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 developed countries (DCs) vis-à-vis the less developed countries (LDCs), 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 TRIPS agreement. A paradigmatic example of what is going on is the agricultural sector. The objective of this chapter is the assessment of a success story of genetic engineering application to agriculture and its marketing to LDCs – the creation of Bt-cotton seed and its adoption in China. At a first glance, this case study seems to contradict the expected adverse impacts on LDCs of decommodification of agricultural inputs. But, in spite of the apparent counter-example of the Chinese cotton case, we argue that the Chinese example is unique and as such it is an exception which confirms the general rule.

Keywords: decommodification, IPR, GM, China, cotton, institutional arrangements, LDCs

JEL classification: Q12, Q16, Q18

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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 process since trade in high-value differentiated products (e.g. wines, cheeses, etc.) has occurred for centuries also in the agricultural sector. What is new is rather the acceleration of this process under the current wave of globalization because 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 traditional ones – makes possible a degree of product "customization" that was simply unimaginable a few decades ago. But those changes would not make too much difference if they had not been favored by policy interventions that reshaped the institutional set-up at national as well as at international level. The worldwide strengthening of intellectual property rights (IPR) protection provided robust incentives for unprecedented private investments. 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 (2001: p. 191) 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."

As Pollan adds, the Peruvian Incas, whose ancestors domesticated the *Solanum tuberosum* seven thousand years ago, can never claim property rights over the potato gene 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 favoring 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 chapter provides an assessment of genetic engineering application 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, and its adoption in China. Although a thorough and exhaustive assessment of GM seeds adoption in LDCs is still far to come, there is quite a widespread disbelief regarding the suitability of GM seeds to 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). Conversely, the Chinese case seems to contradict the expected adverse impacts on LDCs of decommodification of agricultural inputs:[1] about one half of the total Chinese cotton acreage is currently Bt-cotton and this 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 counterexample of the Chinese cotton case is unique and as such it represents an exception which confirms the general rule.

This chapter 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 pros and cons of GM seed adoption in LDCs. Section 3 analyzes the Chinese Bt-cotton case using original data from a survey carried out in 2002-03 in Hebei Province that show the positive impacts 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 reasonable high likelihood of success. Finally, section 6 summarizes the main findings of this study.

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[1] Another apparently success story of Bt-cotton adoption is South Africa, where it is reported a higher profitability by Bt-cotton smallholder growers in the Makhatini Flats - Kwazulu Natal Province (Ismaël *et al*., 2002a; Ismaël *et al*., 2002b; Gouse *et al*., 2002; Mennessier, 2001; 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 of the GM seed industry (Fok *et al*., 2004) show that the alleged success of the South African case must be more balanced.

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 national as well as international level marked a profound change in agricultural research and development (R&D) activities that can be qualified 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. IPR Protection Strengthening

Prior to 1980 patenting living things was not needed. In those years there was no available technology that justified the patenting of living things. 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 ground 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 granted for genetically engineered plants and animals, is much stronger than that granted to traditional patents, i.e. the ones granted in the field of mechanics, electricity, chemistry, etc.

In the case of expanded patents no longer applies the traditional removal-from-secrecy clause intended to make public the knowledge associated to the invention such that a researcher or inventor is 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 the 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 cautious countries on this issue, adopted the Directive 98/44/EC on the legal protection of biotechnological inventions that explicitly allows patenting all types of life forms except for the clearly stated exceptions, such as the human body.

At supranational level there were several breakthroughs. 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 use 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 procedure. 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 relevant duty. 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 when the exclusive right of an individual or a firm implicitly assigns duties to all other individuals. Paradoxically, it is the non-rival nature of knowledge that determines such a strong asymmetric outcome once knowledge is privatized and its protection 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 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 because this means the obligation to add the enforcement of international sanctioned standards to the already domestically enforced standards. This is not a trivial cost for many

LDCs, especially if we take into account the meager budgets of most of them and if we consider its real opportunity cost in terms of foregone development alternatives (Romano, 2006). And it is also a vivid example of what Pagano (2006) calls a "legal disequilibrium" because the international regulations, e.g. the TRIPS agreement, while clearly assigning the right to get IPR protection in all WTO member countries, do not guarantee the real enforcement of the corresponding duties, which are indeed left to individual governments that may not be able to do that.

