The Regulation of Genetically Modified Organisms in Latin America:

Policy Implications for Trade, Biosafety, and Development

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Abstract

This study examines how Latin American countries' policies toward Genetically Modified Organisms (GMOs) affect trade. It examines intellectual property rights, biosafety regulations, trade restrictions, food labeling regimes, and trends in public agricultural research investment. We use data from the UN Comtrade database to analyze trade patterns. The aim is to extrapolate future trends that may arise as the GM Revolution continues. Results include an examination of how Brazil's GM exports are shifting from Europe to China, as well as analysis of how Argentina's GMO adoption forced GM products upon neighboring states. Furthermore, we find that developing nations often use IPR limitations as an opportunity to borrow technologies in the face of limited innovation capacity, but that these IPR limitations may not dissuade foreign investors as traditionally thought. Finally, using the Balassa Index, we find that Latin America possesses a strong Revealed Comparative Advantage in GM crops compared to the world.

1. Introduction

The first genetically modified (GM) crops (including potato, soybean, cotton, and canola), commercialized in the United States between 1995 and 1996, soon caught on in Canada and Argentina as well. The benefits of these crops included reduced herbicide and pesticide use, drought and insect resistance, and higher yields across the board, yet they nevertheless failed to take hold outside of these highly developed agricultural economies. European Union (EU) countries that had initially embraced these innovative GM crops soon turned against them (Paarlberg 2001).

One partial explanation for this European rejection of GMOs is the Mad Cow Disease crisis of the 1980's and early 90's (Woods 2011). While obviously not the entire cause, the crisis is an illustrative example of what has made European public opinion so sensitive to GM products. Bovine Spongiform Encephalopathy (Mad Cow Disease) first emerged in Britain in the 1980's. An obscure neurological condition caused by including material from affected cows in cattle feed, it spread quickly, triggering the culling of millions of cows. Despite the severity of the outbreak, however, the Ministry of Agriculture, Forests, and Fisheries (MAFF) assured the public that Mad Cow Disease presented no risks to human health, acknowledging only much later, in 1996, that the disease caused Creutzfeldt-Jakob disease in humans. This event destroyed public confidence in food safety, and, of more profound import, damaged public trust of scientific pronouncements (Woods 2011). The lack of transparency shown by the MAFF and their prioritizing of farmers' interests over public health created an environment of mistrust which, during the subsequent advent of GM foods, caused public advocacy groups and consumers to reject scientific pronouncements of "substantive equality" between GM and non-GM foods (Paarlberg 2001). GM import bans arose, as well as complex regulations on the production and sale of GM products (Friant-Perrot 2010).

Europe's reorientation away from the GM agricultural revolution dichotomized global markets. Private GM innovators such as the multinational giant, Monsanto, had directed most GM research toward crops intended for large scale monoculture cultivation in technologically developed settings. Nevertheless, many developing countries, dependent as they were on raw agricultural exports, seemed to have much to gain from GMO adoption (Paarlberg 2001). Europe changed the calculus. Many developing countries had a history of exporting to either the United States or the EU, and thus risked incurring competitive losses in exports if they continued exporting conventional crops to US, or the loss of their entire European market if they followed the United States' path. In addition, many developing countries faced the technical challenges associated with regulating GMOs. Europe often required biosafety and traceability regimes which were beyond developing countries' means to implement, thus requiring an either-or decision to fully adopt or completely ban the new crop technologies (Falck-Zepeda 2009).

Today, the GM crop revolution has enveloped many developing countries as well, but the challenges surrounding genetic products have not resolved themselves. In contrast to the previous Green Revolution, which was carried out largely by public research institutions, the GM revolution is largely private (Paarlberg 2001, Stads, Beintema 2009). The difference lies in the technical requirements of the technology. While the strong network of National Agricultural Research Institutes (NARIs) in developing countries around the world could innovate in the 1970-80's using conventional plant breeding techniques, GM innovation today requires advanced laboratories, highly skilled staff, and well-constructed regulatory systems. Thus, only a handful of these once innovative NARIs can now compete with multinational corporations in the creation of new GM crop products. Most remain focused on adapting already patented foreign GMOs to local conditions through conventional breeding techniques (Falck-Zepeda 2009).

Growth in developing country agricultural research spending continues to rise, but at a much slower rate than during the Green Revolution, and not quickly enough to establish substantive domestic GM innovations (Stads, Beintema 2009). The result of this shift from public to private agricultural innovation is a rising system of Intellectual Property Rights (IPRs) in agriculture, where multinational corporations own the rights to nearly all GM crops grown in developing countries. Increasingly strong international IPR norms have arisen since the onset of the GM revolution in the mid-nineties, including the Trade Related Intellectual Property Rights Agreement (TRIPS) of the World Trade Organization, which imposes the United States' IPR norms on all WTO signatories, allowing only brief waivers for less developed nations. With regard to GM crops, the International Union for the Protection of New Varieties of Plants agreement (UPOV), establishes norms of licensing and Plant Breeders Rights (PBRs) intended to protect producers' IPRs and ensure the collection of royalties on all licensed products (Helfer 2004). These two agreements give multinational corporations unparalleled access to local markets within developing countries, as well as the legal clout to extract royalties.

While private innovation is highly efficient and effective in developing new GM technologies, the problem for developing countries lies in where multinationals place the emphasis of this innovation (Paarlberg 2001). Green Revolution technologies were directed primarily at poor small-hold farmers, while new GM technologies focus on large-scale, advanced monoculture agriculture. This explains why Argentina was quick to embrace GMOs, and also why many other developed countries have hesitated in their adoption (Silva Gilli 2010).

Within this context of reorientation, privatization, and expansion, Latin America emerges as a striking case, in both the scale of its adoption, and in the diversity of its approaches. Of the 29 countries which had approved GM crops in 2011, 10 were in Latin America, and half of all developing country GMO-adopters are Latin American. 37% of global GM crop hectarage lies in the region–a total of 59.3 million hectares in 2011. Furthermore, of the 12 million hectares of GM crops added globally in 2011, 7.05 million, or 59%, were added in Latin America. Most of this growth comes from Brazil and Argentina, the second and third largest GMO producers in the world, respectively. Brazil alone accounts for 19% of global GM crop hectarage (calculated from James 2012).

Latin America's history as an exporter of primary agricultural products explains part of this: many countries in this region host agricultural ecosystems similar to the North American ecosystems for which GMOs were originally invented. They also grow many of the same types of crops–soy, maize, and canola (Duncan, Rutledge 2009). Another piece of the explanation may lie with Argentina's early and fervent adoption of GMOs. Strong evidence exists that illegal and unregulated GM seeds crossed Argentine borders with Uruguay, Paraguay, and Brazil, spreading throughout these nations' agroeconomies and effectively forcing their governments to acknowledge a GM reality through appropriate policy changes (Silva Gilli 2010, Ettinger 2011, Gaisford, Kerr 2004). Given its vast agricultural potential, Brazil would undoubtedly have adopted GMOs eventually, but the decision was preempted by the illegal smuggling of GM seeds from Argentina. This situation illustrates again a fundamental difficulty faced by developing countries in general, and Latin American countries specifically: the regulation and tracking of GM products requires a very high level of technical competency and organization, something lacking in nations such as Paraguay, Bolivia, Colombia, Uruguay, and elsewhere (Falck-Zepeda 2009).

In short, treatment of GMOs in Latin America will be predictive for the rest of the world. As more and more developing countries begin to contemplate these newly dawning technologies, the templates for adoption that they will follow are already forming in South and Central America. With its high rate of adoption and diverse policy approaches, the Latin American region can provide analysts, governments, and multinational businesses with a window into the future of the GM Revolution.

Given this motivation, this paper will seek to answer these questions:

- Will a divided global regulatory environment dichotomize developing nations in regard to GMO regulation; that is, force them to take either the EU or US approach, or will these nations construct newly imagined/negotiated middle roads between developed-world extremes?
- How will countries with both enormous GMO potential and significant numbers of subsistence farmers balance IPR concessions to multinational corporations with local interests and traditional knowledge, and can they construct policies that benefit all groups?
- How will Latin American countries' agricultural exports change as they evolve into a new GM reality?

1.1 Contribution

Given the region's global dominance in GMO production and its complex policy environments, the literature on genetically modified organisms in Latin American is extensive. Countless studies have examined individual countries' policies or have analyzed individual policy traits like biosafety or IPR across countries. Other studies have examined trade issues relating to GMO adoption. However, no work has compiled the relevant information for all relevant policy areas for the majority of GMO approving countries in the region, as this study has. Detailed data on IPR, Biosafety regulations, trade policies, food labeling requirements, and public research investment are given for each country, as well as extensive supporting tables containing the data necessary to get a handle on such a broad issue. Furthermore, few policy analysis studies link their findings about laws, decrees, or treaty compliance with trade data to examine and illuminate correlations between trade and policy evolution. This study accomplished this by examining trade in GM crops across all GMO approving countries, with a special section on how dramatic alterations in Brazil's agricultural trade have accompanied its recent GMO adoption. In addition, this study examines Latin American countries' Revealed Comparative Advantages (using a calculated Balassa Index) in the light of GM adoption and cultivation at a region-wide level.

1.2 Organization

This study will begin with an in-depth policy analysis of key countries in Latin America. Ten Latin American nations that have approved GMOs as of 2011: Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Honduras, Mexico, Paraguay, and Uruguay (James 2012). As Honduras produces only 0.001% of global biotech crop hectarage, saw no growth in GMO cultivation in 2010, and has only a handful of trial plots as its active growth, it has been excluded from this study (James 2012). MERCOSUR countries (Argentina, Brazil, Paraguay, and Uruguay) produce 98.7% of Latin America's GMO crops, but they are not the only influential players on the GMO stage. Chile provides 1/5 of the world's supply of GMO seed through a curious policy which allows GMO production while banning consumption, and the controversy over transgene escape and biodiversity in Mexico promises to define much of the GM Revolution to come. Thus, while MERCOSUR dominates GM production in Latin America, Chile and Mexico have been included as well.

The structure of the policy analysis was inspired by Robert Paarlberg's 2001 work, *The Politics of Precaution*, published for the International Food Policy Research Institute (IFPRI) by Johns Hopkins Press. In **Figure 1**, taken from this work, Paarlberg lays out a categorization of policy areas relevant to GMO regulation: IPR, biosafety, trade, food safety and consumer choice, and public research investment. Within each of these areas, he rates a country's policy on a scale from "preventive of GMOs" to "promotional of GMOs." While I have altered and adapted Paarlberg's chart to what, upon analysis, proves to be an ever contradictory, ever evolving reality, I have followed his basic categorizations for my policy briefs.

Following the policy section, I analyze trade in Latin America, using Balassa Indices to find Revealed Comparative Advantage, and UN Comtrade Data of agricultural exports to analyze inter-country trade interactions. In this section I again give country-specific analyses of trade, focusing on GMO relevant issues.

Next, I adapt Robert Paarlberg's table categorizing GMO policies to the current Latin American context. I illustrate each country's situation with a detailed table.

The following section draws analytic ties between Latin American policies toward GMOs and these countries' trade, searching for correlations. This section will attempt to build foundations from which answers to the questions posed above can be constructed.

Finally, a conclusion will seek answers to the above questions on where the GM revolution is going in Latin America.

Appendices will explain data and methods, as well as give important charts and, especially, key tables which researches will find very helpful in examining this issue. Refer to appendix 6.1 for summaries of case-study countries using Robert Paarlberg's table approach.

2. GMO Policies by Country

2.1 Chile

Chile as a whole is oriented toward agricultural exports, and nearly all of these are directed out of the region. As an illustration, its largest Latin American trading partner, Brazil, received only 6% of total exports in 2011; 100% of its rape or colza seed production, 99.16% of its unmilled maize, and 99.97% of its soya beans left Latin America (UN Comtrade). Notably, Chile is the world's fifth largest seed exporter, with a 2011 seed export value of US$370 million (James 2012). In 2011 Chile exported approximately US$200 million in non-meat agricultural products, excluding maize seed, while maize seed exports alone contributed another US$167 million, giving Chile a strong revealed comparative advantage in maize seed production (Balassa index = 7.22, r = World) (UN Comtrade).*

Multinationals grow seed in Chile because its southern hemisphere location and phytosanitary isolation–between the Atlantic and the Andes–offer a "counter season" for Northern Hemisphere agricultural producers, which can use Chile as a seed production and testing ground during their winter (Seed association of the Americas 2009). The multinational agribusinesses that have been drawn to Chile for this reason face a relatively deregulated market for export agriculture, but cannot grow GM products for domestic consumption within Chile–the first GM regulation on the books in Chile appeared in 1993, when the Ministry of Agriculture's Animal and Livestock Service (SAG by its initials in Spanish) limited GM cultivation to "export destinations only," warily observing that "GM seeds pose a risk to agriculture." However, as GM seed cultivation has gained a foothold and economic clout within the country, new regulations softened the language used in reference to GMOs. For example, a 2001 reworking of the 1993 regulation maintained the export-only stipulation but also pointed out the "potential benefits" of GM agriculture (Salazar 2011)

The majority of seed exports go to China, which receives 25% of Chile's total exports, and the USA, with which Chile has disproportionately strong ties in the agriculture sector. Compared to the 9% of total Chilean exports that reach the United States, 22.8% of non-meat agricultural exports go to the USA (UN Comtrade). An unreported proportion of these crop exports are GM, although 2011 saw a 150% increase in total GM crop hectarage from 2009 levels, indicating increasing levels of GM exports (James 2012).

First adoption of GMOs in Chile dates back to 1992. Adoption was negligible until 2000 when the first crops were commercialized for seed export, and cultivation only began to grow significantly after around 2004. The main crops are soy and maize, with maize dominating at 90% of production (Salazar 2011). In 2010 the Minister of Agriculture, Jose Antonio Galilea, began a push to permit the cultivation of GM crops for domestic consumption, arguing that farmers need GM technologies to compete in a global marketplace (Burgoine 2010). Others argue that Chile's reputation as a "pura vida" all natural fruit producer could be jeopardized by GMOs (Ramiraz 2010). Nevertheless, GMs are still only approved in BT Maize and HT soybean, with small scale trial plots of canola (currently 3,500 hectares) (James 2012).

Opposition movements against GMO's in Chile have been highly vocal but have only recently attracted any broad based support. This anti-GM support, spearheaded by organizations such as "Yo no quiero transgenicos, (I don't want transgenics)" (PiensaChile, 2011) and the introduction of a new Transparency Law in 2009 which allows public access to details about GMO cultivation, may have dampened support for new GMO event approvals, as indicated in the decline in GM hectarage between 2008-11) (Ramirez 2010). These resistance movements culminated in 2011 when they took the Chilean Senate's approval of the 1991 UPOV Treaty to the nation's Supreme Court (Salazar 2011). Nevertheless, resistance groups do not seem to be crippling GM cultivation, given the 150% increase in hectarage from 2009 to 2011.

*Refer to section 3.1 for explanation of Revealed Comparative Advantage and the Balassa Index

2.1a Intellectual Property Rights

Walter G. Park, in his global index of national intellectual property protections (see Materials and Methods) gave Chile a rating of 4.28. This is the highest of any Latin American country and is well above both the developing nations' mean of 3.27 and the world mean of 3.34 (Park, 2005). Additionally, as this index was compiled in 2005, Chile's accession to the 1991 UPOV Agreement, approved by the Senate in 2011, would only strengthen this measure. Plants are not patentable under Law 19.039 of Industrial Property (amended in 2007 by Act 19.996), which defends the "essentially biological nature" of organisms and their subsequent exclusion from the originality of invention usually used as a benchmark of patentability (Salazar 2009). Furthermore, gene patentability remains an unresolved issue within the IPR patentability framework (Falck-Zepeda et. al 2009). As a member of the WTO and the TRIPs agreement, Chile uses the *sui generis* option granted in Article 27.3(b) of TRIPs to employ what had been until 2011 the UPOV78 agreement, and which is now the more protective UPOV91 agreement. A general cross-country survey suggests that patentability, which remains the only non-promotional aspect of Chile's IPR protection, is largely a non-decisive issue in multinationals' GM in-country cultivation and investment decisions (see Mexico brief, Leger 2005).

2.1b Biosafety

As mentioned earlier, Minister of Agriculture Jose Antonio Galilea has begun a sustained push to bring GM crop production home by allowing domestic consumption. In reality many foods consumed in Chile already contain GM derivatives, but these are imported products, largely from Brazil (Salazar 2011). The (acknowledged) introduction of GM foods for consumption would require compliance with the International Codex Alimentarius (which encourages universal labeling and food safety norms) as well as nominal compliance with the Cartagena Protocol on Biosafety, which it has signed but never ratified (Falck-Zepeda 2009). Given that production of GMOs for domestic consumption is forbidden by regulations renewed in 2001and that imported GM food volumes appear low, GM food products have so far fallen under the broader category of Phytosanitary protocols which govern seed production as well (Salazar 2009). Under the Decree of the General Phytosanitary 3557, importers or producers are required to submit a description of "botanical, agronomic, and molecular components" of their target crop to the Advisory Committee for the Release of Transgenics (CALT) (Salazar 2009). Importers, exporters, or producers must also register any GM crop approval with the Ministry of Health (USDA GAIN report 2011). Physical environmental protections of GM crops are established in Resolution 1523 of 2001, which establishes a traceability regime for biotech crop plantings, as well as requirements for "physical isolation of sexually compatible species and post-harvest management (USDA GAIN 2011)." Overall, biosafety regulations appear well established in Chile with regard to production of GM crops or seeds for export, but given the lack of development and very recent appearance of GM food appearing openly in Chile, the regulations on food safety seem more limited since they continue to fall under more general phytosanitary production codes.

2.1c Food Safety and Consumer Choice

In January of 2000, the Ministry of Health decreed that all GMO introductions should be reviewed and approved on a case by case basis (Salazar 2009). This departs greatly from the United States tradition of assumed-safety given substantive equivalence, and from the European Union's invocation of the Precautionary Principle (see Sidebar 1). While either of these approaches may be adopted in the examination of each case, the avoidance of any absolute Food Safety principle highlights Chile's continuing middle way.

GM products are allowed into the country as imports for consumption, and no organized regulatory regime or labeling requirement exists to regulate this (Ramiraz 2010). While GM crops are prohibited from children's foods as of 2003, and the Law of Consumers Rights requires compulsory labeling, neither of these measures has been followed through, largely because the requirements have not been applied to GMO containing foods. Thus, according to Maite Salazar Lopez, professor at la Escuela de Biotecnología, Universidad Santo Tomás, "Currently, there are no labeling requirements for GM foods or foods containing GM ingredients, either imported or produced locally (2009)." A resolution passed in 2007 initiated the establishment of an "approved list" for GM foods, but no GM foods have yet been approved for domestic consumption, indicating a further gap between reality and regulation. This area falls under SAG's ambit even though SAG overseas Animals and Livestock within the Ministry of Agriculture, making this a clearly ad hoc regulatory arrangement. While oversight of crops is efficient, well documented, and orderly, regulation of GM foods in the country have fallen behind and remain essentially deregulated (Salazar 2011). The lack of substantive labeling regime and simultaneous existence of GM containing/derived food products within Chile suggests what some would term a failure of consumer choice standards. Anti-GM activists have also raised complaints over lack of public access to records and regulatory proceedings, though the 2009 Transparency Law has allayed some concerns (Alianza por una Mejor Calidad de Vida 2009). While GM supporters view this non-discrimination between GM and non-GM imports as progressive, given that all imports must still pass SPS Treaty guidelines and all GM products have passed the rigorous US testing and screening process (FDA, USDA, APHIS), opponents taking a more precautionary stance feel duped by their inability to choose between GM and non-GM foods (Paarlberg 2001)

2.1d Public Research Investment

Chile's public domestic research is centered on the INIA, or the Institute of Agricultural Research (Instituto Nacional de Investigaciones Agropecuarias), founded in 1964 as a nonprofit organization under the Chilean Ministry of Agriculture (INIA mission statement). The INIA receives 40% of total public agricultural research funds and has 655 researchers. Between 1981 and 2006 the INIA has seen 2.4% annual increases in staffing and an average increase in annual public funding of 3.41%. In 2009 it received a total of US$98 million in funding (at 2005 PPP). Chilean Universities such as the Pontificia Universidad Católica de Chile and the Universidad de Talca are also active in agricultural technologies research (Stads, Beintema 2009). More broadly, agricultural R&D spending claims 3% of Chile's agricultural GDP (Economist Intelligence Unit, Global Food Security Index 2012). The Program of Development and Technological Innovation (2005 under the Ministry of Economy) has focused on GM research, although the primary focus has been on non-traditional crops specialized to Chile, such as peaches, nectarines, grapes, citrus, and potatoes (Salazar 2009). Jose Falck-Zepeda, a researcher with the International Food Policy Research Institute (IFPRI), considers Chile to have "intermediate innovation capacity," placing it below high research capacity countries such as Brazil, Argentina, and Mexico, above Bolivia and most Central American states, and even with Uruguay, Peru, and Costa Rica (2009). However, when examined on the basis of public/private investment comparison, Chilean research institutions are clearly very dependent on public investment: 17 out of 20 of Chile's research organizations are public (Falck-Zepeda 2009). This indicates a dearth of private capital investment, despite private capital's high usage of Chile as a counter season GM seed producer. It seems plausible that Chile's strong IPR protections on previously protected innovations (an exceptionally high Park index of 4.28) encourage high investment in GM crop production, but that its lack of patentability for plants or genes disincentivizes basic innovation itself. Thus, weaker IPR does not dissuade multinationals from bringing GMOs to Chile; it only undercuts the private research investment that would make the country less dependent on these multinationals. Perhaps following from this lack of private investment, one also observes a lack of modern research focuses: only 38% of research spending is dedicated to modern genetic techniques; the remainder goes to conventional breeding programs (Falck-Zepeda 2009). And again, despite the skew toward endogenous public funding, of 624 patents awarded between 1985 and 2005, 92% went to foreigners (ibid). This portrait, of high public investment but continued dominance in crop research by foreigners, further highlights the situation of dichotomization within Chile's high tech agricultural market. Domestic innovation is focused more on specialized fruit crops, while already developed GM crops come in from abroad.

