



**Stanford**  
Center for International  
Development

**Working Paper No. 312**

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January 2007



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# **Genetically Modified Seeds and Decommodification: An Analysis Based on the Chinese Cotton Case\***

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## **Abstract**

Decommodification of international trade is becoming a pervasive phenomenon. This process is mainly driven by the spreading out of intellectual property rights in the form of branding, certification, patents and copyrights, in other words by the creation of pan-global rights that have visible beneficiaries but diffused and often invisible obligation-targets. The issue is that the ongoing decommodification process comes along with the creation of economic rents that are more easily captured by the developed countries as opposed to the less developed countries, since the former have a stronger institutional setting and a better resource endowment to produce decommodified goods, market them, and enforce the compliance with the WTO-TRIPS agreement. A paradigmatic case of what is going on is the agricultural sector. This paper deals with a success story of home-grown agricultural genetic engineering, the creation of the genetically modified (GM) cotton seed and its adoption in China, in parallel with its competitor of multinational origin, and the possible transference of the success story to other developing countries. At a first glance, this case study seems to contradict the expected adverse impacts of decommodification of agricultural inputs in developing countries. But, in spite of the apparent counter-example of the Chinese GM cotton case, we argue that the Chinese example is unique and as such it is an exception which confirms the general rule.

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\* The authors acknowledge the contribution of Guiyan Wang and Yuhong Wu in the conduct of the survey in Hebei Province.

**Keywords:** decommodification; intellectual property rights; genetic modification; agricultural biotechnology; China; cotton.

**JEL classification:** Q12, Q16, Q18

## 1. Introduction

Decommodification of international trade is becoming a pervasive phenomenon even in a sector, like agriculture, where products are primarily traded as commodities. Of course, this is not an entirely novel breakthrough since international trade in high-value differentiated agricultural products, such as wines, cheeses, etc., has been taking place for centuries. What is new is the acceleration of this trade and the expansion of its domain under the current wave of globalization as a result of a complex set of technological and institutional changes that occurred in the last two decades (Yotopoulos, 2006).

One of the driving forces of this process of decommodification is agricultural biotechnology. Indeed, the application of new scientific methods – more precise and more effective than the traditional ones – makes possible a degree of product “customization” that was simply unimaginable a few decades ago. But those changes would not have made much difference if they had not been favored by policy interventions that reshaped the institutional set-up at the national as well as at the international level. The worldwide strengthening of the protection of intellectual property rights (IPR) provided robust incentives for unprecedented private investments in biotechnology. This is good news, because it has brought more private resources into the agricultural research industry. Yet it is also a fundamental cause of systematic asymmetries in globalization (Pagano, 2006). In fact, as artfully written by Michael Pollan in presenting the story of a recent agricultural biotechnology innovation:

In the case of the NewLeaf [potato] a gene borrowed from one strain of a common bacterium found in the soil – *Bacillus thuringiensis*, or Bt for short – gives the potato plant’s cells the information that they need to manufacture a toxin lethal to the Colorado potato beetle. This gene is now Monsanto’s intellectual property. With genetic engineering agriculture has

entered the information age, and Monsanto's aim, it would appear, is to become its Microsoft, supplying the proprietary "operating systems" – the metaphor is theirs – to run this new generation of plants.

(Pollan, 2001: 191)

As Pollan adds, the Peruvian Incas, whose ancestors domesticated the *Solanum tuberosum* seven thousand years ago, can never claim property rights over the domesticated potato genes since intellectual property can be recognized only to individuals and corporations – not to tribes! Furthermore, the economic rents accruing to the IPR holder seem systematically to favor the developed countries (DCs) vis-à-vis the less developed countries (LDCs) because the former have a stronger institutional setting and a better resource endowment to produce decommodified goods, market them and enforce compliance of the customers with the IPR regulations.

This paper provides an assessment of the application of genetic engineering to agriculture and its marketing to LDCs in the specific case of a success story, namely the creation of a genetically modified (GM) seed, Bt-cotton (GM cotton from here on), and its adoption in China. Although a thorough and exhaustive assessment of the adoption of GM seeds in LDCs is still far to come, there is quite a widespread disbelief regarding the suitability of GM seeds for LDCs, justified with the claim that GM seeds do not match poor farmers' real needs and, even if suitable, they cannot be accessed because they are too expensive (Myers, 1999; Mazoyer, 2000). On the contrary, the Chinese case seems to contradict the expected adverse impacts on LDCs of decommodification of agricultural inputs:<sup>1</sup> about one half of the total Chinese cotton acreage is currently in GM cotton and this has led to a decrease in insecticide use, a reduction in the related costs, an increase in cotton yields and a higher profitability due to significant labor savings (Pray *et al.*, 2001; Huang *et al.*, 2002; Huang *et al.*, 2003a; Huang *et al.*, 2003b). But, on balance, we argue that welcome as it is, the counter-example of the Chinese cotton case is unique and as such it represents an exception which confirms the general rule.