2.2. Decommodification and the Ingredients of Customization

The rules that form the marketing framework of Bt-cotton varieties were initially drawn up by Monsanto for the USA in mid nineties and were subsequently extended to many other countries. Monsanto and its seed subsidiary Delta and Pineland Co. were the first to market Bt-cotton, and they have enjoyed so far nearly a monopoly power in this area. These new rules have been challenged, to no avail, by many who interpreted them as endowing the multinational firms with too much power. The focus of this section is not the challenge of the rules applying on agricultural biotech products. These rules are discussed briefly in order to set the stage for applying the concept of decommodification/customization in analyzing the asymmetries created for LDC agriculture as a result of these new rules.

The commercialization of the GM seeds is illustrative of the approach of customizing a "new" good, the GM variety of seeds, 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 with the price of conventional seeds, but this price is no longer the only expense users have to pay. 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 payment for the "technology fee" for the production of the GM seed.[2] Second, the buyer of the GM seeds assumes a formal contractual commitment not to hold back seeds from one season to another (via any vegetative form). Third, the buyer is also contractually obligated to implement

[2] As compared to selling GM seeds at a higher price than conventional seeds, the set up of the "technology fee" procedure is in line with the approach of claiming a totally new product which required high level investment and which must be used according to particular conditions. This procedure of distinguishing seed price and technology fee is likely adapted too to the partnership between the biotech firm (namely, Monsanto) which owns the Bt-gene and the seed company (Delta and Pineland Co.).

techniques that prevent the development of resistance to the traits incorporated by the GM varieties, in the case of the Bt-cotton variety resistance to Bt-toxins.[3]

The purpose of all three customization features embedded in the GM varieties is to create and protect economic rents, fully exploiting the market power guaranteed by the extension and deepening of IPR.[4] The more conventional means of extorting economic rents are widely employed. The levels of technology fees seem in fact quite arbitrary. Fees for Bt-cotton, for example, were first set at US$ 90/ha, before being reduced to around US$ 60/ha with some variation between countries, if not between provinces within the same country (Mexico). In South Africa, the technology fees applied differ according to agricultural irrigation features: fees are higher for farmers who produce cotton under irrigation and have higher expected yields.[5] Clearly, biotechnology service is not being provided at marginal cost of production but on what the market could bear (Romano, 2006).

More important seems 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 seed, is a rather blatant and unusual innovation.[6] Software companies, for example, attempt to achieve the same through creating "upgrades" of their products, but the choice is with the customer whether to buy them or to continue using the older version of his program. The obligation of the customer to protect the Bt-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

[3] This contractual clause in the case of Bt-cotton is honored by forcing the farmers to set up "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 Bt-cotton.

[4] Another feature signaling the market power enjoyed by the agro-biotech companies is the promotion of a very limited number of genetically engineered varieties, a feature which is more or less hidden through the use of distinct trade names: in USA and Australia, the same variety is commercialized with two different names (Bollgard and Ingard), in South Africa only two varieties (NuCotton and NuOpal) were successively launched, and in China are commercialized the same two US Bt-cotton varieties (named 33B and 99B) which are commercialized in Mexico too. The strategy of disseminating a very limited number of varieties 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.

[5] For example, in the Makhatini Flats, where rainfed production still dominates, smallholders paid fees of about US$ 50/ha during the 2002-03 crop season.

[6] For conventional seeds, the notion of "farmers' seeds" is retained so as to enable their producers to re-use them to their convenience although they can no longer pass them to other farmers, either donating or selling them. In Europe, the transmission of farmers' seeds has been strongly restricted by Directive 98/95/CE after the occurrence of GM seeds.

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 storm rising!