2.2 Brazil

With a nominal exchange rate GDP of US$2.5 trillion, 14% of the world's renewable fresh water, and, at 170 million head, the world's largest cattle herd, Brazil is an agricultural power (US State Department 2011). Agriculture accounts for 6% of GDP, a midrange value among Latin American countries, but in absolute terms the agricultural sector in Brazil, at US$150 billion in 2011, is the largest in the region (UN Comtrade). Brazil's general export sector is oriented toward China (receiving 15% of exports), the United States (10%), and Argentina (9%), but when examined at the level of non-meat agricultural product exports, Brazil is strongly oriented toward Europe (UN Comtrade).

Brazil is Latin America's largest producer of soybeans, and the second largest overall in the world, with soybean exports at US$16.33 billion in 2011 (UN Comtrade).

The agricultural products in Figure 5 are also all viable GM products within the region. As of 2011 Brazil has approved commercialization of HT soybean, Bt cotton, and Bt maize, and in 2012 it stands as the world's second largest GM producer, accounting for 19% of global GM crop production (James 2012). In 2011 Brazilian growers cultivated 30.3 million hectares of land with GM crops, a 19% increase on 2010. GM soybean cultivation increased 16%, and GM maize cultivation increased 25%. Nevertheless, despite this recent explosion in Brazilian GM cultivation (32 distinct GM introduction/commercialization events have been approved since 2003, and 14 in the last two years alone), analysts were lamenting Brazil's slow GMO adoption as recently as 2004: Silveira and Borges of Harvard's Belfer Center noted that "the dissemination of GMOs in agriculture lies very much behind that of the competitors on the world market, such as the USA and Argentina. In 2003, the production of GMOs in Brazil represented only 4% of the world production. (2004)." The main reason, they explained, was an unstable and oppositional regulatory framework which dispersed powers of approval to regulatory bodies with incentives to prevent GMO introduction. Decree 1752/1995 regulated the Law of Biosafety 8974, giving full discretionary power of approval to CTNBio (the National Technical Commission on Biosecurity, or Comissão Técnica Nacional de Biossegurança), which often refused approvals. In addition, strong opposition from the Brazilian Consumer Protection Agency and Greenpeace had limited legal production since 1998 (Silveira and Borges 2004). Illegal production, on the other hand, had begun in 1998 when seeds were smuggled in from Argentina, an early GM proponent (Ruiz-Marrero 2011). The new soya seeds' RoundUp® resistance made them popular with farmers, and use spread, unapproved and unregulated, to such a degree that the Federal government was forced to issue provisional approval for the 2003 (heavily GM containing) crop (Ruiz-Marrero 2012, Silveira and Borges 2004, Zarrilli 2005). The high illegal GM presence and its continuing spread through southern Brazil prompted a new biosafety law to accommodate the changing reality. The Law of Biosafety 11.105/2005 set up a broad national framework covering all GM crops and their derivatives, which makes Brazil the only Latin American country to regulate GMOs through a single, coordinated major statute (Silva Gilli 2010). Since the 2005 Biosafety Law, GM crop production has skyrocketed (to levels explained above, and in **Figure 11**). In 2011 the 1st Review of the adoption of biotechnology in the 2011/12 Harvest reported that growth in Brazil's GM planted cropland was for the first time outpacing growth in traditional cultivation (Ettinger 2011).

2.2a Intellectual Property Rights

The Park index (2005) places Brazil at 3.59, well above Latin America's average protection of 3.44 (Park 2005). Nevertheless, as a signatory of the older 1978 UPOV agreement, Brazil may appear less well protected in the eyes of international investors (See Sidebar) (Paarlberg 2001). Particularly striking is the degree and extent of "unpatentables" in Brazil: plants and animals are both unpatentable, while regulatory ambiguity confuses the cases of genes and biological processes (Falck-Zepeda 2009). Microorganisms are patentable but this categorization often does not cover GM innovations (Park, Smith 2011). Law 9456/1997, art. 8

permits the issue of plant variety protection certificates and requires compulsory licenses, serving as a supplement or replacement to standard UPOV procedures. However, much of this protection is reversed by Idem, art. 10(IV), which defends farmers and traditional rights to exchange or donate seeds with other small rural producers (Dalle Mulle, Ruppanner 2010).

The issues within Brazilian IPR law lead many Brazilian companies and institutions to seek patents outside of the country, often in the United States given its strong patent protections (and Park index value of 4.88, the world's highest) (Vaz e Dias 2009, Park 2005). The number of Brazilian patents obtained within the United States between 1977 and 2006 was 1,959, the most of any Latin American nation (Falck-Zepeda 2009). Within Brazil innovators seek alternatives to patent protections, often making use of trade secrets protections or the plant variety licensing agreements cited above. The Brazilian Federal Government has acknowledged the limitations in this piecemeal approach, and "significant debates" about IPR protection have arisen in the Brazilian parliament, where a group of deputies and senators aim to amend the Law of Industrial Property to address GMOs, chiefly by making plants, animals, or genes patentable (Vas e Dias 2009). Thus, while IPR protection remains relatively weak in Brazil and most domestic innovators obtain alternative patent protection in the US, the quickly changing GMO situation on the ground may be driving a correlated revolution in IPR legislation within the Brazilian Parliament.

2.2b Biosafety

As detailed earlier, the Federal Government of Brazil passed a Law on Biosafety in 2005 (Law 111/2005), which replaced previous biosafety regulations formulated on a state-by-state basis. These state formulated regulations had varied greatly, with the central western region largely prohibiting GMOs, while the southern states, led by Rio Grande do Sul and limited by a lack of technical regulatory ability, embraced GMOs or at least permitted their uptake (Ettinger 2011, Silva Gilli 2010).

Brazil signed and ratified the Cartagena Protocol on Biosafety (within the broader Convention on Biological Diversity) in 1998 and incorporated its precautionary principle and desire for full risk assessment into the national legal framework in 2006. However, according to Rosario Silva Gilli, Dr. in Law and Social Sciences at the University of Brasilia and the University of Rosario, despite Brazilian guarantees of advanced segregation, screening, and testing facilities (objectives identified in the 2005 Biosafety Law and encouraged by GMO-wary Europe), MERCOSUR countries essentially lack the ability to "assure accuracy in these measures (Silva Gilli 2010)."

The process of approval of a new GM crop event, as specified in the 2005 Biosafety Law, begins with the National Biosafety Council, which resides in the Office of the President and formulates national-scale biosafety policy, considering any potential socio-economic implications of a GMO introduction (Silva 2010, Silva Gilli 2010). Next, the National Technical Commission on Biosafety (CTNBio) reviews the application. First established in 1995 and expanded in 2005 from 18 to 27 members to incorporate expert opinions from a broad range of scientific, medical, environmental, and legal disciplines, CTNBio considers the technical and scientific costs and benefits of any GM event. Any imports for food or feed fall under CTNBio's ambit, and it reviews all applications on a case-by-case basis (Silva 2010). Significant change came in 2008, when the CNBS agreed to contain itself to socioeconomic considerations and to regard all CTNBio decisions on scientific/technical issues as final. A simultaneous change from supermajority to simple majority voting as method of approval within CTNBio made approval much easier for GM events. They now only needed to pass one panel, and garner only 50+1% of the vote. This, according to a 2011 USDA Global Agricultural Information Network Report, "eliminates a major barrier for approval of biotech events in Brazil." In fact, if one examines the GM cultivation numbers from before and after this 2008 policy shift, one can find what may have been a plateauing of GM adoption turning into a sustained boom (James 2003-12). The CTNBio policy shift may have been a small element in this transformation. Overall, Brazil's strong 2005 Biosafety Law has set the country on a path to further GM crop expansion. Furthermore, through this expansion process increasing GM prevalence and economic clout may in turn drive a movement for stronger IPR or food safety/consumer choice protections. Thus, the Brazilian Federal biosafety regulations, while not completely enforceable given the state's lack of technical capacity and the immense, basically continent-wide scale of the Brazilian geography (Vaz e Dias 2009), may nevertheless serve as a catalyst for an even deeper GMO embrace in the future.

2.2c Food Safety and Consumer Choice

Executive order 4,680/2003 established a 1% tolerance limit for "food and food ingredients destined for human or animal consumption containing or being produced through biotech events (Silva 2010)." A later executive order (2,658/2003) established guidelines for the use of a transgenic logo to be used to label all foods/food products/feeds that contain more than the 1% tolerability benchmark (which was borrowed from the EU's 0.9% tolerability standard). Thus, Brazil has a rhetorically strong mandatory labeling law for all GM products. Nevertheless, very little to no evidence of enforcement of the labeling requirement has been observed in Brazil (Silva Gilli 2010). Despite Directive 2,658/2003 which established a previously absent enforcement regime, enforcement remains apparently nonexistent, and the "transgenic" logo is never seen in supermarkets despite the obvious existence of GM products >1% content in these markets (Silva 2010, Silva Gilli 2010). According to G.P. Gruere and S.R. Rao, "Many developing countries have approved laws requiring the labeling of GM food, but have not implemented the laws, or have only partially enforced the laws. For instance, Brazil introduced labeling laws in 2003, but has yet to actually implement these laws (Gruere, Rao 2007, Silva Gilli 2010)." Gruere and Rao categorize Brazil among "countries with partially enforced or non-enforced GM labeling laws" in their study of global labeling regulations. Thus, while on paper the labeling regime appears quite GM-preventative given its low 1% tolerability threshold and universal ambit, in practice it remains inactive and GM products are not distinguished from non-GM products in the marketplace.

2.2d Public Research Investment

After China and India, Brazil is the developing world's third largest investor in agricultural R&D (Beintema, Stads 2011). The Brazilian Agricultural Research Corporation (EMBRAPA) received US$1.224 billion (at 2005 PPP) in public funding in 2009, which marked a 28% increase during this year (Beintema, Stads 2009). The organization fielded 5,402 total researchers in 2006 (before significant but as of yet unreported staffing growth), and more of these held the highest degrees in their respective fields than in any other Latin American country (Ibid). Funding stagnation through 2006 has turned into booming growth for EMBRAPA, and the correlation between the beginning of the renaissance and the 2005 Biosafety Law which legalized and introduced GMOs suggests that the opening of the GM market could explain much of the increased investment.

Brazil dominates Latin America as an agricultural researcher, accounting for 42% of total agricultural R&D spending in 2008, and Jose Falck-Zepeda, in an IFPRI report from 2009, considered Brazil to be technically dominant in both conventional and modern biotechnologies (Beintema, Avila, Fachini 2010). Brazil hosts 25 biotechnology research organizations, the most in Latin America. Nevertheless, the lack of patentability in Brazil (see IPR section above) puts a roadblock on private R&D investment and the modernizing technologies this could bring with it. Compared to investments in modern genetic technologies (as opposed to conventional breeding) in Argentina and Mexico (43% and 44% of total R&D respectively), Brazil invests only 25% of agricultural R&D funding in modern technologies (Falck-Zepeda 2009). In addition, a vast majority—85%—of patents are issued to foreigners. The fact that 578 plant variety protection certificates were issued between 2001 and 2005 suggests that innovators are using PVPs as a protective substitute for patents.

Despite this mixed research environment, Brazil is nevertheless the first Latin American country to develop and commercialize its own unique GM crop: Golden Bean Virus Resistant Soybean, which was approved for commercialization in September, 2011 (James 2012). Multinational corporation BASF provided HT genes, which EMBRAPA inserted into local soybean seeds. The cooperative effort has already attracted attention from other Latin American countries (Checkbiotech 2010). Overall, Brazil is very promotional of GM innovation within its borders. EMBRAPA, the best funded research organization in Latin America, has recently strengthened cooperative research agreements with other organizations within Latin America and around the world, as well as with multinationals—it signed a US$5.9 million deal with Monsanto in 2010 to incorporate Roundup Ready® technology into its Golden Bean soybeans (Checkbiotech 2010).

2.3 Argentina

Argentina, along with the United States and Canada, was one of the first three big adopters of GMOs upon introduction in 1996. With a technical capacity higher than most other Latin American countries (which allowed a manageable implementation of demanding GM regulatory policies) and an economy heavily reliant on agriculture (agricultural makes up 10% of

GDP, or US$44.6 billion) helps to explain Argentina's exceptionally strong embrace of GMOs (see **Figure 2**) (Silva Gilli 2010, GDP from World Bank 2012). Furthermore, Argentina has many fewer small hold farmers and shows significantly more reliance on modern monoculture agriculture than comparative Latin American countries such as Brazil (Silva Gilli 2010, Paarlberg 2001).

Argentina approved 21 GM crop products between 1996 and 2011. 3 of these have been soybean, 15 maize, and 3 cotton. In all, HT soybean, Bt cotton, and Bt maize are approved, and all have been nearly universally adopted: 100% of Argentine soybean production is GM, as is 85% of maize production and 97% of cotton production. The 19.1 million hectares of biotech soybean in Argentina are second only to Brazil's 20.6 million hectares. Argentina grows 15% of global GM crops, and only recently fell to third place in global GM crop production behind the United States and Brazil (James 2012).

GM regulation and oversight falls under the ambit of CONABIA (Comision Nacional Asesora de Biotecnologia Agropecuaria), the biosafety arm within SAGPyA, the Central Food Ministry (Secretaría de Agricultura, Ganadería, Pesca y Alimentos de la Nación) (Silva Gilli 2010). As Argentina does not differentiate between GM and non-GM seeds upon import or export, has no labeling regime, offers relatively strong IPR protections, and generously funds biotech research, it should be seen as very promotional (Yankelevich 2010). However, recent developments, especially in the field of IPR protections, may be adding some nuance to this generally permissive approach.

2.3a Intellectual Property Rights

With a relatively high Park IPR index of 3.98 and patentability in animals, plants, plant varieties, microorganisms, biological processes, and genes (the only Latin American country to offer all of these), Argentina is historically the most protective of Intellectual Property rights in the region (Park 2005, Falck-Zepeda 2009). This has largely become the case only after broad GMO acceptance in 1996, which brought deep pressure from multinationals to ensure investment security (Paarlberg 2001). Thus, GMOs may be interpreted as one of the causes of IPR protections instead of one of the results. This causative link may offer predictive potential for other Latin American countries, especially Brazil: if broad GMO acceptance in Argentina spurred IPR protections, the relatively weak IPR protections in Brazil may soon improve. However, the general IPR toughening in Argentina around 1996 may also be an independent product of Argentina's accession to the WTO's TRIPs agreement in 1995 (WTO website). Thus, causation or correlation may be difficult to distinguish here. Argentina signed the 1978 UPOV treaty in 1994, allowing plant variety protection certificates for GM product owners but providing weaker protections in terms of post-sale product control (UPOV website, Paarlberg 2001).

The existence of strong patentability on paper is undermined by a lack of enforcement measures and negligible penalties for violation (IIPA Special 301 Report 2012). Furthermore, Argentina interprets the UPOV78 agreement broadly, allowing farmers to exchange, replant, and trade patented seeds without providing an explanation, according to a 2011 USDA Global Agricultural Information Network report, which remarks that "the lack of effective enforcement options for plant variety rights, combined with the absence of patent protection for a significant range of biotech inventions, renders Argentina's intellectual property system inadequate from the perspective of the biotechnology industry." Although the bias within these reports is obvious, the US slant toward the multinational biotech industry actually offers a rather informative view on how outside investors perceive IPR protections in Argentina. Despite this whining, 79% of patents (15,910) were awarded to foreigners between 1985 and 2005, showing a continuingly strong investment culture in the Argentine biotech industry (Falck-Zepeda 2009). Overall, then, Argentina offers stronger patentability than any other Latin American country, but as a signatory of UPOV78, also gives farmers more flexibility with these patented products.

2.3b Biosafety

Unlike Brazil, Argentina has no overarching national biosafety statute. Discussions over a potential general law occurred in 2001, but the 2001 economic crisis derailed them and the agreements never reached Congress. According to Andrea Yankelevich, an agricultural specialist working for the United States Department of Agriculture in Argentina, private sources have indicated that due to the current conditions in Congress, a Biosafety Law is considered a long term objective (2011)." Despite this lack of an all-inclusive national framework, Argentina does have a formalized system of approval for GM events. All releases require approval.

Applications for a new GM event first reach the National Advisory Committee on Agricultural Biotechnology (CONABIA), where a multidisciplinary panel assesses environmental or technological impacts of release, as well as compliance with Resolutions 39 and 60, which regulate specific genetic modification techniques like trait stacking (including more than one GM innovation in a single crop, say, Bt and HT) (Silva Gilli 2010, Yankelevich 2010). CONABIA evaluates applications based upon the Precautionary Principle, the European risk-assessment standard established in legal conferences dealing with climate change which stipulates a limiting of any introduction without full understanding of potential environmental effects (Paarlberg 2001). If this organization approves release, the National Service of Agricultural and Food Health and Quality (SENASA) then evaluates possible risks for human or animal GM-consumption and the National Direction of Agricultural Food Markets (DNMA) issues a technical report on trade impacts (Yankelevich 2010). The entire process can take as long as 42 months, which is "generally considered very long considering the current dynamics of the biotech industry and the fact that Brazil is approving trials at a faster rate than Argentina, with 18 biotech events approved in just two years (Yankelevich 2010)." While all crop introductions, GM and non-GM, undergo this rigorous approval process, the process itself *does* distinguish between GM and non-GM products. This has the effect of activating the precautionary principle in the CONABIA considerations. While this has historically had very little impact given Argentina's exceptionally strong GM embrace, the approval process could hinder future GM introductions–it has already only seen 21 GM introduction events since 1996, in contrast to 32 in Brazil since 2003 (James 2012). While this is partly a reflection of Argentina's more limited agricultural diversity, it also illustrates a not-inconsiderable indurating of the approval stream.

Argentina signed and ratified the Cartagena Protocol in 1994 but has never fully incorporated it within its national legal framework (Silva Gilli, 2010, Falck-Zepeda 2009). Thus, the protocol, which supports labeling requirements and the use of the precautionary principle in socioeconomic considerations going beyond the CONABIA approach, is basically a paper promise with no concrete effects on the regulatory situation (Silva Gilli 2010). Overall, biosafety regulations in Argentina are relatively formalized, and the country has the technical capacity to evaluate and monitor GM releases and impacts. Nevertheless, failure to incorporate the Cartagena protocol leaves small hold farmers and consumers at risk, while the tenuous approval process may divert multinational investments to Brazil.

2.3c Food Safety and Consumer Choice

Argentina has no labeling requirements for food or feed products (Yankelevich 2010, Silva Gilli 2010). Guillaume Gruere and S.R. Rao, in a 2007 IFPRI report, explain that Argentina has a purely voluntary labeling system, which means in practice that no labels on GM foods are to be found in supermarkets. According to these researchers, large GM producing countries such as Argentina, Canada, and the United States do not have strict labeling policies, while countries that import large GMO volumes often have stricter regimes with established tolerability thresholds and production process reporting (Gruere, Rao 2007). Argentine regulators see a lack of labeling regime as justifiable since no scientific evidence exists showing GM food/feed products to be riskier or lower quality than non-GM food/feed products. Since the two types are thus "substantially equivalent," divergent regulatory treatments would be unjustifiable (Yankelevich 2010).

2.3d Public Research Investment

In the 1950's, Argentina, along with Ecuador, was a pioneer in creating the National Agricultural Research Institute, which has become the standard model for nearly all Latin American countries (Stads, Beintema 2009). Argentina's National Institute of Agricultural Technology (INTA) oversees both research and extension services, receives 48% of public funding, and had a total of 3,947 researchers in 2006 (Stads, Beintema 2009). The University of Buenos Aires also plays a significant research role, receiving 7% of funding in 2006. Argentina's commitment to agricultural research has increased significantly in the last decade, with approximately 1,000 new researchers added to INTA since 2004, more than doubling their total staffing, and public expenditure on agricultural R&D accounted for 3% of agricultural GDP in 2011 (Stads, Beintena 2009, Economist Intelligence Unit, Global Food Security Index 2012). Along with Brazil and Mexico, Argentina belongs in the group of Latin American countries with the highest technical, financial, and educational capacity for intensive research (Falck-Zepeda 2009). According to Falck-Zepeda's study for the International Food Policy Research Institute, five out of fifteen Argentine agricultural research organizations are private, a value higher than the Latin American average, reflecting sounder than usual IPR protections and a relatively technologically advanced innovation environment. Nevertheless, 57% of Argentina's public research funding remains dedicated to traditional breeding methods. This may reflect the pre-formed dominance of multinational corporations in this field. With multinationals having too much of a head start, more advanced technologies, access to a more educated workforce, and a strong source IPR of protections in the US, developing nations' agricultural research institutions often limit themselves to conventional techniques since competing in biotech applications would be unfeasible (Falck-Zepeda 2009). This is one explanation for why the existence of strong domestic research institutions in Latin America has not correlated with more domestic innovation.

