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Modifying Argentina: GM soy and socio-environmental change

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ABSTRACT

This paper examines Argentina's agro-export strategy for socioeconomic development based on the adoption and expansion of genetically modified (GM) soy. The *modelo sojero* a model based on large scale mechanized production of GM soy, is widely praised at home and abroad and used as an example of "success" for other poor countries on the brink of adopting GM biotechnologies for socio-economic development. In this work I interrogate and contextualize this dominant representation of the success associated with Argentina's soy boom. Indeed, in terms of economic growth Argentina's transition to GM soy has been a success. However the GM-induced soybean boom is illusory when other factors are taken into consideration, most importantly its impact on socioenvironmental dynamics. Thus, I argue that there is a fundamental conflict between the narrative of "success" of the Argentinean GM soy boom and socio-ecological sustainability. After an introduction, section two looks at the historical context of GM soy adoption in Argentina and shows the trend of expansion of production since the adoption of the new GM biotechnology. Section three explores the socio-environmental impact of the GM soy-based agrarian transformation in Argentina. Section four looks at the current context of the Argentinean soybean boom. Thus, it focuses on Argentina's current domestic political economy, particularly the Kirchners' National-Popular model. I argue that the GM soy-based agro-export model as currently configured in Argentina is a socially and ecologically unsustainable model of national development.

1. Introduction

Soy is the goose that lays the golden eggs in Argentina. After the 2001 crisis that sent half of Argentines into poverty, foreign income from soy exports helped revive a near-dead economy (Newell, 2009; Teubal, 2006, 2008). Since then, Argentina's economy has been fueled by the growth of commodity exports, rising on average 8.6% a year for eight of the last nine years.[1] Indeed, since genetically modified (GM) soybeans were introduced in 1996, production has spiked: Argentina is today the third largest global grower and exporter of soybeans,[2] all of which are genetically modified (James, 2010). This *modelo sojero*, a model based on large scale mechanized production of GM soy, is widely praised at home and abroad and used as an example of "success" for encouraging other poor countries to adopt GM technologies as a means of boosting socio-economic development (Newell, 2009).

Argentina has fully embraced GM seeds alongside a model of industrial agricultural soy production for export. Today it is the government's main economic strategy and farmers continue expanding the agricultural frontier, while most of the scientific community and mainstream media celebrate the benefits of the biotechnology. It is not unusual to read headlines in mainstream newspapers praising GM biotechnology and the model's success, extolling "Only biotechnology can save the world" or "Soy, 21st century manna."[3]

GM soybean in Argentina was adopted as part of the neoliberal agro-export strategy for socio-economic development. Agro-industrialism and neoliberalism have been tied in Argentina as in most the Global South (McMichael, 2007; Otero, 2008). Under this paradigm, maintaining high rates of economic growth became the measure of the model's success, and as such, Argentina's transition to GM soy has been a boom: continuous expansion of production, record harvests, and record profits from agro-exports have been nearly constant, harvest after harvest, year after year.[4] Argentina's

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[1] Average GDP annual percentage growth rate 2003–2011, excluding 2009. World Bank Indicators, GDP Growth (annual %). http://data.worldbank.org/. Accessed 8/16/12.

[2] After the United States and Brazil. USDA, United States Department of Agriculture. USDA-FAS, Production, Supply and Distribution (PS&D) database. http://www.fas.usda.gov/psdonline/psdHome.aspx. Accessed 4/21/12.

[3] "Sólo la biotecnología salvará al mundo," *Clarín,* January 29, 2001; "Soja, el maná del siglo XXI," *Clarín,* December 30, 2006.

[4] "La soja impulsó un récord de las exportaciones," *Clarín,* May 31, 2004; "La soja alcanzó el precio más alto en dos años y medio," *La Nación,* November 7, 2006; "La soja no tiene freno: llegó a los $ 900," *La Nación*, December 27, 2007; "La soja volverá a ser la reina en la campaña agrícola 2010/11," *Clarín,* August 30, 2010; "La soja continúa en pleno ascenso," *La Nación,* April 21, 2012.

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GDP continues to grow (by 9.2% in 2010 and 8.9% in 2011), despite the global economic crisis.[5]

These remarkable results have prompted supporters of the technology to present Argentina's soybean model as an example for other poor countries to follow (Chudnovsky, 2006; Trigo and Cap, 2003; Qaim, 2005). In Latin America in particular, Argentina's pro-biotech stand is prominent: the country is the earliest GM crop adopter and the main promoter of GM biotechnology in the region. As GM soy expands from Argentina to the rest of the region, many questions arise: can the model be implemented in other countries with similar results? On what terms is "success" understood? Are increased yields and profits the best measure of a model's success? Based on these questions, the aim of this work is to interrogate and contextualize the dominant representation of the success associated with Argentina's soy boom. The analysis has three strands. First, I consider the historical context of GM soy adoption in Argentina and critically evaluate the trend of expansion of production since the adoption of the new GM biotechnology. Recent studies critically investigating triumphant narratives of GM biotechnology's expansion into the Global South suggest that the *context of adoption* of agricultural technologies is crucial to evaluating claims of success (Glover, 2010; Schnurr, 2012). This research similarly aims to consider the historical, political, economic, social, and environmental settings of GM soy adoption in order to analyze the full impacts of Argentina's embrace of agricultural biotechnology. In common with other studies (Glover, 2010; Schnurr, 2012), I conclude that the success of the GM soy model in Argentina is contingent on the context in which the technology was applied.

Second, I propose to assess the model's success on broader terms, beyond yields and profits. Argentina's soybean model could be deemed successful within the confines of neoliberalism insatiable quest for growth. However, the benefits of GM-induced soybean expansion become less certain when other criteria – particularly socio-environmental considerations such as the protection of livelihoods, social equity, and ecological integrity – are taken into account (Agyeman et al., 2003; Daly, 1996; Redclift, 1992). As authors within the critical strand of environmental sociology argue, there is a "conflict" (Schnaiberg and Gould, 1994) or "contradiction" (O'Connor, 1998) between sustained growth overtime and the environment. In this manner, I argue that there is a fundamental conflict between the narrative of "success" of the Argentinean GM soy boom and socio-ecological sustainability.[6] This work therefore builds on a small but growing literature that aims to critically assess the *modelo sojero* (Giarracca and Teubal, 2005, 2010; Gras and Hernandez, 2009a; Newell, 2009; Pengue, 2005, 2009; Teubal, 2006, 2008), as I explore the consequences of the GM soy boom in detail; in particular its impact on socio-ecological dynamics.

Third, I look at the current context of the Argentinean soybean boom, with a focus on Argentina's domestic political economy. Argentina's soybean boom was propelled by particular political economic conditions that supported the expansion of biotechnology in various ways. In his article "Bio-Hegemony: The Political Economy of Agricultural Biotechnology in Argentina," Newell (2009) examines some of these factors, focusing in particular on the role of business. Newell investigates corporate strategies to secure power over the desirability of an agro-export model based on the production of GM soy in Argentina – to create and maintain what he refers to as "bio-hegemony". Building on Newell (2009), in this article I look into other aspects of the domestic political economic context of GM biotech adoption and expansion, particularly the political strategies of the Kirchners' administrations, in order to assess how changes in the current domestic political context have impacted on the GM soy model and its consequences. Most significantly, under the Kirchners', a fraction of foreign income generated by soy exports is appropriated by the government to fund projects for social development. I argue that these measures, as they are sustained on soy exports, are partial and limited solutions to improve livelihoods; not least because the model cannot be sustained over time, as it gradually exhausts the natural base on which it relies. The conclusion summarizes this conflict between Argentina's GM soy-based developmental agenda and socio-ecological sustainability, the central argument I advance in this paper.[7]

2. GM soy production in Argentina: historical context

The introduction of the GM biotech package and neoliberalism have gone hand in hand in Latin America, as in many nations of the Global South; but nowhere to the extent as it has in Argentina (Otero, 2008). In the 1990s, neoliberalism, also known as the "Washington Consensus," became Latin America's official model of development. The model proposed a re-organization of the international political economy based on the principles of free trade and comparative advantage (meaning, for Latin America, the end of subsidies and tariffs, privatization, deregulation, unrestricted foreign investment, and specialization in a few commodities produced for export), on the belief that economic growth will create social wellbeing (Harvey, 2005).

