The politics of technological upgrading: international transfer to and adaptation of GM cotton in Argentina

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ABSTRACT

We describe patterns of technological upgrading in genetically modified (GM) cotton within Argentina's agricultural sector, and ask whether political bargaining between the technology owner, a multinational enterprise (MNE), and host country actors may have influenced upgrading. We suggest that the MNE was able to use its exclusive capacity to upgrade GM cotton technology as a negotiation tool to persuade host actors to change the rules that affected its multi-lines of business in the country. This implies a wider scope for policy making to encourage technology upgrading; host actors could negotiate over a wider range of aspects of interest to MNEs.

KEYWORDS

Agricultural biotechnology; Multinational seed industry; Technology transfer; Technology adaptation; Political bargaining; Cotton; Latin America; Argentina

1. INTRODUCTION

From the 1960s through to the 1990s, the international transfer and adaptation of agricultural technology (or technological upgrading) in developing countries was largely a public sector led activity. Subsequent processes of market liberalization, and much stronger intellectual property protection for biological technologies, have meant that the private sector has begun to play a more prominent role in agricultural innovation in developing countries, although it is still small in comparison to the public sector.[i] It is in the area of modern agricultural biotechnology, however, and transgenic (or genetically modified) crop technologies in particular, where that shift has been most pronounced. The development, international transfer and local adaptation of genetically modified (GM) crop technologies takes place overwhelmingly within private markets, dominated by a small number of multinational firms.[ii] The proprietary protection provided for gene sequences, genetically modified plants, and the techniques involved in creating GM artefacts limits public sector involvement in agricultural biotechnology innovation processes. So do the high costs of conducting tests for commercial bio-safety approval. .

Indeed, with the important exception of Chinese innovation in GM crops, all the transgenic 'events' (i.e. the gene sequences that confer, for example herbicide tolerance or insect resistance) currently in commercial use were developed initially by the private sector for the large established commercial United States (US) and Canadian agricultural markets (Traxler, 2006), and inserted into crops that were important in those markets. The subsequent transfer of those technologies to developing countries, and most adaptation efforts, to the extent that they occur at all, have been led by multinational enterprises (MNEs) and/or their local affiliates with the host-economy

public sector only contributing to the process. This rather fundamental shift from public to private sector led technology transfer and adaptation raises important questions about what will determine the extent and rate of upgrading in the new agricultural biotechnologies, as well as interesting questions about the direction of technological upgrading.[iii]

For MNEs that produce transgenic events and seeds, developing countries may provide (i) an opportunity to transfer existing technology, e.g. a transgenic seed variety, but they may also provide (ii) an opportunity to create new applications for their existing technology, say in the form of minor adaptations to imported seed varieties orientated to the distinct needs of host economies. They may even provide (iii) the opportunity to expand the MNE's knowledge and technology assets through interactions with highly specialised host actors through a local research programme, in the form of inventive adaptation of existing knowledge and technology. Pingali & Traxler (2002) have noted that as one moves up this ascending order of hypothetical technological upgrading activities (say from i to iii), costs inevitably increase, and so the minimum market size required for market entry decisions would increase too.[iv]

Other incentives, such as institutional factors, are also likely to be important in MNE decisions about which level of technological upgrading to undertake. On this point, agricultural economists have argued that private investment in GM crop technologies in developing countries is unlikely not only in the absence of a sufficiently large potential market, but also the ability to capture some of the benefits from the new technology (related mainly related to the nature of intellectual property regulation and enforcement) and acceptable costs of research and/or commercialization (which is related to local infrastructure and science and technology (S&T) capabilities) (Pingali & Traxler, 2002; Pray & Naseem, 2007; Pray & Umali-Deininger, 1998; Traxler, 2006).

However, beyond such claims, there is little empirical evidence of how and why technology upgrading in transgenic seeds occurs in developing country contexts. From a policy perspective it is therefore important to understand what influences MNE's technological upgrading strategies in regard to GM technologies.

In what follows we explore the evolution of technological upgrading in relation to genetically modified (GM) cotton in Argentina by the affiliate of the multinational seed firm Monsanto, the only firm currently involved in developing and commercialising GM cotton in the country. In particular, we are interesting in understanding how political bargaining between MNEs' subsidiaries and host country institutional actors, and the outcomes of such bargaining, may influence technological upgrading.

All economics research on technological upgrading argues that aspects of host country institutional context are key drivers of the existence and nature of upgrading activities. In doing so, however, host country institutional factors such as intellectual property rights (IPR), tariff conditions, subsidies, etc. are treated as exogenous variables when explaining MNE investments in technology. In this paper we challenge this assumption. We ask "Could upgrading be in part a resource for and an outcome of political bargaining by MNEs with host actors for institutional reforms of interest to the MNE?"

Some of the literature on Foreign Direct Investment in the fields of International Business and Political Science certainly recognises that MNEs may seek to influence host country institutional rules, but it has largely done so with respect to issues of location and the characteristic of initial investments, and not, in so far as we can tell, in relation to technological upgrading activities.

Our interest is therefore in linking the literature on what determines upgrading activities in developing countries with insights about how MNEs sometimes bargain for favourable changes to host country institutional contexts. In doing so we provide at least some evidence that the MNE subsidiary was able to use its exclusive capacity to upgrade GM technology as a negotiation tool in an attempt to persuade government to change the institutional rules that affected its multi-lines of business in the host country.

Our claim is tentative because corporate strategy is generally confidential, and therefore we did not expect and did not obtain an open explanation of subsidiary strategy in interviews or in announcements to the press. Indeed in general, the literature on MNE bargaining with host country governments rarely provides direct empirical evidence of such bargaining and instead assumes that it must occur (see for example Boddewyn & Brewer, 1994). Therefore, we believe that our evidence, although partial, will be of interest on this empirically thin issue. Moreover, our claims, although tentative, are interesting and important because if what MNE subsidiaries actually do in terms of technological upgrading is, at least in part, an outcome of a negotiation process with host governments, this raises somewhat different kinds of policy implications about how host governments can encourage technological upgrading, in comparison to those discussed in the existing literature.

The remainder of this paper is structured as follows: Section 2 provides a brief review of the literature on MNEs' technology upgrading activities and political bargaining with host governments. Section 3 provides a description of how markets for agricultural biotechnology and cotton seeds function in Argentina, focussing particularly on institutional matters. Sections 4, 5, and 6 set out our empirical work. Section 4 describes the main activities undertaken by the MNE affiliate in Argentina regarding technology upgrading of GM cotton technologies between 1998 and 2011.

Section 5 outlines our evidence on MNE bargaining with the host government for institutional reforms over the same period, and Section 6 suggests that cotton upgrading activities were influenced by that political bargaining. Section 7 concludes and offers some policy recommendations.

2. MNE TECHNOLOGY UPGRADING IN DEVELOPING COUNTRIES, THE ROLE OF LOCAL CONTEXTS: A BRIEF LITERATURE REVIEW

Since the late 1970s both our general understanding of MNEs technological upgrading activities in developing countries, and our more specific understanding of how those activities are influenced by local institutional contexts, has shifted, in response to changes in the ways that MNEs organise their global innovative activities.

Very broadly, an 'old' literature argued that MNE headquarters would decide what their local affiliates would do in developing countries, which was typically limited to the international transfer of relatively old technologies, and their minor adaptation to exploit local resources or markets (ECLAC, 2007 ; Katz & Bercovich, 1993 ; Lall, 1982; Rugman, 1981 pp. 135-137; Velho, 2004). The literature argued that those centrally-driven decisions, mostly about location, were influenced by the institutional incentives and constraints present in the host country. Here, for example, the literature highlighted issues related to restrictions on capital mobility (e.g. Asiedu & Lien, 2004; Ihrig, 2000), trade openness (e.g. Taylor, 2000), IPR (e.g. Maskus, 2000; Naghavi, 2007; Nicholson, 2007) and tax incentives (e.g. Barrel & Pain, 1998; Simango, 1993; Yin, 1999). In doing so, however, this literature effectively assumes that these kinds of factors are an external context to MNE headquarters' strategic decisions.[v]

More recently, MNEs' technological upgrading activities have been understood as not exclusively centrally-driven by headquarters. Instead, subsidiaries were recognized as relatively autonomous actors, embedded in both internal networks within the corporation but also external networks within the host country (Meyer, Mudambi & Narula, 2011). Subsidiaries may therefore develop their own innovative capabilities and follow their own development path, and in doing so, subsidiaries might become a source of competence-building for the corporation as a whole (Asmussen, Pedersen & Dhanaraj, 2009; Cantwell & Mudambi, 2005).

This 'new' framework has two important implications for our purposes. One is that the technological assets transferred to a developing country, via a subsidiary, were no longer assumed to be ready-made technological kit from the core countries, with decisions about what to transfer and adapt made only by the headquarters. Instead, some authors showed how subsidiaries' technological upgrading activities may evolve over time, as a result of learning processes within the subsidiary, and as subsidiaries developed their own strategies, partly in interaction with host country actors. That evolution might progress from, say, managing the transfer of established technological designs and the provision of technical support and minor adaptation, through to increasingly more complex activities, including inventive adaptation or genuine innovation; in other words, asset augmenting strategies (Ariffin & Bell, 1999; Boehe, 2007; Cantwell & Mudambi, 2005; Meyer, 2004).