Given Argentina's history as an R&D innovator in Latin America, the recent reemphasis on INTA and other organizations (see **Figure 3**, which illustrates Argentina's dramatic funding increases since 2000), and the strong capacity in modern biotech research applications, Argentina appears relatively promotional of GM technologies. Nevertheless, INTA staffing remains relatively undertrained by regional standards (60% of Argentine INTA researchers hold only the equivalent of a bachelor's degree; 20% hold the equivalent of a doctorate, whereas in Brazil, the nation with the most highly qualified researchers, ~4% hold bachelor's equivalents and ~65% hold doctorates)(Stads, Beintema 2009). This, along with softening IPR protections, could point to changes in the future.

2.4 Uruguay

Agriculture dominates Uruguay's economy. It accounted for 10% of total GDP and 70% of exports in 2011 (World Bank). Agricultural activities occupy 90% of Uruguay's land area (Hareau 2002).

Beef and soya remain the primary exports, with beef making up about 50% of total export value in 2000, and 63.9% in 2009 (Uruguay's data reporting to UN Comtrade is more irregular than other countries; the most current Comtrade data for Uruguay comes from 2009) (UN Comtrade). As mentioned in the Argentina trade subsection below (section 3.2c), this heavy reliance on beef exports (most of which reach Europe) eliminates some of the discrepancy between high export volumes to Europe and simultaneous GM cultivation: GM feedstuffs consumed by Uruguayan cattle do not label those cows as GM upon entrance to the EU. Current technology and policy are not sophisticated enough to maintain the multi-tiered derivative/input traceability regime that this would require. However, the GM-derivative nature of MERCOSUR beef products exported to the EU could point to future areas of regulatory innovation, where in-country tracking schemes regulate GM presence along the entire supply chain.

Uruguay first approved two GM crop varieties in 2004 (Hirschfeld 2011). It undertook this policy after GM crops had already leaked in, unregulated, along the Argentine border, much like the introduction of GMOs to Brazil (Silva Gilli 2010). Thus, the Uruguayan government, which had originally had little say in the GM presence inside its country, reversed its approval policy and issued an 18 month moratorium on new GMO approvals, in order to more carefully evaluate the technical, economic, and environmental risks of GMOs (Hirschfeld 2011, Yankelevich 2009, James 2012). It lifted the moratorium in 2009 and established a commission to oversee new events and applications (James 2012). Decree 353/2008 established a newly strengthened General Law on the Environment which requires prior authorization on the whole field of GM related issues such as release, trials, commercialization, imports and exports (Silva Gilli 2010). Nevertheless, legal texts for this new decree remain unwritten, all precautionary policies remain voluntary, and the entire legal body has had negligible effect on GMO introductions (Silva Gilli 2010). Along with this ambitious but unimplemented policy, the government pronounced an interest in "moving forward on a policy of coexistence between GM and non-GM foods (Hirschfeld 2011." Since the 2008 moratorium, Uruguay has increased its biotech plantings dramatically–by 150,000 hectares in 2010 alone (James 2012). With a 33% growth in biotech crop hectarage in 2010, Uruguay became the world's 10th largest GM crop producer. Ht soybean and Bt maize have gained approval, and five GM release events were approved in one day in 2011 (James 2012). The approval process remains onerous, as will be explained in section 2.4b), but Uruguay nonetheless appears to promise increased GMO use in the future, for better or worse.

2.4a Intellectual Property Rights

Park gives Uruguay an index score of 3.39, placing it approximately even with both the world mean index score and the MERCOSUR mean, as well as countries such as Bolivia, El Salvador, and Venezuela. Of course, it only matches the MERCOSUR average because Paraguay (index = 2.89) pulls down the scores of Brazil (index = 3.59) and Argentina (index= 3.98) (Park 2005). Much of Uruguay's weakness in this score comes from its membership in the 1978 UPOV agreement, which allows more lenient farmers' rights, including undocumented trading and saving of seeds, as well as only 15 years of plant variety certificate protection instead of the 1991 agreement's 20 years. In Uruguay, plants, animals, genes, and biological processes were unpatentable as of 2009, while microorganisms and plant varieties were patentable (Falck-Zepeda 2009). Given Uruguay's agricultural history, plant variety protections seem intuitive, while more advanced protections of genes, biological processes, plants, and animals (the groups GMOs nearly universally fall under) may appear too much of a concession to multinationals. According to Andrea Yankelevich, the USDA's agriculture specialist in the Southern Cone, Uruguayan seed laws allow farmers to save and use seeds from previous years, regardless of royalties owed on these seeds. This is in compliance with UPOV78. Nevertheless, the seed law regulations now require producers to sign a contract when buying new seeds in which they promise to pay royalties the next year (USDA GAIN 2009). Multinationals thus seem to be circumnavigating the pro-farmer holes within UPOV78 to negotiate secondary level legal assurances of royalty collections when the broader statutes fail to suit their needs. In all then, Uruguay's intellectual property rights protections appear rather weak from the standpoint of capital investment, but the country's overwhelming comparative advantage in agriculture may outweigh this in multinationals' investment calculations.

2.4b Biosafety

Decree 249 of 2000 created CERV, the nation's Risk Assessment Commission of Genetically Modified Plants and established an application process and regulatory framework. This framework decree was later used to halt all GMO introductions from January 2007 to July 2008, when Decree 353/2008 replaced it (Yankelevich 2009). After the moratorium, GM crop approvals increased dramatically in number (James 2012), which comes as somewhat of a surprise given the exceptionally long and seemingly onerous GM crop event approval process. Four major organizations are involved: the National Biosafety Commission (GNBio), the Commission for Risk Management (CGR), the Evaluation of Risk in Biosecurity (ERB), and the Institutional Articulation Committee (CAI). All of these groups require application fees, which can range from US$11,650 for scientific evaluation to US$163,100 for commercial evaluations (Yankelevich 2009). The rather rapid issuance of new GM events in 2011 suggests that the majority of this legal mass may be a mere paper process in which small bribes are paid or for which the organizations exist to give nominal scrutiny in compliance with TRIPs or UPOV agreements.

Uruguay is not yet a signatory to the Cartagena Protocol on Biosafety, although it has signed on to the Convention on Biological Diversity (Falck-Zepeda 2009, USDA GAIN 2011). Cartagena encourages labeling regimes and tighter biosafety controls, but, while Uruguay has shown a history of discriminating against GMOs through bans, its broad post-moratorium GM embrace seems to have done away with fears of a relapse.

2.4c Food Safety and Consumer Choice

Uruguay has put in place a voluntary labeling regime for any products which may contain directly detectable quantities of GM substance. Products derived from GM, like beef fed on GM feedstuffs, or highly processed syrups or oils in which any coherent genetic material has been destroyed, would not register under the labeling guidelines. Of course, to highlight, this regulation is completely voluntary, and it is thus highly unlikely that sellers or marketers will participate (Silva Gilli 2010, Yankelevich 2009). Given Uruguay's dependence on exports to Europe, future trends may hint at an upcoming push for a traceability regime which would track and possibly segregate GM products. Whether Uruguay's current technical and regulatory capacity could cope with these challenges remains doubtful (Falck-Zepeda 2009, USDA GAIN 2011). Thus, in summary, no real regulatory distinction is made between GM and non-GM food products in Uruguay.

2.4d Public Research Investment

Uruguay's principle research institute is INIA, (Instituto Nacional de Investigación Agropecuaria). This organization receives 36% of total agricultural R&D funds within the country, has benefitted from an annual staffing growth rate of 2.61% from 1981 to 2006, and had 209 fulltime researchers in 2006 (Beintema, Stads, 2009). This places it in a moderately well-resourced position in comparison to comparative Latin American countries. According to Jose Falck-Zepeda in a 2009 IFPRI report, Uruguay, along with Costa Rica and Chile, has a "respectable potential to use new as well as traditional agricultural technologies." However, this same researcher later notes that Uruguay pulls above its weight in the research field due to a government commitment to science and technology, as well as the nation's overall dependence on agricultural products and subsequent focus in this area. Guy Hareau, in his thesis on Uruguay GMOs, highlights the governments' strong commitment to research and investment in new agricultural technologies (2002). Beintema and Stads agree in their 2010 IFPRI report, noting that Uruguay's researchers are the third most qualified in Latin America. At 4% of agricultural GDP, Uruguay's public expenditure on agricultural R&D is higher than all countries in the region besides Brazil (Economist Intelligence Unit Global Food Security Index 2012). However, a deeper examination of Uruguay's research investment paints a slightly different picture: only 19% of Uruguayan public agricultural research funding went toward modern genetic engineering technologies in 2009, in contrast to 43% in Argentina, and 89% of patents issued in Uruguay went to foreigners (Falck-Zepeda 2009). Nevertheless, Uruguay is a small country, and it may not always be representative to use its enormous MERCOSUR neighbors as a measuring stick. With 51 patents awarded per million people in 2009, Uruguay was, by this measure, more intensely innovative than Brazil (41 patents per million people), Chile (40 per million), or Mexico (32 per million) (Ibid). In all, Uruguay, while most likely forced toward a conventional breeding focus by dominant multinationals, nevertheless maintains a strong commitment to agricultural research.

2.5 Mexico

After an eleven year moratorium on all new GM crop approvals, Mexico reapproved GM field testing procedures in 2009. Regulatory agencies quickly approved 21 applications for test plots in 2010, with the applications coming from Monsanto, Dupont's Pioneer Seeds, and Dow Chemical (James 2012, Rosenberg, Fahmy 2011). A lobbying group for the multinationals expects more sizable plot approvals, as well as the first commercial plantings, by 2012. Current regulations allow trial plots of 2.5 acres, and all trial-site GM produce must be destroyed after testing. Only a few of the 2010 proposals remain viable; the government rejected many for lack of information about the target crops (Rosenberg, Fahmy 2011).

These recent developments in Mexico's GM approval environment reflect only the latest stage in a long history of agricultural conflict: Under the obligations of the North American Free Trade Agreement (NAFTA), Mexico is formally committed to liberalizing trade, which includes trade in agricultural products (Wise 2007). Nevertheless, as the world's origin of maize and a country heavily reliant on agriculture as a means of sustenance and food security, Mexico faces simultaneous pressures to defend its enormous agricultural diversity broadly, as well as its historically, environmentally, and culturally important maize landraces specifically (Antal, Baker, Verschoor 2007). With over forty distinct landraces uniquely adapted to local environments and farming practices, Mexico represents the world's most valuable living seed bank, protecting biodiversity and ensuring a solid source of germplasm for industrial innovations (Wise 2007). Furthermore, maize lies at the center of Mexican culture: to quote Antal et al., "Maize is the staple foodstuff, the holy object for ancestral cultures, the symbol of nationalism and the country's political and cultural resistance. These extra-economic factors make the origin and quality of maize extremely important for Mexicans, even more so than their cost and price (2007)."

Nevertheless, soon after NAFTA came into force, the Mexican government either waived or failed to apply a majority of the import restrictions which had been built into the agreement, including those on maize products (Nadal 2000). Thus, as the United States proceeded to increase its domestic agricultural subsidies, particularly to maize producers, Mexican farmer-support fell: by 2004, US subsidies had risen 48% while Mexican subsidies had fallen 39%, until they matched only 10.4% of the US subsidy support (Wise 2007).

Corn flows from the United States increased dramatically, bringing GM maize products to Mexican markets. Mexican regulators, conscious of the potential vulnerability of the smallholder controlled landraces, decreed that GM maize imports could be used only for consumption, not production.

Despite the consumption-only decrees, GM maize products may have found their way into cultivation. In 2001, word began to spread that "transgene escape" had occurred (Antal, Baker, Verschoor 2007). The source of the claim was a provocative study published in the journal Nature in 2001, titled "*Transgenic DNA introgressed into traditional maize landraces in Oaxaca, Mexico* (Quist, Chapela 2001, Antal, Baker, Verschoor 2007)." Subsequent Nature studies questioned the methodologies and findings of the Quist, Chapela report. One such was "*Genetic modification: Transgene introgression from genetically modified crops to their wild relatives*, which contested that the maize ears that had raised the fears of gene introgression (which the Mexican press labeled "contamination") showed only weak signs of *hybridization*: transgene introgression would have required "repeated backcrosses and the stabilization of the transgene in the new host genome," something which has never been done unintentionally (Stewart et al., 2003). Nature eventually retracted the Quist, Chapela study, but the seeds of distrust had been sown. Previously disorganized social movements opposing GMOs ignited over the threat of contaminated landraces, and broad public opposition arose, fed by the already quite painful chafing over NAFTA's effects on *campesinos* from Mexico's southern states–smallhold farmers who relied much more on indigenous maize cultivation than did the more industrialized, monoculture agropowers of northern Mexico (Roserberg, Fahmy 2011). The effects of NAFTA's pricing and trade dynamics on these *campesinos* have been drastic and deeply felt through losses of income and competitive ability. The reasoning behind the free trade agreement was that inefficient subsistence farmers would abandon maize cultivation, take up more efficient occupations, and buy less expensive, imported (GM) maize from the United States (Antal, Baker, Verschoor 2007, Nadal 2000). While this has occurred, resulting in a 30% decrease in domestic maize production, the transfer from subsistence maize cultivation to the more "efficient" and urbanized occupations has not been as swift nor as smooth as NAFA theorists had prophesied–*campesinos* now "free" to buy cheaper maize have moved *en masse* to urban centers and, illegally, to the United States (Aoki et al., 2012).

While agriculture, at ~US$57.75 billion, makes up only about 5% of Mexico's GDP, it employs 30% of Mexico's labor force, and approximately 55.2% of the agricultural population depends directly or indirectly on maize (Antal, Baker, Verschoor 2007). In this light the issues surrounding NAFTA's effects on maize cultivation and any potential GMO threats to maize landraces take on a more palpably decisive hue. The deep coupling of Mexico's economy and trade with that of the United States (recipient of 85% of Mexico's agricultural exports and a similar percentage of overall exports) suggests that commercialized GM crop production is highly unlikely to stay out of Mexico forever (UN Comtrade, Nadal 2000, Aoki et al., 2012, Juarez 2010). Release events are dawning, and should be interpreted with Mexico's conflicted and contested agricultural history in mind.

2.5a Intellectual Property Rights

Mexico was one of the first developing nations to strengthen its IPR protections, creating a new regulatory system for IP in 1991 and revamping it in 1997–two years prior to the WTO's TRIPs deadline for developing countries–to comply with newly anticipated NAFTA demands (Leger 2005). This revamping brought plant variety protections under the UPOV78 agreement, which Mexico signed in 1997 (Ibid). This fundamental IPR reorientation brought the private sector in full into Mexico, especially life-science focused multinational corporations like Monsanto. In 2005, Walter Park indexed Mexico at 3.88, a high score in line with Argentina's, which reflects the tougher measures brought about under NAFTA. Plants, plant varieties, and microorganisms are patentable, while biological processes remain unpatentable and gene patentability regulations ambiguous (Falck-Zepeda 2009).

A study conducted by Andreanne Leger of the German Institute for Economic Research in 2005 examines the case of IPR in Mexico, and argues that traditional IPR theory may not always apply in a developing country context. She argues that IPR are "not important for breeders in general" and that "Only a minority of breeders considered that IPR provided incentives for the performance of maize breeding, while approximately half though they had no effect." Her study, conducted through extensive questionnaires and interviews with breeders and others involved in the industry, found that the judicial and regulatory environment, as well as the overall level of technological development played a much greater part in incentivizing innovation than did IPR.

While breeders at advanced multinational corporations thought patent protections aided innovation in theory, they acknowledged that in the Mexican context, the lack of understanding of IPR or patent/licensing arrangements made the norms unenforceable and unused. Most local breeders did not even know the differences between UPOV78 and UPOV91, though when the differences were explained to them, they thought that UPOV78 would be much more conducive to Mexican innovation because it preserved local farmer's rights to swap seeds and pursue conventional breeding innovations. Neither could quantitative effects of IPR strengthening upon innovation be found: analyses of number of breeding programs and program staffing and skill-level did not show any notable increases or decreases from before to the UPOV activation in 1997. Leger contends that the need for IPR protections is discursively generated through channels benefitting multinationals. A viable maize industry, after all, existed in Mexico long before IPR protections. Leger calls for a reconsideration of IPR protections in the developing country context, particularly Mexico's, since her study found little incentive-creating effects of IPR introductions. Ideally, she argues, developing countries which cannot yet compete in innovation with developed countries would benefit more from imitating advanced technologies than from ceding the rights to the developed country innovators within their borders (Leger 2005).

2.5b Biosafety

As detailed above, concerns in Mexico over biosafety are of particular concern given the nation's fraught and contentious history of "contamination" events and the overarching importance of native crop diversity. With worries ranging from transgene escape into new "superweeds," to the deaths of Monarch butterflies, biosafety is a high profile area of the Mexican GM debate (Antal, Baker, Verschoor 2007). Mexico currently has not authorized any GM crop event commercialization, although it has approved numerous trial plots (James 2012). Approximately 10 of these plots remain viable within the approval pipeline process (James 2012). The Law on the Biosecurity of Genetically Modified Organisms (the Biosafety Law) was passed in December, 2004, forming an approval framework and broad regulatory system with which to deal with GMOs, despite the fact that it remained inactive until lifting of the trial moratorium in 2009 (Antal, Baker, Verschoor 2007, USDA GAIN 2011). This law created the *Reglamento*, a coherent body of biotech laws, as well as the Inter-ministerial Commission on Biosecurity and Genetically Modified Organisms (CIBIOGEM), which oversees all biotechnology related activities in Mexico (Juarez 2010). The Mexican biosafety regulatory process begins with the Secretariat of Agriculture, Livestock, Rural Development, Fisheries and Food (SAGARPA), which assesses environmental or technological risks to plant and animal health on a case-by-case basis. It oversees the entire GMO evaluation process, from written application, to field trials, pilot release programs, commercialization, and GM imports and exports (Juarez 2010, SAGARPA website 2012). The Secretariat of Environment and Natural Resources later evaluates potential risks to biological diversity or ecosystem functioning, while the Secretary of Health assures food safety of GM products (Juarez 2010). Thus, the *Reglamento* is the main new biopolicy body in Mexico. Issued March 19, 2008, it permits, under the proper testing and surveillance regime, controlled trial releases and ultimate commercial release.

2.5c Food Safety and Consumer Choice

While the Mexican Biosafety Law permits the marketing and sale of packaged foods without a GM/non-GM label, Provision 101 of the *Reglamento* mandates labeling of GM content in seeds for planting, in compliance with the GM crop approval process and cultivation bans detailed above. Labels on these GM seeds must detail the type of genetic modification, specific genetic engineering processes used, changes in environmental interactivity, and unique reproductive characteristics (Juarez 2010). Within the food consumption market, however, the Mexican government has never pushed for labeling of GM containing products (Antal, Baker, Verschoor 2007). Since 30% of maize is imported to Mexico from the United States, and nearly all of this is GM, it is likely that a majority or large plurality of maize products for consumption in Mexico contain GM or are derived from GM (UN Comtrade). Any labeling requirement would clearly be rather ubiquitous and redundant.

2.5d Public Research Investment

Mexico presents a particularly complex case in the field of research funding and institutional organization. Jose Falck-Zepeda, a researcher with the International Food Policy Research Institute, places Mexico alongside Brazil and Argentina as a country with high capacity in both conventional and modern technologies (2009). The main Mexican public research institution is INIFAP, (Instituto Nacional de Investigaciones Forestales, Agricolas y Pecuarias, or National Institute for Forestry, Agricultural, and Animal Husbandry Research), which oversees most government-led agricultural research in the country (Stads, Beintema 2009). INIFAP runs eight regional research centers which are known for their high levels of expertise within particular disciplines. It boasted 2,227 total researchers in 2006, and enjoyed a budget of over US$500 million (2005 PPP) (Ibid). INIFAP, in contrast to many other Latin American nations' research institutions, receives a rather low 25% share of public agricultural research funding, pointing to the plethora of complementary organizations that operate within this sector. Notable are the Universities involved in agricultural research. Over 125 universities operate research programs, with the Autonomous University Chapingo (UACh), and the Autonomous Agricultural University Antonio Narro (UAAAN) the most prominent and expansive (Stads, Beintema 2009).

Also important in Mexico is the International Maize and Wheat Improvement Center (CIMMYT), a regional headquarters of the the Consultative Group on International Agricultural Research (CGIAR), an international body which, since the 1960's, has dedicated substantial funds to agricultural research in Latin America (around 14% of its total budget) (Ibid). While CIMMYT has become a controversial organization within the GM controversy given its long-standing endorsement of GM cultivation in Mexico, it remains an innovative center within the region: 33.3% of total cultivars released by Mexican public research institutions between 1966 and 1997 used CIMMYT germplasm. This value was 81.3% in the private sector (Antal, Baker, Verschoor 2007, Leger 2005)

Mexico's strong embrace of research investment in agriculture is clear from its high investment figures (public expenditure in agricultural research occupies 3% of agricultural GDP), its orientation toward modern genetic engineering techniques (44% of spending is dedicated to these techniques, the highest value in Latin America), and its achievements in patenting: Mexico received almost twice as many patents as any other Latin American country between 1985 and 2005 (Economist Intelligence Unit Global Food Security Index 2012, Falck-Zepeda 2009).