The core of the neoliberal program for many Latin American countries is referred to as *Non-Traditional Agro-Export production* (NTAE) and it is based on specialization in a few commodities for the export market. In order to increase agricultural production, a "modernization" of agricultural techniques was advised. International financial organizations, like the World Bank and the International Monetary Fund, gave conditional credits to governments that would "encourage" their farmers to invest in new foreign technology, taking credits to buy machinery and seeds (McMichael, 2007; Shiva, 2000).

Neoliberal economic restructuring gave the necessary institutional and ideological framework for the introduction of GM seeds in Argentina. In 1991, the Deregulation Decree – signed by President Menem and Minister of Economy Cavallo as part of their Convertibility Plan to end hyperinflation and promote growth – gave the final neoliberal twist to Argentine political economy, as it ended regulations that protected domestic economic activity, such as import and export sectors of goods, services, and capital, and foreign direct investment (Carranza, 2005; Ferrer, 2004). This decree also wiped out all the boards that had regulated agricultural activities since 1930 (Barsky and Gelman, 2001; Teubal, 2008). The Convertibility Plan became the backbone of Argentina's neoliberal era. The Convertibility Law was the core of the Plan, a new currency scheme that pegged the Argentine peso to the US dollar at a fixed exchange rate of one-to-one (Ps1:1US$). With a cheap dollar

[5] World Bank Indicators, GDP Growth (annual %). http://data.worldbank.org/. Accessed 8/16/12.

[6] *Sustainability* is a highly contested term (see Gould and Lewis, 2009; Redclift, 1992). In here I use the broad but basic notions of sustainability introduced by the World Commission on Environment and Development report (1987). Those are, the need to discuss the role of the environment in development debates, and two, the need to protect the environment for future generations. Thus a model is "unsustainable" when it will not be able to provide the same level of social wellbeing over time, for future generations.

[7] A note on methods: For this work, I draw on data gathered from archival research, quantitative analysis of micro and macro-data from statistical databases, and ethnographic fieldwork, consisting of participant observation and interviews with peasants, rural workers, small, medium and large producers, rural contractors, and members and employees of agribusinesses, as well as with rural inhabitants who do not profit directly from soy production. I carried out 40 formal interviews between 2009 and 2012, 27 in the Pampas region (in the provinces of Buenos Aires, Córdoba, and Santa Fe) and 13 in the North (in Santiago del Estero and Chaco).

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and no import taxes on agricultural products, and a weak legal and regulatory framework for GM seed use set in place, it became enticing to switch production to GM soy (Pengue, 2005; Teubal, 2006).

A weak system for the protection of intellectual property rights is pointed out by supporters (Qaim and Traxler, 2005; Chudnovsky, 2006) and critics (Pengue, 2005; Teubal, 2006) alike as one of the main institutional factors for the fast diffusion of GM soy in Argentina. In 1996 the Argentine government approved the commercial use of Monsanto's *Roundup Ready*® (RR) soybeans, engineered to be resistant to Monsanto's bestselling herbicide, the glyphosate *Roundup*®. GM soy production comes in a 'technological package' comprised of the 'no-tillage' or direct seeding machinery, the transgenic soybean seeds, and the weed-control agrochemical, Roundup glyphosate.[8] The adoption of the package promised dramatic cost reductions, for it requires less inputs and less labor than conventional crop growing (Trigo and Cap, 2003). GM seeds, patented and owned by corporations, are typically a matter of contention for farmers (Shiva, 2000). Patented seeds are expensive and, under contract, cannot be saved for the next growing season as it is tradition in agriculture. Argentine farmers, however, are protected under UPOV 78 (1978 Convention of the Union for the Protection of New Varieties of Plants) so farmers can legitimately plant their own saved seeds[9] (Chudnovsky, 2006; Pengue, 2005; Qaim and Traxler, 2005). Moreover, Argentine farmers who plant RR seeds are not compelled to sign a contract with Monsanto, as it is customary in other countries, such as the United States (Pierri and Abramovsky, 2009; Qaim and Traxler, 2005). There is also a black market for GM soybean seeds, generally bought in unlabeled white sacks, which farmers refer to as *bolsa blanca* (Chudnovsky, 2006; Pengue, 2005; Qaim and Traxler, 2005). It is estimated that only 25% of seeds planted are "certified" (where a small technology fee is paid); the remaining are either saved seeds or seeds bought in unlabeled *bolsa blanca*.[10] The significant loss from technology fees for Monsanto's patented RR soybeans is, as might be expected, a source of dispute between the agribusiness and the Argentine government (Newell, 2009).[11] For farmers, the result is that seeds are not an expensive component of the technological package. In 1996, Argentine farmers paid $9 for a 50-lb bag of RR soybeans when farmers in the US were paying $21.50 (Hearn, 2006). Glyphosate prices also went down, from $28 per liter to $3; also cheaper than in the US (Pengue, 2005). Therefore, all together, the adoption of the package represented a dramatic cost reduction, as imported glyphosate was cheaper than other agrochemicals in use, seeds could be saved, and the no-tillage method reduced the price of labor and fossil fuel use (Bisang, 2003). Growing GM soy thus became a cheaper and the most profitable option for many farmers. Bisang (2003:437) estimates the switch to the technological package of GM soy represented a 15% profit increase compared to the use of conventional techniques in soy-maize rotation.

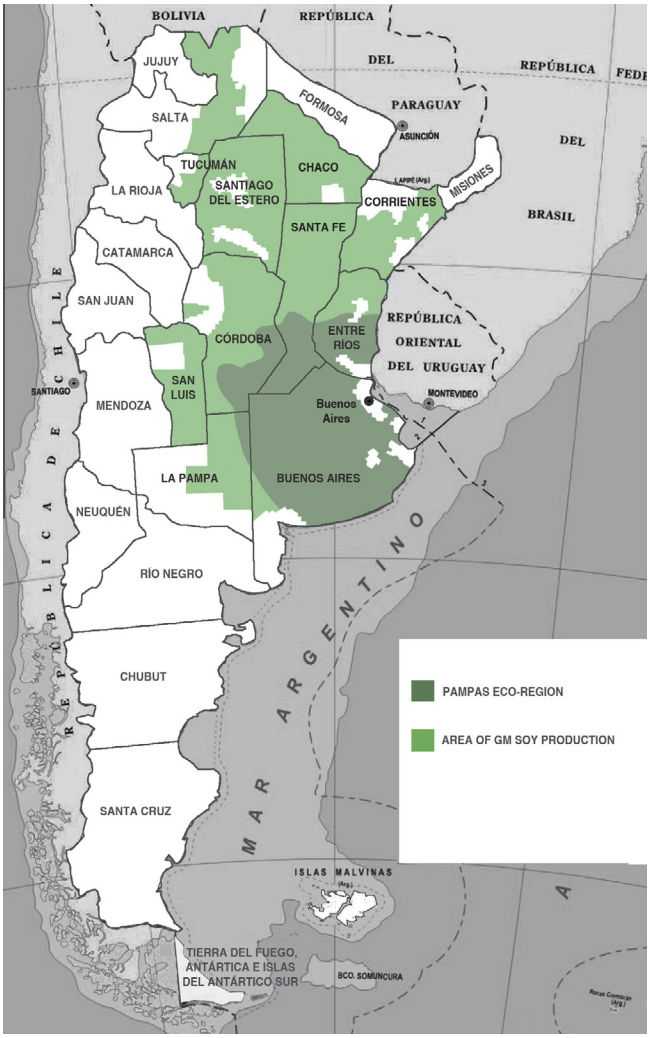

Fig. 1. Map of Argentina, Pampas Ecoregion and area of GM soy production. *Source:* Author; Based on data from Ministerio de Agricultura, Ganadería y Pesca (Argentine Ministry of Agriculture, Livestock and Fishery).