The second implication is that the ways in which host countries' contexts were recognised as influencing the evolution of subsidiaries' upgrading strategies altered. The literature, which has mainly focused on evidence from developed economies, has typically stressed the role played by local S&T capabilities, as a source of opportunities for value-creating activities by subsidiaries. This implies, therefore, that knowledge may

flow from local S&T capabilities, via the subsidiary, to the corporation as a whole - a direction that is the reverse of that assumed within the 'old' framework.[vi] The literature focusing on developing countries, on the other hand, has noted how locally-driven upgrading activities may be adversely influenced by poorly functioning markets, as a result of an absence of strong formal institutions (Delios & Henisz, 2003; Meyer, 2001; Meyer & Nguyen, 2005).

The recognition that technology upgrading activities may evolve over time, and that the evolution partly depends on the characteristics of the local context, is important when considering policy. For example, the UNCTAD World Investment Report (2005) argued that policy makers in developing countries should encourage local managers of subsidiaries to become better integrated into their corporations' internal networks in order to ensure that knowledge intensive activities are located on the subsidiaries' premises. The policies recommended as a means of doing so are, nevertheless, fairly general and horizontal[vii] and are assumed to be exogenous to firms' strategic behaviour.

In sum, both the 'old' and the 'new' literature highlight the role of institutional factors as influencing technological upgrading dynamics but it takes host country institutional incentives and constraints as exogenous to the strategic decisions of individual organisations. This is perhaps a consequence of traditional disciplinary focus in economics, for which the context is taken as a background condition.[viii] In other words, the literature largely neglects the possibility that MNEs might attempt to purposively shape those incentives and constraints.

Some international business scholars do nevertheless acknowledge the effect that relatively autonomous MNE subsidiaries can have on host country institutional frameworks, but not specifically in relation to subsidiaries' upgrading activities. For example, in what is described as a co-evolutionary process (Cantwell, Dunning &

Lundan, 2010), practices adopted by subsidiaries, for example in relation to labour standards, may diffuse to other local firms and become institutionalised (Van Tulder & Kolk, 2001) or subsidiaries may engage in political lobbying over regulations and policies that are important to their business activities (Boddewyn & Brewer, 1994; Doh, Teegen & Mudambi, 2004; Ramamurti, 2005). This reference to political lobbying is reminiscent of an older international business literature on political bargaining by MNE headquarters with host country governments, over the nature of MNE's *initial* investments, for example in terms of location, personnel recruitment, export markets, and relationships with local suppliers (Evans, 1979; Lecraw & Morrison, 1991). However, the possibility that technological upgrading undertaken by installed subsidiaries may be partially the outcome of bargaining or lobbying by MNEs has not been investigated in either the economics or the international business literature.[ix] This issue is the empirical focus of this paper.

Our empirical work was based on 28 interviews conducted between 2009 and 2011 with personnel working in the private seed industry, Argentina's public agricultural research system, universities, and in local and national government. We use an open-question questionnaire organised in three sections: i) technical issues: to identify technological upgrading activities and also MNES' relations with the local S&T system; ii) diffusion and commercialisation issues: to identify potential clients and the ways to approach them, especially in relation to small farmers; iii) political issues: to identify main triggers of businesses (including R&T and technology transfer) in the country, particularly in relation to host governments and public institutions. Interview lasted around one hour and a half and they were normally recorded. Data from the interviews was complemented with media articles published between 1998 and 2011 in the rural section of *La Nación*, a leading newspaper in Argentina. We also reviewed

official documents related to government policy decisions, particularly the Official Bulletin.

3. POLICY AND LEGAL CONTEXT FOR AGRICULTURAL BIOTECHNOLOGY AND THE GM COTTON MARKET IN ARGENTINA

Since the early 1990s, both the Argentinean state and the agri-business sector have strongly backed the development and commercialisation of agricultural biotechnologies. GM varieties of soybean, maize and cotton were introduced commercially in the mid to late 1990s and have diffused rapidly. This section provides a brief background for the empirical material that follows by first outlining the enabling sets of regulations that have accompanied the commercialisation of GM crops, and second by describing the market for GM cotton seeds.

(a) National regulations

Two sets of regulatory rules have been critical in terms of enabling the transfer, adaptation and commercial introduction of GM crops in Argentina. First are bio-safety regulations which govern the licensing of novel GM crop events and that require experimental work to investigate potential agronomic, environmental and food safety impacts. Estimates from other developing countries of the direct regulatory costs involved range from 100,000 to 4 million dollars, depending on the jurisdiction and crop-event combination, and on whether there already exists, for example food safety or composition data, as a result of prior applications in other countries (Bayer, Norton & Falck Zepeda, 2010).

Second are intellectual property regulations which comprise both a plant variety protection regime and a patent regime. The former, modelled on the 1978 version of the International Convention for the Protection of New Varieties of Plants (UPOV), provides seed breeders with a monopoly on the commercial propagation and marketing of their seed varieties, whilst allowing competing breeders to use those seeds as a basis for genetic improvement, and permitting farmers to save their own harvested seed for replanting (but not for commercial resale). The patent regime allows modified genes (but not the seed varieties into which they are inserted) to be patented. This enables the patent holder to prevent other seed breeders from using its genetic constructs in the development of new seed varieties, as would be permitted if IPR only comprised the plant variety protection regime.

It is worth noting that this regulatory context (i.e. the plant variety protection and patent regimes and the regulatory rules on bio-safety) has remained consistent and stable ever since agricultural biotechnology firms first introduced GM seeds commercially in 1996. The only important institutional innovation since then has been the emergence of private regulatory agreements between biotechnology firms and farmers and/or seed producers, some of which have affected the GM cotton market and which will be described in the next section.[x]

(b) GM Cotton in Argentina

Cotton production represents a relatively small proportion of Argentina's agricultural economy, but it is an important crop in the north east of the country. In 2011/12 cotton was grown on over 600,000 hectares.[xi] As can be seen in Figure 1 the area cultivated with cotton has been growing in recent years but it is still small in

comparison to the 1990s. Changes in the land area devoted to cotton cultivation follow both international prices and the evolution of the national textile industry.

(insert Figure 1 around here)

Cotton farms and farmers are heterogeneous. A small number of very large farms produce most of the crop under modern capital intensive conditions. The majority of farms, however, are small holdings where the crop is produced using family labour and with little mechanisation. For example, in Chaco Province, which historically accounted for about 60% of Argentina's cotton production, data from 2002 indicate that about three quarters of the Province's cotton farms were less than 25 hectares in size and were responsible for 18% of the acreage sown to cotton. By contrast 6% of cotton farms were more than 100 hectares in size and represented 50% of the land area cultivated with cotton.[xii]

GM cotton varieties first began to be sold commercially in 1998 after Monsanto had obtained a bio-safety licence for the first of three novel events for cotton. The varieties themselves were sold by a firm called Genética Mandiyú, which had been created as a joint venture between Monsanto, the owner of the modified genes, Delta & Pine which had provided the cotton germplasm for some of the seed varieties (and which Monsanto subsequently purchased), and a local firm CIAGRO, which has a major seed distribution network in the north east of Argentina. In 2011 Monsanto Argentina acquired Genética Mandiyú. As can be seen in Figure 2, Genética Mandiyú's

GM seed varieties diffused rapidly, accounting for more than 90% of the acreage sown to cotton by 2007, and virtually 100% by 2011.

(Insert Figure 2 around here)

Large cotton farmers (i.e. with typically more than 100 hectares under production) were the only group of cotton producers to whom Genética Mandiyú started to market its GM seed varieties, which cost four times as much as conventional cotton seeds (Qaim & Janvry, 2005). Small and medium sized farmers, to whom certified seeds were not marketed, soon obtained copied versions of the GM varieties, however, that had been produced and made available in informal markets. The informal market is illegal under Argentinean seed legislation, but in practice extremely difficult to police. Even amongst the large cotton farmers, however, only a small percentage of seed needs were certified seeds purchased from Genética Mandiyú. Large farmers save and re-sow most of their seeds, purchasing only about 10% of their needs each year to maintain seed quality (Arza et al., 2010). Seed saving and replanting by the large commercial farmers is lawful under Argentinean seed legislation but Genética Mandiyú had introduced stricter private regulations in the form of a contract that requires commercial farmers that buy its certified seed to pay a royalty to the firm if they reuse the cotton crop for replanting.

Throughout the 2000s, farmer-saved seed and copied seed sold in informal markets continued to make up the vast bulk of the acreage planted with GM cotton. Trigo & Cap (2006) estimated in the period 1998-2005 the proportion of informal market was 66% for insect resistant varieties and 80% for herbicide tolerant varieties. In our interviews with Monsanto, the firm claimed that only 8% of GM cotton seeds were

purchased from the company, meaning that 92% of GM seeds used were either illegally marketed or re-used by farmers in 2009, a proportion that dropped to 84% the following year after an agreement was reached between Monsanto and several actors regarding royalties. That agreement involved the supply of certified seed to the informal seed dealers (who received a subsidy from the provincial government to purchase that seed). The informal seed dealers, largely cotton co-operatives, would then be free to multiply the certified seed two times, and sell the multiplied varieties on to smaller farmers, although they would have to pay a levy on each bag of multiplied seeds they formally produced.

In sum, the information summarised in this section suggests that local conditions regarding effective market size and regulatory rules have remained relatively stable in the period since GM cotton varieties were first commercialised. Certainly that is the case for regulatory rules. As far as market size is concerned, demand for cotton seeds in terms of the cultivated area has remained stable between 1999 and 2009, and increased a bit in 2010 and 2011. Demand for GM seeds specifically increased substantially, even though the majority have not been purchased from Genética Mandiyú. Thus, the effective market size for GM seeds purchased from the company over time is unlikely to have decreased, and it might have increased after 2009.