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<sup>1</sup> Another apparently success story of GM cotton adoption is South Africa, where a higher profitability is reported by smallholder growers in the Makhatini Flats - Kwazulu Natal Province ( Ismaël *et al.*, 2002; Gouse *et al.*, 2002; Thirtle and Jenkins Beyers, 2003). However, the dramatic reduction in cotton production in the Makhatini Flats during the 2002-03 crop season, due both to institutional and climatic reasons, as well as the rising cost of GM seeds due to an increasing market concentration in the seed industry, show that the alleged success of the South African case must be more balanced (Fok *et al.*, 2004a).

This paper is organized as follows. Section 2 is devoted to the analysis of the changes of the rules of the game that accompanied the emergence of the GM seed industry and summarizes the debate about the pros and the cons of GM seed adoption in LDCs. Section 3 analyzes the Chinese GM cotton case using original data from a survey carried out in 2002-03 in Hebei Province that show the positive impact of GM seed adoption by farmers. In Section 4 the institutional and economic conditions that made possible this success are assessed, contrasting them with the conditions existing in most LDCs. Section 5 analyzes the likely future evolution of GM seed diffusion and the interventions required to ensure a reasonably high likelihood of success. Finally, Section 6 summarizes the main findings of this study.

## **2. The Gene Revolution: “Pan-positional” IPR Protection and Product Decommodification**

The advances in biotechnology, especially genetic engineering, and the contemporary change of IPR regulation at the national as well as the international level marked a profound change in agricultural research and development (R&D) activities that can qualify as a true revolution, the so-called “gene” revolution. We argue that the shift towards stronger plant IPR protection and the contemporary presence of product “decommodification” dramatically changed the rules of the game of competition in the agricultural sector and ultimately determines asymmetric outcomes between DCs and LDCs.

### ***2.1. Strengthening of IPR Protection***

Prior to 1980 patenting was applied only to inanimate things like machines and equipment. The situation changed with the advent of modern biotechnology. The application of genetic engineering to living things represents indeed the fundamental justification for claiming intellectual property protection through “expanded patents,” on the grounds that an “inventive” step is involved in creating the GM good, in a process that is not dissimilar to that of standard patents. However, the IPR protection granted with expanded patents, i.e. the ones that apply to

genetically engineered plants and animals, is much stronger than that granted in traditional patents, as in the fields of mechanics, electricity or chemistry, for instance.

In the case of expanded patents, the traditional removal-from-secrecy clause that was intended to make public the knowledge associated to the invention no longer applies, so that a researcher or inventor is not free to use it in making a follow-on invention. The IPR owner of expanded patents has the right to exclude their use in breeding programs because the parental components can be identified in the biological progeny, which can be regarded as an IPR-protected component of the invention. This “high-potential” nature of expanded patents is further compounded by the fact that the knowledge of useful genes (genomics) and of engineering transgenic plants is “basic” in the sense that it is located at the upstream extreme of the R&D process and can be used in a variety of downstream innovations. It is this prospect of capturing the huge economic rents accruing to the GM innovator that makes entering the agricultural biotech industry so appealing to private firms.

Beginning with the Bayh-Dole Act of 1980, the institutional arrangements for patenting university research discoveries and protecting plant varieties were substantially strengthened in the United States. Other developed countries followed the US example in strengthening domestic intellectual property rights in this area. Eventually also the European Union, which includes some of the most guarded countries on this issue, adopted the Directive 98/44/EC on the legal protection of biotechnological inventions that explicitly allows patenting of all types of life forms except for the clearly stated exceptions, such as the human body.

At supranational level there were several legal and regulatory breakthroughs in this field. In 1991 the Convention for the Protection of New Varieties of Plants was amended strengthening plant breeders’ rights, making them more patent-like, and weakening the “farmer privilege” which allowed farmers to replant saved seeds without reference to the breeder (see Section 2.2). More important, in 1994 an agreement was reached at WTO level in Marrakesh giving the WTO powerful dispute-settlement jurisdiction. This was followed by enacting in 1995 the Trade Related Aspects of Intellectual Property Rights (TRIPS) agreement, which extended US-like patentability of living forms to the global level.

As emphasized by Pagano (2006), all those regulatory shifts changed the relative position of different individuals, in the sense of who will enjoy the right and who will bear the symmetrical obligation. More specifically, the worldwide extension of IPR protection warranted under the

TRIPS agreement, is a prototypical example of what Pagano (2006) calls a “pan-positional good,” that is the case where the exclusive right of an individual or a firm implicitly assigns obligations to all other individuals in the world. Paradoxically, it is the non-rival nature of knowledge that determines such a strong asymmetric outcome once knowledge is privatized and its protection is extended to the whole world as within the TRIPS framework.