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 ranking of decommodified goods is subject to ordinal ranking (as opposed to the cardinal measurement of the cost of production), based on "reputation" – 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 by international environmental groups and by NGOs, although seldom explicitly from the perspective of decommodification process: there is a risk of exploitation of farmers by GM seeds company having a strong market power (MacDonald, 2003; Pschorn-Strauss, 2004).[7]

However, decommodification of GM seeds seems to have its limits. In China, for instance, farmers seem to be those who benefit the most from the adoption of GM seeds.[8] The success of the Chinese experience seems to undermine the argument that LDCs usually lie on the short hand 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; if so, what are the conditions that made it possible such a success; and finally, whether those conditions can be replicated in other LDC contexts.

3. A Success Story of GM Seed Adoption: Bt-cotton in Hebei Province

At first glance, China seems to provide a counter-example of the decommodification process which is taking place in the GM seed industry and trade. Indeed, economic impacts are beneficial to farmers and no monopolistic exploitation is reported, as proven by the results from a survey conducted in 2002-03 in Hebei Province.[9] Historically, this province has

[7] Some studies on the distribution of costs and benefits of GM seeds adoption in DCs show that biotech companies actually got big shares of the welfare gains generated by the adoption of GM seeds (cf. Falck-Zepeda *et al*., 1999; McBride and Books, 2000). For instance, in the USA the trend of the combined share of Monsanto and Delta and Pineland Co. in the welfare gains generated by using Bt-cotton in 1996, 1997 and 1999 were 26%, 44%, 47% respectively, while farmer shares decreased accordingly. In South Africa, the welfare gains accrued to smallholders are more favorable (Gouse *et al*. 2004).

[8] In 1999, it was estimated that Chinese farmers got between 82.5 and 87.0% of the surplus generated by the adoption of Bt-cotton, depending on the use of either a Chinese or an American GM variety, respectively (Pray *et al*., 2001).

[9] 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 production districts of the province (Cangzhou, Handan,

contributed significantly to Chinese cotton production, but the development of strong resistance in the cotton bollworm (*Helicoverpa armigera*) in the early 1990s stalled the progress of this production. The continuation of cotton production was threatened and the challenge was to find an effective technical solution. Therefore, Hebei Province was the first province where Bt-cotton varieties began to be disseminated in 1998 (after two years of field experiments) and in three years the whole cotton area of the province was converted to Bt-cotton, which eventually led to a remarkable rebirth of cotton production in this region (Table 1). The biotech multinational Monsanto contributed to this rebirth by providing its Bt-cotton varieties which were introduced with an attractive and informative packaging containing seeds properly treated. When fake products appeared, packaging was coded and customers could freely call and check how genuine their products were.[10]

Table 1. Cotton Production Patterns in Hebei Province (10^3 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: National Bureau of Statistics of China (several years)

Growing Bt-cotton proved to be very profitable to farmers. As opposed to maize or wheat, which were the main alternative crops grown in the surveyed villages, the gross revenue from cotton was far higher, i.e. higher than the cumulative revenues of wheat and maize which are grown in sequence (Table 2).

Table 2. Comparison 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: original data from the Hebei province survey

Hengshui, Shijiazhuang and Xingtai). The average family size is about 4 people, cultivating about 0.7 ha, 40% of which is devoted to cotton growing. These figures are consistent with former studies (Pray *et al*., 2001; Huang *et al*., 2003a).

[10] The inclusion of all these services is a genuine example of product customization (Yotopoulos, 2006) and transformed the competition of pure commodities into a positional competition (Pagano, 2006).

The financial profitability of growing Bt-cotton depends on the high yields achieved and on the favorable output/input price ratios. Comparing the situation of Chinese farmers with that of other LDC farmers, the former is much more profitable. In fact, the price of cotton is quite high due to the protection of the domestic market from imports, despite China entry into the WTO. The cotton lint farm gate price equivalent was US$ 0.57/pound and US$ 0.89/pound in 2002 and 2003, respectively, whereas the world market price was US$ 0.41/pound and US$ 0.63/pound from the c.i.f. northern Europe position.