4. TECHNOLOGICAL TRANSFER AND ADAPTATION OF GM COTTON VARIETIES BY MONSANTO IN ARGENTINA

The purpose of this section is to describe Monsanto's activities regarding technological upgrading of GM cotton. We characterise those activities in terms of three upgrading steps in GM seeds as discussed in the introduction:

i. transfer of existing technology (i.e. no adaptation) and the extent to which the GM events were relatively novel for the world;
ii. development of new applications of existing technology, mainly using local germplasm (i.e. minor adaptation);
iii. expansion of MNE competence by creating new technology (i.e. inventive adaptation), for example developing new traits that respond to specific needs drawing on local knowledge

As summarised in Table 1, technological upgrading by Monsanto in cotton has consisted of the transfer of three novel events and the incorporation of those events into nine seed varieties. The first of the three events (MON 531) was for a gene sequence that codes for the soil bacterium *Bacillus thuringiensis* (Bt) which is toxic to some insect pests. It was transferred two years after its initial release in the USA. The second (MON 1445) was for a sequence that confers tolerance to the herbicide glyphosate (RR), transferred 4 years after its initial US release, whilst the third was a 'stacked' event (BR) that combines both the insect resistance and herbicide tolerance traits, transferred 10 years after its initial release in the USA.

(Insert Table 1 around here)

Based on those three events, nine cotton varieties (i.e. germplasm containing the GM events) have been introduced commercially. Applications to register those varieties were made by Delta Pine/Monsanto and commercialised by Genética Mandiyú.

The first variety was a Bt seed called NUCOTN 33 B, originally developed for US cotton growers, and imported into Argentina. Thus, in this case, no adaptation was carried out for the Argentinean market; the seed variety containing the transgene was imported from abroad. Diffusion rates were relatively slow (Qaim & de Janvry, 2003). In 2001, three years after being commercially launched Bt cotton covered only about 6% of the cotton growing area of Argentina, and was never particularly successful.

A herbicide tolerant variety was first introduced in 2001, and involved minor adaptation, since the herbicide tolerant event had been backcrossed into a conventional seed variety that had been bred by National Institute of Agricultural Technology (INTA). Although formal permission from INTA was not legally necessary, Monsanto had formed an agreement, known as a technological link, with INTA in 1998, a consequence of which INTA provided permission for the firm to use all of INTA's germplasm developed up to 1998 in its own seeds. Diffusion was far more rapid than the earlier imported Bt varieties, as shown in Figure 2. The fact that it was based on a successful conventional variety, bred for Northeast Argentina's agro-ecosystem, was the main reason, according to Argentinean specialists in agricultural biotechnology, why farmers purchased the seed (Trigo & Cap, 2006 p. 40).

Between 2001 and 2009 further Bt varieties were marketed, again imported from abroad (see Table 1). Then, in 2009, Monsanto obtained approval for its stacked cotton event. An imported variety based on that stacked event, Nuopal BR, was launched commercially. Monsanto acknowledged that the variety was not ideal for Argentinean agronomic conditions.[xiii] However, it was widely and rapidly adopted by Argentinean

farmers: by 2010 it was being grown on some 80% of the area devoted to cotton. A second stacked variety was released commercially later in 2011. It was based on insertion of the stacked genes into a variety that was itself derived from a conventional INTA seed that had been developed in 1996.

In terms then of the three different kinds of upgrading, listed at the beginning of this section, most upgrading has taken the form of *technology transfer*, in this case of all three events, and seven of the nine cotton varieties that incorporate those events. Furthermore, whilst the first event to be transferred was of relatively recent vintage, the two subsequent events were of progressively older innovations; 12 years in the case of the third stacked event, as compared to 2 years for the first Bt event. In addition, the GM cotton events marketed in Argentina are now obsolete in the US and other industrialised countries. Monsanto's more recent vintage of GM events such as a Bt event that combines two different *cry* genes, and a glyphosate resistant variety that provides both vegetative and reproductive tolerance to the herbicide (now the only traits available in say US markets) have not been commercialised in cotton varieties in Argentina. All this suggests that Argentina has lost importance as a market for cotton within the corporation.

Upgrading in the form of *minor adaptation* - by using local well adapted local seed varieties as the basis for the transgenic seeds - was used for only two of the nine GM varieties released in Argentina. Furthermore, the local INTA seed varieties that formed the basis for the two GM seeds are, as of 2012, relatively old (23 and 16 years respectively). More recent germplasm, bred by INTA, or indeed any of the 30 registered local varieties, are not available in the form of GM varieties.

Upgrading in the form of *inventive adaptation*, such as the development of new traits that respond to local agronomic constraints, has not occurred. One very significant

local constraint for Argentinean cotton producers is a pest called the boll weevil (*Anthonomusgrandis*),[xiv] which is not affected by the toxin released by Monsanto's insect resistant varieties. The boll weevil is the major cotton pest in Argentina (and in other Latin American cotton producing countries, but not in other parts of the world that produce cotton). In principle, it may be possible to develop transgenic cotton varieties that are effective at controlling the boll weevil. Argentina's public S&T institutions have invested in research to develop both potential GM-based and other solutions to the boll weevil and Monsanto was engaged in the past in some small scale research investigating Bt strains that are toxic to the boll weevil in the US.[xv] But the company is not engaged in any current R&D, either alone or in conjunction with local S&T institutions, on that or any other locally specific agricultural problems. We were told by our interviewees that the cotton market in Argentina, and in Brazil where the pest is also highly problematic, is too small to warrant the research and development (R&D) and regulatory costs involved in trying to produce an entirely new trait.[xvi]

In Figure 3 we characterise graphically the above description of technological upgrading. The height of the bars represents a rough approximation of the extent of technological upgrading. The scale is arbitrary and therefore values are not shown, but take into consideration the dimensions of technology transfer (in GM events and GM seeds), event novelty, and efforts of adaptation described above.

(insert Figure 3 around here)

Looking at the entire period from 1998 to 2011, the initial step taken in 1998 by Monsanto in the Argentinean cotton seed market was to transfer an up-to-date technology, in the form of a US seed variety containing the Bt event. The alternative

option of inserting Monsanto's Bt gene into a locally bred variety (i.e. a minor adaptation) might have been more attractive to farmers if it was a local variety that performed well. Indeed, as Traxler argues, obtaining access to locally-adapted germplasm is one of the factors that might make a small market attractive to an MNE (Traxler, 1999). One possible reason for not undertaking that kind of minor adaptation was that the size of the potential market was too uncertain to justify the R&D costs, given that no GM cotton varieties had yet been released commercially. The business strategy might therefore have been to import ready available seeds straight away after licensing approval was gained, and to see how they performed. In practice, however, the imported Bt variety was not particularly successful.

The firm subsequently consolidated its position by undertaking minor adaptation using a relatively new herbicide tolerant event and a local INTA variety that had been very successful in its own right. To that end the firm signed an agreement with INTA, which both enabled further joint research and local diffusion of the product. The new seed variety diffused rapidly and became a market success. However, this business practice of accessing the Argentinean cotton market, and consolidating the firm's position within it soon altered. In fact, upgrading activities then ceased, except for the import of further Bt seed varieties, until 2009 when a new trait was transferred and minor adaptation was again performed using local germplasm.

What factors might then explain the specific dynamics of Monsanto's upgrading decisions in cotton? In particular, why did the initial transfer of up to date technology, followed by more complex adaptation of what was still relatively new technology, pause after 2001? Why subsequently was it not until 2009 that transfer and adaptation resumed, albeit with much older vintages of technology?

It is unlikely that this pattern only reflects the potential domestic market for cotton seed and the nature of the institutional incentives and costs. The effective market size for GM cotton seeds, the magnitude of R&D and licensing costs, and the nature of the IPR regime, have remained relatively stable since the beginning of Monsanto's cotton business in the country, as discussed earlier in Section 3. As we shall argue below, we think it is plausible that some of the strategic decisions about upgrading, adopted by the MNE affiliate in Argentina, were also likely to have been influenced by political bargaining between the MNE and the host economy in relation to intellectual property and its enforcement, which was of interest to the parent corporation in all of its spheres of its activity. We begin, however, by discussing political bargaining between Monsanto and the Argentinean Government, mainly over soya, another crop that was a key part of Monsanto's activities in Argentina.

5. MONSANTO BARGAINING STRATEGIES WITH HOST ACTORS

Herbicide resistant soybean varieties are the most widely cultivated crop in Argentina,[xvii] and a far more important market for Monsanto than cotton. As with cotton, GM soy seed is widely saved and then replanted or sold on in informal markets. Indeed, only about 20 percent of the total area planted with soybeans in Argentina is sown with seeds purchased from authorized dealers; whilst an estimated 30 percent is planted with seeds saved by farmers for their own use, and the remaining 50 percent with seeds sold in illegal markets (USDA, 2010).

A further issue with soya is that Monsanto does not have a patent on its company's herbicide resistant event for soya. In brief, Monsanto was not the first firm to commercialise a glyphosate tolerant soybean variety in Argentina. An Argentinean-

Dutch company, Nidera, had obtained a GM soybean variety, as a result of the fact that Monsanto had licensed the use of its glyphosate resistant gene to another firm, in the late 1980s, which Nidera subsequently purchased. Nidera did not therefore have to pay a licensing fee to Monsanto for use of its glyphosate resistant technology when it launched its own GM soybean variety in Argentina. Nidera did not file for a patent either, because it was not the inventor of the technology. Nidera rapidly gained a 70% share of the certified soybean seed market (Qaim & Traxler, 2005).