2.6 Paraguay

Paraguay is a nation dominated by agriculture. Much like Uruguay, a large part of its arable land‒35%‒is in production, and agriculture constitutes 19% of national GDP (James 2012, World Bank 2012). Its major markets are Brazil, Uruguay, Argentina, and Chile, which together account for around 61% of total exports (UN Comtrade).

Around 250,000 Paraguayan families use subsistence farming practices and remain largely outside of any type of formal agricultural industry (US State Department 2011). Nevertheless, Paraguay is the world's fourth largest exporter of soybeans. It approved HT soybean in 2004 and Bt cotton in 2010-11(James 2012). GM soybeans now dominate in Paraguay, forming 97% of the overall crop, and nearly all of these are for export. Bt cotton remains in the test trial stage.

Paraguay has a significant underground economy. The US State Department estimates that it is approximately equivalent to the formal economy (GDP US$23,877,089,240) (World Bank). A large part of this economy consists in the illegal cultivation of unregistered GM crops by foreign multinational corporations, using seeds smuggled over the Argentine and Brazilian borders (Barnett 2010). Opposition movements to this illegal growing remain strong within the country. An illustration of resistance came in September, 2010, when Miguel Lovera, head of SENAVE, the Servicio Nacional de Calidad y Sanidad Vegetal y de Semillas (National Service for Plant and Seed Health), undertook an operation to destroy illegal GM plantings in Paraguay. Government agents burned transgenic corn fields around the country, trying to send a message to corporations like Cargill and Monsanto, which have had, "virtually unchallenged political influence [in Paraguay] for years (Barnett 2010)." So far, then, GMOs in Paraguay appear a multinational imposition as much as a fully accepted part of the agricultural tradition.

2.6a Intellectual Property Rights

The Park Index for Paraguay is 2.89, the lowest in Latin America (Park 2005). Paraguay signed the 1978 UPOV agreement in 1997 (UPOV website). Plants, animals, and biological processes are unpatentable, microorganism patentability is weak, and the patentability norms around genes remain in the formulation stage and are unlikely to resolve themselves soon (Falck-Zepeda 2009). It seems clear from this drastic lack of IPR protections that Paraguayan GMO producers are not respecting multinationals property rights (particularly Monsanto's, since the majority of Paraguayan production is RoundUp Ready® soybeans) (James 2012, UN Comtrade).

Also, given the high level of illegal cultivation and penetration of domestic markets by these same multinationals growing unapproved GM maize, the companies are willing to find a balance between lost royalty payments and a weakly controlled market (Barnett 2010).

2.6b Biosafety

Paraguay initiated a broad biosafety reform in 1997, creating a Biosafety Commission (ComBIO) to evaluate field trials, controlled releases, and the establishment of a national plant varieties register (Silva Gilli 2010). RR® Soya entered Paraguay, unapproved and unregulated, from Argentina in 1998, likely brought by multinationals in an effort to expand markets, as had been documented earlier in Brazil (Gaisford, Kerr 2004). These GM soybeans were cultivated along with conventional soybeans until 2001, when the national government banned commercial GM use. This ban was never enforced, for the most part because GM soybeans had spread so thoroughly through production sectors that their elimination was impossible. In 2004, reconciling with reality, the government reversed the ban on GMOs and created a legal body to regulate them (Silva Gilli 2010). This was SENAVE, which oversees all GMO related activities in Paraguay. SENAVE provides no clear details on its GMO event approval procedures, but it is clearly unable to screen incoming or outgoing products for GM content, given the high intrusion of unapproved GM seeds in the country. This is often the case for developing countries: the high technical and legal capacity required to maintain a sound GM regulatory policy is lacking, and GMOs thus flood the market, regardless of consumer or producer opinion (Falck-Zepeda 2009).

Paraguay signed and ratified the Cartagena Protocol in 1993 and incorporated it into its national legal framework in 2003, much ahead of fellow MERCOSUR countries like Brazil, which have signed the agreement but have never implemented it in national policy (Silva Gilli 2010). This treaty should make some progress toward limiting unregulated GM products, as it did in empowering Miguel Lovera to destroy illegal GM maize cultivation. Nevertheless, the same technical limitations in implementation remain.

2.6c Food Safety and Consumer Choice

Little information exists detailing Paraguay's food safety and consumer choice regulations, although it is clear that no labeling policy exists and GM products are sold for consumption in the marketplace (USDA GAIN 2011). From a precautionary perspective, this represents a failure of consumers' right-to-know, while GMO supporters may characterize the lack of labeling as pro-production and scientifically based, given the lack of concrete evidence of harm (Paarlberg 2001).

2.6d Public Research Investment

Paraguay's Agriculture Research Directorate receives 50% of public agriculture funding, fields 78 full time staff, and enjoys an annual budget of US$3.1 million (Stads, Beintema 2009). Only 1% of agricultural GDP is dedicated to agricultural R&D, and of this funding, 100% goes to conventional breeding practices, which adapt foreign crops to local conditions through standard cross-breeding techniques (Economist Intelligence Unit Global Food Security Index 2012, Falck-Zepeda 2009). Falck-Zepeda, an IFPRI analyst, notes that Paraguay has "a very poor capacity in conventional biotechnology innovation, and virtually no capacity in modern genetic engineering (2009)." Between 1985 and 2006, Paraguay's public research funding has been falling approximately 0.34% annually. Almost none of Paraguay's researchers hold the highest degree in their field (~2% hold PhDs) (Stads, Beintema 2009). Paraguay hosts only 3 public research institutions, and zero private institutions. This is the lowest number of any Latin American country except El Salvador, which holds 2 institutes and is only 5% of Paraguay's size (Falck-Zepeda 2009). In all, Paraguay has done little to develop domestic GM innovation, likely, as Falck-Zepeda points out, because multinationals are so much better equipped in this area that Paraguay is wiser to adapt foreign innovations to local conditions (as their Research Directorate does) and offer very weak IPR protections to avoid high royalty fees on these adaptations.

3. Agricultural Trade, with Subsections by Country

3.1 General Analysis

In 2011, Latin America contributed only 5.8% of the world's total exports, but 24.4% of maize exports, 27% of soya beans, 23% of rape/colza seed, and a striking 62.5% of world exports in soya oil. These numbers demonstrate the disproportionate role played by agriculture within the Latin American economies: non-meat agricultural exports constituted approximately 5% of overall GDP and had an export value of roughly US$40 billion in 2011 (World Bank 2012, UN Comtrade).

These crops* are also those most often approved for GM. GM maize is approved in five Latin American countries (mostly HT, or herbicide tolerant), GM soybean in seven countries (mostly Bt, which stands for Bacillus Thuringiensis, a soil dwelling bacterium whose DNA is incorporated into crops to give them insect resistance), and GM cotton in 5 (mostly Bt) (James 2012). Furthermore, when countries make the shift to GM adoption, they tend to embrace these GM crops fully, probably since farmers, recognizing the potential benefits, leap to adopt. **Figure 4** shows biotech soybeans as a percentage of countries' total soybean crop. Clearly, countries making the move to adopt GM soybeans should expect GM soybean cultivation to increase quickly to dominant levels.

Thus, given that maize, soya, and cotton are the primary GM crops in Latin America, and that cultivation levels are often near 100% for GM approving countries, general export data in these crops should be broadly interpreted as GM, especially in Brazil, Argentina, Paraguay, and Uruguay.

*Crops measured using UN Comtrade Database were [Maize unmilled, Maize (corn) flour, Soya beans, Soya oil and fractions, Cotton seeds, Cotton Oil and Fractions, Rape/colza oil]. Together, these crops make up a vast majority of total non-meat agricultural exports in the region, and are thus used as a representative approximation for all non-meat agricultural exports.

As shown in **Figure 5**, Latin American countries specialize in very different crops. Soya products are dominant in MERCOSUR nations (Argentina, Brazil, Paraguay, Uruguay). 98% of Uruguay's non-meat agricultural export value comes in soya beans, while this value is 77% in Paraguay, 35% in Argentina, and 80% in Brazil (UN Comtrade). Maize plays an important role in Mexico, Colombia, and Costa Rica. If one examines volumes instead of percentages, Brazil clearly dominates MERCOSUR exports, with a higher 2011 export value in soya beans alone than Argentina, Uruguay, or Paraguay show in total non-meat agricultural exports.

Looking beyond MERCOSUR, Chile exports a high volume of maize products, while Bolivian exports consist mainly of soya oil. The sheer difference in export volumes between MERCOSUR and non-MERCOSUR nations in Latin America should however be noted. If exports from the two were graphed along the same axis, non-MERCOSUR countries' export value bars would be nearly invisible.

Turning now to agricultural trade within Latin America, that is, bilateral trade between Latin American countries, one sees a drastic falloff in export volumes. The sum of all non-meat agricultural export *to Latin America from Latin America* is only US$4.8 billion, or 1.8% of total Latin American exports within the region. Clearly, Latin American nations trade relatively extensively with each other (US$269 billion in 2011), yet nevertheless do not trade in agricultural products. An illustrative case in point is that of Paraguay.

Paraguay exported in total only US$2.935 billion worth of agricultural crops in 2011, but within Latin America this country plays a disproportionately large exporting role, making up 27% of all exports within the region. Looking at a graph of regional exports (**Figure 6**), Paraguay is very prominent, but when looking at a graph of exports to World (**Figure 7**), in which these regional exports are included, Paraguay's exports disappear in comparison to larger global exporters Brazil and Argentina. Part of the explanation for this disproportionately high export rate from Paraguay is this nation's landlocked status. Chile, a country with extensive sea access, exports 99.31% of its crops out of Latin America, while Paraguay, with no ports, exports the majority to Brazil and Argentina (UN Comtrade).

Returning, however, to the dearth of regional agricultural exports, the Balassa Index may provide answers. Measuring Revealed Comparative Advantage, the Balassa Index assesses how advantaged a country is in a certain industry. In this analysis, each crop sector (Maize unmilled, maize (corn) flour, soya beans, soya oil and fractions, cotton seeds, cotton oil and fractions, rape/colza seeds) was assessed in comparison to two reference groups, r = World, and r = Latin America. The Index gives values according to this formula:

$$BI_{ij} = \text{share of j in country i's exports} / \text{Share of j in reference set r's exports}$$

Where j = specific export crop, i = specific exporting country, and r = reference set to which the export proportion is compared. Balassa Index values above 1 show a Revealed Comparative Advantage (RCA) for that country in that crop (Princeton Encyclopedia of the World Economy).

When countries' exports are analyzed using r = Latin America, the resultant Balassa indices are strikingly low: only 11 out of 63 industries show RCA, and the average index value is 1.308 (**Figure 8**). However, when r = World, Balassa indices rise dramatically across the board. 17/28 sectors now show RCA, and the average value is 8.739 (**Figure 9**).

On an individual basis, Argentina shows RCA in all assessed crops excluding cotton seed oil; Brazil in all but rape/colza, and Paraguay in all but Maize corn flour. In each of these cases, the country's production weakness is paired with a noticeable strength in the corresponding crop in a neighboring MERCOSUR country. Thus, for example, Paraguay's relative weakness in maize flour exports is matched by strong Balassa indices in maize flour in Argentina and Brazil. This coherence may reflect crop specialization within the relatively more unified MERCOSUR market. On the other hand, or course, all four MERCOSUR nations show strong RCA in soya bean production.

Overall, the sharp contrast between RCA within Latin America and the strong index numbers when the region is compared to the world suggest tough competition: LA as a region appears to boast a strong comparative advantage in agricultural crop production when compared to the world. This may be a factor of land and resource availability, and/or a lack of alternative resource allocations. However, and excitingly, another, at least partial explanation could be the regions' disproportionately strong embrace of GM crops. As explained earlier, more Latin American countries have adopted GMOs than has any other world region, and much of the current global GM hectarage growth is coming from Latin America (James 2012). Thus, one impact of this strong GM embrace could be an increasing level of competitiveness and efficiency from Latin American GMO producers in comparison to conventional agriculture world markets. This consideration may merit further study, which could include the calculation of Balassa Indices from dates prior to broad Latin American GMO adoption in the early 2000's−if RCA rose notably after this period, GMOs may have played a role.

The discrepancy between low Balassa Indices within regional trade and high Indices when compared with the world as a whole can also help explain the lack of regional trade. All countries examined here are considered agricultural exporters, and all have strong agricultural sectors within their domestic economies (UN Comtrade). Thus, compared with the world, individual Latin American countries are highly specialized in agriculture, but when compared to other highly specialized agricultural producers, their Comparative Advantage is diminished, explaining the low regional Balassa Index values.

Brazil and Argentina dominate GM crop cultivation just as they dominate exports. Until recently (2008), Argentina was the second largest GMO cultivator in the world after the United States, but Brazil has recently edged ahead, and now grows 19% of global GM crop hectarage. Argentina grows 15%, Paraguay 2%, and Uruguay 0.7% (James 2012). To follow growth trends, **Figure 10** shows growth rates in GM hectarage graphed across Latin American countries. Since the passage of its Biosafety Law, Brazil has experienced high growth each year (for more detailed information, refer to the Brazil subsection 3.2b). Uruguay, after the lifting of its recent moratorium on new GM events, saw this pent up GM potential explode in 2011 with 30% growth in GM crop hectarage in a single year.

When looking at growth rate figures among countries, one must take their context into account−Paraguay's dramatic increase in crop hectarage involved far less land area than Argentina's small increase, given the already existing levels of GM crops. Furthermore, Argentina's lower growth should not be interpreted as a declining or slowing acceptance of GMOs. Rather, it simply highlights the fact that the great majority of Argentina's crops are already GM, and thus little area remains for dramatic increases (refer to **Figure 2**).

3.2 Trade Briefs by Country

3.2a Chile

Chile offers a rather mixed bag in terms of GMO trade policy. With 22.8% of non-meat agricultural exports going to the US and only 3.4% to the European Union and Japan (UN Comtrade), one would expect an orientation toward a more permissive policy. What has occurred in actuality is a division between the internal market dynamic, which remains closed from most GMOs, and its export market, which exports over US$360 million in non-meat agricultural products, largely to the United States and China. Thus, the apparent contradiction between a closed internal market and a US (pro-GMO) export orientation resolves itself: the US$360 million dollar seed production market in Chile, controlled for the most part by foreign multinationals, is channeled through Chile as a "world laboratory" for GM seeds without ever reaching Chilean consumers (UN Comtrade, James 2012, Salazar 2011). In short, to quote a N. Ramiraz, an agricultural specialist for the USDA in Chile, "Chile does not produce any crops for sale domestically. However, Chile has propagated transgenic seeds under strict field controls for re-export for more than a decade." Preventative or precautionary domestic measures do not preclude promotional trade regulations.

Chile in 2009 imported approximately 890,000 kg. of GM seed, 97% of which came from the United States, cultivated this seed, and re-exported 45,291,624 kg. of seed back to the USA (UN Comtrade). Resolution 1523 of 2001 (Ministry of Agriculture and SAG) regulates this process, whereby the seed is cultivated over the duration of the Northern Hemisphere's winter and then re-exported without ever contacting Chilean consumers (USDA GAIN 2011). Thus, no significant barriers stand in the way of GM production in Chile: GM seed imports are treated equally with non-GM imports as long as they remain within the closed production channel detailed above.

3.2b Brazil

Brazil, Latin America's largest soybean producer (soybean exports were US$16.33 billion in 2011) (UN Comtrade), displays exceptionally high Revealed Comparative Advantages for a number of important agricultural products, including soya beans, soya oil, and various maize products.

Brazil trades heavily with the United States, Argentina, and China, with 33% of exports and 39% of imports involving these three countries (UN Comtrade). However, when one focuses on the agricultural sector alone, as explained earlier, export orientation shifts to Europe. Brazilian imports from the USA in major agricultural products only totaled an approximate US$5 million in 2011, and its exports to the US in these products totaled 3,574,942 kg. in total. This was only .06% of exports to Europe and Japan of these same crops, giving Europe+Japan a 29.5% share of Brazil's non-meat agricultural exports, contrasted with a 0.1% share for the United States.

3.2bi Brazilian GMO adoption and trade with Europe

Brazilian agricultural exports to Europe and Japan show a trending increase from 1990 to 2007, as the growing nation built stronger ties with the European Union. This trend reversed itself sharply after 2007, showing a very notable decline of export volumes after this date. While agricultural exports to Europe are still significantly higher than those to the United States, the drastic decline may indicate the lagging but very real effects of Brazil's massive reorientation toward GMOs (UN Comtrade). Passed in 2005, Brazil's far-reaching Biosafety Law was the first in Latin America to incorporate a specifically GMO-focused regulatory body into national law. The Biosafety Law effectively legalized what had been an increasing cultivation of GM crops, smuggled across the border from Argentina as early as 1998. After the legalization, and now under the governmental aegis, GMO cultivation took off in Brazil, as illustrated in **Figure 11**. As can be seen, plateauing hectarage numbers before 2005 became skyrocketing growth after the passage of the Biosafety Law. Last year alone, Brazil saw a 19% increase in its GM crop cultivation (James 2012).

During this same period, Brazil's trade with Europe and Japan has been in constant adaptation and evolution. Agricultural trade dipped in 2005, spiked by 2007, and after that fell by more than half up to 2011. (UN Comtrade) (see **Figure 12**). An important point is that this analysis is not tracking total trade volumes, which have increased nearly 400% over this same time frame.

Thus, while total trade between Brazil and Europe and Japan has been increasing steadily since 1995, trade in the very agricultural products which Brazil has approved for GM (Brazil has approved HT soybean, Bt cotton, Bt maize, and crops analyzed in export data were maize, soya, and cotton) has declined since slightly after the passage of the Brazilian Biosafety Law in 2005. The European Union and Japan, more so than nearly any other country or regional group, are highly precautionary toward GM products. They demand strict regulations on GM imports, as well as any domestic cultivation (Silva Gilli 2010, Falck-Zepeda 2009, Paarlberg 2001). Thus, the declining import of Brazilian agricultural products, which are increasingly GM, is entirely intuitive, but nonetheless very illustrative of the kind of tradeoffs faced by developing countries in their decision-making calculus regarding GMOs. Luckily for Brazil, rising Chinese demand for Brazilian exports, including all of these agricultural products, has picked up the slack, as illustrated in **Figure 13**. Over the 2005-2011 time frame in which Brazilian agricultural exports to Europe and Japan have declined by well over half, China's receipt of these same products has increased from 7,593,095,615 kg. to 22,789,222,077 kg., a ~300% increase (UN Comtrade).

Brazil ratified the Cartagena protocol in 2006, establishing "detailed documentation requirements for genetically modified organisms in the international trade of agricultural commodities," according to a European Commission press release from Curitiba, Brazil (Europa, 2006). Given the nation's detailed labeling requirements (discussed below), Brazil does not appear to discriminate between GM and non-GM foods for import nor for export, and it equally makes little substantial effort at segregation of production and supply lines, which would be necessary for export segregation (USDA GAIN 2011).

3.2c Argentina

Argentina has many fewer small-hold farmers and shows significantly more reliance on modern monoculture agriculture than comparative Latin American countries such as Brazil (Silva Gilli 2010, Paarlberg 2001). Examining the Balassa index, Argentina clearly has a strong incentive to invest in agricultural improvement and expansion, given the fact that it has a Revealed Comparative Advantage in almost all crop sectors with GM potential.

38% of Argentina's total exports stay within Latin America, while 5.4% of non-meat agricultural products reach the European Union or Japan. While this number appears rather small, it can be misleading in that Europe and Japan actually do receive much of Argentina's exports, but these are in the form of beef. Since this product is fed on GM feedstuffs but does not retain intact GM content, EU regulations do not monitor or limit beef as strictly as they do feedstuffs endogenous to Europe or GM feedstuffs/foods imported directly into Europe (*REGULATION (EC) No 1760/2000 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 17 July 2000 establishing a system for the identification and registration of bovine animals and regarding the labeling of beef and beef products and repealing Council Regulation (EC) No 820/97, and REGULATION (EC) No 1830/2003 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 22 September 2003 concerning the traceability and labeling of genetically modified organisms and the traceability of food and feed products produced from genetically modified organisms and amending Directive 2001/18/EC*) (Official Journal of the European Communities 2003). This same principle‒a relative buffering of the negative effects of GM production on trade with the EU thanks to a diversion of GM crops into feedstuffs for EU-destined beef‒applies equally to other MERCOSUR countries (Uruguay, Brazil, and Paraguay).

Argentina has approved full imports and exports of Bt Cotton, Bt maize, and HT soybean. Given its 100% GM soy production, it exports ~US$10.5 billion in GM soy products each year (UN Comtrade). It does not discriminate between GM and non-GM imports or exports besides the aforementioned approval process for new releases. However, the Argentine National Seed Institute has forbidden imports of GM rapeseed with Resolution 305/2007. It requires a certified absence of GM seeds in rapeseed shipments for all imports (USDA GAIN 2011). This appears to be the only strict regulation on GM border crossings in Argentina.