The rate of adoption of transgenic soy in Argentina is unprecedented; even higher than that in the United States, the first country to introduce the technology: It took 15 years for American farmers to exceed 90% adoption of total soybeans planted, whereas in Argentina that level was reached in only seven seasons (Trigo and Cap, 2003). The adoption of the technological package of GM soy took place first in the Pampas, Argentina's historic core of agro-export production. Covering the central provinces of Buenos Aires, Entre Ríos, Santa Fe, Córdoba and La Pampa, the Pampas is an ecoregion especially suited for farming and cattle ranching, a vast flatland of highly productive land (see Fig. 1). Over 80% of GM soy production in Argentina takes place in this Pampas region.[12] However, in the last few years, production has expanded beyond this core, into the northern provinces of Chaco, Santiago del Estero, and Salta.

By the time the technological package of GM soy arrived in the Argentine Pampas in 1996, farmers were already planting soy and

[8] Traditionally farmers till the soil before planting to remove weeds. With the use of RR seeds farmers can plant first and spray later, when weeds appear. Because RR soy has been genetically modified to be resistant to Roundup glyphosate, the weeds will die but the RR plant will not.

[9] Glyphosate-tolerant soybeans were first released commercially in Argentina under license of the multinational agribusiness Nidera (which had access to Monsanto's RR gene through the acquisition of Asgrow Argentina). At this time, Nidera did not apply for patent-rights for RR soy because Monsanto, not Nidera, had developed the RR gene. By the time Monsanto sought to revalidate the patent, the petition was rejected on the grounds that the RR-tolerant plants were not a new variety, they were already widespread in Argentine soil. This is protected under UPOV 78 (for more details, see Chudnosvky, 2006, Qaim and Traxler, 2005).

[10] "Monsanto ya se aseguró el cobro de las regalías por su nueva súper soja," *Clarín,* August 22, 2012.

[11] It is important to note that Monsanto starts the battle over this issue only after 2001, when RR soy was well established in Argentina and, thanks to Argentine farmers, in neighbor countries Brazil, Paraguay, and Bolivia, where Argentine RR soy was smuggled through the borders despite GM crops being illegal in these countries. Critics argue that 'keeping quiet' during this initial period was a good strategy for Monsanto to enter the South American market (Monsanto also benefited in Argentina from high glyphosate sales). See Pierri and Abramovsky, 2009; Teubal 2006.

[12] All data for on soy production in this section and for Fig. 2, unless otherwise noted, comes from the Argentine Ministry of Agriculture, Livestock, and Fishery (Ministerio de Agricultura, Ganadería y Pesca, MAGyP). http://www.siia.gov.ar/index.php/series-por-tema/agricultura. Last accessed 4/17/12.

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experimenting with the adoption of new agrarian technologies (Barsky and Gelman, 2001). Argentine farmers started to grow soy in the Pampas in the summer of 1970. In this first growing season (1969/1970), production accounted for a mere 30.5 ha that yielded meager results: 26.8 tons produced (see Fig. 2). By the end of the 1970s (season 1977/1978), there was the first boom in soy production after the adoption of new agrarian technologies associated with the Green Revolution: hybrid seeds, mechanization, fertilizers, and herbicides (Barsky and Gelman, 2001). The adoption and intensification of agro-industrial techniques, which replaced labor by fuel and energy intensive machinery and inputs, resulted in increased production (but not yields necessarily) as they allowed expansion over a bigger area, as well as the planting of more seeds per acre. Total output ballooned as a result. For the 1977/1978 season, the area planted with soybeans increased from a few hundred hectares to over a million (from 442.5 ha in 1975/1976 to 1.2 m ha in 1977/1978) and production soared: 2.5 million tons of soybeans were harvested by the end of the summer of 1978.

Production grew steadily during the eighties and nineties, adding an average of 267,000 ha a year and reaching six million hectares by 1995/1996. For the 1996/1997 season, the first year the new Roundup Ready variety was available, the average area increase rate doubled in just one season: In the summer of 1996/1997, almost 670 thousand hectares planted with soybeans were added to production, to reach 6.67 million hectares. Just like the Green Revolution in the seventies, labor saving/replacing technological innovation made much greater production possible (Schnaiberg, 1980). Since the introduction of GM soy, an average of almost a million hectares were added to production every year (900,799 ha, average between 1998/1999 and 2010/2011), to cover 18.9 million hectares by the planting season of 2010/2011.

As the area planted with soybeans increased so has production (see Fig. 2). From the few dozen tons produced during the early seventies, the massive increase in area planted in the season 1977/1978 yielded a soybean bounty: 2.5 million tons were harvested that season. Since then, soybean output has expanded steadily, running apace with increasing land under cultivation, reaching 20 million tons in 1999, 30 million tons in 2001, and 40 million tons in 2005. The 50 million mark was passed for the 2009/2010 season, reaching 52.7 million tons. For this season 2011/2012, the production forecast is down to 45 million tons, a reduction that is consequence of the damaging effects of this year's drought.[13]

As production soared, so too did exports. GM soybeans produced in the Argentine countryside are not meant for domestic consumption but for export. Of total soy production for the 2010/2011 seasons, a mere 5.4% was destined for the local market whereas the remaining 94% was exported.[14] Soy is exported raw, as beans, or processed, as oil or soycake, and it is mostly used as livestock feedstuff. Main destinations for Argentine soy are China (beans), South and East Asia (soybean oil and oilcake), and the European Union (soybean oilcake).[15] In 2010, 83% of soya beans exports were shipped to China. That same year, 27% of soybean oil production was shipped to India, 10% to Iran, 5.6% to China, and 4.8% to Bangladesh, while soybean oilcake was destined, among other countries, to the Netherlands (12%), Italy (8%), Indonesia (7.6%), United Kingdom (5.3%), Poland (5%), and Vietnam (4.6%). The weight of soy exports on Argentina's economy is significant. For 2010, soy exports accounted for US$17.6 billions out of US$69.2 billion of total exports. Therefore, soy exports represented 25.4% of total exports for that year. The share of soy in total exports has remained strong and stable in the last decade, accounting on average for 22.8% of total exports.[16]

The adoption of GM soy in Argentina is presented as a rounded success; and indeed, in terms of production and exports, the GM soy model has created a boom. However, as described in

this section, GM's diffussion in Argentina was not merely about the intrinsic qualities of the technology but also about a context that allowed it to thrive. GM biotechnologies are not inserted in a vacuum but in specific contexts that condition their reception, dissemination, and performance (Russell, 2008; Schnurr, 2012). This was the case of Argentina, where GM thrived thanks to a socio-institutional context that was amenable to its dissemination.