This has major implications for the international standings of the different countries. In such a context it is easy to anticipate asymmetric outcomes deriving from the different endowment of resources, skills and infrastructures between DCs and LDCs. In fact, for many developed countries the compliance with international regulations often means no more than the application of already implemented domestic regulations. This is not the case with developing, let alone poor countries for which the cost of compliance with international regulations like IPR protection and biosafety risk assessment (food safety and environmental protection) is much higher. On top of the cost of enforcement of the domestically sanctioned standards, the additional obligation to enforce also the internationally sanctioned standards entails an extra cost. This is not a trivial cost for many LDCs, especially if we take into account their meager budgets and if we consider their real opportunity cost in terms of foregone development alternatives (Romano, 2006). This is also a vivid example of what Pagano (2006) calls a “legal disequilibrium” because the international regulations, e.g. the TRIPS agreement, while clearly making the “right” of inventors “pan-positional” in protecting their IPR in all WTO member countries, do not explicitly assign the corresponding “obligation” of enforcement, nor do they provide for the cost of such enforcement. Implicitly the obligation of that protection is left to the member-country governments, which may find the cost prohibitive and may not be able to deliver.

## ***2.2. GM Seeds: Decommodification and the Ingredients of Customization***

The rules that form the marketing framework of introducing the Bt-gene into cotton varieties to create the GM cotton were initially drawn up by Monsanto for the USA in the mid 1990s and were subsequently extended to apply to all countries.<sup>2</sup> The commercialization of the GM seeds is illustrative of the approach of customizing a “new” good, the GM cotton in this case, with the

objective of embodying in it economic rents that the “producer” can claim. From the point of view of the economic characteristics, the price of the seed remains the same as the price of conventional seeds, but this price is no longer the only cost users have to incur. Indeed, the economic rents accruing to the biotechnology manufacturer are created and captured in a triple customization intervention. First, a surcharge is applied on the price of the conventional seeds in the form of (an annual) “technology fee” for the production of the genetically modified seed for GM cotton.<sup>3</sup> Second, the buyer of the GM cotton seeds assumes a formal contractual commitment not to hold back seeds from one season to another (in any vegetative form). Third, the buyer is also contractually obligated to implement techniques that prevent the development of resistance to the traits incorporated in the GM cotton, in this case of the resistance to Bt-toxins.<sup>4</sup>

The purpose of all three customization features embedded in the GM cotton is to create and protect economic rents, fully exploiting the market power guaranteed by the extension and deepening of IPR.<sup>5</sup> The more conventional means of extorting economic rents are also widely employed. The levels of technology fees seem in fact quite arbitrary. Fees for GM cotton, for example, were first set at US\$90/ha, before being reduced to around US\$60/ha with some variation between countries, or even between provinces within the same country (Mexico). In South Africa, the technology fees applied differ according to agricultural irrigation features: fees

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<sup>2</sup> Monsanto (and its seed subsidiary Delta and Pineland Co., hereafter just Monsanto), were the first to market GM cotton, and they have enjoyed so far nearly a monopoly power in this area.

<sup>3</sup> The effective price the farmer pays for the GM seeds is higher than the price of conventional seeds by the amount of the “technology fee.” The latter represents the economic rents accruing through decommmodification to the producer and claimed on the grounds that the GM seed is a totally new product which required a substantial investment and which must be used according to particular specifications. This procedure of distinguishing between seed price and technology fee is legally devolved into the partnership between the biotech firm (Monsanto) which owns the IPR on the Bt-gene and its subsidiary seed company (Delta and Pineland) that produces (with the Bt-gene) and markets the GM cotton seeds.

<sup>4</sup> This contractual clause in the case of GM cotton is honored by forcing the farmers to set up in adjacent fields “refuge plots” to be sown with conventional varieties that are not to be controlled chemically. The purpose of this intervention is to prevent the emergence of new strains of pests resistant to the Bt-toxin that might be metabolized within GM cotton.

<sup>5</sup> Another feature signaling the market power enjoyed by the agro-biotech companies is the promotion of a very limited number of GM cotton varieties, a feature which is more or less hidden through the use of distinct varietal trade names: in the USA and Australia, the same GM cotton variety is commercialized with two different varietal names (Bollgard and Ingard), in South Africa only two varieties (NuCotton and NuOpal) were successively launched, and in China and also Mexico the same two US GM cotton varieties (named 33B and 99B) are commercialized. The strategy of disseminating a very limited number of varieties makes sense for Monsanto that probably holds the patents only on 33B and 99B varieties, but it is quite sub-optimal and certainly unusual from an agronomic standpoint. Objectively, one can hardly expect that the same varieties could be adapted to growing conditions which vary greatly from one country to another, if not from one region to another within the same country.



are higher for farmers who produce cotton under irrigation and have higher expected yields.<sup>6</sup> Clearly, the biotechnology service is not being provided at the marginal cost of production but on what the market would bear (Romano, 2006).

More important seem to be the other two institutional innovations devised to extract rents. In fact, the technology fee is a familiar feature of intellectual property rights in various information-technology applications. The fact that it is annualized through the total prohibition of holding back seeds, is a rather blatant and unusual innovation.<sup>7</sup> Software companies, for example, attempt to achieve the same result through creating “upgrades” of their products, but the choice is with the customer whether to buy the upgrade or to continue using the older version of the program. The obligation of the customer to protect the GM cotton from new strains of pests that are resistant to Bt-toxins is an even more creative method of extracting economic rents. It is akin to obliging the passengers of a cruise ship to buy insurance remunerating the ship owners in case the vessel proved not sea-worthy in the event of a storm or, even worse, to contribute to prevent the rising storm!