On the input side, the average cost of production inputs (fertilizers, pesticides, seeds, plastic film, growth regulators, irrigation water) was only 15-20% of the output value, while in West African cotton countries it was around 30-40% (Béroud, 2001; Fok *et al*., 2004).[11] More specifically, the cost Bt-cotton seeds to Chinese farmers is far lower than in other countries. Chinese farmers could grow more than one variety, and more than half of them used, either partly or totally, the seeds they held back from the previous season (Table 3), at virtually zero cost.

Commentaire [f1] : Actually, at a market value of US $ 0.1/kg

Table 3. Distribution of Farmers According to Their Seed Acquisition Mode and the Number of Varieties Used

Seed acquisition mode	Farmers using			All farmers
	1 variety	2 varieties	3 varieties	
By exchange	1%	0%	0%	1%
Partly bought	26%	29%	75%	30%
Totally bought	53%	33%	0%	45%
Totally held back	20%	38%	25%	25%
Total	100%	100%	100%	100%

Source: original data from the Hebei province survey

Even when Chinese farmers buy GM seeds, the unit cost is lower than in other countries (Table 4). This is the result of market competition between US and Chinese varieties and among Chinese varieties. In fact, at least 22 distinct cotton GM varieties were grown in the survey area.[12] Clearly, the US firms pioneering in introducing Bt-cotton seeds in China were not able to achieve a monopolistic position and are losing ground gradually from the nearly 100% market share they had in 1998, because of the higher prices of their varieties vis-à-vis

[11] Chinese farmers benefit from easy access to production inputs: 50% of farmers can get them at less than one kilometer from their farms, and they can have a large range of input providers so that they seldom have only one input suppliers. Moreover, mechanization, if not motorization, is very common: all farmers are equipped with tractors and chemical sprayers, and they can also easily call for mechanized field operations on service basis.
[12] In addition to the two varieties introduced by US companies, there were 10 varieties derived from research institutes operating at the national level, 5 at the provincial level and 5 at the district level. There are already five hybrids which have been classified as Bt-cotton, mainly from the research institutes operating at the district level.

the domestic varieties (Table 4). There is no sign indicating that this firm is revising its price policy and the most updated estimation points out that Monsanto is not holding more than 10% of the Chinese Bt-cotton market.

Table 4. Market Share and Cost of Cotton GM Seeds

Origin of varieties	Type of varieties	2002			2003		
		Seed cost $/kg	% users	% surface	Seed cost $/kg	% users	% surface
China	Population	3.3	29	39	4.5	43	49
	Hybrids	4.8	4		5.4	6	
USA	Population	5.0	67	61	6.1	51	51

Source: original data from the Hebei province survey

Although the profitability of GM cotton seem to rest on the technological features of Bt-cotton, it should be stressed that institutional factors played a crucial role in encouraging the adoption of Bt-cotton and in gaining higher profits with little risk. Indeed, China succeeded in designing and enforcing quite peculiar rules of GM seed commercialization that can only hardly be found in other countries. The fact that China had an acknowledged background in the field of research and development of GM varieties contributed to this achievement.[13] China was in fact the first country to market GM varieties in the world, e.g. for tobacco production in 1992. It also launched very ambitious research programs in the mid-1980s which 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.[14] Chinese institutions have tried to disseminate bollworm resistant varieties since 1994 without real success. Then, Monsanto moved to conquer the Chinese market somewhat in response to the very Chinese need to find a solution after the cotton bollworm break-out.

However, China succeeded in preventing the set up of a monopolistic situation. In 1996, the American companies were invited to endorse a joint venture with the Hebei Seed Company, while another Chinese firm was established in collaboration with the Chinese

[13] China has so far authorized the commercial use of GM seeds on four crops (cotton, tomato, sweet pepper and petunia) and is still hesitating to extend this use to food crops.

[14] A Chinese research company - the Biocentury Transgene Co. Ltd (BTCC) - is the owner of a new Bt-gene construction, based upon sequences controlling Cry 1B and Cry 1C toxins, and these should be the genes used in all Chinese Bt-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 impact of this combination of two distinct effects on the pest to control could potentially be more sustainable than just combining two Bt-genes as Monsanto did.