3. Socio-environmental change: consequences of GM soy production

The Argentinean GM soybean boom may be a success in macroeconomic terms, however its success is less apparent when other factors beyond economic indicators are considered, such as social and environmental wellbeing, sustainability, and justice. In this section I look at the impact of the adoption and expansion of GM RR soybean on socio-environmental dynamics in Argentina to assess the performance of GM biotechnology in context.

The introduction of the GM biotech package in a context of neoliberal restructuring has radically altered socio-environmental dynamics and social relations in Argentina (Otero, 2008). The transition from a labor-intensive type of agricultural production towards one that is machine-, chemical-, and fossil fuel-dependent, has dramatically transformed rural life: Energy and petrochemicals displace labor and increase environmental degradation (Gould et al., 2008; Schnaiberg, 1980; Schnaiberg and Gould, 1994). In the Argentine Pampas, the introduction of GM biotechnology is the latest event in its history of mechanization, which dates back to the mid-1940s. In his foundational work on Argentine rural life, American sociologist C. Taylor (1948) devotes an appendix on the "progress of mechanization in the Argentine countryside" and the whole tone of the book celebrates how "modern" and technified the Argentine countryside is, a type closer to the American farmer's model and far from the *campesino* of the rest of Latin America. In the 1970s, with the Green Revolution, Argentine farmers readily innovated and adopted the newly available agrarian technologies such as hybrid seeds and agro-chemicals (Barsky and Gelman, 2001). By the time GM seeds entered the Argentine seed market, rural displacement in the Pampas was already a well-established trend: rural population in 1970 accounted for 4.85 million people, or 20.2% of total population (a low number already, compared to 43.6% for the rest of the Latin American region).[17] By 1980, the rural population had declined to 17.1% (4.81 m) and, by 1995, accounted for only 12.6% of total population (4.37 m people). The transition towards GM soy monocropping has exacerbated this trend, further reducing rural populations: in 2010, only 2.79 million people lived in the countryside (6.9% of the total population).

[13] USDA, World Agricultural Supply and Demand Estimates. WASDE #505 – April 10, 2012. http://www.usda.gov/oce/commodity/wasde/latest.pdf.

[14] Sociedad Rural > Indicadores Agrícolas > Estimación Valor Exportaciones y Retenciones a la Exportación Cereales y Oleaginosas. http://www.ruralarg.org.ar/. Accessed October 30, 2011.

[15] All data on soy exports in this paragraph, except otherwise noted, comes from the The Atlas of Economic Complexity, http://atlas.media.mit.edu.

[16] All data on soy exports in this paragraph, except otherwise noted, comes from the The Atlas of Economic Complexity, http://atlas.media.mit.edu. Average years 2003–2010.

[17] All data for percentages of rural population in Argentina and Latin America, from CEPAL/ECLAC (UN Economic Commission for Latin America and the Caribbean). Database: CEPALSTAT – Estadísticas e Indicadores Sociales, Población – http://websie.eclac.cl/infest/ajax/cepalstat.asp?carpeta=estadisticas. Accessed on 10/29/2011.

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This accelerated depopulation of the rural areas can be largely attributed to the expansion of GM soy production. The technological package requires little labor, and as machines get bigger, they can cover more ground in less time (meaning less people employed to drive them). For example, with no-till seeding, if seed and fertilizer are ready beside the tractor, only one person, the driver, can operate the whole process: he fills the tanks with a chain dump, programs seed and fertilizer delivery, and then, on auto-pilot, drives through the field, seeding between 80 and 100 ha/day with a large machine, around 50 ha/day with a smaller one. Argentina's temperate weather conditions allow for 'windows' to perform tasks, in particular for planting and spraying, meaning that the agricultural task at-hand can be accomplished within a period of 1 or 2 weeks without harming the crop. As a result, at the time of soy planting (which takes place after the last frost in September, or in mid-December for what farmers refer to as *soja de segunda,* which has a shorter cycle), not all farmers need to have their machines in use at the same time, but, within a period, the same tractor can work in the same field (thus, doing several hundred hectares working in successive days) and then on many adjacent fields. By contrast, for harvesting, producers prefer to finish work as fast as possible, as once crops are ready to harvest, extra days on the ground may expose crops to the risk of hail, rain, or winds that can destroy them. Thus, more machines, typically two or three, are at work in the same field. A large combine can harvest around 100 ha/day, which employs only one person, the driver. Occasionally, if the combine is not equipped with a grain tank, a second employee is required, to drive a small truck that moves beside the combine as beans are unloaded. This means that no more than six workers are needed to harvest a 600 ha farm in 2 days. Larger farms tend to employ more people to work on double-shifts, harvesting through the night.

Because agricultural machinery is expensive, and it is used for only a few days in each field, soy producers tend to contract these services, as they do not find it "efficient" to buy them. *Rural contractors*, a type of rural actor that has grown in numbers with the GM agrarian transformation, are the ones hired to perform these services; mostly pest control and harvesting (Lódola, 2008). Contractors typically have no control over the land; they only own the machinery and do the labor. Because the specialized agricultural machinery used to grow transgenic soy can be used with other crops, such as oats, wheat, ryegrass, and alfalfa, contractors are at work almost all year round, traveling with their tractors and combines from field to field, from province to province. Consequently, only a limited number of machines are needed to accomplish agricultural tasks all throughout the country. Rural labor becomes more specialized and concentrated as a result.

As machines get bigger and more technologically advanced, specialized knowledge is necessary to operate them. Moreover, production planning happens in advance and it also requires specialized skills. Rural skills and knowledge, traditionally transmitted within the family or community, are now transmitted through universities. Agronomists and engineers with Masters' Degrees in agribusiness now plan and follow production from afar, from the offices of the agribusinesses, with the aid of information technologies such as computers, cellphones, and satellites. Field visits are increasingly rare. One person can oversee several thousand hectares. In an interview, an agronomist reported covering over 5000 ha in a season when working for a large agribusiness, which he oversaw driving by himself from Santiago del Estero to central Buenos Aires.[18]

As GM soy production replaces other agrarian activities that are more labor intensive, such as horticulture, milking, and cattle grazing and slaughtering, there are fewer jobs available for rural inhabitants. As a consequence, either because there are less rural jobs available or because rural work is not tied to the field anymore, many rural families migrate to the closest big town or city, where there are jobs and children are closer to schools and hospitals.[19] (For more on agrarian transformation and rural depopulation in the Pampas, see Stratta Fernández and de los Ríos Carmenado, 2010.)

Rural depopulation goes hand in hand with a decrease in the number of farms as well as with increased farm size and concentration of landholdings (Gras, 2009, 2012; Gras and Hernández, 2009b; Teubal, 2006). According to the 2008 rural national census, in the Pampas region there has been a reduction of 24,405 farms between 2002 and 2008; an 18% decrease in farm numbers.[20] Set in comparison with data from the 1988 rural census, the decrease is even steeper: a loss of 78,900 farms between 1988 and 2008, which is a plunge of 41.7% in just two decades. In the northern provinces there is a similar trend in the reduction of farm numbers, almost a 15% drop between 2002 and 2008 (a loss of 7166 farms), and 20.6% in the two decade-period 1988–2008 (a loss of 10,657 farms).[21] Farm size has also increased. Gras and Hernández (2009b:24) calculate that between 1988 and 2002 median farm size has ballooned by 25%, increasing to 587 ha.[22] Larger farms ranging between 1000 and 2500 ha have increased their relative size by 8.5%, on average. The largest farms, with 10,000 ha or more, represent a small fraction of total farms (0.9%), but control almost 36% of landholdings (Gras and Hernández, 2009b:24). Increasingly, small landholders lease their farms to bigger producers, as they report it is now more profitable and less risky to rent out the land than engage in production themselves. The area operated under a rent-tenure system accounted for 52% of the total in 2002 (Gras and Hernández, 2009b:24). That figure has kept increasing, and Gras (2012:12) estimates that currently 70% of all land under cultivation is leased.