3.2d Uruguay

Uruguay exports few potentially-GM crops. Since it has approved GM event releases in HT soybean and Bt maize, these crops thus include all maize and soy products (given that 100% of soybean and 83% of maize is GM) (James 2012). With a value of about US$455.7 million, Uruguay's soya bean exports constitute a significant portion of its foreign trade, which seems reasonable given that soya is Uruguay's only GM crop showing a revealed comparative advantage on either the world market or within Latin America (UN Comtrade). Approximately 36.7% of Uruguayan exports remain within the region, and the majority of soya products go to the United States. Beef is by far Uruguay's biggest export: it accounted for US$3.4425 billion in exports in 2009, which is 63.9% of total exports. 32.6% of this beef went to Europe or Japan (UN Comtrade). The argument extended in section 3.2c in regards to other MERCOSUR countries' beef exports as a diluting effect on the GM crops/exports to Europe controversy applies perhaps most powerfully in Uruguay, given its sheer lack of raw GM exports and simultaneous dependence on GM-derived beef destined for Europe. As mentioned earlier, future regulations may alter MERCOSUR nations' abilities to escape this current contradiction.

The United Nations' Comtrade database does not show any trade in GM crops between Uruguay and the EU or Japan (country groups which are traditionally oriented away from GM products and regulate their import much more closely‒see introduction). Uruguay's total crop hectarage declined considerably between 2006 and 2008, which was precisely the duration of the moratorium on GM crop commercialization (UN Comtrade). Since then, total hectarage has leaped back up. GM crops as a percentage of this quantity have remained relatively stable, and the 33% increase in GM crop hectarage in 2010 mirrored a similar increase in total hectarage. The strong decline in hectarage during the GM moratorium, and strong rebound after it was lifted, suggest a link between the two. GM crops may have gained such a decisive foothold in the country prior to 2006 that the moratorium simply could not overcome their momentum. In this light, the harmful effects of the moratorium across the agro-economy (as seen in overall hectarage decline) may have forced the government to reverse course. Here again, then, we can see the interplay of trade and policy, and the influence GMO trade can have in molding national laws (See **Figure 14**).

A USDA GAIN report from 2011 claims that Uruguayan rice farmers (rice made up a substantial US$1.3 billion in exports, or 24.2% of total exports in 2009) would push for GM rice products but do not want to damage export markets. The weight of this claim seems dubious, given that only ~8% of Uruguayan rice exports go toward Europe or Japan, but nevertheless, this situation would be illustrative of the concerns and quandaries facing any producer, large or small, when considering the use of GMOs (Yankelevich 2010, UN Comtrade, Paarlberg 2001).

3.2e Paraguay

As a landlocked nation, Paraguay's exports must pass through these surrounding nations, which can sometimes skew trade statistics, especially if raw goods like soya beans (a large Paraguayan export) have value added in Argentine or Brazilian processing facilities and thus appear in the Argentine or Brazilian export numbers. Paraguay's landlocked status may explain why its exports alone make up 40% of endogenous Latin American non-meat agricultural trade. In fact, despite a relatively negligible role in world international trade, Paraguay dominates within Latin America, as shown in **Figure 6**, detailing exports from Latin American countries to other Latin American countries.

The majority of Paraguay's agricultural exports go to Brazil and Argentina (UN Comtrade). Since both of these nations have embraced GMOs, Paraguay should see little discrimination of its GM soy exports. As touched on earlier, Paraguay dominates internal Latin American trade in agricultural products. ~86% of soya beans traded within the region come from Paraguay, as do ~78% of rape/colza seeds (UN Comtrade)

Paraguay's dominance is further illustrated in its Balassa Index, which is strongly >1 for all major non-meat agricultural products that are prevalent within the country. This indicates a strong comparative advantage in agricultural production in comparison with the world. When compared against other MERCOSOUR countries in the area of Latin American trade, Paraguay is one of the few countries with strong comparative advantage, especially in soy products (UN Comtrade). While agricultural trade is strong, bans on GM corn cultivation represent a slight limitation on GM expansion. Furthermore, the fact that GMO introduction to Paraguay was illegal, that the government banned GMOs until it realized their inevitability, and that it continues with anti-GMO regulations (albeit grievously unenforced/unenforceable), trade conditions should be seen as relatively preventative.

3.2f Mexico

Note: Part of this section is repeated from the Policy Section report on Mexico. See that section for a full account of the Mexican GMO controversy; see this section for a summary of NAFTA's impacts on Mexican trade, especially with the United States.

Soon after NAFTA came into force, the Mexican government either waived or failed to apply a majority of the import restrictions which had been built into the agreement, including on maize products (Nadal 2000). Thus, as the United States proceeded to increase its domestic agricultural subsidies, particularly to maize producers, Mexican farmer-support fell: by 2004, US subsidies had risen 48% while Mexican subsidies had fallen 39%, until they matched only 10.4% of the US subsidy support (Wise 2007). Corn flows from the United States increased dramatically, bringing GM maize products to Mexican markets. Mexican regulators, conscious of the potential vulnerability of the smallholder controlled landraces, decreed that GM maize imports could be used only for consumption, not production.

Under NAFTA, Mexico's trade is intimately tied with that of the United States: 80.5% of Mexican agricultural exports go to the United States (UN Comtrade). In turn, the US promotes its own agricultural exports to Mexico, which, of course, contain GM components. As explained earlier, US farm subsidies underprice small Mexican producers, especially in maize, forcing these smallholders off their farms and into situations of forced urbanization or immigration. (Aoki 2012). At the same time, the flooding of the Mexican consumption market with GM maize makes this seed visible to large Mexican maize producers, who see the undeniable up-front technological benefits offered by the herbicide and pest tolerant, sometimes drought tolerant seeds (Rosenberg and Fahmy 2011). Thus, GM products are effectively promoted to lower production costs through US subsidies, with the intention of boosting US exports (Wise 2007). This creates a strongly promotional environment for these transgene products within Mexico (Paarlberg 2001), perhaps against the interests of many, but within the interests of those making large scale crop production decisions, both in the United States and in Mexico.

4. <u>Policy Impacts on Trade; Trade Impacts on Policy</u>

Developing countries often face a stark choice. Grant far-reaching IPR concessions to multinational corporations, or suffer a lack of investment and innovation. Robert Paarlberg's chart epitomizes this view by categorizing countries' IPR policies on a scale from "preventive" to "promotional." The most promotional countries, according to Paarlberg, are those with the strongest IPR protections (2001). The current situation in most Latin American countries belies this dichotomy and reveals it as, at least in part, a false choice.

One of the clearest examples is Brazil. IPR protections remain weak in Brazil (see section 2.2a), yet GM crop cultivation nevertheless increased 19% in 2010 alone, and now makes up 19% of global GM hectarage (James 2012). Clearly, weak IPR protections in this case did not dissuade multinational investors, nor did they slow domestic GMO expansion. A nearly identical situation exists in Uruguay, where historically weak IPRs, including unpatentability in most GM products, have not discouraged multinationals from clamoring for GM event approvals: over 20 since the lifting of a GM moratorium in 2008 (James 2012, Hirschfeld 2011).

Paraguay presents an even more striking case. GM maize is still not approved in Paraguay (James 2012). Despite this, Paraguay hosts an enormous underground economy, much of this engaged in illegal GM maize production (Barnett 2010). Extensive governmental efforts to stop this production, including the destruction of GM maize fields, have gone unheeded by multinationals, which continue to cultivate these GM products (Barnett 2010, USDA GAIN 2010). Thus, the nearly complete lack of IPR protections within Paraguay, coupled with the government's explicit attempts to keep GM maize out, have thus far failed to have any discernible effect on actual GM maize cultivation. Clearly, IPR protections are not necessary to draw GM cultivation and investment into a country. Rather, very few policy options appear available for countries endeavoring to keep GMOs out.

This contention, however, should not be seen too simplistically. IPR protections have complex effects that extend far beyond cultivation levels and foreign investment. Some of the most notable effects of IPR protection variations can be found in Brazil and Uruguay. Weaknesses within Brazilian IPR laws typically lead innovators to seek patent protection in the United States, or to use trade secrets protections in place of patents (Falck-Zepeda 2009, USDA GAIN 2010). This could have oppressive effects upon innovation if researchers do not make public their discoveries owing to trade secret limitations. These weaknesses seem to be driving Brazilian policy-makers toward a stronger IPR policy, a policy/trade interaction which will be discussed shortly (Vas e Dias 2009). In Uruguay, multinational agribusinesses are working around a weak patent system by creating individual contracts with local farmers (Yankelevich 2010). Here too then, market forces desire IPR protections, and face hurdles when patentability is weak or UPOV78 is in force. For policy-makers, the observation that lack of IPR protections *do* hinder corporations and researchers, but equally *do not* prevent GM cultivation, should color all IPR related decisions. Limiting patentability may have consequences for diverse actors in situations extending far beyond the false GM/non-GM dichotomy.

While IPR protections may be a poor indicator of GMO strength within Latin American countries, Revealed Comparative Advantage correlates closely with degree of GMO acceptance. The Latin American nations displaying the largest Balassa Indices are also those most strongly involved in GMO cultivation (see **Figures 8 and 9**). And, if the relationship is reversed, we see that countries with low Balassa Indices and Comparative Advantages also display relative weakness in GMO cultivation: take Bolivia, Colombia, and Mexico as examples. This suggested correlation, while strong, is of course affected by countless alternative explanations, including geography, economic makeup, governmental situation, and legal environments. Nevertheless, the fact that one cannot find a contradictory case–strong RCA in crop exports coupled with low GMO use–is a strong illustration of this as a predictive factor. Basically, those countries with the largest and most powerful agricultural sectors can afford to make the GM transformation and dictate the consequences to less dominant neighbors and trading partners. This was illustrated by Argentina's early and fervent GMO adoption, which had the effect of spreading GMOs throughout the rest of the region.

I searched for another very intuitive correlation, between agricultural export destination and degree of GM acceptance, as illustrated in **Table 6**. Given Europe's strict regulations and oppositional stance to GMOs, it would seem reasonable that countries exporting significant volumes of agricultural products to this region would be more opposed to GMOs or would at least regulate them more closely. Similarly, countries exporting crops primarily to the US would seem likely to have promotional GM policies. Nevertheless, this correlation did not appear. Mexico, for example, sends nearly all of its agricultural exports (85%) to the United States (a strongly GMO-supportive nation), yet nevertheless maintained a GMO moratorium until recently and still has harsh approval standards in place. A possible and partial explanation for the lack of correlation is the very recent nature of the GM revolution in Latin America. Nearly all major GM transformations within these nations have occurred within the last decade, and historical trade ties with Europe may continue to hold, despite an increasingly GM agricultural paradigm. Equally, as in Mexico's ties to the US, exogenous factors like NAFTA may maintain trade ties despite diverging GMO approaches. As the GM revolution progresses, we are likely to observe a realignment in global agricultural trade toward what **Table 6** would suggest. This realignment is already occurring in Brazil, as documented in detail in the Brazilian Trade Brief.

Fundamentally, and as suggested above, we must ask whether trade drives policy or policy drives trade. In Latin America, trade in GMOs has nearly universally preceded legal approval of these products (refer to Policy and Trade Briefs), and countries have regularly been forced to adapt their policies to a GM reality. Some nations have refused to acknowledge an existing GM presence, as Chile effectively does now with its refusal to write new GM food policy regulations in the face of high GMO content in foods. Nevertheless, most countries eventually find their hand forced, as Brazil did in 2003 and 2004 when it had to issue a special decree to temporarily legalize GM crops. The alternative would have been the destruction of nearly all soya beans in the country. Thus, trade in GM products often precedes approvals of these products, and continues, after adoption, to influence regulations. This too is seen today in Brazil, where increasing levels of GM crops are prompting policy-makers to rewrite weak IPR protections.

And policy can also affect trade, most obviously through moratoriums. Of more far-reaching consequences are Europe's labeling and traceability regulations. As explained in the Argentina Trade Brief, if Europe refines its regulations and extends traceability requirements to GMO-derived imports (like MERCOSUR beef), Latin American countries may find maintenance of their cross-Atlantic trade ties difficult.

The major limitation of this study is clearly the inability to distinguish between correlation and causation. While data regression analysis could evaluate the degree of correlation between, say, Brazilian GMO adoption and agricultural trade with Europe, causation would still remain elusive.

Furthermore, in conducting policy research I often encountered significant gaps in the relevant policy information. There is a distinct lack of scholarly work on some countries' agricultural policies. Readers will thus note the use of newspaper articles and reports from the United States Department of Agriculture. For all of these non-scholarly sources, considerable accounting for bias has been made.

Moving forward, researchers could extend my calculations of Latin American nations' Balassa Indices back through 1990. Doing so would show the evolution of RCA in agricultural products over time. Correlating this evolution with the onset of GMO adoption and promotion could allow conclusions to be drawn regarding the effect of GMOs on Comparative Advantage. If the Balassa Index (r = World) rose substantially after the adoption of GMOs, my postulation that GMOs may be part of the explanation for Latin America's high regional RCA in agriculture may be substantiated.

In addition, researchers over the next few years could collect further data on GM crop hectarage in Uruguay, which may confirm the hypothesis that the GM moratorium correlated almost perfectly with the sharp drop in GM cultivation.

It will continue to be worthwhile to monitor Brazil's agricultural trade with Europe and China. My results would suggest that agricultural exports to Europe will continue their sharply downward trend, while export volume to China in these same categories will continue to rise.

5. Conclusions: Where is the GM Revolution going in Latin America?

This paper set out to answer these questions:

- Will a divided global regulatory environment dichotomize developing nations in regard to GMO regulation; that is, force them to take either the EU or US approach, or will these nations construct newly imagined/negotiated middle roads between developed-world extremes?
- How will countries with both enormous GMO potential and significant numbers of subsistence farmers balance IPR concessions to multinational corporations with local interests and traditional knowledge, and can they construct policies that benefit all groups?
- How will Latin American countries' agricultural exports change as they evolve into a new GM reality?

Throughout the 1990's a great schism split the developed world in two. The United States embraced genetically modified organisms fully, and supported the technology as it spread throughout the nation's farmlands, north across the Manitoban prairies, and south into the northern states of Mexico. The newly forming European Union, in contrast, opposed the new genetic technologies, seeing within them the shadows of past crises in its troubled food history. The rise of onerous regulations and sophisticated GM tracking regimes in Europe pulled large parts of the world out of their natural orbit: Africa abandoned many emerging GMO initiatives to maintain agricultural markets to the north, and Latin America hesitated, pulled along the fault lines of this 21st Century continental drift, unsure how to calculate the costs and benefits of the GM revolution.

Now, approximately one decade on, these Latin American countries continue to negotiate a balance between developed world extremes, but one thing has become clear: many of their calculations and policy choice are made for them, whether through the smuggling of GM seeds, bilateral treaties like NAFTA, or the impositions of broad new IPR regimes like the World Trade Organizations' TRIPs agreement.

Mexico entered the North American Free Trade Agreement in the early 90's. One of NAFTA's primary aims was to improve the efficiency of Mexican agricultural markets. Subsistence farmers would move to productive jobs in urban areas and benefit from less expensive US corn. While this process has been, in practice, far from the frictionless transition praised by economists, it did bring a flood of genetically modified maize from the United States into Mexican food markets. In so doing, it sparked a prolonged struggle between GM proponents urging the commercialization of GM maize, and critics, who defend the nation's historically and culturally significant maize landraces. This conflict, then, highlights Mexico's torn position within a dichotomized GM globalization: policy-makers must seek a balance between agricultural innovation and the accompanying economic growth on one hand, and considerations of traditional knowledge and biodiversity on the other. Today, emerging from a broad moratorium on GM crop cultivation, Mexico has erected an innovative and elaborate procedure of test plots and trial periods for all GM crops. Based upon a precautionary principle that considers both known and unknown scientific risks, the Mexican *Reglamento* (its biosafety law) promises to reform the domestic situation. However, the *Reglamento* does not install a regulatory body to evaluate the socioeconomic risks of GMO commercialization. This lapse, perhaps a mark of the country's continuing close ties with the United States, may leave small farmers unprotected in the face of a potential rush of GMOs. Mexico's balancing act between NAFTA's unending flood of GM products from the US and the need to protect maize biodiversity and diverse lifestyles highlights one developing nation's attempted forging of a middle path. We will see the successes or failures of its newly instituted approval process and regulations in the coming years.

Chile too is seeking an alternative approach to GM regulation. Producing one fifth of the world's seed exports, a large proportion of which are GM, Chile nonetheless bans the cultivation of GM products for domestic consumption. It is apparently seeking the US-style agricultural benefits of GM crops (reduced chemical use, increased yields, etc.) while simultaneously maintaining a cautious, European approach to food safety. Unfortunately, in recent years high volumes of GM-containing food have begun to enter Chile from abroad, thwarting the interests of food safety regulators. Chile has done little to acknowledge or regulate these GM food imports, showing the difficulties countries face in trying to maintain a moderated GM stance in the face of global pressure.

Accompanying the rising GM revolution in the 1990's were a series of Intellectual Property Rights agreements. The most decisive, TRIPs, was folded within the World Trade Organization's Uruguay Round, and emerged as a bargain between developed and developing nations: the US and Europe would only open their markets to developing countries' exports if these countries would protect the intellectual property (GM products) of US and EU based companies. With no real alternative, developing nations accepted. This gave multinationals unparalleled access to local markets and the legal clout to extract royalties on locally grown GM products, diverting profits and benefits to foreign corporations and often imposing disruptive technologies on previously sustainable communities. At the same time, however, these IPR protections brought positive change as well. Developing country research institutions could now innovate, knowing that their inventions would garner an appropriate reward, and reduced prices and chemical use in agriculture benefited stressed environments. Thus, policy-makers today must navigate carefully when constructing IPR policies, for even subtle changes in these regulations can have far-reaching and contradictory effects.

A body of scholarly work, represented in this study by Andreanne Leger's analysis of IPR implementation in Mexico (2005), asserts that, within developing countries, IPR protections are so often ignored or ineffective that they do not in reality offer any of their promised incentives. This study supports this finding to some extent in its finding that IPR strength does not reliably correlate with GMO or foreign investment strength. At the same time, however, many of the Latin American countries which have resisted or failed to implement strong IPR measures show a dependence on foreign patents and foreign inventions (Falck-Zepeda 2009). Clearly, without recourse to in-country patenting, local innovators are handicapped against foreign researchers with access to US patent protections. Without adequate IPRs, Latin American research institutions may never have the innovation capacity necessary to escape situations of agricultural dependence.

Can Latin American nations emerge from this double-bind with policies benefitting all parties? Uruguay, which employs UPOV78 and grants broad discretion to farmers' seed rights, has effectively ceded much of its IPR control to multinational corporations, which have begun formalizing private, individual royalties contracts with farmers. While the lack of formal royalties schemes may leave more benefits with farmers, the ceding of contract privileges to market forces may risk yet more problems, given the asymmetric resourcing between small farmers and multinational corporations.

In Brazil, a strong labeling regime exists on paper, but is never enforced. Workable enforcement clauses could change this. As the GMO situation in Brazil evolves, we may see regulators leaning one way or another on this important issue. While consumer choice in GMO consumption is important, imposing a strict labeling regime, with its resultant price-hikes, may have negative consequences for a population which already spends a disproportionate amount of its income on food (Economist Intelligence Unit 2012).

What seems needed, both in Latin America and around the developing world, is a more open, participatory GMO approval process. Too often, GMO introduction decisions are made behind closed doors, the product of negotiations between bureaucrats and foreign businessmen. Countries cannot ensure a representative, publicly supported GM policy while simultaneously prohibiting public participation. At the same time, environmentalist groups' across-the-board smear campaigns create a misleadingly negative portrait of GMOs. The GM Revolution does present grievous challenges to developing countries, but the completely oppositional stance taken by many NGOs is counterproductive. With flexibility on both sides, more constructive GMO policies could be built.

Finally, we are beginning to see shifts and realignments in the dynamics of global agricultural trade as the GM revolution plays around its two developed pivots–the United States and the European Union–and a newly decisive force: Asia. As demonstrated in section 3.2bi on Brazilian Trade, Brazil's crop exports are shifting from an increasingly isolated, anti-GM Europe toward a rising China. Hungry for raw materials, including grains, China devours Brazil's agricultural products and promises to redefine the dichotomy described above. Developing countries now making the shift to GM cultivation may lose their European markets, but now have an alternative in China. Nevertheless, trade is never a fully flexible process. Multilateral and bilateral treaties, regulations, and historic ties can maintain trade between regions long after GMOs should seemingly have altered the calculations (see **Section 4** above). NAFTA shapes Mexico's import and export dynamics, and MERCOSUR agreements prefigures trade in the Southern Cone. Recent machinations within MERCOSUR have suspended Paraguay from the group and included Venezuela. With Venezuelan president Hugo Chavez now a member, along with Peronista President Cristina Kirchner in Argentina, former revolutionary and current president Jose "Pepe" Mujica in Uruguay, and Labor Party leader Dilma Rousseff in Brazil, MERCOSUR may be trending away from free trade and towards a regional production pact. This trend extends beyond MERCOSUR to the rest of Latin America. A new reorientation toward the Left, in response to two decades of neoliberal expansion, may yet have a broad impact on adoption of new GMO technologies, given that these Leftist governments are often opposed to multinational involvement. To the contrary, however, this paper has shown strongly that developing nations can often do little to keep GMOs out. The GM revolution appears to have established itself permanently in Latin America.

6. Appendices

6.1 Policy Tables

Robert Paarlberg's chart of policy options toward GMOs (see **Figure 1**) lays out a scale along which policies can lie: most "preventive" to most "promotional." He proceeds to categorize countries along these scales in each of five areas: intellectual property rights, biosafety, trade, food safety, and public research investment.