In 1995, Monsanto filed for an Argentinean patent on glyphosate resistant soybean seed, but the application was rejected, on the grounds that the company had applied for its patent after the legally set period following the first world-wide application. Monsanto appealed to the Argentinean Supreme Court but was unsuccessful. Correa (2006) suggests that Monsanto's decision to leave the gene in the public domain might have been a miscalculation about the commercial impact that glyphosate resistant soybean might have in Argentina, or it might have been for other practical or strategic reasons, for example so as to ensure rapid dissemination of the technology so as to guarantee sales of the herbicide glyphosate, which the modified soya is resistant to, and which is also owned by Monsanto. In the absence of a patent for its modified soybean, any seed firm can use available glyphosate resistant varieties in Argentina for further development. Other companies that have developed herbicide tolerant soybean varieties in Argentina have therefore not been obliged to pay royalties to Monsanto but, with the exception of Nidera, they have all done on a voluntary basis, so as to secure access to future genetic innovations (Qaim & Traxler, 2005).

The difficulties faced by Monsanto in obtaining revenues on its herbicide tolerant soy varieties became the source of major tension between the firm and the Argentinean government in 2004 when Monsanto announced the temporary suspension

of its sales and soy-related research and development activities in Argentina, alleging that the illegal market in uncertified soya "…has come to the point where it is impossible even to cover our costs" (Smith, 2004). That move was seen as an attempt to pressure the government into strengthening seed legislation or at least to enhance enforcement of existing law (ibid). In 2005 and 2006 Monsanto filed law suits in European countries in an attempt to enforce royalty payments on Argentine soybean exports at ports of destination in countries in which Monsanto holds a patent on the glyphosate resistant soybeans. Those strategies were unsuccessful because the European Courts ruled in favour of Argentina.

Some commentators, including one Argentinean Foreign Minister, argued that Monsanto began to put sustained pressure on the Argentinean government to strengthen intellectual property rules and/or obtain other means of extracting royalties on its herbicide-resistant soybean once Monsanto's patent on glyphosate expired in the end of 2000,[xviii] given that, since then, the market was flooded by similar herbicides imported from China. In fact, in June 2001, Monsanto sued imports of glyphosate from China for alleged dumping. The Argentine government agreed to initiate investigations. According to the Chamber of Agricultural Health and Fertilizers the price range that a farmer paid for Monsanto's glyphosate was between 2.2 and 2.45 USD per litre, while the herbicide imported from China was around 1.18 USD per litre. However, in February 2004 the government decided to dismiss the Monsanto's complaint, allowing Chinese imports of herbicides without imposing dumping penalties.

From 2004 onwards, after Monsanto's decision to temporarily suspend soybean sales and soy-related research, the firm began to stress, in announcements reported by the media, that the enforcement of property rights was a pre-condition for technology transfer and adaptation. Our analysis of media articles in the rural section of the

newspaper *La Nación*, identified 287 articles related to news on 'Monsanto' and biotechnology, published between January 1998 and September 2011.[xix] Of those articles Monsanto was the core topic in 36% of the news items, new technologies the core topic in 36%, IPR in 7%, and cotton in 4%. Regarding occurrence, among those 287 articles, IPR was mentioned in 23% of articles and cotton in 13%.

(Insert Figure 4 around here)

Unsurprisingly, Figure 4 shows that Monsanto received the highest number of press articles in the year 2004, when disputes between Monsanto and the Argentinean Government began, and then in 2005 and 2006 when soybean shipments were seized in European ports. This also explains the high number of references to IPR in 2004 and subsequent years. In fact, a large proportion of articles refer to issues regarding intellectual property since 2004 (31%), while only 5% have done so before that year. Since 2004 and especially in recent years the implementation and enforcement of a strong IPR regime was explicitly mentioned at conferences and in comments to the media as a necessary condition to ensure that the Argentinean farmers would get access to the latest technology in the future. As an illustration:

- 2003, November 8th: Timothy Conner, Monsanto's director of technology in oilseeds, "implied that the introduction into [Argentina] of second generation [GM soybeans] will arrive only if there is recognition of intellectual property" (Mira, 2003)
- 2003, November 22nd: Carlos Becco of Monsanto Argentina said three things threaten the development of agriculture, one of which was: "Respect for intellectual property. No one does it, especially for crops such as soybeans and wheat. If

they do not pay royalties it jeopardises the development of genetics. Someone will have to pay the costs some day" (La Nación, 2003)

- 2004, January 24th: in an article about illegal seed markets the reporter mentions an interview conducted in 2001 with to Roger Krueger, Monsanto's Director of International Trade Development based in US, who said that if Argentina did not change its 'regime' (referring to the IPR regime) it would not have access to the second generation of transgenics that as well as producing benefits for producers will be accompanied by nutritional and pharmaceutical benefits. (La Nación, 2004).

- 2007, September 8th: Monsanto announced investments in Brazil of 28 million US dollars. "Alfonso Alba, president of Monsanto Brazil, said that we are seeking to develop a soybean resistant to *Anticarsia gemmatalis* a caterpillar which is found especially in Argentina and in Brazil … Alba stressed that the company decided to invest in Brazil because that country 'demonstrated its respect for intellectual property' and because environmental standards are moving in favour of genetically modified organisms. The company reported that the new soybean will be launched in Paraguay but not in Uruguay or Argentina, countries where Monsanto has not yet signed intellectual property agreements." (La Nación, 2007).

- 2011, June, 1[1th], Pablo Vaquero, from Monsanto said that data on the proportion of royalties paid to biotechnology firms justify the leadership of Brazil in soybean material and the reasons why Brazilian farmers already have access to four biotech events and are waiting for the commercial release of RR2BT in 2012. (La Nación, 2011).

Monsanto started to highlight IPR issues as core topics affecting the availability of new technologies, largely in soybean, but also other GM crops too for the first time in November 2003, even though the firm has been engaged in technology transfer and

has had a presence in the seed market for many years before that date. It is worth noting that GM soybean has been sold in Argentina since 1996 and maize and cotton shortly thereafter, and ever since then (and indeed before the introduction of GM seeds) there has been extensive replanting of saved seed and an informal market in copied seed. Yet the claim that a particular kind of IPR regime was required for technology releases has not always existed. It began only in late 2003, after the loss of the firm's patent on glyphosate (O'Donnell, 2011), the decision by the Argentina Government not to place dumping sanctions to Chinese imports of herbicides, and the beginning of an overt dispute over whether royalties could be claimed at the point of export. It is difficult to find any other reasons for the decision to demand stricter IPR conditions as a condition for further technology transfer and innovation other than a shift in the company's strategy. In other words, once agricultural biotechnologies were established, the company attached as a condition for further new releases its aspirations in terms of changes to the national regulatory framework. Further technology releases were used as a political currency to try and obtain those regulatory changes.

6. TECHNOLOGY UPGRADING IN COTTON IN RELATION TO MNE'S POLITICAL STRATEGIES

(a) 2003-2009

This apparent shift in political strategy appears to be reflected in decisions about the transfer and adaptation of cotton technologies after 2004. Figure 5 relates the extent of technological upgrading in cotton (represented by bars) with those facts that characterised political bargaining with host actors that were identified in Section 5.

As noted in Section 4, until to 2002/2003, when the herbicide tolerant seed variety was launched commercially, Monsanto's decisions regarding upgrading in cotton seeds might be as expected based on a business strategy for a biotechnology MNE analysing the potential of a relatively small foreign market. Nevertheless, this strategy of accessing a new market and consolidating its position paused, and until 2009 there was no further technological upgrading in GM cotton.

(insert figure 5 around here)

The period 2003-2009 was both a period in which technological upgrading in GM cotton virtually ceased, and also the most overt in terms of Monsanto's efforts to obtain better intellectual protection for its technology and obtain royalties on GM soya sales.

One seed industry interviewee noted that Monsanto's decisions not to use its more recent events in Argentinean GM cotton varieties is principally because of weak intellectual property protection which led to widespread informal copying and use of the firm's seeds (here it was not clear whether the reference was to cotton or all the firms' seeds). The same source suggested that farmers would want the new events and that eventually a compromise would be reached that would enable the firm to introduce the new technology.

This argument - that the firms' more recent events have not been commercialised because of weak and poorly enforced intellectual property protection - is interesting because the backcrossing of Monsanto's new events into a local variety would not necessarily be more expensive or time consuming than using an older event.

Nor would the import of an existing GM variety that was based on a more recent gene construct be any more expensive or time consuming that one based on an older technology. It is possible therefore that the rationale of bringing pressure to bear via Argentina's farmers to strengthen intellectual property rules and enforcement was a more significant reason for Monsanto's decision not to use its more recent vintage of GM events, or that other reasons also underlie that strategy.

We noted in Section 4 that Monsanto is not engaged in any current R&D, either alone or in conjunction with local S&T institutions, on transgenic cotton events that could be effective against the boll weevil. One option that might improve the chance of obtaining such a solution is for a co-operation agreement between INTA, who are actively conducting researching with such a product in mind, but would be unlikely to afford the commercialization costs, and Monsanto. Our interviewees provided somewhat mixed messages as to why such an agreement has not been forthcoming. We were told that Monsanto would not regard such an agreement as appropriate in a context where there has been a dispute over intellectual property with the Argentinean government.[xx] However, some INTA officials in turn suggested that Monsanto is monitoring INTA developments and may be keen to enter into an agreement in a later development phases, once it becomes clearer that a GM variety effective against the boll weevil is feasible. [xxi]

(b) A shift in strategy since 2009?