The essence of decommodification is to remove a commodity from the domain of cost-of-production competition and to launch it into the domain of positional goods, where the ordinal ranking of decommodified goods applies (as opposed to the cardinal measurement of the cost of production), based on “reputation,” which is a general term for the ability to extract economic rents (Yotopoulos, 2006). The discussion above on the decommodification in the seed industry makes clear why the diffusion of GM crops in LDCs is questioned and challenged by international environmental groups and by NGOs, although seldom explicitly from the perspective of the decommodification process: there is a risk of exploitation of farmers through the strong market power that has been vested to GM seed companies (McDonald, 2003; Pschorn-Strauss, 2004).<sup>8</sup>

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<sup>6</sup> For example, in the Makhatini Flats, where rain-fed production still dominates, smallholders paid fees of about US\$50/ha during the 2002-03 crop season.

<sup>7</sup> In contrast, in the case of conventional seeds the notion of “farmers’ seeds” is retained so as to enable their producers to reuse them to their convenience although they can no longer pass them to other farmers, either donating or selling them. In Europe, the transmission to third parties of farmers’ seeds has been seriously curtailed by Directive 98/95/CE after the appearance of GM seeds.

<sup>8</sup> On the distribution of costs and benefits of adopting GM seeds over the traditional seeds some studies for DCs show that biotech companies actually capture a big share of the additional gains generated (cf. Falck-Zepeda *et al.*, 1999; McBride and Books, 2000). For instance, in the USA the trend of the share of Monsanto in the gains generated by using GM cotton in 1996, 1997 and 1999 were 26 percent, 44 percent and 47 percent, respectively, while the

However, decommodification of GM cotton seems to have its limits. In China, for instance, the farmers seem to be those who benefit the most from the adoption of GM cotton.<sup>9</sup> The success of the Chinese experience seems to undermine the argument that LDCs usually lie on the short end of trade asymmetries when decommodification is involved. In order to assess this apparent contradiction, we have first to analyze whether the Chinese case is a success story or not and, if so, what are the conditions that made such success possible and, finally, whether those conditions can be replicated in other LDC contexts.

### 3. A Success Story of GM Seed Adoption: Cotton in Hebei Province

At first glance, the experience with the Chinese adoption of GM cotton looks like a counter-example of the decommodification process which is taking place in the GM seed industry and trade. Indeed, the economic impact of the adoption of GM cotton is beneficial to farmers and no monopolistic exploitation is apparent, as reported by the results from a survey conducted in 2002-03 in Hebei Province.<sup>10</sup> Historically, this province has contributed significantly to Chinese cotton production, but the development of strong resistance in the cotton bollworm (*Helicoverpa armigera* Hübner) in the early 1990s stalled the cotton cultivation. The long legacy of cotton in the province was threatened and the challenge was to find an effective technical solution. Therefore, Hebei Province was the first province where the dissemination of the GM cotton varieties began in 1998 and soon thereafter the entire cotton area of the province was converted to GM cotton, which eventually led to a remarkable rebirth of cotton production in this region (Table 1).

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farmer shares decreased accordingly. In South Africa, the share of the GM cotton gains accruing to smallholders is more favorable (Gouse *et al.* 2004).

<sup>9</sup> In 1999, it was estimated that the Chinese farmers' share in the gains from adopting GM cotton varied between 82.5 and 87.0 percent, depending on the use of either a Chinese or an American GM cotton variety, respectively (Pray *et al.*, 2001).

<sup>10</sup> The Hebei Province is situated in northern China, along the Yellow River. The survey covered 218 farms across seven counties in the five most important cotton producing districts of the province (Cangzhou, Handan, Hengshui, Shijiazhuang, and Xingtai). The average family size in the survey was four people, cultivating about 0.7 ha, 40 percent of which was devoted to growing cotton. These figures are consistent with earlier studies (Pray *et al.*, 2001; Huang *et al.*, 2003b).

**Table 1.** Cotton Production in Hebei Province (10<sup>3</sup> tons of lint)

Year	1986	1987	1988	1989	1990	1991	1992	1993	1994
Hebei province	511	626	577	536	571	634	306	192	390
China	3,541	4,245	4,149	3,788	4,507	5,673	4,510	3,739	4,342
Hebei/China (%)	14.4	14.8	13.9	14.2	12.7	11.2	6.8	5.1	9.0
Year	1995	1996	1997	1998	1999	2000	2001	2002	2003
Hebei province	370	258	249	270	223	298	419	402	522
China	4,768	4,202	4,603	4,501	3,828	4,417	5,320	4,920	4,870
Hebei/China (%)	7.8	6.1	5.4	6.0	5.8	6.7	7.9	8.2	10.7

Source: Fok *et al.* (2004b: Table 1, p. 48).

Growing GM cotton is very profitable for the farmers, by far exceeding the profits from the main alternative available to the farmers in the province, the cultivation of wheat and maize that are grown in sequence (Table 2).