Academy of Agricultural Sciences.[15] However, the possibility of holding back seeds, and the marked increase in the number of Bt-cotton varieties emerging from research institutions of various levels, has prevented the permanence of such a duopoly.[16] Moreover, Bt-cotton is supplied under conditions that prevail in Western countries for common seeds. Seeds are only bought and there is no requirement for farmers neither to sign a contract nor to make a commitment to follow special cultivation techniques (e.g. refuge plots to prevent the emergence of resistance by the targeted pest to the Bt-toxin).[17] The prices farmers pay are all inclusive, with no distinction or mention of any technology fee. All these conditions make cotton production very attractive and profitable and reduce the financial risk in adopting Bt-cotton.

4. The Ingredients of Chinese Success with Commodified GM Seeds

The Chinese case cannot be regarded as a 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 first three countries in terms of yields among the countries with substantial production in the world: this means that an attractive price impacts greatly the farmer incomes. Moreover, such a high level of yield results from a high degree of intensification in using production inputs (fertilizers, pesticides, etc.). The direct implication is that the additional cost deriving from using GM seeds appears to be relatively more acceptable, as compared to countries where agricultural intensification is low.[18] At a more general level, it is worth stressing that the Gene Revolution (deriving from adopting the agricultural biotech outputs) is not a substitute for the Green revolution. Rather,

[15] Although there was a limitation with respect to the provinces where Bt-cotton seed could be disseminated. Seed dissemination began in three provinces and the authorization is now extended to nine provinces, although Bt-cotton can be found in non-authorized provinces like in Jiangsu.

[16] To be more precise, in China there are two biotech gene providers (Monsanto and BTCC) and many GM seed suppliers since BTCC is not restrictive in supplying its gene to many breeders. So there is no market power in the area of GM seeds, but there is a duopoly in the supply of biotech genes. It is noteworthy that BTCC tried to act as any private biotech company that is requesting very high royalties for each new variety integrating the gene construction technology. This was regarded as excessive by the Chinese breeding teams and the Central Government intervened to support the latter position imposing a revision of the commercialization conditions.

[17] From the technical point of view this precaution must be adopted in countries where each farmer might grow hundreds to thousands of hectares of cotton. Its extrapolation to countries characterized by a multi-cropping pattern based on smallholding farms that already serve as refuges for cotton pests, as it is the case in Chine, is debatable (Wu *et al*., 2004).

[18] For example, the adoption of GM seeds in Mali, hypothesizing the same costs incurred by South African farmers, would double the total input costs the Malian farmers are facing (Fok *et al*., 2004).

Gene Revolution appears to be a further stage of the Green Revolution and not a second chance for the countries which missed it entirely.

In terms of technological abilities, several factors contributed positively. First, China possesses its own Bt-gene technology whose use can be managed independently of the strategy of any multinational firm. Second, China has achieved a good command in the gene transfer so that the integration of extra-specific genes does not raise any problem. Third, China possesses a big portfolio of genes of agricultural interest so that the combination of various genes can lead to more extended efficiency than the first generation of Bt-cotton. Fourth, China has developed many varieties characterized by a great genetic diversity. This multi-fold technological ability appears to be key in proposing a large array of locally-adapted GM varieties within a competitive context.

In terms of the rules under which the Bt-cotton is being diffused, the Government played a crucial role that can be singled out into several steps. First, the Government's willingness and ability to play a role. Second, the Government bargaining power so that multinational firms accepted to revise the rules they had originally in mind. Third, the ability to enforce a policy for managing foreign direct investment based on the development of joint ventures between foreigner and domestic firms so that the latter could benefit directly from the technology introduction.[19] Fourth, some understanding of the farmers' constraints and needs as a pre-requisite to adjust the diffusion rules in a favorable way to farmers (no contract, preservation of the right in using farmers' seeds).