Since 2009 there appears to have been a shift in strategy. After Monsanto obtained biosafety approval for its stacked event in that year it commercialised two new cotton varieties, one in 2009 and another in 2011, based on that new event. Monsanto

officials pointed out, however, that the firm would not have introduced its stacked event in a commercial variety in 2009 were it not for the agreement, reached the previous year, aimed at formalising the informal seed multiplication and seed dealing activities of the cooperatives. As reported in La Nación, in February 2009 "According to [Monsanto] officials 'the release of the BR technology was possible thanks to the efforts of all actors in the cotton value chain who managed to create new rules that benefit the seed market and respect intellectual property'" (La Nación, 2009)

Moreover, by 2010 Monsanto had completed field trials in Argentina on a new cotton seed variety that may be released only one year after it was released in the US. The new seed has two Bt genes, and will also be tolerant to the herbicide glyphosate. It has been released commercially in Colombia, Mexico and the US, using American germplasm, but for the Argentinean and the Brazilian markets, the new stacked variety would probably be based on Brazilian germplasm.[xxii]

7. SUMMARY AND CONCLUSIONS: TECHNOLOGY UPGRADING DECISIONS AS BARGAINING TOOLS?

To recap, we have described how Monsanto entered the Argentinean cotton market by transferring an up-to-date technology - the Bt trait –which, in the absence of local adaptation was not particularly successful. The firm then consolidated its position by undertaking minor adaptation of a relatively new herbicide tolerant trait, and formed an agreement with INTA, which both enabled further joint research and local diffusion of the product. We suggested that this upgrading strategy lasted until the early 2000s after which conflicts over IPR and their enforcement, largely over soya, and the loss of the firm's patent over glyphosate, coincided with the firm beginning to argue that the

absence of satisfactory IPR would hinder further transfer and technology adaptation. Although that dispute, and the firms' argument that further technology transfer would depend on stronger IPR, has been primarily over soya, the lag in technology transfer in cotton events has increased, even though the effective market size for cotton had not changed in any significant way. The firms' recent events have either not been introduced commercially or only after they had been marketed elsewhere for a relatively long time. Furthermore, initial interest in research to control the boll weevil, which could have triggered some form of inventive adaptation, has not been forthcoming and new agreements with INTA to conduct joint R&D, or to access the institutions more recent germplasm have not occurred. This suggests that the shift in upgrading strategy, although prompted by the dispute over soya, may have been applied across all the firm's lines of business. The most recent GM cotton varieties were only introduced after progress had been made in limiting the size of the informal market in cotton seeds with an agreement with local government and actors in the cotton seed supply chain and after the soya dispute had dissipated.

Our account of technology transfer and adaptation has argued that Monsanto's decisions about which kinds of technology transfer and technology adaptation to pursue were not only made in response to a given set of economic opportunities and constraints. Rather the firm actively sought to alter those constraints, (in terms of the nature of IPR and their enforcement, of interest to the firm across its business activities), once it was established in the country, and has done so partly by withholding or delaying decisions to adapt or transfer technology as a currency to bargain for those resources.

Whilst the literature on technological upgrading has not explicitly documented such tactics, they are not inconsistent with the argument in that literature, that firms will

engage in transfer and adaptation in response to exogenous market and institutional incentives. However, our account provides a rather more political take on that economic argument, because it suggests that firms actively seek to alter those conditions rather than treat them as given. This is not unsurprising. Firms lobby and bargain for resources all the time; but the literature has not explored so far how the promise to transfer and adapt technologies may be used as a bargaining resource to obtain resources favourable to the MNE in its multi-product global lines of business.

Our claim that technology upgrading strategies –and thus the rate and direction of innovation within a host economy- may depend not only on given economic and institutional opportunities and constraints, but also on the outcome of political negotiations for resources relevant to a firm's entire multi-product business, has several potential implications. One important one is that governments in developing countries may have additional scope to promote the transfer of foreign technology and/or its adaptation to host country conditions. Rather than being confined to deciding whether or not to offer incentives to MNEs, in circumstances where, say potential market size is insufficient in itself to induce firms to bear the costs of transferring and or adapting a particular technology, governments might also be able to bargain with the MNE over its upgrading strategy for that technology by negotiating over resources of interest to the firm in all its lines of business. If the firm makes strategic decisions that apply across all its technologies, then governments might negotiate at that level too. In other words a new political arena is opened up for influencing firms' innovation decisions. In our example of cotton, the firm appeared to be deciding on its upgrading activities in light of its broader strategic, multi-product interests in the region. Moreover, since MNEs not only have a multi-product but also global logic to their innovation strategies, there is also scope for regional collaboration between governments in designing innovation

policies that focus on bargaining with MNEs over the kinds of technology transfer and adaptation activities that are undertaken. Such collaboration may be desirable because it increases the bargaining power available to government. For example, Argentina and Brazil could negotiate together to allow MNE seed firms access to the public sector resources provided by INTA and Brazilian EMBRAPA (in particular germplasm, expertise, and basic research) in exchange for investment by the firm in R&D in maize or whatever might, in itself, be insufficiently commercially attractive for the firm, but which would be of benefit to both countries. This kind of regional negotiation with MNEs is already practised but for non R&D resources (e.g. Argentina and Brazil have bargained with MNEs to ensure that the automobile industry in both countries is complementary rather than overlapping) and there is no reason why this kind of regional policy collaboration could be extended to innovation strategies too.

References

Almeida, P. & Phene, A., (2004). Subsidiaries and Knowledge Creation: The Influence of the Mnc and Host Country on Innovation, *Strategic Management Journal*, 25, 847-64.

Alston, J. M., Pardey, P. G. & Roseboom, J., (1998). Financing Agricultural Research: International Investment Patterns and Policy Perspectives, *World Development*, 26(6), 1057-71.

Ariffin, N. & Bell, M., (1999). Firms, Politics and Political Economy: Patterns of Subsidiary-Parent Linkages and Technological Capability-Building in Electronics TNC Subsidiaries in Malaysia, in K. S. Jomo, G. Felker & R. Rasiah (eds.), *Industrial Technology Development in Malaysia. Industry and Firms Studies*. New York: Routledge, 150-190.

Ariffin, N. & Figueiredo, P. N., (2006). Globalisation of Innovative Capabilities: Evidence from Local to Foreign Firms in the Electronics Industry in Malaysia and Brazil, *Science, Technology & Society*, 11(1), 191-227.

Arza, V., Fazio, M. E., Goldberg, L. & van Zwanenberg, P., (2010). Problemas De La Regulación En Semillas: El Caso Del Algodón Transgénico En El Chaco, *Desarrollo Económico*, 49(196), 605-28.

Asiedu, E. & Lien, D., (2004). Capital Controls and Foreign Direct Investment, *World Development*, 32(3), 479.

Asmussen, C. G., Pedersen, T. & Dhanaraj, C., (2009). Host-Country Environment and Subsidiary Competence: Extending the Diamond Network Model, *Journal of International Business Studies*, 40(1), 42-57.

Barrel, R. & Pain, N., (1998). Real Exchange Rates, Agglomerations, and Irreversibilities: Macroeconomic Policy and FDI in EMU, *Oxford Review of Economic Policy*, 14(3), 152-167.

Bartlett, C. & Ghoshal, S., (1986). Tap Your Subsidiaries for Global Reach, *Harvard Business Review*, 64(6), 87-94.

Bayer, J., Norton, G. & Falck Zepeda, J., (2010). Cost of Compliance with Biotech Regulation in the Philippines: Implications for Developing Countries, *AgBioForum*, 13(1), 53-62.

Bell, M., Arza, V., Giuliani, E. & Marín, A., (2008). The Evolving Role of Multinational Enterprises in Latin America and Caribbean Innovation Systems, A report for The International Development Research Centre of Canada (IDRC), 1-125.

Birkinshaw, J. & Hood, N., (2000). Characteristics of Foreign Subsidiaries and Industry Clusters, *Journal of International Business Studies*, 31(1), 141-54.

Boddewyn, J. J. & Brewer, T. L., (1994). International-Business Political Behavior: New Theoretical Directions, *Academy of management review*, 19(1), 119-43.

Boehe, D. M., (2007). Product Development in Mnc Subsidiaries: Local Linkages and Global Interdependencies, *Journal of International Management*, 13, 488-512.

Cantwell, J., Dunning, J. H. & Lundan, S. M., (2010). An Evolutionary Approach to Understanding International Business Activity: The Co-Evolution of Mnes and the Institutional Environment, *Journal of International Business Studies*, 41(4), 567-86.

Cantwell, J. & Mudambi, R., (2005). Mne Competence-Creating Subsidiary Mandates, *Strategic Management Journal*, 26(12), 1109-28.

Correa, C. M., (2006). La Disputa Sobre Soja Transgénica. Monsanto Vs. Argentina, *Le Monde Diplomatique/El Dipló,* Buenos Aires: Capital Intelectual Translated version available at http://www.biosafety-info.net/bioart.php?bid=474&ac=st.

Delios, A. & Henisz, W. J., (2003). Policy Uncertainty and the Sequence of Entry by Japanese Firms, 1980–1998. , *Journal of International Business Studies*, 34(3), 227-41.

Doh, J. P., Teegen, H. & Mudambi, R., (2004). Balancing Private and State Ownership in Emerging Markets' Telecommunications Infrastructure: Country, Industry, and Firm Influences, *Journal of International Business Studies*, 35(3), 233-50.

Dunning, J. H., (1993). *Multinational Enterprises and the Global Economy*, Addison-Wesley.

ECLAC, (2007). Foreign Investment in Latin America and the Caribbean, 2006, 1-195.

Evans, P., (1979). *Dependent Development: The Alliance of Multinational, State and Local Capital in Brazil*, Princeton, New Jersey.: Princeton University Press.