**Table 2.** Comparison of Profitability of Cotton, Wheat and Maize Incomes (US\$/ha)

	Gross revenue		Income net of input costs	
	2002	2003	2002	2003
Cotton	1,716	2,377	1,425	2,064
Wheat	781	819	461	554
Maize	814	880	578	707

Source: Fok *et al.* (2004b: Table 8, p. 52).

At the international level also, and in comparison with other LDCs, Chinese farmers dominate in terms of profitability. The financial profitability of growing GM cotton depends on the level of yields achieved and on the favorable output-input price ratios. In fact, the price of cotton is quite high due to the continuing protection of the domestic market from imports and despite China's entry into the WTO. The cotton lint farm gate prices found in the survey were US\$0.57/lb and US\$0.89/lb in 2002 and 2003, respectively, whereas the world market parity prices (c.i.f. Northern Europe) were US\$0.41/lb and US\$0.63/lb.

On the input side, the average cost of production inputs (fertilizers, pesticides, seeds, plastic film, growth regulators, irrigation water) is only 15-20 percent of the output value, while for instance in West African cotton countries it is roughly twice as much (Bérout, 2001; Fok *et al.*, 2004a).<sup>11</sup> More specifically, the cost to Hebei farmers for accessing GM cotton seeds is far less

<sup>11</sup> Chinese farmers benefit from easy access to production inputs. One-half of surveyed farmers could access their farm inputs from quite a few input providers located within one kilometer from their farms. Therefore, the problem of monopoly in supply of inputs does not exist. Farms in general have a certain degree of motorization, while

than in other countries. This is the outcome of an effective competition between several GM seed suppliers, foreign as well as domestic, with the result that the farmers can choose from a large portfolio of distinct GM cotton varieties.<sup>12</sup> The access to GM cotton seeds by Hebei farmers seems quite easy as shown by the fact that many of them grow more than one variety and by the mode of GM seed acquisition: more than half of farmers use either partly or totally the seeds they held back from the previous season, at virtually zero cost (Table 3).

**Table 3.** Distribution of Farmers Adopting GM Cotton, According to Their Seed Acquisition Mode and the Number of Adopted GM Cotton Varieties (percent)

Seed acquisition mode	Farmers adopting <sup>a</sup>			All farmers adopting GM seeds <sup>b</sup>
	One variety	Two varieties	Three varieties	
By exchange	1	0	0	1
Partly bought	26	29	75	30
Totally bought	53	33	0	44
Totally held back	20	38	25	25
Total	100	100	100	100

<sup>a</sup> The percentages reported in these three columns are the shares to totals after partitioning the farmer sample according to the number of GM cotton varieties they adopted.

<sup>b</sup> The percentages reported in this column are the shares to the whole sample of farmers adopting GM cotton varieties.

Source: Adapted from Fok *et al.* (2004b: Table 14, p. 58).

Even when farmers access the GM cotton seeds through market purchases, the cost they have to pay is lower than in other countries. In fact, no supplier has been able to maintain a monopolistic position in the province. In particular, despite the fact that Monsanto had a virtual monopoly in marketing GM cotton seeds when the government first gave permission for GM cotton cultivation, its market share has been gradually decreasing as a result of the competition from an increasing number of domestic GM varieties which are commercialized at a lower price (Table 4).

Although the profitability of cotton seems to rest on the technological features of GM cotton (e.g. higher yields, fewer pesticide sprays, etc.), it should be stressed that institutional factors played a crucial role in encouraging the adoption of GM cotton and in gaining from it higher

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mechanization is very common. All farmers are equipped with tractors and chemical sprayers, and they can also easily call for other mechanized field operations on a service basis.

<sup>12</sup> In fact, at least 22 distinct cotton GM varieties are grown in the survey area. Only two of these varieties are supplied by a foreign company (Monsanto), while there are ten varieties provided by research institutes operating at the national level, five at the provincial level and five at the district level.

profits with little risk. Indeed, China succeeded in designing and enforcing quite particular rules of GM seed commercialization that can hardly be found in other countries.

**Table 4.** Market Share and Cost of GM Cotton Seeds

Origin of varieties	Type of varieties <sup>a</sup>	2002			2003		
		Seed cost (US\$/kg)	% users	% surface	Seed cost (US\$/kg)	% users	% surface
China	Population	3.3	29	39 <sup>b</sup>	4.5	43	49 <sup>b</sup>
	Hybrids	4.8	4		5.4	6	
USA	Population	5.0	67	61	6.1	51	51

<sup>a</sup> Populations are varieties composed of plants which are not completely identical from the genetic point of view, but whose genetic composition is stable; vice versa hybrids are made from the crossing of two parents which are pure lines, that is varieties composed of plants which are completely identical from the genetic point of view.

<sup>b</sup> Sum for China of population and hybrids.

Source: Adapted from Fok *et al.* (2005: Table 8, p. 21).