However, Paarlberg makes significant generalizations that draw him away from a specifically Latin American context. For example, in the IPR sections he gives too great a role to the UPOV treaties. Within Latin America there is very little variation in UPOV membership: nearly all countries are party to UPOV78. Recognizing diverse alternative factors that play into IPR strength is an important part of adapting the analysis to the local reality. His categorizations in other categories are equally over-general.

My chart adapts Robert Paarlberg's approach to the specifically Latin American situation. I give nuance to the categorizations by explicitly including current national regulatory situations in the chart's classifications. I also offer significantly more detail within each box, thus giving researchers a more accurate, less ambiguous tool with which to assess policy. While I have maintained Paarlberg's lexicon, I offer a critique as well: it is important to recognize that what this chart deems "promotional" may be (especially in Paraguay's current case) directly opposed to what the government desires for its people: their policies are only "promotional" in the sense that they have tried to stop GMO introduction and have failed.

Policy Options for the Regulation of GM Crops

Policy area	Promotional	Permissive	Precautionary	Preventive
IPR	Broad patentability of GM products, signitory to UPOV 1991, high Park Index, evidence of meaningful compliance and enforcement	Limited patentability, membership in UPOV 1978, relatively strong enforcement standards	Low patentability for GM products, membership in UPOV 1978, low Park index, high reliance on foreign patents, evidence of poor enforcement/lack of legal enforcement measures	No patentability for GM products, membership in UPOV 1978 but no compliance, no evidence of domestic patenting, total absence of enforcement
Biosafety	Evaluation of scientific/social risk nonexistent or unenforced, no regulatory process for GM product approval, Gm products exist in market but are unregulated	Official approval procedures exist, but only as a formality; nearly all GM events approved, with short-term field tests and monitoring required	Multi-tiered procedure for GM product approval, regulatory bodies embrace "Precautionary Principle" and examine both scientific and socioeconomic risk, extensive testing and lengthy evaluation periods required	GM crops and foods banned through a temporary moratorium or permanent exclusion, risk assumed in all GM cases, onerous evaluation procedures
Trade	No trade barriers exist for GM products; bilateral or multilateral agreements promote GM trade; national policies or subsidies aid GM producers and promote GM exports	GM imports/exports are not distinguished from non-GM; "substantively identical" products are treated the same; no trade barriers exist for GM products	Border inspections required for GM products; traceabilitiy norms and labeling requirements required of all GM imports, regulatory body charged with GMO import/export monitoring	Significant regulatory efforts are made to prevent GMO imports/exports. Explicit bans on GMOs, as country tries to establish GMO free status or protect local markets
Food safety and Consumer Choice	GM and non-GM products are never distinguished within the production or consumption markets; no labeling requirements exist; supermarkets or producers do not apply voluntary labeling restrictions	Labeling regime exists for GM food products but is not enforced. Voluntary regimes are not enforced; high levels of GM products exist in production and consumption markets	GM food labeling regime is in place and enforced. Supermarkets and vendors comply with labeling requirements; production and consumption markets are segregated, or production market is GM-free	Blanket bans on GM food consumption are in place; Strong segregation policies between production and consumption channels exist; evidence of strong enforcement
Public R&D	Significant funding dedicated to agricultural R&D; national institutions show track record of innovation; strong focus on modern GM technologies rather than conventional breeding; recent resourcing increases evident	History of stable funding for agricultural research; moderate R&D investments in agriculturalal technologies; at least 25% of funding goes to modern GM techniques	Weak public spending on agricultural R&D; reliance on foreign innovations; instability in resourcing for national research organizations; little to no research in modern GM technologies	Neglible funding for public agricultural research; total dependence on foreign technologies; total lack of capacity in modern GM techniques; recent cuts in staffing or funding

Table created by author

Policy approaches of representative Latin American Countries

Brazil

Categories	Promotional	Permissive	Precautionary	Preventive
IPR			X	
Biosafety			X	
Trade		X		
Food safety		X		
Public R&D	X			

IPR: low patentability, reliance on PBRs and Trade Secrets

The 2005 Biosafety Law embraces the Precautionary Principle and a case-by-case evaluation structure

GM food imports are not distinguished in practice from non-GM

A strong GM food labeling regime exists on paper, but is not enforced.

EMBRAPA is strongly funded. The developing world's third largest agricultural R&D center, it is the only Latin American institute to commercialize its own GM crop product: Golden Bean Soybeans

Argentina

Categories	Promotional	Permissive	Precautionary	Preventive
IPR		X		
Biosafety			X	
Trade	X			
Food safety	X			
Public R&D	X			

Historically strong IPR protections, including broad patentability, may not be regularly enforced, and IPR strength has recently declined.

GM crops undergo careful, multilevel case-by-case screening. They are evaluated using the Precautionary Principle in regard to scientific, as well as socioeconomic risk.

No GMO-discriminatory trade barriers exist. Trade in GMOs is actively promoted.

No food labeling requirements are in place. Most food includes GM components, and public acceptance is high.

Recent years have seen doubling of agricultural R&D staff, as well as funding increases. However, many of these staff were less educated than Chilean or Brazilian counterparts.

Paraguay

Categories	Promotional	Permissive	Precautionary	Preventive
IPR				X
Biosafety	X			
Trade				X
Food safety	X			
Public R&D				X

While nominal IPRs exist, nearly all go unenforced and almost no GM products are patentable.

"Promotional" on Paarlberg's template here means incredibly bad: no enforced approval procedures exist, and an enormous underground economy in GM products highlights lack of biosafety regulation.

Paraguay makes strong efforts to prevent trade in GM process, and all GM growth here has been against the government's will. Thus, while high GMO trade occurs, it is against official but unenforced trade barriers.

Again, "promotional highlights Paraguay's lack of enforcement capacity. No labeling requirements exist.

Chief research agency receives only US$3.1 million, and all funds are dedicated to conventional plant breeding.

Uruguay

Categories	Promotional	Permissive	Precautionary	Preventive
IPR		X		
Biosafety			X	
Trade	X			
Food safety	X			
Public R&D		X		

Uruguay offers a mix of patentable and unpatentable products, a mid-range Park Index, and membership in UPOV 1978, which grants broad seed-rights to farmers. Multinationals may be negotiating royalties agreements directly with farmers, circumventing official statutes.

A lengthy, expensive, and onerous application process would seem to limit GM events; biosafety mechanism was used to install a three year GMO moratorium. Not having ratified the Cartagena protocol, Uruguay is not required to enact tighter evaluation or labeling protocols.

No trade barriers to GM products. Its membership in MERCOSUR leaves markets open to GM products from Argentina and Brazil, thus allowing significant GM imports.

No real regulatory distinction is made between GM and non-GM food products. A labeling regime exists, but is voluntary and thus negligibly employed.

Uruguay has a mid-range capacity in agricultural R&D, but spends a greater proportion of GDP in this area than any other Latin American country. Significant recent increases in funding and staffing have occurred, although multinational dominance has pushed Uruguay toward research in predominantly conventional technologies.

Mexico

Categories	Promotional	Permissive	Precautionary	Preventive
IPR		X		
Biosafety			X	
Trade	X			
Food safety	X			
Public R&D	X			

Strong IPR protection under NAFTA and broad GM patentability is available. However, much of these protections go unheeded, and many actors, mostly local, remain unaware of formal protections. This situation assuredly applied to most developing countries.

Given agriculture's importance in Mexico and the long GM controversy there, government has established a strong regulatory procedure for field testing. Process lasts a number of years.

Subsidy arrangements under NAFTA privilege GM crop imports from the US, flooding Mexico with these products.

30% of maize for consumption is imported from US. Thus, GM content is high but labeling requirements do not exist.

Mexico boasts a long history of innovative investment from domestic and international sources. Strong focus on modern GE technologies.

Chile

Categories	Promotional	Permissive	Precautionary	Preventive
IPR	X			
Biosafety		X		
Trade		X		
Food safety		X		
Public R&D		X		

Strong patentability, a high Park Index, and evidence of extensive enforcement make Chile very promotional in this field.

Biosafety protocols are well established for GMO cultivation, with extensive, rather strict evaluation measures, including a transformative Transparency Law in 2009 which requires producers to make public significant information about GMO cultivation. However, GM food evaluation lags significantly, which allows more GM foods to enter Chile more easily. This is part of what makes Chile a notably contradictory case: the divide between GM production and consumption, as well as the gap between regulations and the everyday reality of GM consumption, make the Paarlberg scale difficult to apply.

Chile bans domestic production of GM foods for in-country consumption, but allows GM food imports with no labeling measures imposed.

Chile generously funds its domestic research institutions, which may be necessary given a dearth of private research investment. A significant proportion of funding goes to modern GM technologies.

Tables created by author

6.2 Data Appendix

Bilateral trade, taken from the United Nations Commodity Trade Statistics Database, is measured as the dollar value of agricultural commodity exports, detailed by country-of-origin, countries-of-destination, and appropriate agricultural commodity codes. Within the Brazilian Trade subsection, trade volume is substituted for dollar value, and units are kilograms. The primary commodity codes used throughout were:

- 044 Maize unmilled
- 04711 Maize (corn) flour
- 2222 Soya beans
- 2223 Cotton Seeds
- 4211 Soya bean oil, fractions
- 4212 Cotton seed oil, fractions
- 4217 Rape, colza, mustard oil

Data on GDP and Agricultural GDP are from the *World Tables*, published by the World Bank. Patentability and IPR strength is evaluated using the Park Index (2005) and data from Jose Falck-Zepeda's 2009 International Food Policy Research Institute Report, *La Biotecnología Agropecuaria en América Latina: Una Visión Cuantitativa*. Membership in the UPOV agreement was taken from the International Union for the Protection of New Varieties of Plants (UPOV) *List of UPOV Members* (2012). Membership in the WTO's TRIPs agreement was taken from the World Trade Organization website: *Membership: Agreement on trade-related aspects of intellectual property rights* (2012). Data on public agricultural research investment was aggregated from *Public Agriculture R&D Investments in Developing Countries: Recent Evidence for 2011 and Beyond*, Agricultural Science and Technologies Indicators, International Food Policy Research Institute, 2010 (Beintema and Stads), as well as *La Biotecnología Agropecuaria en América Latina: Una Visión Cuantitativa* (Falck-Zepeda 2009). Data on GM crop hectarage and GM cultivation by country was taken from *Global Status of Commercialized Biotech Crops, 2003-2012*, International Service for the Acquisition of Agri-biotech Applications (James 2012).

7. Figures

Figure 1

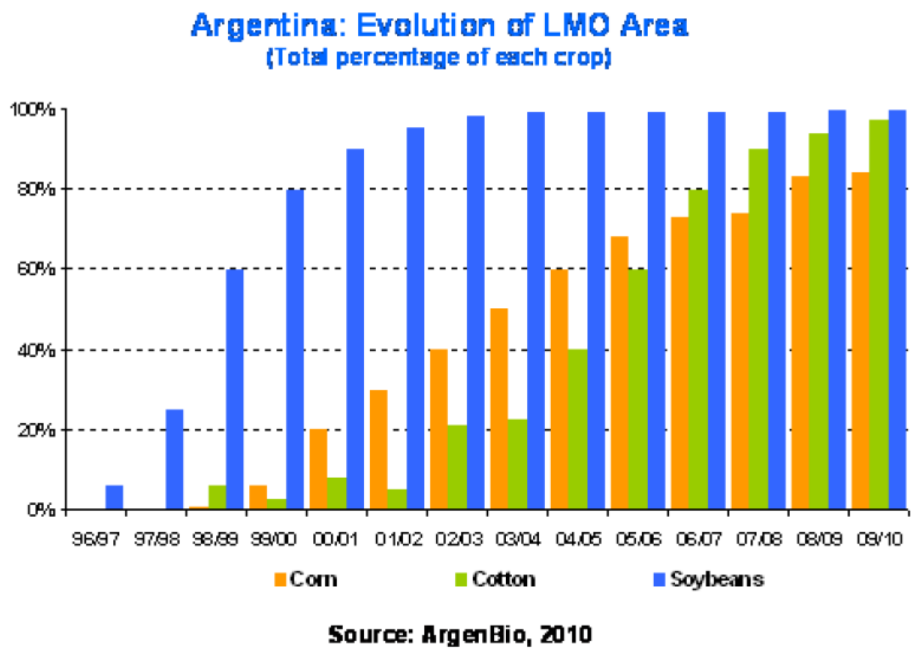
Table 1—Policy options toward GM crops

	Promotional	Permissive	Precautionary	Preventive
Intellectual property rights	Full patent protection, plus plant breeders' rights under UPOV 1991	PBRs under UPOV 1991	PBRs under UPOV 1978, which preserves farmers' privilege	No IPRs for plants or animals, or IPRs on paper that are not enforced
Biosafety	No careful screening, only token screening, or approval based on approvals in other countries	Case-by-case screening for demonstrated risk, depending on intended use of product	Case-by-case screening also for scientific uncertainties owing to novelty of GM process	No careful case-by-case screening; risk assumed because of GM process
Trade	GM crops promoted to lower commodity production costs and boost exports; no restrictions on imports of GM seeds or plant materials	GM crops neither promoted nor prevented; imports of GM commodities limited in same way as non-GM in accordance with science-based WTO standards	Imports of GM seeds and materials screened or restrained separately and more tightly than non-GM; labeling requirements imposed on import of GM foods or commodities	GM seed and plant imports blocked; GM-free status maintained in hopes of capturing export market premiums
Food safety and consumer choice	No regulatory distinction drawn between GM and non-GM foods when testing or labeling for food safety	Distinction made between GM and non-GM foods on some existing food labels but not so as to require segregation of market channels	Comprehensive positive labeling of all GM foods required and enforced with segregated market channels	GM food sales banned, or warning labels that stigmatize GM foods as unsafe to consumers required
Public research investment	Treasury resources spent on both development and local adaptations of GM crop technologies	Treasury resources spent on local adaptations of GM crop technologies but not on development of new transgenes	No significant treasury resources spent on GM crop research or adaptation; donors allowed to finance local adaptations of GM crops	Neither treasury nor donor funds spent on any adaptation or development of GM crop technology

Note: UPOV = Union for the Protection of New Varieties of Plant; PBRs = plant breeders' rights; WTO = World Trade Organization.

Source: Paarlberg, R.L., 2000. Governing the GM Crop Revolution: Policy Choices for Developing Countries. International Food Policy Research Institute.

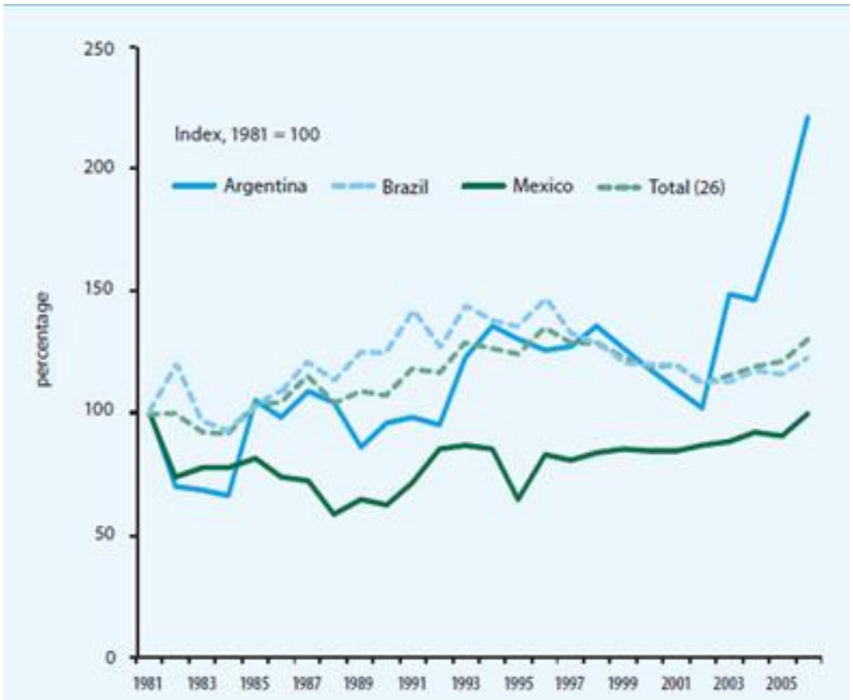
Figure 2



Source: Yankelevich, Andrea, 2010, Argentina, Biotechnology−GM Plants and Animals, 2010 Annual Biotechnology Report. United States Department of Agriculture Global Agricultural Information Network.

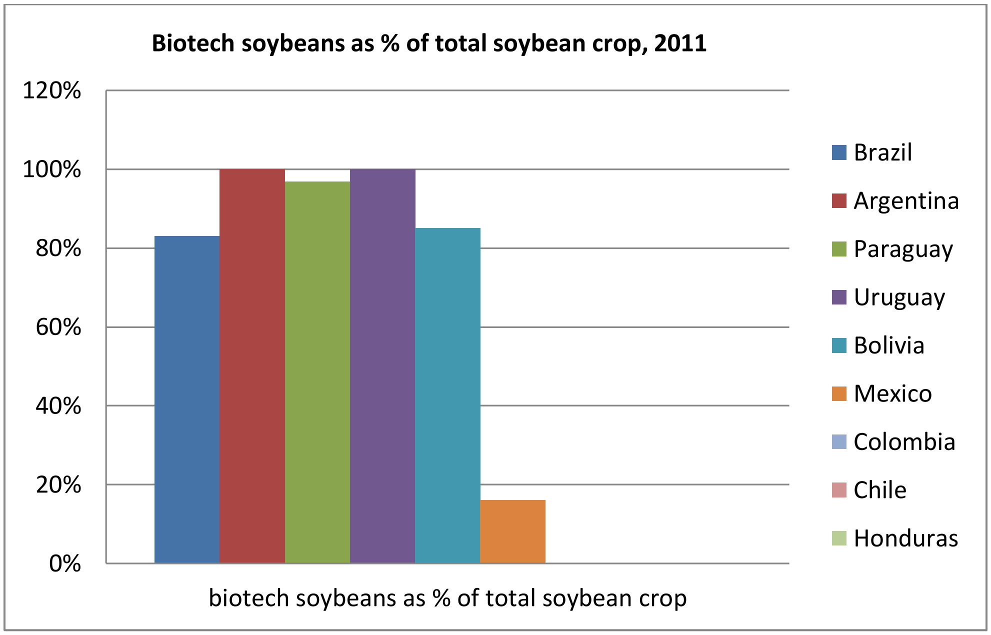
Figure 3

Trends in public agricultural research spending, 1981-2006



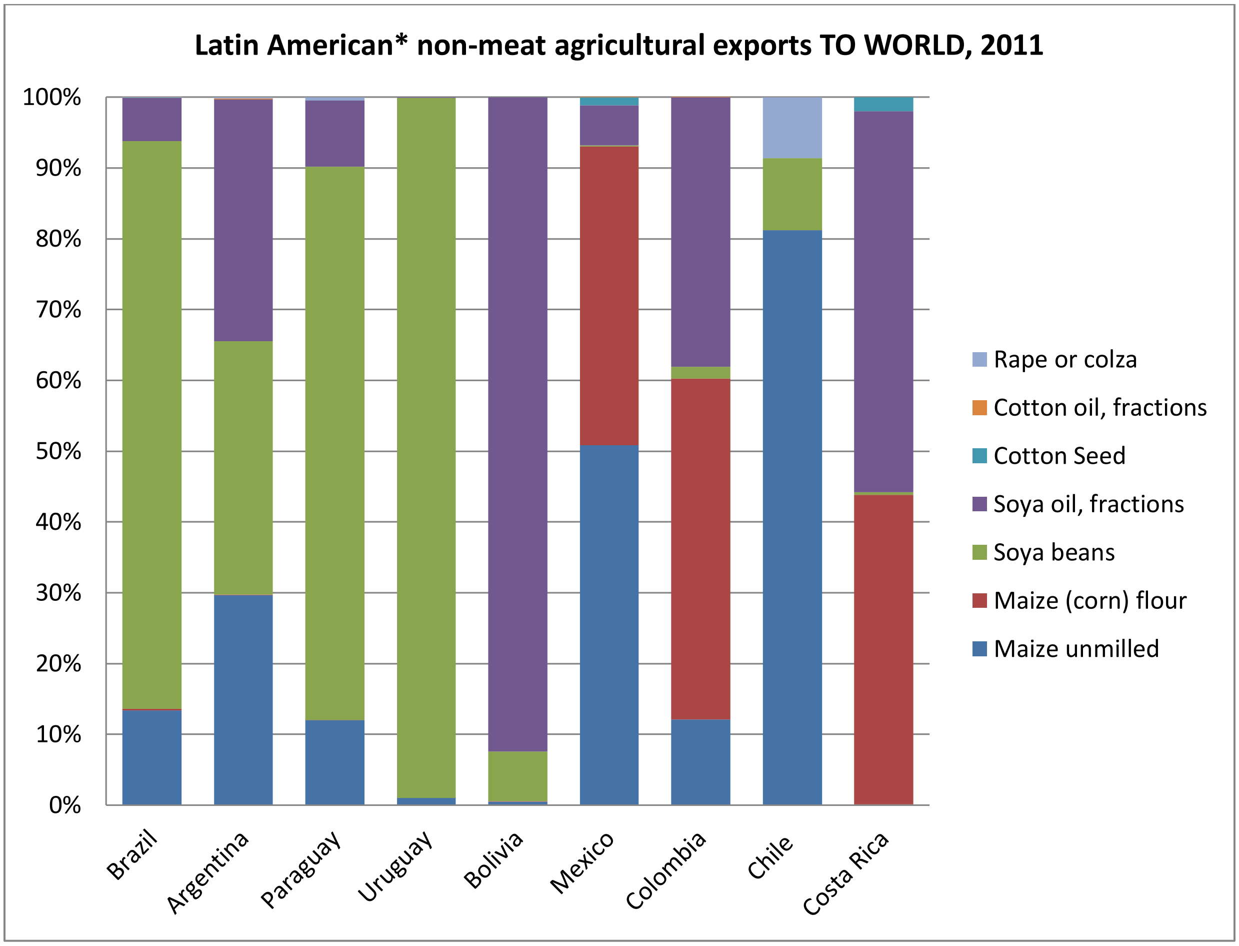
Source: Stads, Gert-Jan and Beintema, Nienke, Public Agricultural Research in Latin America and the Caribbean. ASTI Synthesis Report, 2009.