Grossi-de-Sa, M. F., De Magalhaes, M. Q., Silva, M. S., Margareth, S., Silva, B., Dias, S. C., Nakasu, E. Y. T., Brunetta, P. S. F., Oliveira, G. R. & de Oliveira Neto, O. B., (2007). Susceptibility of Anthonomus Grandis (Cotton Boll Weevil) and Spodoptera Frugiperda (Fall Armyworm) to a Cry1ia-Type Toxin from a Brazilian Bacillus Thuringiensis Strain, *Journal of Biochemistry and Molecular Biology*, 40(5), 773-82.

Ihrig, J., (2000). Multinationals' Response to Repatriation Restrictions, *Journal of Economic Dynamics & Control*, 24(9), 1345-1379.

International Cotton Advisory Committee, (2009). Biotech Cotton and the Technology Fee, *ICAC Recorder*, 27(1).

Katz, J. & Bercovich, A., (1993). National Systems of Innovation Supporting Technical Advance in Industry: The Case of Argentina, in Nelson (ed.), *National Innovation Systems: A Comparative Analysis*, Oxford: Oxford University Press.

Kuemmerle, W., (1999). The Drivers of Foreign Direct Investment into Research and Development: An Empirical Investigation, *Journal of International Business Studies*, 30(1), 1-24.

La Nación, (2003). "Se Cosecha La Siembra De Las Tecnologías", *La Nación*, Buenos Aires: 22/11/2003.

La Nación, (2004). La Bolsa Que Ahuyenta La Mejora Genética, *La Nación*, Buenos Aires: 24/01/2004.

La Nación, (2007). Monsanto Invierte En Brasil, *La Nación*, Buenos Aires: 08/09/2007.

La Nación, (2009). Un Futuro Para El Algodón, *La Nación*, Buenos Aires: 21/02/2009.

La Nación, (2011). La Argentina Pierde La Carrera Biotecnológica, *La Nación*, Buenos Aires: 11/06/2011.

Lall, S., (1982). Technological Learning in the Third World: Some Implications of Technology Exports. Chapter 8, in F. Stewart & J. James (ed.), *The Economics of New Technology in Developing Countries*, London: Frances Pinter.

Lanteri, A. a. A., Confalonieri, V. A. & Scataglini, M. A., (2003). El Picudo Del Algodonero En La Argentina: Principales Resultados E Implicancias De Los Estudios Moleculares, *Revista de la Sociedad Entomológica Argentina*, 62, 1-15.

Lecraw, D. J. & Morrison, A. J., (1991). Transnational Corporations-Host Country Relations: A Framework for Analysis, *South Carolina Essays in International Business*, 9, University of South Carolina: CIBER.

Maskus, K. E., (2000). Intellectual Property Rights and Foreign Direct Investment, CIES POLICY DISCUSSION PAPER, Adelaide, Australia: No. 22,

Meyer, K. E., (2001). Institutions, Transaction Costs, and Entry Mode Choice in Eastern Europe. , *Journal of International Business Studies*, 32(2), 357-67.

Meyer, K. E., (2004). Perspectives on Multinational Enterprises in Emerging Economies, *Journal of International Business Studies*, 35(4), 259-76.

Meyer, K. E., Mudambi, R. & Narula, R., (2011). Multinational Enterprises and Local Contexts: The Opportunities and Challenges of Multiple Embeddedness, *Journal of Management Studies*, 48(2), 235-52.

Meyer, K. E. & Nguyen, H. V., (2005). Foreign Investment Strategies and Sub-National Institutions in Emerging Markets: Evidence from Vietnam. , *Journal of Management Studies*, 42(1), 63-93.

Mira, C., (2003). Un Límite Al Crecimiento, *La Nación*, Buenos Aires: 08/11/2003.

Naghavi, A., (2007). Strategic Intellectual Property Rights Policy and North-South Technology Transfer, *Review of World Economics*, 143(1), 55.

Nicholson, M. W., (2007). The Impact of Industry Characteristics and Ipr Policy on Foreign Direct Investment, *Review of World Economics*, 143(1), 27.

O'Donnell, S., (2011). El Santo Preferido De La Embajada, *Página |12*, Buenos Aires: http://www.pagina12.com.ar/diario/elpais/1-163369-2011-03-03.html.

Pardey, P. G. & Pingali, P., (2010). Reassessing International Agricultural Research for Food and Agriculture, Report prepared for the Global Conference on Agricultural Research for Development (GCARD), Montpellier, France, 28-31 March.

Pearce, R. D., (1999). Decentralised R&D and Strategic Competitiveness: Globalised Approaches to Generation and Use of Technology in Multinational Enterprises (Mnes). , *Research Policy*, 28, 157-78.

Pingali, P. L. & Traxler, G., (2002). Changing Locus of Agricultural Research: Will the Poor Benefit from Biotechnology and Privatization Trends?, *Food Policy*, 27(3), 223-38.

Pinstrup-Andersen, P. & Cohen, M., (2000). Modern Biotechnology for Food and Agriculture: Risks and Opportunities for the Poor, in G. J. Persley & M. M. Lantin (ed.), *Agricultural Biotechnology and the Poor*, Washington DC, USA: Consultative Group on International Agricultural Research.

Polak, M., (2011). *Guía Para La Lucha Contra El Picudo Algodonero*, Buenos Aires: Fundación de Lucha contra el Picudo del Algodonero (FULCPA).

Pray, C. E. & Naseem, A., (2007). Supplying Crop Biotechnology to the Poor: Opportunities and Constraints, *Journal of Development Studies*, 43(1), 192-217.

Pray, C. E. & Umali-Deininger, D., (1998). The Private Sector in Agricultural Research Systems: Will It Fill the Gap?, *World Development*, 26(6), 1127-48.

Qaim, M. & de Janvry, A., (2003). Genetically Modified Crops, Corporate Pricing Strategies, and Farmers' Adoption: The Case of Bt Cotton in Argentina, *American Journal of Agricultural Economics*, 85(4), 814-28.

Qaim, M. & Traxler, G., (2005). Roundup Ready Soybeans in Argentina: Farm Level and Aggregate Welfare Effects, *Agricultural Economics*, 32(1), 73-86.

Ramamurti, R., (2005). Global Regulatory Convergence: The Case of Intellectual Property Rights, in R. Grosse (ed.), *International Business and Government Relations in the 21st Century*, Cambridge: Cambridge University Press.

Rugman, A., Verbeke, A. & Yuan, W., (2011). Re-Conceptualizing Bartlett and Ghoshal's Classification of National Subsidiary Roles in the Multinational Enterprise, *Journal of Management Studies*, 48(2), 253-77.

Rugman, A. M., (1981). *Inside the Multinationals: The Economics of Internal Markets*, New York: Columbia University Press.

Sargent, J. & Matthews, L., (2006). The Drivers of Evolution/Upgrading in Mexico's Maquiladoras: How Important Is Subsidiary Initiative?, *Journal of World Business*, 41(3), 233-46.

Shimizutani, S. & Todo, Y., (2008). What Determines Overseas R&D Activities? The Case of Japanese Multinational Firms, *Research Policy*, 37, 530-44.

Simango, C. C. B., (1993). Strategic Locational Factors Influencing Foreign Investment, *European Business Review*, 93(4), 12-18.

Smith, T., (2004). Argentine Soy Exports Are up, but Monsanto Is Not Amused, *2004 January 21st, New York Times*,

Tacla, C. L. & Figueiredo, P. N., (2006). The Dynamics of Technological Learning inside the Latecomer Firm: Evidence from the Capital Goods Industry in Brazil, *International Journal of Technology Management*, 36(1-3), 62-90.

Taylor, C. T., (2000). The Impact of Host Country Government Policy on Us Multinational Investment Decisions, *The World Economy*, 23(5), 635.

Traxler, G., (1999). Assessing the Prospects for the Transfer of Genetically Modified Crop Varieties to Developing Countries, *AgBioForum*, 2(3&4), 198-202.

Traxler, G., (2006). The Gmo Experience in North and South America, *International Journal of Technology and Globalisation*, 2(1), 46-64.

Trigo, E. & Cap, E., (2006). Diez Años De Cultivos Genéticamente Modificados En La Agricultura Argentina, Buenos Aires: Argenbio.

UNCTAD, (2005). *World Investment Report 2005: Transnational Corporations and the Internationalization of R&D*, United Nations.

USDA, (2010). Argentina Biotechnology - GE Plants and Animals, *2010 Biotechnology Report*, Global Agricultural Information Network, USDA Foreign Agricultural Services.

Van Tulder, R. & Kolk, A., (2001). Multinationality and Corporate Ethics: Codes of Conduct in the Sporting Goods Industry, *Journal of International Business Studies*, 267-83.

Velho, L., (2004). Science and Technology in Latin America and the Caribbean: An Overview, Maastricht: UNU-MERIT.

Yin, X., (1999). Foreign Direct Investment and Industry Structure, *Journal of Economic Studies*, 26(1), 38-57.