China launched a very ambitious biotechnology research program from the mid 1980s. This enabled Chinese scientists to identify many genes, to build new specific gene constructions of their own and to master an original method for gene transfer through the pollen tube.<sup>13</sup> With this head start in the field of research and development of GM varieties, Chinese institutions had been networking successfully. The Chinese government endorsed a joint venture between Monsanto and the local Hebei Seed Company. At the same time, a “private” Chinese biotech firm that held the rights of Chinese Bt-genes, the Biocentury Transgene Co. Ltd (BTCC), started a collaboration with the Chinese Academy of Agricultural Sciences and its local branches to develop GM cotton seed varieties adapted to the different ecological conditions of China. In parallel, the government-sponsored field experiments to determine the suitability of GM cotton cultivation in the region led to approval of GM cotton. As a result, when Monsanto started marketing its own GM cotton varieties in 1998, China had already put in place the local institutions that would eventually contain the voracious appetite of the multinational.

The success of the Chinese plan was immediate, as shown by the willingness of Monsanto to adjust its standard “rental” seed contract, giving favorable treatment for China. As a result the GM cotton varieties were supplied right from the beginning under the same conditions that

<sup>13</sup> A Chinese research company, the Biocentury Transgene Co. Ltd (BTCC), is the owner of a new Bt-gene construction technology, based upon sequences controlling Cry 1B and Cry 1C toxins: those are the genes used in all Chinese GM cotton varieties. China also launched, more or less at the same time as Monsanto, a new variety with dual-gene resistance to bollworms (SGK 321) by combining a Bt-gene and a protein inhibition gene. The

usually prevail for conventional seeds. Farmers were not required to sign a contract that prevented the possibility of holding back seeds or committed them to special cultivation techniques (e.g. refuge plots to prevent the emergence of resistance by the targeted pest to the Bt-toxin).<sup>14</sup> The prices farmers paid were all inclusive, with no distinction or mention of any technology fee.<sup>15</sup> Finally, as the local GM cotton varieties were being released into the market, the farmers had more seed choices. By the time of the survey farmers could choose from twenty local GM cotton varieties that compete with the two varieties of Monsanto. Moreover, the ample varietal offerings of local GM cotton not only are better matched to the ecological adoption conditions than the alternative two varieties, but they are also cheaper than the foreign GM cotton seeds (Table 4). All these conditions contribute to make cotton production very attractive and profitable and reduce the financial risk in adopting GM cotton.

#### **4. Replicability: Is the Chinese Success with Commodified GM Seeds a Unique Case?**

As mentioned already in the previous section, the Chinese case cannot be regarded as a general counter-example of the decommodification process because China basically is not representative of LDCs. Referring to the economic results of GM cotton adoption, it should be noted that China ranks as one of the top three countries in terms of yield among the countries with substantial cotton production in the world. This means that an attractive price impacts greatly on farmers' revenues. Moreover, such a high level of yield is the outcome of a high degree of intensification in using production inputs (fertilizers, pesticides, etc.). The direct implication is that the

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combination of two distinct pest control mechanisms could potentially be more sustainable than just combining two Bt-genes as Monsanto did.

<sup>14</sup> It is worth noting that this contractual clause can be hardly justified on pure technical grounds in many LDCs. In fact, while the obligation to keep refuge plots can be justified in countries where farmers grow the crop extensively, as in the US, its application becomes disputable in the Chinese environment featuring a multi-cropping pattern based on smallholder farms that already serve as refuges for cotton pests (Wu *et al.*, 2004).

<sup>15</sup> It is noteworthy that BTCC initially tried to act as any private biotech company by claiming a high technology fee. This was considered excessive by the Chinese breeders and the Central Government intervened to support the breeders' position by forcing a revision of the commercialization conditions.

additional cost deriving from using GM seeds appears to be relatively more acceptable, compared to countries where agricultural intensification is low.<sup>16</sup>

In terms of technological abilities, China was able to decrease further the cost of adopting GM cotton. As mentioned earlier, the country has its own endogenous, and flexible, GM technology that is adaptable to producing many GM cotton varieties characterized by a great genetic diversity and being adaptable to various micro-environmental conditions. This home-grown technology can be managed independently of the strategy of any multinational firm.

In terms of the rules under which the GM cotton is being diffused, the Government played a crucial role that is multifaceted. The Chinese success was not due so much to Adam Smith's invisible hand on market operation as it was to the strong arm of the Government's intervention. It was the suasive power of the state that changed the extortionary terms of the standard contract of the multinational. This power became even more persuasive as a result of China's general policy for managing foreign investment through joint ventures, in this case that by Monsanto and the Hebei Seed Company that was mentioned earlier. In summary, there was a comprehensive package of technical and institutional factors that worked synergistically in re-commodifying the GM cotton seeds for sale to the farmers at minimum production cost, thus thwarting the decommodification regime of globalized IPRs and of multinational corporations.

Can this pattern be replicated in developing countries? Considering different categories of countries according to their ability to carry out biotech R&D, India and Brazil can be ranked at the same stage of technological sophistication as China and as a result they may achieve substantial GM seed diffusion soon. On the other hand, most developing countries lack the technological and institutional infrastructure that makes the diffusion of GM agriculture possible. For the purpose of making an assessment of the replicability of the Chinese experience, we examine the case of India and Brazil, along with the Sub-Saharan African (SSA) countries, that have featured on the international radar screen as promising for the adoption of GM varietal agriculture.