GM soy production in Argentina is mostly concentrated on by agribusinesses (Gras, 2012; Gras and Hernández, 2009b; Newell, 2009; Teubal, 2006; Teubal and Rodríguez, 2002). Some agribusinesses operate with their own capital, including land ownership, but most pool capital from external investors and operate under short-term contracts. These types of agribusinesses are known locally as *pools de siembra,* "sowing pools." *Pools de siembra* are investment groups that combine financial investors with a managerial core that rents land, labor, and machinery to produce at a large scale and often includes stock investment in the commodity market (Bustamante and Maldonado, 2009). Some *pools* are small (i.e., control a few hundred hectares) but some have grown to control hundreds of thousands of hectares and have become powerful actors in the trend of technological innovation (Gras, 2012; Gras

[18] Interview with agronomist (*ingeniero agrónomo*), former agribusiness employee (*pool de siembra)*, Buenos Aires, March 2011. Most of the agronomists employed to do this job are young graduates (mostly men) under short contracts (usually this employment lasts just long enough to complete the inspection tour).

[19] A typical concern, in particular from mothers, is the lack of services in rural towns, in particular education and medical. Typically kids have daily hours-long commute to school. Dirt roads get impassable in rainy days, making transportation harder or impossible, isolating the town. City amenities, like services, and electricity, gas, clean water and sewers, and paved streets are enticing as they make everyday life "easier" compared to the hardships of rural life.

[20] Rural National Census, *Censo Nacional Agropecuario (CNA)* 1998, 2002, and 2008. Data for 2008 is preliminary. "Censo Nacional Agropecuario 2008: resultados provisorios" http://indec.mecon.ar/nuevaweb/cuadros/11/cna08_10_09.pdf – "Pampas region" includes the provinces of Buenos Aires, Entre Ríos, Santa Fe, Córdoba and La Pampa. "North" includes Chaco, Santiago del Estero, and Salta.

[21] Rural National Census, *Censo Nacional Agropecuario (CNA)* 1998, 2002, and 2008. Data for 2008 is preliminary. "Censo Nacional Agropecuario 2008: resultados provisorios" http://indec.mecon.ar/nuevaweb/cuadros/11/cna08_10_09.pdf – "Pampas region" includes the provinces of Buenos Aires, Entre Ríos, Santa Fe, Córdoba and La Pampa. "North" includes Chaco, Santiago del Estero, and Salta.

[22] Authors calculate from data from Rural National Census, *Censo Nacional Agropecuario (CNA)* 1998 and 2002. Similar data from CNA 2008 has not yet been made available.

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and Hernández, 2009c; Hernández, 2007). *Los Grobo, El Tejar,* and *Adecoagro* are iconic examples of bigger *pools*. For example, a *pool de siembra* like Los Grobo controls 240,000 ha,[23] most of it operated under lease (Gras, 2012:11). There are no official statistics that account for land leasing contracts, thus landholding concentration by the different *pools* is difficult to assess (Bustamante and Maldonado, 2009). Relying on qualitative techniques and data from websites, Gras (2012:8) estimates that in Argentina 1.5 million hectares are controlled by the 10 largest agribusinesses, and they are expanding production in other countries of the South Cone. For example, *El Tejar* produces GM soy in Argentina, Brazil, Uruguay, and Bolivia.[24] The technological package of GM RR soy has, in many ways, made possible the existence of these *sowing pools*, since in order to make the activity profitable it is necessary to produce over huge land areas. There is therefore an intimate connection between the increased control of agribusiness and the expansion of GM biotechnology in Argentina and South America. The combination of no-tillage machinery and the GM RR seeds allows for the expansion of production. Also, the bigger the *pool* becomes, the more leverage they have to negotiate cheaper prices for inputs, thus allowing for increased profits, which then allows them to produce at an even larger scale. The treadmill of production is thus at work, as the agribusiness' logic of profit requires increased production achieved through constant technological innovation (Gould et al., 2008; Schnaiberg, 1980; Schnaiberg and Gould, 1994). In this way, Argentine agriculture resembles that of other large GM biotech adopters, such as the United States, as the number of farms and farmers shrinks, farm-scale expands, and control shifts increasingly to agribusinesses (Magdoff et al., 2000; Magdoff and Tokar, 2010).

The ever-expanding production of GM soy has pushed past the agricultural frontier of the Pampas region into the northern provinces of Chaco, Santiago del Estero, and Salta (see Fig. 1). This is where the monocultures of GM soy have taken their heaviest toll (Pengue, 2005). These northern provinces sustain a very different ecosystem than the Pampas: Here, *el monte,* the rainforest, is the predominant ecosystem, which is rapidly being torn down by bulldozing and fire to clear land for mechanized large-scale production. The expansion of the agricultural frontier threatens highly sensitive biodiverse ecoregions, including the Yungas, the Great Chaco, and the Mesopotamian forest (Pengue, 2005). It also threatens the livelihood of many northern rural inhabitants, who are mostly indigenous and peasant *campesinos*. With the expansion of GM soy production, land in the northern provinces has suddenly become very valuable. For example, a farm in Santiago del Estero that is suitable and ready for extensive agricultural production, in particular for GM soy cultivation, was valued at US$7,000/ha in 2011, up from US$150–200/ha in 2001–2002.[25]

With this increased value of land, historically absentee landowners are now back to claim the land with the goal of clearing the forest and renting or selling it for agricultural production.[26] But to their surprise, when their return they often find out that there are entire families living on what they claim is their property. Many times, these are the families of "forgotten" ex-workers, men who in the past had been employed as lumberjacks but when the landowner fled and the job was over, the lumbermen remained there, and over time brought up their own families. These families claim the land as theirs based on the *Ley Veinteañal,* a law that concedes property rights to families that have lived on the same land for 20 years or more. Many families also claim land based on their ancestral origin, as native peoples, such as Wichís, Tobas, and Mocovíes.

El monte, the forest, is a vital resource for campesino and indigenous families. Managed as a commons, the forest provides wood for home cooking or sale and pasture for domestic animals, mostly goats. The forest also provides most of household income, from charcoal sale to direct employment. Men would previously often find work as *hacheros*; loggers for timber sold to build furniture, posts for wiring fields to fence cattle, and rail foundations. As demand for wood fell, as wooden rail foundations are replaced by concrete, and cattle are enclosed in feedlots, while at the same time profit margins for soy grow, switching from forestry to agriculture becomes more profitable and attractive. Nowadays, men and women are typically hired to gather the roots remaining after the forest has been bulldozed or burnt down, to prepare land for extensive industrial agriculture. This is an unsustainable and disheartening job, as it soon ends when there is no more forest to clear out; the very same forest that is their source of life.

In the land rush for soy, violence is escalating. Members of the *Movimiento Campesino de Santiago del Estero* (MOCASE), part of the international peasant movement *Vía Campesina,* have documented the threats and assaults directed towards campesino and indigenous families, as paramilitary-like forces bulldoze their homes, threaten death to entire families, and murder their leaders.[27] While violence against indigenous and peasant families for land control has a long history in these northern provinces – violence that prompted the emergence of the MOCASE as the strongest and most visible of campesino movements in Argentina – the expansion of GM soy in the North has certainly sped up the cycle of violence related to land grabs.