TABLES

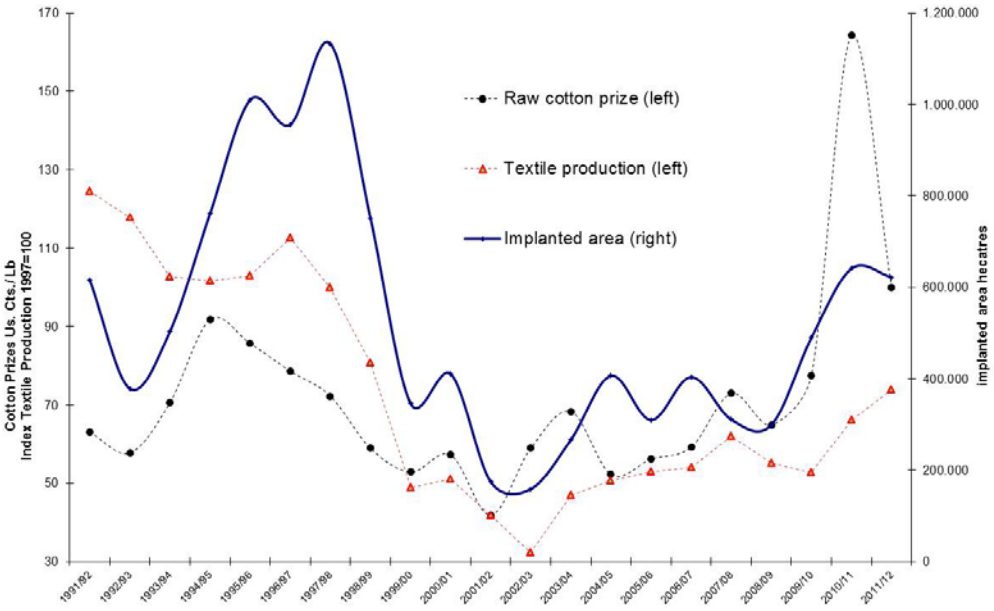
Table 1: Technology transfer and adaptation in GM cotton by Monsanto in Argentina, 1998-2012

Year	Technology Transfer (TT)				Technology Adaptation (TA)	
	GM events authorised commercially by CONABIA	**Event novelty**	**Seed varieties registered in INASE**		**Type of adaptation**	**Local Germplasm**
	name	release year in the US	brand name	vulgar name	None / Minor / Inventive	name / breeder / registered year
1998	MON 531	1996	NUCOTN 33 B	Bt cotton	None	
2000			DP 50B	Bt cotton	None	
2001	MON 1445	1997	Guazuncho 2000	RR cotton	Minor	Guazuncho 2 / INTA / 1989
2003			DP 404 BG	Bt cotton	None	
			DP 428 B	Bt cotton	None	
2004			DP 447 BG	Bt cotton	None	
2007			DP 604 BG	Bt cotton	None	
2009	MON 531 + 1445	1997	DP 402 BG RR	BR cotton	Minor	Chaco 520 / INTA / 1996
			NUOPAL RR	BR cotton	None	

Source: Own elaboration based, mainly, on data by the National Commission for Bio-safety (CONABIA) for commercial authorisation of GM events, the National Seed Institute (INASE), for seed registration, and the Official Bulletin published by the Argentinean Government.

FIGURES

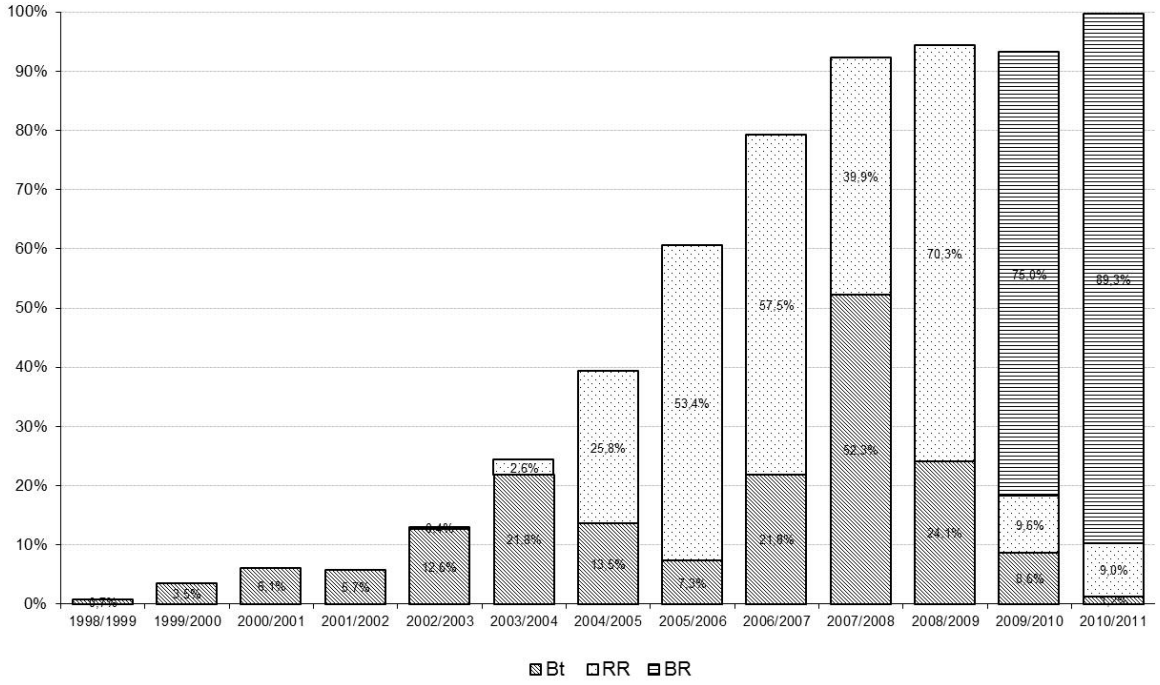
Figure 1: Textile production and cotton international price and area sown, Argentina 1991-2012



Source: Own elaboration based on *Cotlook Index "A" (http://www.cotlook.com/)* for the price index (the international source most widely used for the cotton fibre export market); the Centre of Studies of Production, of the Ministry of Economy, for the textile production index and the Integrated Agricultural Information System (SIIA) of the Ministry of Agriculture, for the area sown to cotton.

Figure 2: Evolution of the area cultivated with GM Cotton in Argentina

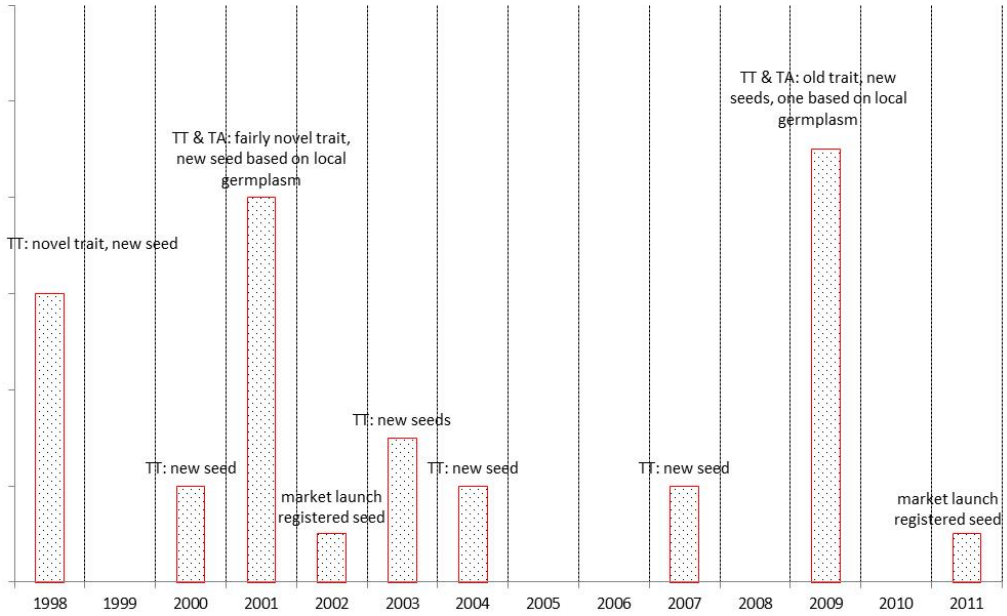
(Share of hectares cultivated with cotton)



Note: Bt: insect resistant variety; RR: herbicide tolerant variety; BR: a variety that is both insect resistant and herbicide tolerant

Source: Own elaboration based on data from *Argenbio* and Ministry of Agriculture

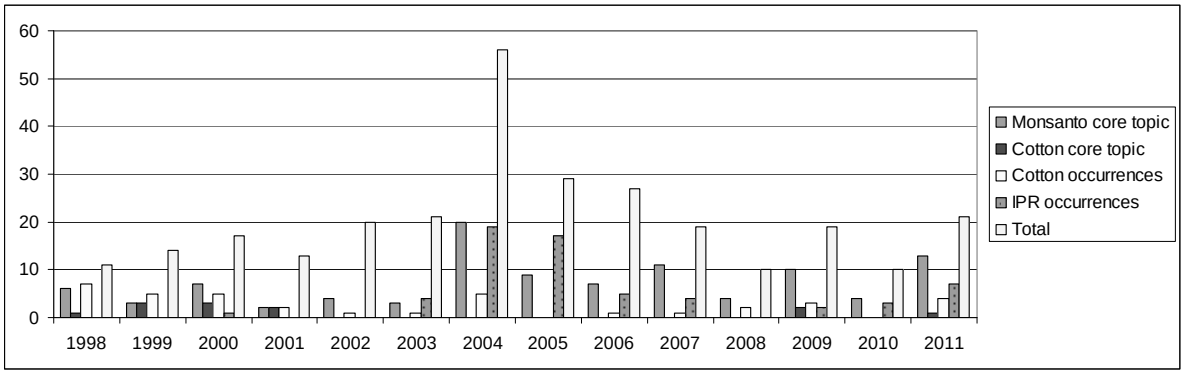
Figure 3: Extent of technological upgrading (TT: technology transfer and TA: technology adaptation), in GM cotton by Monsanto; 1998-2012