The objective of Table 5 is to compare the three cases in terms of various factors that can be considered as proxies for the requisite infrastructural endowments, both technological and institutional, that would be favorable to GM agriculture, more specifically, GM cotton. Of the

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<sup>16</sup> For example, the adoption of GM seeds in Mali, with the same degree of intensification of other inputs as in China,

thirteen indicators appearing in the table, India and Brazil have a modest command in the first eight factors that relate to agricultural and technological preconditions. They have solid “No”s on the last five institutional factors, weighting the balance between free markets and regulation. These indicators are eclipsed in India and Brazil by the tendency to consider the free market approach to globalization as an “up-by-the-bootstraps” universal prescription for development. This may, or may not be the case. But it is certainly different from the Chinese approach to GM agriculture. As for the SSA countries, the favorable factors are the existence of a pool of cotton varieties and the number of research institutions, plus an ambivalent approach to state involvement in reaching the pro-farmer GM goals. The conclusion is that the Chinese pragmatic approach that yielded the pro-farmer outcomes of GM cotton introduction, is not easy to replicate in the three cases examined in the table. In other words, there is no guarantee whatsoever that other LDCs could easily copy China’s achievements.

**Table 5.** Factors Whose Existence Will Positively Affect GM Cotton Diffusion in Selected LDCs

Factors	India	Brazil	SSA <sup>a</sup>
High pest resistance to insecticide	Yes	No	No
High yield	No	Yes <sup>b</sup>	No
High intensification in input use	No	Yes <sup>b</sup>	No
Availability of own Bt-gene technology	No?	No	No
Good command of biotechnotechnology	Yes	Yes	No
Availability of a gene portfolio from national research	Yes?	No	No
Existence of a great pool of cotton varieties	Yes	Yes	Yes
Existence of many research institutions	Yes	Yes	Yes
Willingness for the State to get involved	No	No	Yes
Sufficient bargaining power	No	No	No
Foreign direct investment policy favoring domestic firms	No	No	No
Capacity to adjust diffusion rules to the interest of the smallholders	No	No	No
Capacity to ensure favorable price for cotton produced by smallholders	No	No	No

<sup>a</sup> Sub-Saharan Africa.

<sup>b</sup> Valid for commercial farms, not necessarily for smallholders.

Source: Fok *et al.* (2004b: Table 15, p. 63).

There are, however, some promising signs that the competition in the biotech sector is being further opened up. Multinationals are no longer the unique providers of commercial biotech

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would have doubled the total input costs the farmers are facing (Fok *et al.*, 2004a).



outputs. Due to the high price of GM cotton seeds in India (as a consequence of the Monsanto monopolistic position in providing the Bt-genes), some Indian companies are establishing partnership with the Chinese biotech firm BTTC to contest the Monsanto supremacy (Jishnu, 2006). This is made possible because the Chinese biotech firm gained a reputation by successfully challenging the US multinational at home. And it also shows that in positional competition the reputation ranking of the contestants is fluid and changes with each outcome of gain or loss. This means that once defeated in China, the biotech multinationals do not look convincingly invincible anymore.

## **5. Counter-balancing the Decommodification Process in the Agriculture Biotech Industry**

The view expressed above might be too pessimistic. The future may be better than expected if some institutional reforms aimed at making agricultural biotech R&D work for the poor were implemented and if some promising emerging trends materialized. Addressing the current issues of IPR protection means essentially focusing on: (i) the asymmetric and costly burden that LDCs bear of enforcing the IPR protection on account of owners in DCs who are the holders of these “pan-positional” rights; and (ii) the lack of incentives for private companies to invest in LDC-oriented agricultural biotechnology research. The difficulty lies in balancing patent protection to induce private sector investment in research, with offering access to cheap GM products for the poor of this world.

Some ideas that have been recently proposed to solve similar problems in the pharmaceutical sector can provide inspiration for the reform in the agricultural biotech sector as well (Lanjouw, 2002). For instance, considering that the worldwide markets for GM products of interest for LDCs are very different from the markets for the same products in DCs, the IPR protection system would be improved by being tailored to the differences in these markets. In the case of “global” crops, those that can be raised both in LDCs and DCs, the domain of application of IPR can be restricted by making them weaker in LDCs.<sup>17</sup> The patentee would be required to choose

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<sup>17</sup> This is based on the premise that the profit derived from having a patent-based monopoly in poor countries makes a very limited contribution to the worldwide profits realized by the biotech company (cf. Taylor and Cayford, 2003).

enforcement of his IPR protection either in rich or in poor countries, but not in both.<sup>18</sup> For GM crops that are LDC-specific (mainly subsistence crops) the problem is that there is no market because the prospective adopters cannot afford them. In such a case, IPR protection alone is ineffective in stimulating the biotech company to invest in such crops. Therefore, other mechanisms should be devised, like investing public grants or private benevolent donations to research on LDC-specific GM crops.<sup>19</sup> Alternatively, investments should be channeled to make biotechnology R&D available as a free-share (public) good, as it has been recently made by the CAMBIA consortium or the BIOS initiative, under an “open-source” license scheme (Nature, 2004; The Economist, 12<sup>th</sup> February 2005).<sup>20</sup>

IPR compliance might become less constraining in the near future even if IPR rules remain unchanged, because many patents covering biotechnology outputs are about to expire with the outputs falling into the public domain (Kowalski *et al.*, 2002). If this materializes, it may be possible to establish a clearing-house of those most suitable for LDCs’ biotechnology techniques and outputs, making them thus more accessible for public research (Graff and Zilberman, 2001).