Figure 4



Source: James, Clive, 2012. Global Status of Commercialized Biotech Crops, 2003-2012. ISAAA Global Brief, and Country Briefs, International Service for the Acquisition of Agri-biotech Applications. Figure created by author.

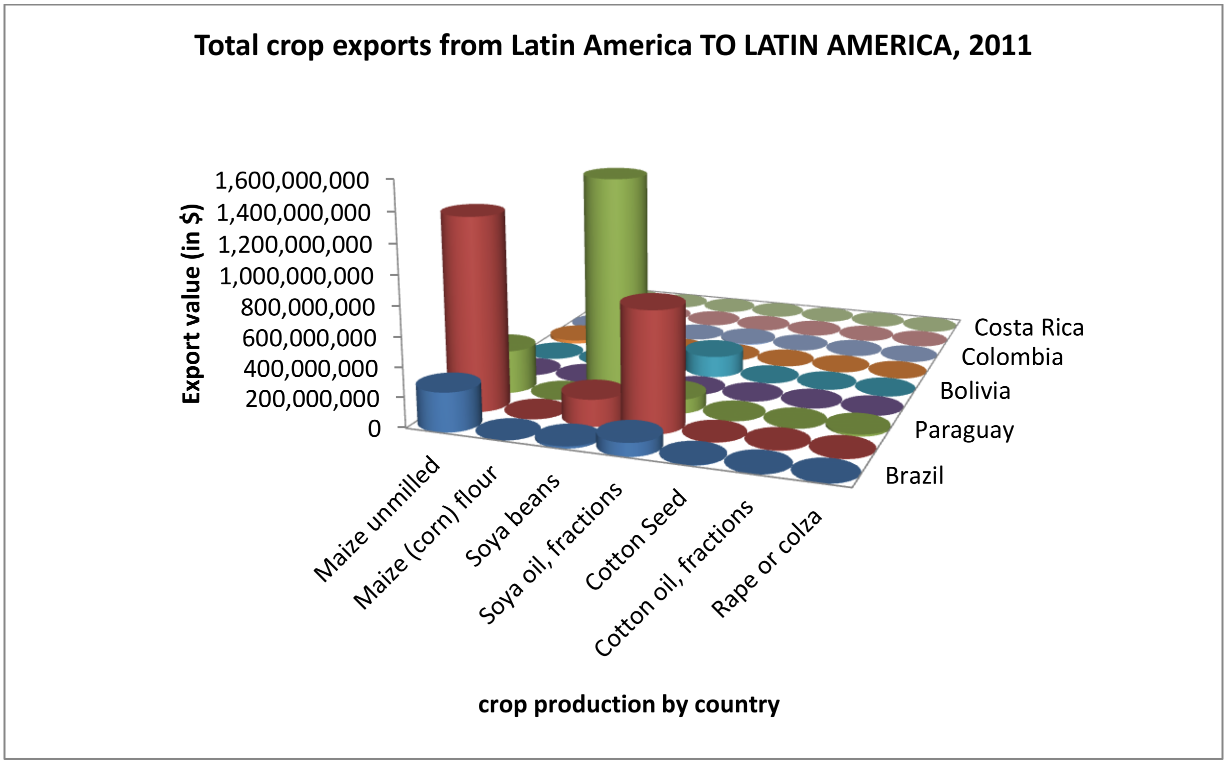
Figure 5



Source: UN Commodity Trade Statistics Database, 2012. Figure created by author

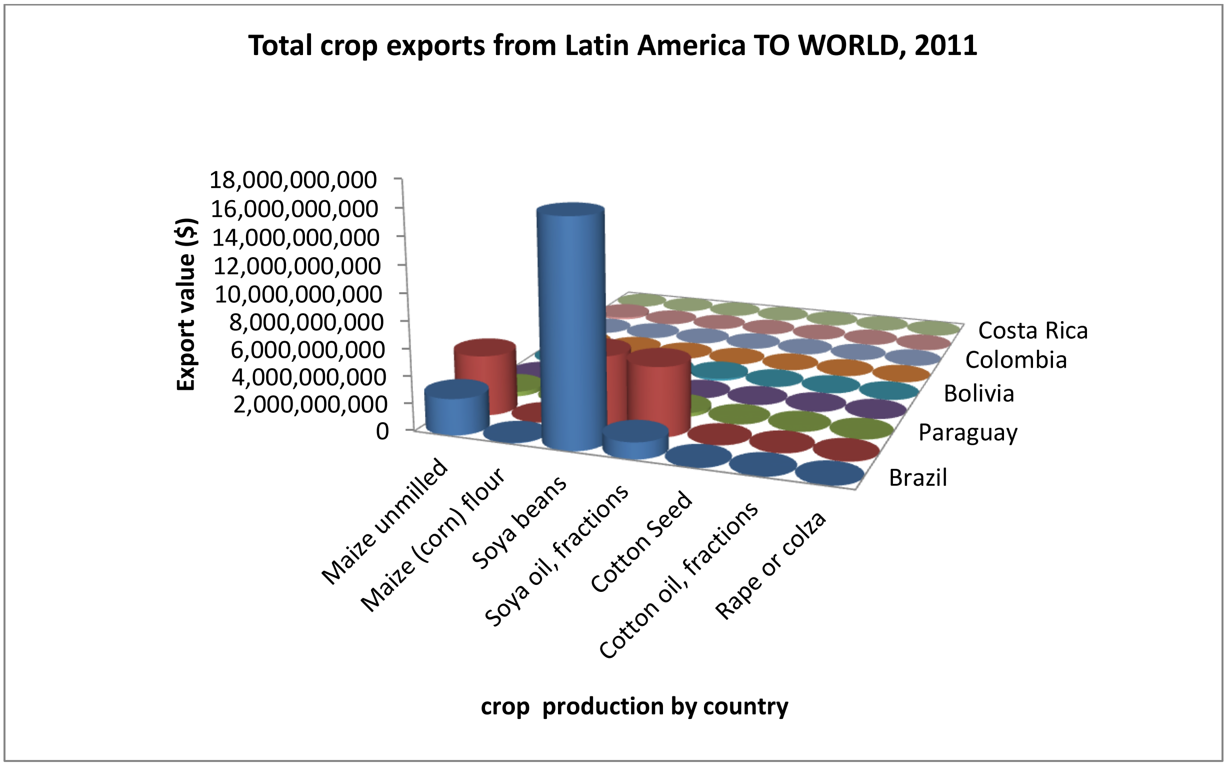
*Note: All references to "Latin America" in these tables and in paper reference specific countries of analysis representing GM adoption in the region [Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Mexico, Paraguay, Uruguay]. Some analyses leave out countries or include Honduras, where relevant.

Figure 6



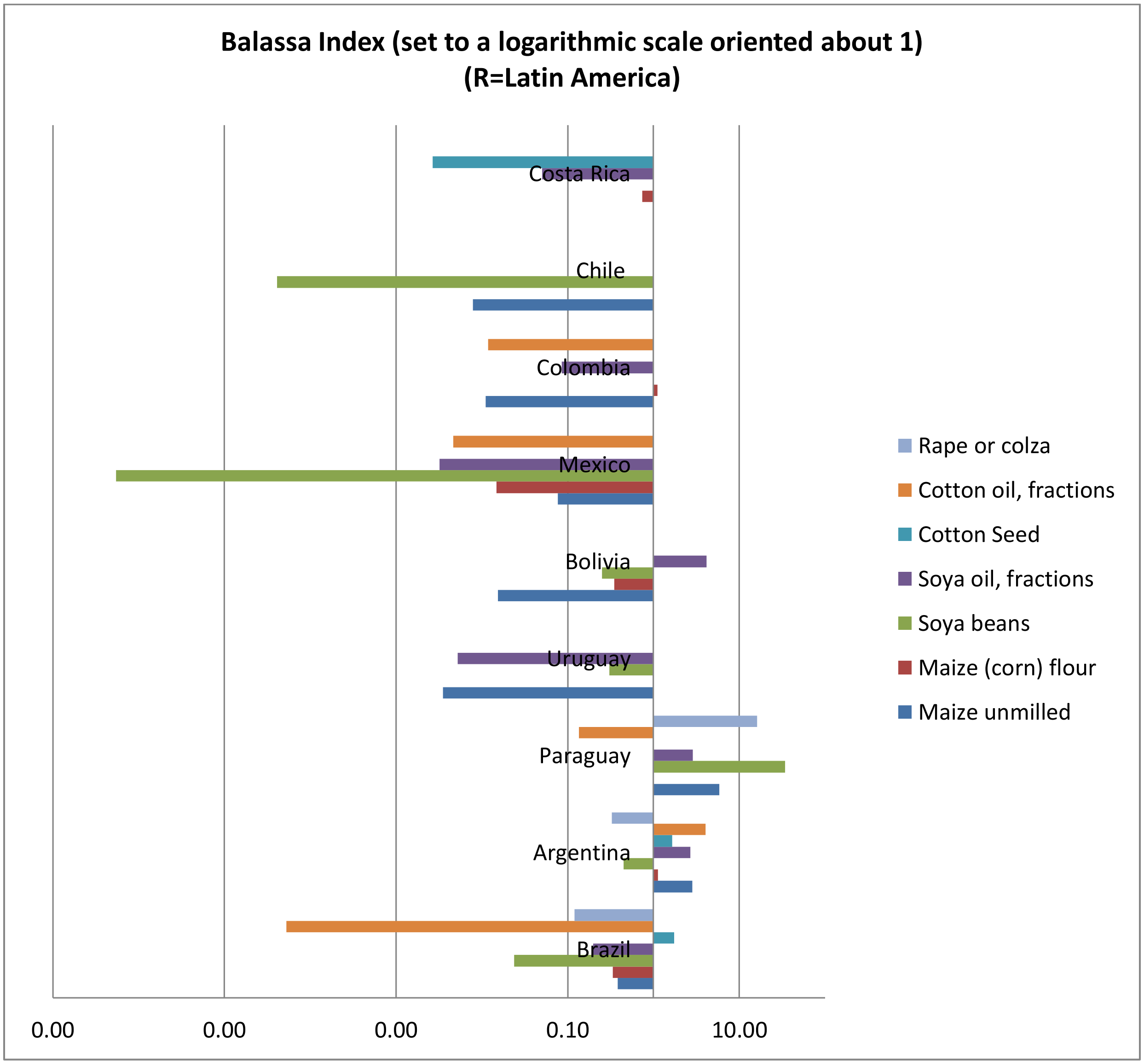
Source: UN Commodity Trade Statistics Database, 2012. Figures created by author.

Figure 7



Source: UN Commodity Trade Statistics Database, 2012. Figures created by author

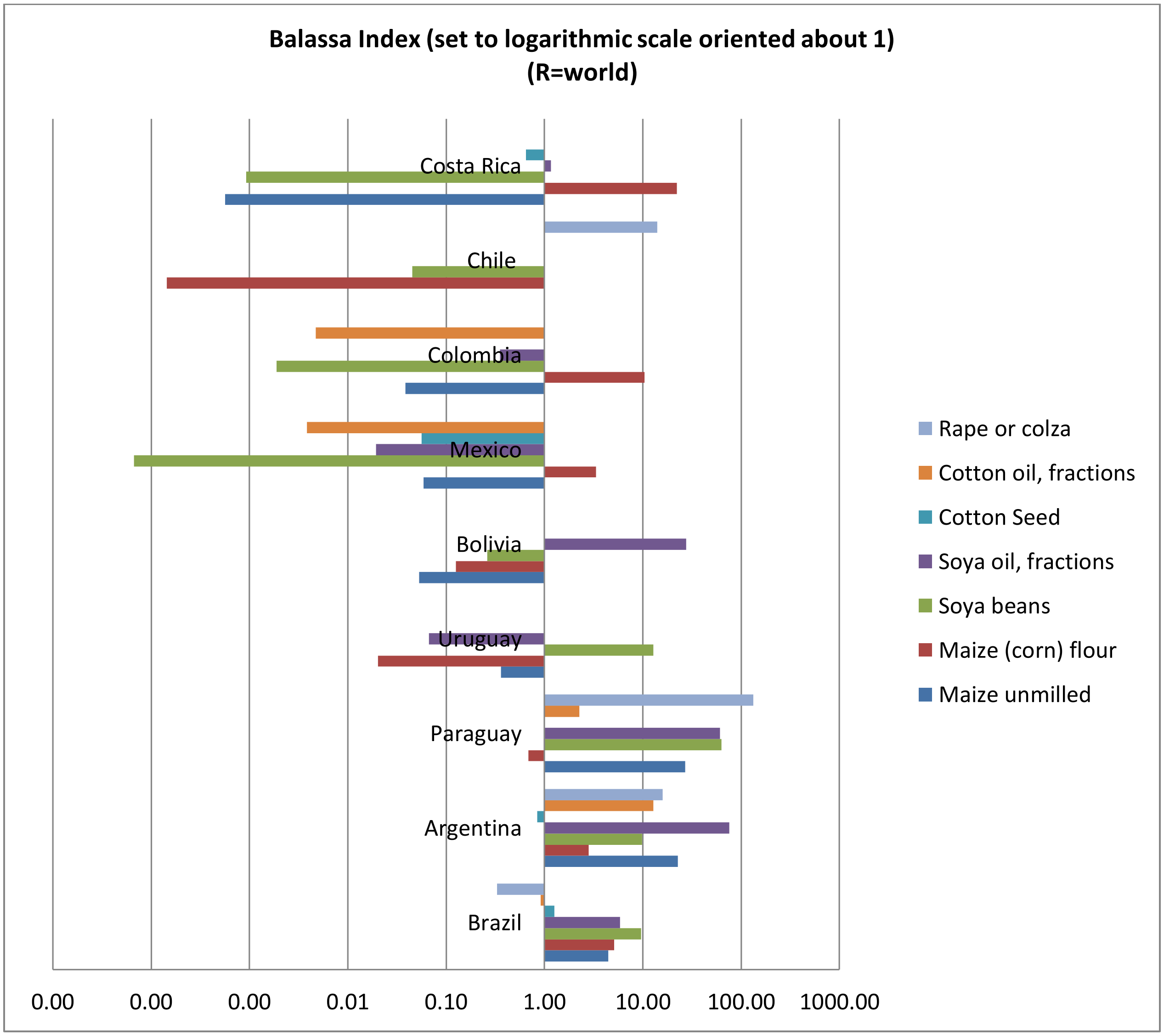
Figure 8



Note: values >1 in the Balassa index indicate a country's Revealed Comparative Advantage (RCA) in that product. The axis in this figure has been set to a logarithmic scale to illustrate the Balassa index. All crops showing RCA move to the right of the vertical axis = 1

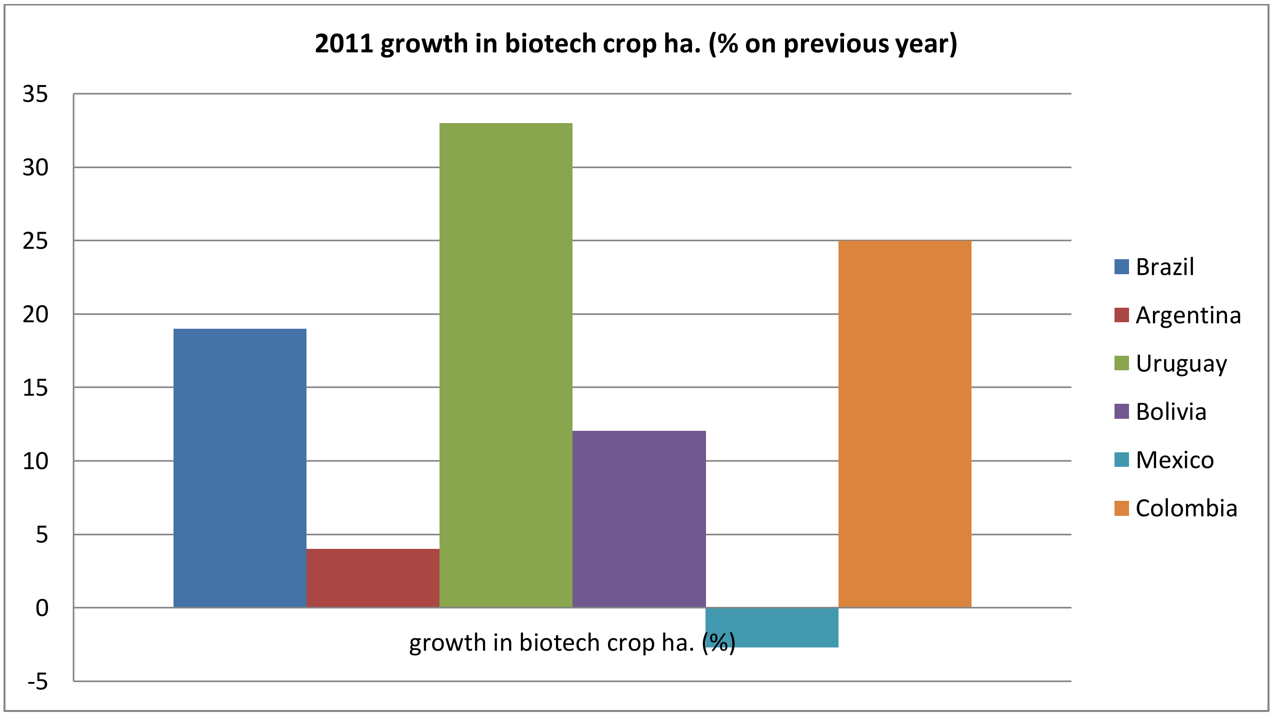
Source: UN Commodity Trade Statistics Database, 2012. Figures created by author

Figure 9



Source: UN Commodity Trade Statistics Database, 2012. Figures created by author

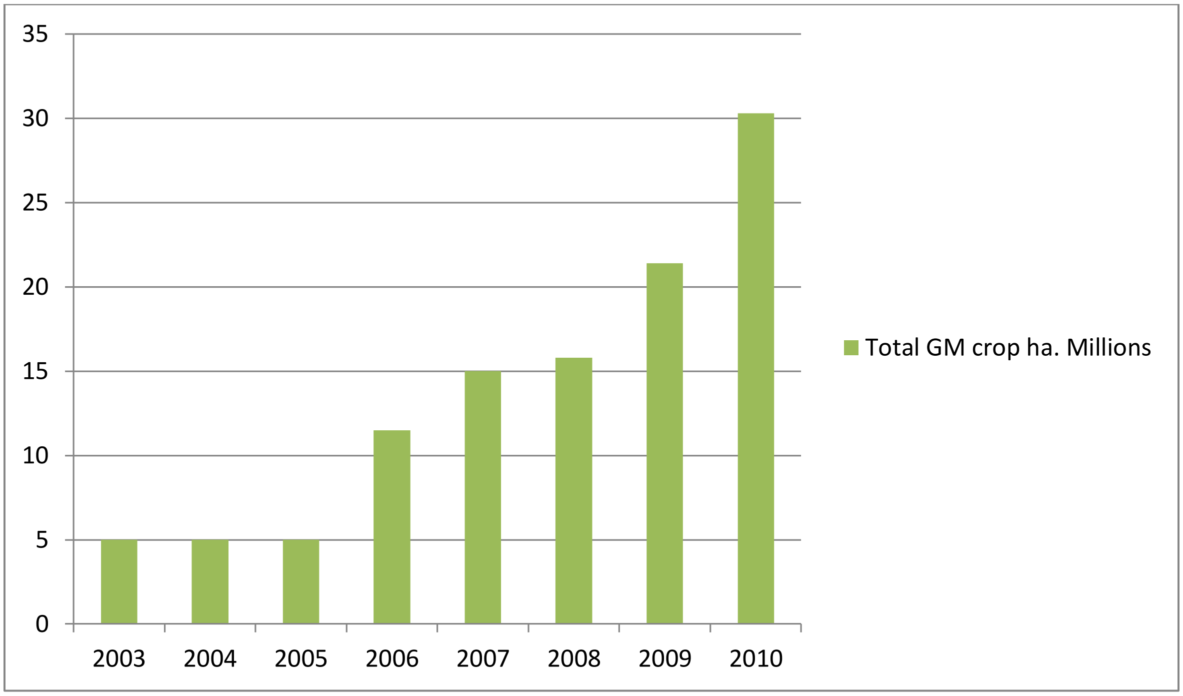
Figure 10



Source: UN Commodity Trade Statistics Database, 2012. Figure created by author.