El monte, the northern forest, is the largest forest ecosystem and the largest biomass reservoir in Argentina and the extra-tropical South America (Gasparri et al., 2008). The clearing of the *monte* to make room for large-scale agro-export production, in particular GM soy, has prompted rapid and wide-scale deforestation (Gasparri et al., 2008; Paolasso et al., 2012; Pengue, 2005). Deforestation in the northern provinces is a process that started long before the expansion of the agricultural frontier of GM soy, a fact brought up by defenders of the technology to ease criticism of the spread of the new technology (Trigo, 2011). Many authors agree, however, that the rate of deforestation has *accelerated* with the introduction of GM soy (Gasparri et al., 2008; Grau et al., 2005; Paolasso et al., 2012; Pengue, 2005). A government report on deforestation in Argentina also points at the expansion of the monocultures of GM soy as the main accelerator of deforestation and forest degradation in the last decades, and claims that this is the strongest process of deforestation in Argentine history (USDEF, 2004:5). Between 1998 and 2008, 1,691,878 ha of native forests have been lost in the northern provinces of Salta, Santiago del Estero, Chaco, and Jujuy (USDEF, 2008:10).[28] The *Ley de Bosques (Forest Law),* passed in 2007, which aims to limit the clearing of the native forest, has failed to impact the pace of deforestation (USDEF, 2008:10).

The environmental impact of large scale GM soy monocropping is felt all throughout the country. As monocrops expand natural habitats disappear, thus endangering plant and animal biodiversity (Martínez-Ghersa, 2011; Pengue, 2005, 2009). Large scale mechanized GM soy monocropping in the Pampas has also resulted in nutrient depletion and soil structure degradation (Martínez-Ghersa, 2011; Pengue, 2005, 2009).

Agro-chemical spraying, necessary to artificially control pests and weeds that grow under monocultures, is another important

[23] www.losgrobo.com.ar; accessed 1/6/12
[24] http://www.eltejar.com, accessed 4/23/12
[25] Interview with licensed rural estate broker, Santiago del Estero, August 2011.
[26] Interview with licensed rural estate broker, Santiago del Estero, August 2011.
[27] Interview with members of Movimiento Campesino de Santiago del Estero-Vía Campesina (MOCASE-VC), Santiago del Estero, August 2011.
[28] This report maps the process of deforestation in the Northern provinces. The map can be downloaded at http://www.ambiente.gov.ar/archivos/web/UMSEF/File/Mapas/deforestacion07-08_ley26331_130x90.jpg

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source of socio-ecological disruption. Proponents of biotechnology highlight the environmental benefits related to no-tillage (Trigo et al., 2002). As described in the previous section, at the time of adoption of GM biotechnology, a reduction in the number of agro-chemicals used was an important element in farmer decision-making around the adoption of GM. However, over time, pest resistance and soil depletion have demanded increased treatments of agrochemicals (Binimelis et al., 2009; Martínez-Ghersa, 2011). The emergence of glyphosate-resistant weeds, like johnsongrass, has been met with the introduction of novel varieties of GM crops that tolerate increasing doses of herbicide, thus intensifying both agrochemical use as well as GM crop adoption, a phenomenon that Binimelis et al. (2009) refer to as the "transgenic treadmill."

With the emergence of glyphosate-resistant "superweeds," producers have resorted to increasingly higher doses and more toxic formulations, including some with globally banned agro-chemicals, such as atrazine, endosulfan, and 2,4-D (Binimelis et al., 2009; Pengue, 2005). In labs, studies have shown that in vertebrate embryos glyphosate and Roundup formulations are endocrine disruptors, meaning that they interfere with normal hormone and enzyme functioning, impeding normal development and causing malformations (Paganelli et al., 2010). A report by Argentine physicians link increasing cases of cancer, miscarriages, and birth defects with the spraying of agro-chemicals, especially glyphosate (1er. Encuentro Nacional de Medicxs de Pueblos Fumigados, 2010). Similar findings are presented in a report commissioned by the provincial government of Chaco (Comisión Provincial de Investigación de Contaminantes del Agua, April 2010).

As fields increase in size, glyphosate spraying is often performed with airplanes, which makes fumigations less controllable. In interviews, rural inhabitants complain of being sprayed over their heads and homes, over their schools and hospitals. In response, some community organizing has taken place in the form of citizen and neighbor assemblies in several towns across the country to protest against *agro-toxics* – as they term agro-chemicals, and to demand stringent regulations for agrochemical use (Berger and Ortega, 2010; GRR, 2009). It is worth noting that some of these protests against the harmful effects of glyphosate have been suppressed with violence: there are reports of assembly meetings being disrupted and individuals intimidated.[29]

The economic boom of GM soy exports has not had equivalent effects at the social or environmental level. On the contrary, throughout the country the expansion of the monocultures of GM soy has resulted in increased socio-ecological disruption. In the next section, I show how a change in the neoliberal model post-2001 crisis has implied some changes in the political economy of Argentina, yet none in the way in which soy is produced (or in its consequences).

4. Current context: The Kirchners' administrations

The Argentine government, under the Kirchners' administration, presents itself as an alternative to the neoliberalism of the 1990s. While many changes have taken place since the 1990s, the GM soy based agro-export model has kept expanding since the adoption of the technological package of RR soy (see Fig. 2). In fact, it was under the Kirchners that the GM soy agro-export model found its ultimate expression. They furthered and deepened it, as they relied on soy-derived revenue to sustain their "National-Popular" model (Svampa, 2008). In this section I place the Argentinean soybean boom in the context of Argentina's current domestic political economy, particularly the Kirchners' political strategy. The goal is to provide further evidence of how Argentina's socio-institutional context is amenable to the dissemination of GM crops and to highlight the contradictions of a model based on natural-resource extraction.

The neoliberal model implemented in the 1990s collapsed by the end of 2001, leaving behind a shattered country. Half of Argentines were living in poverty, amongst the highest rates of inequality in history, with immense despair in a context of institutional, political, and economic crisis (for an explanation of the 2001 crisis, see Carranza, 2005; Teubal, 2011). A massive external debt was one of the main consequences of the neoliberal structural adjustment program of the 1990s and, later on, one of the main catalysts of the 2001 crash (Teubal, 2011). By the end of 2001, external debt had risen to 144 billion US dollars, accounting for 43.4% of gross national product (GNP) (Teubal, 2011:79).

After a year of a post-crisis transition government, in 2003 Néstor Kirchner was elected president with a leftist platform and a strong anti-neoliberal discourse. Commanding shoulder-to-shoulder with his wife Cristina Fernández de Kirchner – who succeeded him in 2007 and was recently reelected until 2015 – the presidential couple established what they have termed as a "National and Popular" model. The Kirchners' National-Popular model, which Ms. Fernández has professedly furthered ever since Mr. Kirchner's death in October 2010, aligns with – and is part of – the more general turn to the left in Latin America.[30]

The National-Popular model that the Kirchners' administration has set in place contrasts with the hands-off, shrink-the-state mentality of the neoliberal 1990s. The new model is rooted in strong government intervention, based on the principle that it is the government's role to promote economic growth and redistribute wealth to reduce poverty and promote social inclusion. Now in place for almost a decade, the Kirchners' model has been successful in establishing and funding a national network of social plans and programs, as well as projects dedicated to infrastructure development. Increased social spending, in particular cash transfer programs such as *Jefas y Jefes de Hogar Desocupados* (Unemployed Household Heads program) and the *Asignación Familiar por Hijo* (a monthly allowance for unemployed families with children), have had a positive impact in reducing income inequality (Lustig et al., 2013). Gini coefficients fell to 0.431 in 2011, from 0.533 in 2002, the peak of the crisis.[31] Extreme and moderate poverty also fell: In 2002, 29.2% of urban population was living with less than US$2.5 a day, 45.5% with less than US$4/day. By 2011, extreme poverty in urban areas had lowered to 5.4%, moderate poverty to 12.9%.