Note: the scale was arbitrarily defined by the authors based on the conceptual discussion on technological upgrading: it assigns a value of 2 for approval of new traits, 2 extra if those traits were novel for the world (i.e. MON 531), 1 extra if it was moderately novel for the world (i.e. MON 1445), 1 for registration of every new seed, 1 extra when the seed was commercialized in the country and 4 extra if the seed was developed from local varieties

Source: Own elaboration based on Table 1

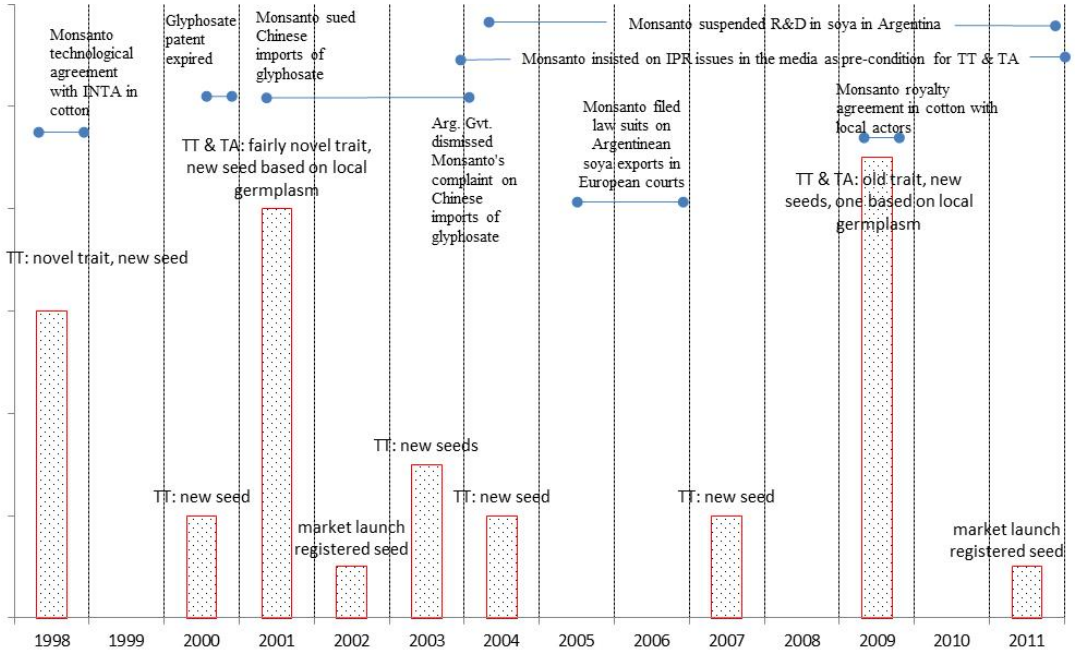
Figure 4: Media articles that mentioned Monsanto in the rural Section of *La Nación*, 1998-2011.



Note: For "core topic" we mean when the articles' main topic was on that particular issue (e.g. Monsanto, cotton, IPR, etc.), normally also referred to that in the title or the subtitle. In contrast, "occurrences" count articles with references to those words or issues in whatever context they were mentioned –except for those articles that were disregarded for being unrelated to our area of study as mentioned in endnote xix.

Source: Own elaboration base on *La Nación* website.

Figure 5: Extent of technological upgrading in GM cotton and political bargaining by Monsanto; 1998-2012



Source: Re-elaboration of Figure 3 adding data on political bargaining mainly built from information published in La Nación, the Official Bulletin, and cables filtered published by O'Donnel (2011)

[i] Despite this trend, in low and middle income economies the private sector's share of agricultural R&D expenditure remains relatively small. Data from the mid 1990s indicated that the private sector accounted for between 10% and 15% of agricultural R&D in developing countries (as compared to about 50% in the OECD countries), much of which is likely to be focused on food processing and post-harvest innovation rather than farm-level technologies (Alston, Pardey & Roseboom, 1998) Data from 2000 indicate that for agricultural and food R&D, private firms accounted for just over 6 percent of the total spend in low and middle income countries, again as compared to about 50% in high income economies (Pardey & Pingali, 2010).

[ii]Interestingly, however, the public sector in developing countries is responsible for the bulk of basic research in genetic engineering (albeit at relatively small absolute levels), in clear contrast to the

industrialised world where both basic and applied R&D are dominated by the private sector, and where the bulk of the initial creation of the technology takes place (Pray & Naseem, 2007).

[iii] For example, the crops grown by, and production constraints of, poor farmers are unlikely to be reflected in adaptation efforts driven by the private sector (Pinstrup-Andersen & Cohen, 2000). And if upgrading comprises the import of foreign germplasm, as opposed to the adaptation of local germplasm, this may involve longer-run shifts in agro-biodiversity.

[iv] The authors suggest that GM cotton would not have been introduced into the relatively small markets of Mexico and South Africa, except for the fact that varieties developed for the US market performed sufficiently well in those temperate climates that the foreign varieties could be directly imported without the firm incurring any R&D costs (ibid., p. 233).

[v] For example, as a matter of model design, the econometric analyses of Asiedu & Lien, Taylor, and Nicholson assume that causation runs only from institutional context to firms' decisions. Likewise, Ihrig performed a theoretical simulation analysis that sought to model how one aspect of context (repatriation restrictions) influences capital investment in, and technology transfer to, its subsidiary. Naghavi provided a theoretical discussion of how IPR in developing countries is made strategically to influence MNEs decisions on location and innovation. In short all such discussions of upgrading examined the ways in which MNE's would react to exogenously defined institutional rules.

[vi] These arguments can be found in the international business literature regarding the global organisation by MNEs (e.g. Ariffin & Figueiredo, 2006; Bartlett & Ghoshal, 1986; Birkinshaw & Hood, 2000; Rugman, Verbeke & Yuan, 2011; Tacla & Figueiredo, 2006) and more specifically in the literature that deals with decentralization of research and development (Almeida & Phene, 2004; Kuemmerle, 1999; Pearce, 1999; Sargent & Matthews, 2006; Shimizutani & Todo, 2008).

[vii] These include for example, achieving coherency and transparency in policy making, developing institutions that are favourable to increases in productivity, strengthening intellectual property regimes, and making investments in infrastructure for human resource formation and S&T research. The report suggested that some more selective policies, such as investment promotion and performance requirements may also be useful, as long as they reflect a country's comparative advantages.

[viii]In a report analysing the relations between MNEs activities and innovation systems in developing countries, Bell et al (2008) suggested that policy analysis in that area should go beyond the disciplinary

boundaries of economics and business to the insights and methodologies of political science and sociology.

[ix] Nevertheless in his seminal work Dunning (1993) hinted –but did not provide empirical evidence - that the promise of R&D activities conducted by subsidiaries may serve as tool to renegotiate the terms of location agreements between host governments and MNE headquarters (e.g. regarding local content, subsidies for infrastructure development, and so on.)

[x] The last of these private agreements is a requirement for making available its latest technology in soya (Intacta RR2 Pro). The agreement requires farmers to resign their legal rights to save seeds.

[xi] Data from Integrated System of Agricultural Information produced by the Ministry of Agriculture of Argentina, http://www.siia.gov.ar/.Last accessed February 2013.

[xii] The information correspond to the National Census on Agriculture 2002 (National Institute of Statistics and Census, INDEC), and it is the last information available on cotton production by farm size.

[xiii]Interview with a multinational seed industry representative.

[xiv] The boll weevil is a specific pest in the Americas, which feeds on the cotton bolls, preventing flowering. It was found for the first time in Argentina in 1993, in Misiones on the border with Paraguay. Ten years later, the insect reached the cotton growing area of Chaco (Lanteri, Confalonieri & Scataglini, 2003). Some studies suggest that the spread of the pest maybe associated with reduced spraying that occurred as a result of Bt and BR cotton (Grossi-de-Sa et al., 2007; International Cotton Advisory Committee, 2009). The boll weevil has become one of the key problems that explain a fall in yields, especially for small farmers who cannot afford the cost of its control. The loss in yields from the boll weevil is estimated to be as high as 50% if left unchecked (Polak, 2011). This has become a severe problem because the pest is very destructive, it lacks natural enemies and it is not controlled by the toxin produced by the Bt and stacked events (BR) that have been commercialised.

[xv] Interview with a multinational seed industry representative.

[xvi] Interviews with a multinational seed industry representative and an INTA official.

[xvii] Since the mid 2000s soya has represented over half of all Argentina's agricultural production. Source: Integrated System of Agricultural Information produced by the Ministry of Agriculture of Argentina, http://www.siia.gov.ar/. Last accessed August 2012.

[xviii] Cables filtered in wikileaks showed that the American Government pressured the Argentinean Government on behalf of Monsanto. In one of those meeting in February 2006 the Argentinean Foreign Minister told an American congressional delegation headed by the powerful chairman of the Finance Committee, Charles Grassley, that Monsanto became interested in those royalties only once the patent on glyphosate expired (O'Donnell, 2011).

[xix] Methodological note: we searched for the word 'Monsanto' which turned up in 387 articles published between January 1998 and September 2011. However many of the articles were unrelated to relevant information for this study. For example, some articles mentioned Monsanto as sponsor of an event, or as firm recruiting personnel, or participating in a Congress among many others, etc. For the analysis we keep articles whose main topic was on issues related either to biotechnology or agriculture.

[xx] Interview with INTA officials and a multinational seed industry representative. However, in a second interview with the firm which took place when the disputes had dissipated and after the interviewees had read some of our preliminary findings, they said that onus was on INTA to request a cooperation agreement, and that in principle Monsanto would be willing to participate in the development of such a variety.

[xxi] Interview with INTA officials.

[xxii] Interview with a multinational seed industry representative.