In summary, there is a comprehensive package of technical and institutional factors which worked synergically for the success. Despite the fact that introduction of Bt-cotton transformed competition in the seed market into a positional competition, China proved to have appropriate institutions, technical achievements, human and social capital, and finally governance skills to challenge the position of Monsanto's GM seeds.

Can this pattern be replicated? Considering different categories of countries according to their command in carrying out biotech R&D, India and Brazil can be ranked in the same stage of good command at the eve of large GM diffusion. Most developing countries, in particular Sub-Saharan African (SSA) countries, lack information and specific skills. Since SSA countries are under international attention for the adoption of GM varieties, we focus on these

[19] An example of this policy is the endorsement by the Chinese Government in 1996 of the joint venture between Monsanto - Delta and Pineland Co. from one side, and the Hebei Seed Company, on the other.

countries, along with India and Brazil, to make an assessment of the replicability of the Chinese experience.

Table 5 clearly shows that virtually no positive factors feature in the SSA countries. India is the country which seems to be in a better position, but even in this country, and furthermore in Brazil, most of the favorable factors are missing and will likely keep missing in the near future. It is hence impossible to claim that what the Chinese farmers get nowadays will be what smallholders in other developing countries will get in the future. In other words, there is no guarantee whatsoever that other LDCs could replicate China achievement.

Table 5. Factors for Favorable GM Diffusion Missing in Most of the Developing Countries

	India	Brazil	SSA
Level of pest resistance to insecticide hampering the cotton production without new solution	Yes	No	No
High yield	No	Yes*	No
High intensification in input use	No	Yes*	No
Availability of own Bt-gene technology	No?	No	No
Good command in biotech techniques	Yes	Yes	No
Availability of many alternative genes from national research	Yes?	No	No
Existence of great pool of cotton varieties	Yes	Yes	Yes
Great number of research institutions	Yes	Yes	±Yes
Willingness for the State to get involved	No	No	±Yes
Sufficient bargaining power	±No	±No	No
Policy in foreign direct investment favorable to national firms	±No	±No	No
Knowledge/capacity to adjust diffusion rules to the interest of the smallholders	No	No	No
Capacity to ensure favorable purchase price of cotton produced by smallholders	±No	No	No

* Valid for commercial farms, not necessarily for smallholders

There are, however, some promising signs that the competition in the biotech sector is being further opened up. Multinational firms like Monsanto are no longer the unique providers of commercial biotech outputs. Due to the high price of the Bt-cotton seeds in India (as a consequence of the Monsanto monopolistic position in providing Bt-gene), some Indian companies are establishing partnership with the Chinese biotech firm (Biocentury Transgene Co Ltd) to contest Monsanto position (Jishnu, 2006). This is possible because the Chinese biotech firm gained reputation 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.

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 working for the poor will be implemented and if some promising emerging trends will materialize. Addressing the current issues of IPR protection means essentially focusing on: (*i*) a too costly enforcement of IPR protection regulations in LDCs, and (*ii*) the lack of incentives to private companies to invest in LDC-oriented agricultural biotech research. The difficulty is the need to balance patent protection to induce private sector investment in research with access to cheap GM products for the world poor.

However, 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, the IPR protection system would be improved by being tailored to these different markets. In the case of "global" crops, that is the ones that can be cultivated both in LDCs and DCs, the domain of application of IPR can be restricted, weakening them in LDCs.[20] The patentee would be required to choose enforcement of his IPR protection either in rich or in poor countries, but not in both.[21] 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.[22] Alternatively, investments should be channeled to make biotechnology R&D available as free-share good, as it has been recently

[20] This is based on the premises 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).
[21] There are several advantages in a proposal like this, but the most relevant for our discussion 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.
[22] This mechanism mimics in the agricultural sector what, for instance, the Melinda and Bill Gates foundation is doing to induce research on malaria and AIDS.

made by the CAMBIA consortium or the BIOS initiative under an "open-source" license scheme (Nature, 2004; The Economist, 12th February 2005).[23]

IPR compliance might become less constraining even if IPR rules remain unchanged, because many patents covering biotechnology outputs are about to fall into the public domain (Kowalski *et al*., 2002). When this materialize, it may possible to establish a clearing-house of the most suitable biotechnology techniques and outputs for developing countries which will make them more accessible for public research (Pingali and Raney, 2004).