To implement the National-Popular model the Kirchners proposed, massive amounts of funds were needed. Early on, the key question the government faced was how to amass the necessary funds to kick-start the economy. Taking on foreign debt is always a possibility, but not for post-2001 Argentina, which had already defaulted on its external loans.[32] After the 2001 crash, the transition

[29] One of the most notorious of these violent events was the "interrupted" visit of Andrés Carrasco – a scientist that has tested the health effects of Roundup fumigations and one of the leading anti-glyphosate/GM soy-voices in Argentina – to La Leonesa, Chaco, in August 7, 2010. Carrasco had been invited by the neighbor assembly to discuss the environmental and health effects of glyphosate spraying, in a town that had organized to protest against fumigations in adjacent rice fields. Right before the meeting, Carrasco and his colleagues were violently attacked by a group of people identified as public (town hall) employees and employees from the rice firm (Aranda, Darío, "Censura y Presiones," *Página/12,* August 17, 2010).

[30] On the rise of the Left and the emergence of National-Popular regimes in Latin American, see Castañeda, 2006; Vilas, 2006.

[31] Data on poverty and inequality from SEDLAC, Socio-Economic Database for Latin America and the Caribbean (CEDLAS and The World Bank); http://sedlac.econo.unlp.edu.ar/ Accessed April 20, 2012. Data are for urban areas only. The national household survey (Encuesta Permanente de Hogares-Continua) covers urban areas only, which represent around 60% of total population. See SEDLAC, Methodological Guide.

[32] It was, in fact, a *partial* default: Argentina defaulted on its external private debt but continued to pay its debt to the IMF and other international financial organizations (see Teubal, 2011).

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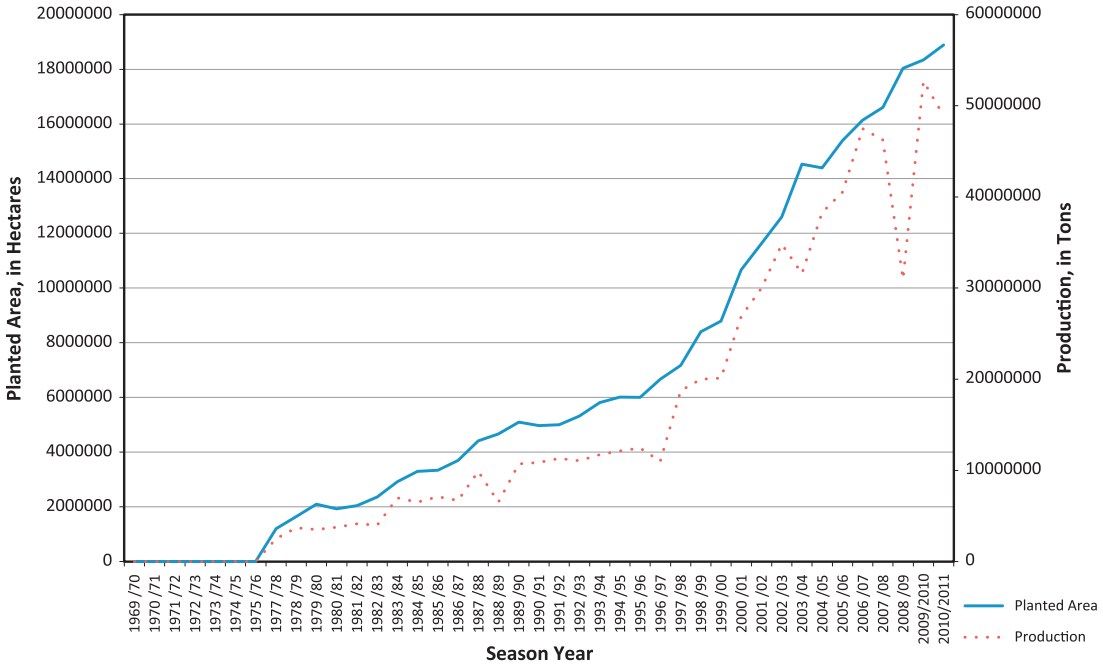

Fig. 2. Soy planted (in hectares) and Production (in tons), Annually. *Source:* Ministerio de Agricultura, Ganadería y Pesca (Argentine Ministry of Agriculture, Livestock and Fishery).

government took a series of measures to deal with the crisis: to default on Argentina's debt and to end the Convertibility Law: the peso's decade long 1-to-1 peg to the US dollar. By 2004, after the peso's devaluation, Argentina's external debt went up to over US$191 billion, accounting for 112% of GNP (Teubal, 2011:79).

A comprehensive debt restructuring was an extremely important piece in the story of Argentina's revival. After Néstor Kirchner's debt exchange in 2005, foreign debt dropped to US$ 126.6 billion (equal to 74% of GNP) (Teubal, 2011:79). The other key piece of the revival story was – and is – the GM soy-based revenue. Once out of the crisis, GM soy exports were hailed as the country's savior, the primary source of fresh inflows of foreign currency (Newell, 2009; Teubal, 2006, 2008). Duhalde's transition government had devaluated the peso (Ps3-4:1US$) and reinstated export taxes established by President Perón in the mid-20th century (Barsky and Gelman, 2001). Now with more pesos for every dollar, increasing soy exports, and high commodity prices, the State's ability to retain a fraction of total exports meant billions of pesos flowing to the state coffers. Mr. Kirchner inherited these economic measures at an exceptional historic moment, when international commercial and financial conditions were beneficial to Argentina's agro-export model. Real GDP, which had bottomed out in early 2002, rebounded to grow by an average of 8.5% annually over the next six years.[33] Foreign income from exports more than doubled: in 2003, total exports amounted to US$30.5 billion and, by 2008, to $71.8 billion dollars, of which soy and soy-derived exports accounted for 22% in average.[34] Since 2003, export taxes have come to represent around 11% of total government revenue.[35] In 2011, the government collected AR$54 billion on export taxes,[36] 61% of which represented revenue from soy exports taxes alone, valued at AR$33.2 billion, around $8.1 billion dollars.[37]

Increasing foreign income from agricultural exports and higher fiscal revenue explain how it was possible for the Kirchners to return to a model of state intervention, investing in infrastructure and social spending, without enacting major structural reform, thus keeping intact the Non-Traditional Agro-Export model devised in the neoliberal 1990s. It is also for these reasons that Néstor Kirchner's administration (2004–2007) heavily promoted the expansion of the agro-export development model based on GM soy monocropping. A 10-year Development Plan, planning towards 2015, continued this trend of promoting agricultural biotechnology as a core element of Argentina's development strategy. The goal of this plan is to promote "long-term development" by promoting an intensive use of imported science and technology applied to agricultural production – Argentina's "comparative advantage" (SAGPyA, 2004). GM technologies are the key to development as they promise to exploit Argentina's potential and to increase the productivity of agriculture.

Cristina Fernández's administrations (2007–2011; reelected for a second term until 2015) represent a continuity of Mr. Kirchner's model (or even its "deepening" or intensification, which has been Ms. Fernández's slogan since Néstor's death in 2010). The agro-export development model based on GM soy monocropping under Ms. Fernández government continues to expand (see Fig. 2). The agricultural Strategic Plan 2010–2016, known as PEA2, is as another example of the continuity of the model as it focuses on increased production through technological innovation, i.e., agro-industrial practices. Once more, the plan also distinguishes Argentina's unique capabilities to produce food to respond to increasing global demand.[38] Here again the narrative of the promise and potential of GM biotechnology to feed a growing world population is at work, a narrative that hits the wall when faced to the fact

[33] Average GDP annual percentage growth rate 2003–2008. World Bank Indicators, GDP Growth (annual %). http://data.worldbank.org/. Accessed 8/16/12.