Another potentially positive factor is that some countries like China and India own genes of agronomic interest through their public research institutions. Private and multinational companies are no longer having the monopoly on genes of agronomic interest. This new context might offer some room to negotiate more affordable conditions of technology transfer to LDCs, provided that international organizations are invested with some leading role in these negotiations.

Finally, the effective adoption of GM seeds depends also on the economic conditions of crop intensification. In most developing countries the cost of crop intensification has increased as a consequence of the implementation of structural-adjustment interventions that canceled all extraneous support for input use. Hopefully, this situation may positively unwind as acknowledged in the WTO Doha Round, where in earlier discussions the principle of supporting poor farmers to get into crop intensification has been rehabilitated (Fok, 2002).

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<sup>18</sup> There are several advantages in a proposal like this, but the most relevant for our case is that the mechanism relies on the quality and reliability of the DCs’ institutions and will not impose any extra-burden on LDCs’ institutions. Moreover, it does not contravene existing treaties.

<sup>19</sup> This mechanism mimics in the agricultural sector what, for instance, the Melinda and Bill Gates foundation is doing in the drug sector to induce research on combating malaria and AIDS in LDCs.

<sup>20</sup> CAMBIA is the Australian Center for the Application of Molecular Biology to International Agriculture based in Canberra. BIOS is the Biological Information for Open Society initiative that attempts to extend the achievements

## 6. Conclusions

There are various controversies raging about agricultural biotechnology in general, and genetic modification in specific, that this paper has totally overlooked. Instead, building on the theme of this volume, *The Asymmetries of Globalization*, it focuses on a specific characteristic of agricultural biotechnology that on an *a priori* basis is expected to tip the balance of the benefits of biotechnological agriculture in favor of the developed countries, while rendering trivial residual profits to the farmers in the LDCs. The spring that releases this asymmetry is decommodification, more specifically the decommodification of the seeds that farmers used to carry forward from one season to the other in order to plant the next year's crop.

The profits from decommodification are generally slanted in favor of the DCs, where the new technologies originate and where the reputation that creates and captures the economic rents resides, being normally an attribute of wealth and power. In the case of agriculture this asymmetry is especially pronounced since the IPRs the producers of biotechnology have been granted claim global applicability. These rights not only create an obligation for all countries to protect them for the benefit of their right-holders, in this case multinational corporations, but the beneficiaries themselves have creatively exploited the protective fence of international legislation built around their product to construct a most generous rent-generating "operating system that runs the biotechnological agriculture." This "high-tech envy" does not constitute an idle boast. It has materialized in "renting" for one year's use the GM seeds that the farmers purchased, with the obligation to "re-rent" them for the next year! After a multinational has squeezed dry all possible economic rents out of agricultural biotechnology, one would have expected that there is precious little left in terms of profits for the farmer in an LDC.

The case of GM cotton in China is unique in that it has turned the tables on the patent-holders, thus making GM cotton cultivation one of the most profitable crops growing in China and among the top profit earners of cotton cultivation in the world. The bottom line of this success rests with the ability of the local biotechnology industry to compete on equal grounds with imported GM cotton seeds. For this to happen, a certain institutional flexibility is required along with the

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originating with CAMBIA. Both try to foster collaborative open-source development of sets of key enabling

determination of the government. The resultant success consisted of re-commodifying the GM cotton seeds, so that the economic rents of the new technology are captured in loco and go to the farmers, as opposed to corporate profits that flee abroad.

The analysis of the replicability of the Chinese experience in other LDCs comes to the conclusion that China should be considered as the exception that confirms the general rule of biotechnological agriculture having little to offer in alleviating rural poverty in LDCs. At present the adoption of GM seeds in developing countries is not gaining much traction, nor is it likely soon to become sufficiently rewarding for the local farmers. This pessimistic outlook could be moderated if the bar of the IPR barrier protecting the use of GM seeds could be lowered. But this outcome would not materialize automatically. Initiatives are needed to reform the current institutionalization of the WTO-TRIPS agreement. This is a necessary condition. Beyond that, LDCs need to create an environment that is conducive to implementing crop intensification, since this is the essence of GM agriculture. In the meanwhile, a more definitive prospect is that various GM genes and some biotechnology methods will be maturing beyond their statutory patent protection and will be falling in the public domain. At that stage, public research initiatives at the international level could play an active intermediation role in identifying such opportunities and help the LDCs take advantage of these “second hand technologies” to create a remunerative biotechnological agriculture.

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