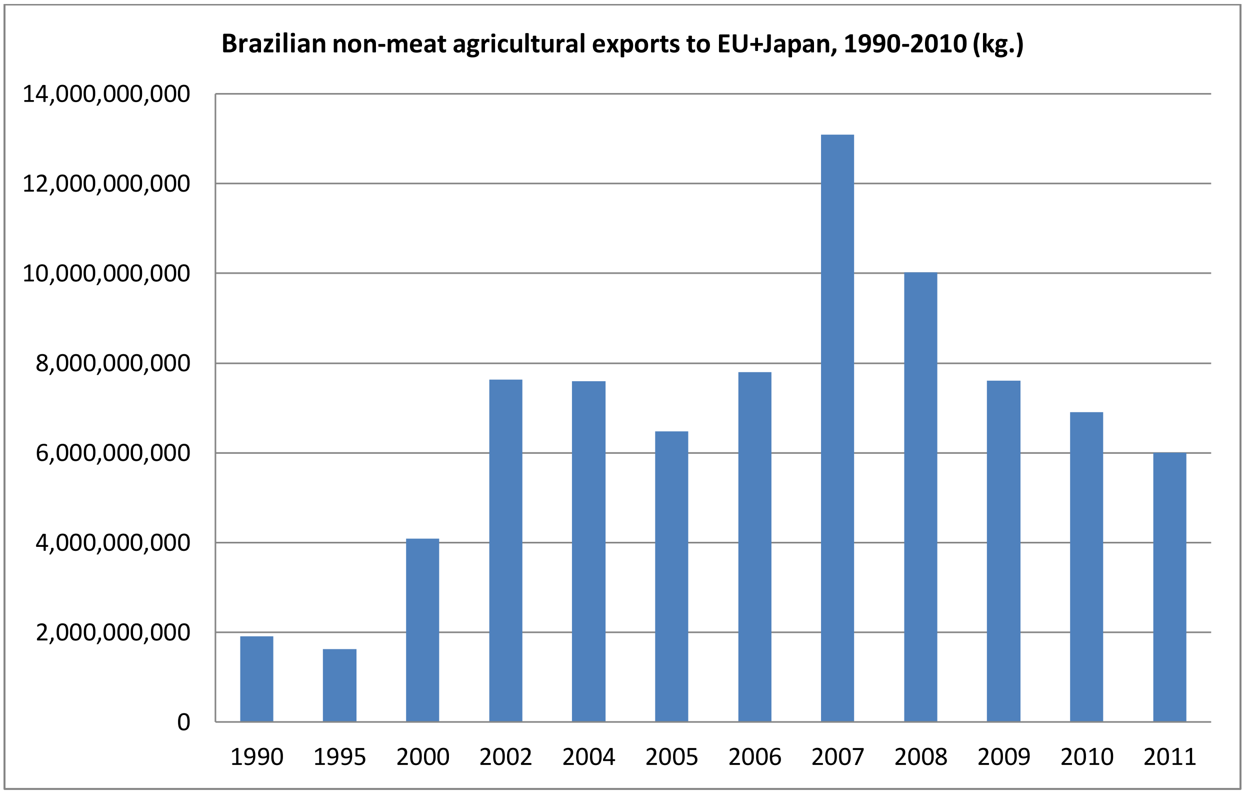
Figure 11

Total GM crop hectarage in Brazil, 2003-2010 (millions of hectares)



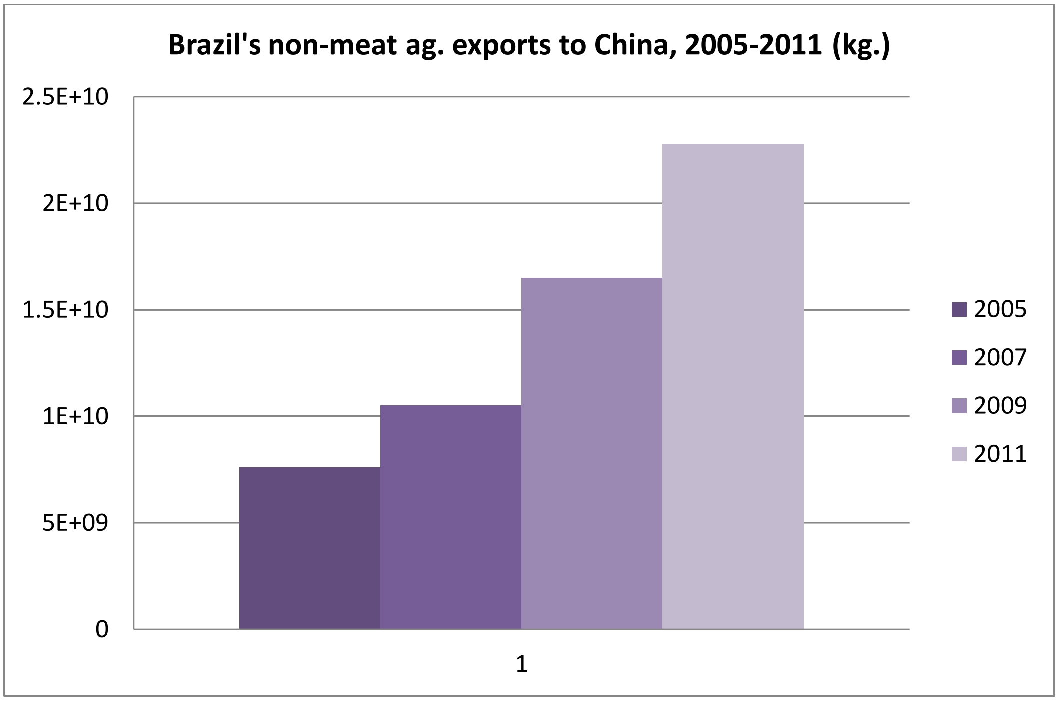
Source: James, Clive, 2003-2012. Global Status of Commercialized Biotech Crops, 2003-2012. ISAAA Global Brief, and Country Briefs, International Service for the Acquisition of Agri-biotech Applications. Figure created by author.

Figure 12



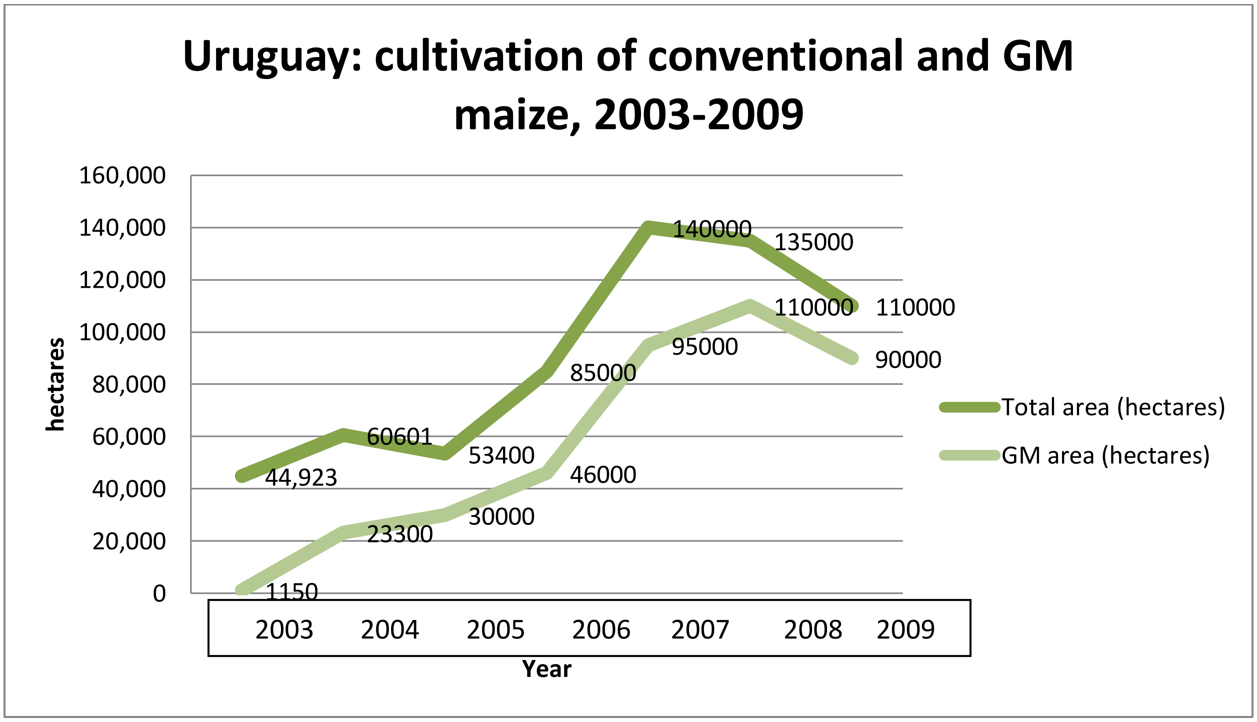
Source: UN Commodity Trade Statistics Database, 1990-2011. Figure created by author.

Figure 13



Source: UN Commodity Trade Statistics Database, 2012. Figure created by author.

Figure 14



Source: James ISAAA Global Brief, 2003-2011, created by author

*The strong 2009-11 rebound in hectarage reported in the Uruguay Trade Brief does not appear on the graph, but is asserted in James 2012.

8. Tables

Table 1

Latin American exports in selected crops, to World and to Latin America (US$)

Total exports								48,408,514		
To World										
Crops	**Brazil**	**Argentina**	**Paraguay**	**Uruguay**	**Bolivia**	**Mexico**	**Colombia**	**Chile**	**Costa Rica**	**World**
Maize unmilled	2,716,353,632	4,518,822,714	351,866,637	4,635,124	865,257	41,951,441	3,627,933	167,197,080	13,646	31,929,102,207
Maize (corn) flour	45,965,491	8,286,035	132,344	3,829	30,281	34,765,843	14,503,875	356	7,958,901	470,322,797
Soya beans	16,327,286,538	5,457,163,621	2,294,622,663	455,773,040	11,822,987	130,992	492,838	21,104,765	62,431	88,757,585,218
Soya oil, fractions	1,233,924,627	5,196,660,147	275,438,034	296,475	155,662,771	4,708,614	11,446,018	0	9,790,126	11,015,892,895
Cotton Seed	17,380,541	3,834,325	0	0	0	905,493	0	0	358,766	725,621,713
Cotton oil, fractions	4,164,716	19,159,853	221,200	0	0	20,307	3,323	0	0	238,406,618
Rape or colza	1,486,974	23,820,548	12,995,000	0	0	0	0	17,666,917	0	238,406,618
Total world exports	256,038,702,056	83,950,225,265	5,517,376,599	5,385,508,677	6,872,197,693	298,305,075,136	39,819,528,642	70,631,510,506	10,222,241,025	13,466,700,000,000
To Latin America										
Crops	**Brazil**	**Argentina**	**Paraguay**	**Uruguay**	**Bolivia**	**Mexico**	**Colombia**	**Chile**	**Costa Rica**	**Latin America**
Maize unmilled	265,589,213	1,304,457,365	294,622,389	100,457	829,616	23,515,731	1,591,969	1,412,618	0	1,976,885,952
Maize (corn) flour	369,948	827,874	0	0	30,281	7,239	254,296	0	16,003	3,168,502
Soya beans	14,405,652	182,147,913	1,525,737,315	7,718,630	11,822,987	146	0	6,439	0	1,741,127,722
Soya oil, fractions	90,147,001	810,258,375	96,177,898	98,683	147,079,156	645,505	7,994,164	0	448,238	1,302,221,195
Cotton Seed	3,307,500	2,099,611	0	0	0	0	0	0	100	5,461,499
Cotton oil, fractions	67	3,416,804	12,645	0	0	2,587	3,105	0	0	3,643,981
Rape or colza	1,308,594	2,377,043	12,995,000	0	0	0	0	0	0	31,292,426
Total LA exports	47,568,678,510	31,646,027,824	3,496,217,678	1,977,956,705	3,711,306,654	21,013,767,199	9,874,221,938	12,335,628,501	932,812,075	136,542,455,012

Source: United Nations Commodity Trade Statistics Database 2012; table created by author.

Table 2

<u>Balassa Indices for Latin America in select crops</u>

Balassa index: (r=World)									
Crops	**Bra.**	**Arg.**	**Parag.**	**Urug.**	**Boliv.**	**Mex.**	**Colom.**	**Chi.**	**Costa Rica**
Maize unmilled	4.47	22.70	26.90	0.36	0.05	0.06	0.04	1.00	0.00
Maize (corn) flour	5.14	2.83	0.69	0.02	0.13	3.34	10.43	0.00	22.29
Soya beans	9.68	9.86	63.10	12.84	0.26	0.00	0.00	0.05	0.00
Soya oil, fractions	5.89	75.67	61.03	0.07	27.69	0.02	0.35	0.00	1.17
Cotton Seed	1.26	0.85	0.00	0.00	0.00	0.06	0.00	0.00	0.65
Cotton oil, fractions	0.92	12.89	2.26	0.00	0.00	0.00	0.00	0.00	0.00
Rape or colza	0.33	16.03	133.04	0.00	0.00	0.00	0.00	14.13	0.00
Balassa index: (r=Latin America)									
Crops	**Brazil**	**Arg.**	**Paraguay**	**Uruguay**	**Bolivia**	**Mexico**	**Colombia**	**Chile**	**Costa Rica**
Maize unmilled	0.39	2.85	5.82	0.00	0.02	0.08	0.01	0.01	0.00
Maize (corn) flour	0.34	1.13	0.00	0.00	0.35	0.01	1.11	0.00	0.74
Soya beans	0.02	0.45	34.22	0.31	0.25	0.00	0.00	0.00	0.00
Soya oil, fractions	0.20	2.68	2.88	0.01	4.16	0.00	0.08	0.00	0.05
Cotton Seed	1.74	1.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cotton oil, fractions	0.00	4.05	0.14	0.00	0.00	0.00	0.01	0.00	0.00
Rape or colza	0.12	0.33	16.22	0.00	0.00	0.00	0.00	0.00	0.00

Source: United Nations Commodity Trade Statistics Database; table created by author.

Table 3

Park Index on IPR protection, 1960-2005				
Countries	**Avg. 1960-1990**	**1995**	**2000**	**2005**
Argentina	1.6	2.73	3.98	3.98
Bolivia	1.38	2.37	3.43	3.43
Brazil	1.22	1.48	3.59	3.59
Chile	2.04	3.91	4.28	4.28
Colombia	1.05	2.74	3.59	3.72
Costa Rica	1.07	1.56	2.89	2.89
Ecuador	1.16	2.04	3.73	3.73
El Salvador	1.71	3.23	3.36	3.48
Guatemala	0.77	1.08	1.28	3.15
Honduras	1.25	1.9	2.86	2.98
Mexico	1.19	3.14	3.68	3.88
Nicaragua	0.92	1.12	2.16	2.97
Paraguay	1.13	1.53	2.39	2.89
Peru	0.59	2.73	3.32	3.32
Uruguay	1.54	2.07	3.27	3.39
Venezuela	0.92	2.82	3.32	3.32
Latin American mean	1.22	2.28	3.2	3.44
World mean	1.8	2.58	3.05	3.34
United States	4.14	4.88	4.88	4.88
Mercosur mean	1.28	2.13	3.31	3.43
EU mean	2.61	4.03	4.33	4.43
Developing countries mean	1.3	2.09	2.78	3.27

Source: Park, Walter G., *International Patent Protection: 1960-2005*. Research Policy, 2008.
Table created by author

Table 4

UPOV Treaty signatories			
Country	**Signitory ?**	**Date signed**	**Latest act of the Convention to which State is party**
Argentina	YES	1994	1978 act
Bolivia	YES	1999	1978 act
Brazil	YES	1999	1978 act
Chile	YES	2011	1991 act
Colombia	YES	1996	1978 act
Costa Rica	YES	2009	1991 act
Ecuador	YES	1997	1978 act
El Salvador	NO	na	na
Guatemala	NO	na	na
Honduras	NO	na	na
Mexico	YES	1997	1978 act
Nicaragua	YES	2001	1978 act
Paraguay	YES	1997	1978 act
Peru	YES	2011	1991 act
Uruguay	YES	1994	1978 act
Venezuela	NO	na	na

Source: International Union for the Protection of New Varieties of Plants (UPOV), List of UPOV Members, 2012. Table created by author.

Table 5

Patentability in Falck-Zepeda Index						
countries	**plants**	**animals**	**bio. Processes**	**plant varieties**	**microorganisms**	**genes**
Argentina	1	1	1	1	1	1
Brazil	0	0	?	1	1	?
Bolivia	0	0	0	1	possibly	0
Chile	1	0	1	1	1	0
Costa Rica	0	0	0	0	1	?
Colombia	0	0	0	1	1	?
Mexico	1	0	0	1	1	?
Paraguay	0	0	0	1	weak	?
Uruguay	0	0	0	1	1	0

Note: 1 = Patentable, 0 = Unpatentable, ? = ambiguous regulation

Source: Falck-Zepeda, Jose, et al., 2009. La Biotecnología Agropecuaria en América Latina: Una Visión Cuantitativa. División de Medio Ambiente y Tecnología de la Producción, International Food Policy Research Institute. Table created by author.

Table 6

Ag. Exports as % of exports to world	to EU + Japan	To USA
Brazil	29.5	0.1
Argentina	5.4	0.4
Paraguay	12.6	1.2
Uruguay	0.0	1.5
Bolivia	0.0	0.0
Mexico	0.7	80.5
Colombia	15.0	13.3
Chile	3.4	22.8
Costa rica	28.0	8.2
Peru	28.0	8.2

Note: Theoretically, if a country's agricultural exports are skewed toward the US it should be promotional of GMOs, and if exports are skewed toward Europe and Japan, it should be preventive. While these trade statistics do not correlate strongly with the policy analysis given above, the case study on Brazil does indicate that GMO adoption may be driving trade away from the EU and Japan, as this intuition would suppose.

Source: United Nations Commodity Trade Statistics Database, Statistics Division, 2012. Table created by author.

Table 7

Public R&D Investment in Latin America

country	Main research institute	% total funds this inst. receives	other important inst.	ann. staffing growth rate 1981-'06	total researchers in 2006	% of those focused on crops	% annual increase in public funding'81-'06	total funding $2005 PPP
Argentina	INTA	48	UBA	0.8	3947	38.5	2.97	448.6 million
Brazil	Embrapa	44		0.98	5402	na	0.58	1,224
Chile	INIA	40	U of Chile	2.4	655	44	3.41	98
Colombia	CORPOICA	27	huge private: 30%	2.63	540	47	0.41	152
Costa Rica	INTA	31	U of costa rica: 29%	1.26	200	71	3.04	30
Mexico	INIFAP	25	Universities ~30%	2.15	2227	37	0.84	518
Paraguay	Ag. Research directorate	50	U of asuncion	0.58	78	72	-0.34	3.1
Uruguay	INIA	36	U of the Republic: 41%	2.61	209	25	4.94	60

Source: Stads, Gert-Jan and Beintema, Nienke, 2009. Public Agricultural Research in Latin America and the Caribbean. ASTI Synthesis Report. Table created by author.

Table 8 GM crop cultivation in Latin America

Categories	Brazil	Argentina	Paraguay	Uruguay	Bolivia	Mexico	Colombia	Chile	Honduras
Agriculture as % of GDP	7	10	19	10	14	4		2	
% of global biotech crop ha.	19	15	2	0.7	0.5	0.05	0.05	0.01	0.001
total biotech crop ha. (millions)	30.3	23.7	3.2	1.1	0.85	0.07	0.07	0.02	0.015
growth in biotech crop ha. (%)	19	4	NA	33	12	-2.7	25%	150%	0%
biotech soybean production (millions of ha.)	20.6	19.1	2.8	1	0.85	0.013	0	0.004	0
biotech soybeans as % of total soybean crop	83%	100%	97%	100%	85%	16%	0	0	0
biotech soybean growth on previous year (%)*	16	na	7	30	35	-24	na	0	0
Biotech maize production (millions of ha.)	9.1	3.9	0	0.1	0	0.01	0.035	0.01	0.015
biotech maize as % of total maize crop	na	85	na	83	na	0	6	na	4
biotech maize growth on previous year (%)	25	na	na	12	na	na	0	0	67**
biotech cotton production (millions of ha.)	0.6	0.7	0.01	0	0	0.06	0.04	0	0
biotech cotton as % of total cotton crop	39	97	na	na	na	73	na	0	0
other major biotech crop production	none	none	none	none	none	none	Blue carnation trial runs	canola, ~3500 ha.	
Farm income gain from biotech crops (US$ in 2010)	1.2 billion	1.8 billion	90.3 million	17 million	165 million	102 million (since 1996)	1 million	NA	1 million
Commercialized biotech crops	HT Soybean, Bt Cotton, Bt Maize	HT Soybean, Bt Cotton, Bt Maize	HT Soybean, Bt Cotton from 2011	HT Soybean, Bt Maize	HT Soybean (RR)	Bt Cotton, HT Soybean	Bt Cotton	Bt Maize, HT Soybean	Bt Maize, Bt/HT Maize

Source: James, Clive, 2012. Global Status of Commercialized Biotech Crops, 2003-2012. ISAAA Global Brief, and Country Briefs, International Service for the Acquisition of Agri-biotech Applications. Table created by author.

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