Another potentially positive factor is that some countries like China and India own genes of agronomic interest through their public research institutions. Private and multi-national firms are no longer having total 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 ensure some leading role in the 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 plans that canceled any support for input use. Hopefully, this situation may positively evolve as acknowledged in the WTO Doha Round, where the principle of supporting poor farmers to get into crop intensification has being rehabilitated during the first discussions (Fok, 2002).

6. Conclusions

The dissemination of GM seeds at international level started in 1996. It took place after a decommodification process resulting from the extension of IPR protection to living organisms. It operated through specific marketing rules which were set up primarily by biotech companies in order to create and capture economic rents. The same set of rules applied to every country but China. These rules are based upon contracts signed by each user so as to ensure written commitment in complying with IPR on GM seeds. Application of IPR in using crop varieties is not new. What is new is the additional payment of the technology fee and the required explicit individual and annual commitment to comply with cultivation practices

[23] 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 attempt to extend the achievements originating with CAMBIA. Both try to foster collaborative open-source development of sets of key enabling technologies that intend to develop licensing strategies inspired by the open-source movement in software.

aiming at preserving the efficiency of GM varieties. This is an institutional innovation which associates the users to the preservation of the economic rent they have to pay for. All these institutional innovations in the rules of marketing of GM seeds are genuine examples of a decommodification process in the seed industry.

In line with this process, asymmetric outcomes are expected as a consequence of the alteration of the mutuality of international trade in favor of those who own IPR. This argument does not imply that farmers are prevented to benefit from the adoption of GM crops, as GM opponents contend. After all, the fact that farmers in many countries are using GM seeds indicates that they get some benefits in doing so. The issue is that these benefits are not fair enough and usually the process implies equity issues (e.g. the poor are generally excluded). Farmers actually complain about the level of technology fee which prevents further extension of the use of GM seeds (Qaim and de Janvry, 2003) or leads farmers to free-ride in turning round this fee. This is comparable to the phenomenon of product imitation observed in the area of patented manufactured goods.

The case study analyzed in this chapter – Bt-cotton seed adoption in China – provides some insights on the attempt to impose GM seeds as a positional good by a multinational firm. This attempt did not succeed in the case of China because this country had appropriate institutions, technical achievements, human and social capital, and governance skills to define its own terms in using GM seeds. Research and institutional capabilities actually gave China a bargaining power in negotiating with the multinationals a set of marketing rules that are totally different from what is happening elsewhere. Furthermore, the Chinese success in using Bt-cotton is so far little subject to controversy. This success confers international reputation to the Chinese biotech know-how which is being exported, somewhat at the expense of the well-established multinational Monsanto.

However, those conditions can hardly be replicated in other LDCs. In fact, Chinese agriculture has little in common with other LDC agricultures. In other words, China could be regarded as an exception which confirms the general rule. This conclusion is opposed to the optimism expressed by some authors (Huang *et al*., 2002; Elbehri and Macdonald, 2004). Nevertheless, this pessimistic view might not materialize if the IPR barrier protecting the use of GM seeds can be loosened. This outcome would not materialize automatically. initiatives are needed to reform the current institutionalization of the WTO-TRIPS agreement. This could be realistic provided that two conditions are fulfilled. One is that public research, at international level, could become more active in playing an intermediation role in assisting LDCs to identify and apply genes or biotechniques which are about to fall into the public domain (Pingali and Raney, 2004). The second is that LDCs could benefit from favorable conditions to implement crop intensification.

International coordination is needed in order to let both conditions to materialize. This kind of coordination seems to be a realistic way to help LDCs overcoming their lack of appropriate institutions, human and social capital, governance skills which condemn them to the short end of asymmetries in the trade of GM seeds and crops.

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