provinces of China. The response rate was 87.7%. Of the remainder 13.6% chose for better law enforcement; 10.6% for public participation in environmental protection; 9.7% for monitoring of pollution control by enterprises and 5.4% for innovation in environmental technologies. When asked to rank who had the highest responsibility in environmental protection, NGOs came last with the central and local government in first and second place, companies at the third, and the individual at the fourth place.

[38]Of the interviewees, 37.2% had heard about GM food through the media, 12.8% through friends, 12.3% through books and papers, 2.8% through school, 2.0% through the government and 1.5% through companies. (See Green Community Research Center, 2002).

[39]The office was reopened in spring 2002 after being closed down in 1995 because of an incident in August of that year when public security personnel arrested six foreign Greenpeace demonstrators, detained them for one day, and expelled them from China for unfurling an antinuclear banner in Tiananmen Square.