[34] Average years 2003–2008. The Atlas of Economic Complexity, http://atlas.media.mit.edu.

[35] Average years 2003–2011; AFIP, http://www.afip.gob.ar/institucional/estudios/recaudacionAnual.asp.

[36] Average years 2003–2011; AFIP, http://www.afip.gob.ar/institucional/estudios/recaudacionAnual.asp.

[37] Sociedad Rural, *Op. Cit.*.

[38] PEA2, Plan Estratégico Agroalimentario y Agroindustrial Participativo y Federal, 2010-2016. www.minagri.gob.ar/site/areas/PEA2/index.php.

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that GM soy in Argentina is produced not for human consumption but, as I have shown above, entirely for export, as livestock feedstuff.

The current global context is particularly beneficial to Argentina's GM soy based agro-export model. An increase in global food demand based primarily in China and India, increasing financial speculation, and crops diverted to agrofuels created by 2008 the "perfect storm:" food scarcity, hunger riots, and a spike in commodity prices (Magdoff and Tokar, 2010). The Argentinian government and producers were poised to profit from this crisis; soy production was a "gold mine." The government decided that these extraordinary conditions necessitated extraordinary measures. In March 2008, Ms. Fernández signed a decree to increase the government's share in export revenue; increasing existing soy export taxes from 30% to a floating rate tied to international prices (at higher commodity prices, the higher the export tax). In response, soy producers, big and small, hit the streets, backed by a very significant share of the rural and urban population discontented with the presidential couple. A 3-month strike became known as *el conflicto del campo*, the conflict with the countryside, which is considered by some to be, because of its magnitude, the most important agrarian conflict in Argentine history (Barsky and Dávila, 2008, for a detailed analysis of the 2008 *conflicto del campo*, see also Giarracca and Teubal, 2010). This attempt to raise export taxes exemplifies the Kirchners' approach towards GM soy production in Argentina: It is not about regulating the activity but about the allocation of surplus, as it is soy-derived revenue that makes it possible to sustain the National-Popular model without abandoning neoliberal agro-export development (Richardson, 2009).

The Kirchners' administration also indirectly promoted and encouraged GM soy expansion through policies that were originally presented to promote wealth redistribution and to secure food for domestic consumption, as part of the general National-Popular orientation. For example, price caps and export quotas on specific agrarian products – in particular, wheat, meat, and milk – have been set to secure domestic food supply, as a response to the 2008 global food crisis. This measure, while celebrated by many, has had the unintended effect of pushing more growers towards GM soy. The moratorium sounds "right," as it serves to protect domestic needs (in particular in the face of a global food crisis, see Bello, 2009; McMichael, 2010). However, as the measure was not paralleled with others measures that would encourage food production, such as credits or tax breaks for small growers, its unintended consequence was the *expansion* of the GM soy model.

As rural producers organize production on the basis of profitability, if growing soy is an option (i.e., if the depth of soil, humidity, and nutrients allow it), they will likely choose soy over other crops or cattle; at least for as long as current conditions remain, in particular high international prices and no caps on exports, either in terms of price or quotas. Producers from the Pampas southwest, where environmental conditions are not optimal to grow GM soy, complain of being "stuck" with wheat growing, which has price and export caps, and are envious of the "lucky" ones that can grow soy. This is the southern frontier of the GM soy expansion (see Fig. 1). This border is drawn by environmental limits and not by rural producers' preference for other crops. Nowadays, a new GM soy variety is being developed that will allow soy planting south of this border, into the Patagonia region; a development certainly linked to Chinese land grabs in the Río Negro province.[39] Considering patterns of adoption of agricultural technologies it is likely that, if the new variety works, southern producers will switch to GM soy as well.

As it becomes more profitable to switch production, more producers abandon their traditional crops to plant GM soybeans. Cattle ranchers have also followed the trend. Beef price caps and export quotas made ranchers wonder whether or not to continue with Argentina's most emblematic activity, cattle grazing, or to free up land to grow soy. The drought of summer 2008 killed many animals, expediting the decision. For those still undecided, federal credits to build feedlots gave them the further push. Nowadays the number of cows across the country is growing after it bottomed out in 2008 (Guevara and Grünwaldt, 2012). However, these are mostly feedlot-raised animals, which carry their own socio-ecological consequences: increased use of hormones and antibiotics, health issues related to feedlot-raised beef consumption, and degraded environmental quality, as feedlots pollute air, water, and soil (Schlosser, 2002). Animal enclosure, typical in the US, was not common in Argentina until very recently although it is rapidly reaching all animals grown for human consumption, cows, chickens, and hogs, freeing land for agricultural use. Dairy farms have fallen under the same trend and regions specializing in dairy products, such as south of Córdoba's province, now are covered with abandoned mills and water tanks, and rusty, toppled fences, if they are completely removed to make room for GM soy production. Similar stories of traditional activities, such as milking, cattle grazing, wheat growing, or horticulture, being replaced by large scale mechanized GM soy production are common as one travels across the Argentine countryside. In consequence, there is now there is now less available food for domestic consumption and it is of lesser quality (Teubal, 2008).

In sum, the policies taken to allegedly protect domestic food consumption have actually produced food insecurity. Argentina, historically the Breadbasket of the World and still today a net-crop exporter, has lost its food sovereignty; the ability to feed its own (Teubal, 2008). Moreover all these changes have freed up land for soy, creating favorable conditions for the expansion of large-scale mechanized production. Small farmers and campesinos are at a huge disadvantage, as they do not receive any direct help in the form of subsidies, credit, or machinery. Many small and medium producers from the Pampas have unwillingly switched to soy, just because it is the only crop that gives enough profit to enable them to afford the next growing season. Because of economic hardship, some have been forced to rent or sell their plots and thus exit farming altogether. The fact that the government taxes producers of any size a flat export tax clearly benefits the bigger producers as they have lower costs and higher profits.

The Kirchners' administration also promotes and encourages GM soy production by manufacturing quiescence in the face of the negative consequences of production (Leguizamón, 2011; Newell, 2009). Social spending in the form of conditional cash transfers, while important and necessary to relieve poverty, have a demobilizing effect. For example, in the northern Chaco province, social funds started being distributed right at the time when people started to lose access to the forest as a means of subsistence. Thus, instead of fueling protest – as would be expected in comparison to similar cases in the Global South, where poor people have organized when at risk of losing access to their means of livelihood (Dwivedi, 2001) – government cash has substituted for the lost income, easing the strain. Moreover, because cash transfer programs are contingent on unemployment or disability status, the unintended effect is to increase poor people's dependence on the State and, therefore, to further increase demobilization. Lapegna (2011) on his study on peasant movements in the Formosa province, also points to government transfers, as an aspect of networks of patronage and clientelism, as a cause for demobilization and quiescence in the face of GM soy expansion in the north of the country.

Governments at the town- and province-level also depend on federal soy-based revenue and thus become trapped in quiescence.

[39] In October 2010, a Chinese state-owned agribusiness, Beidahuang, and the government of the Río Negro province, in the Patagonia region, signed a 20-year lease over 320,000 hectares to produce GM staple crops aimed for the Chinese market (Lopez-Gamundi and Hanks, 2011).

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After the 2008 *conflicto del campo*, Ms. Fernández signed a decree to create the *Fondo Solidario de la Soja*, the Solidary Soy Fund.[40] The rural strike had placed soy production on every TV channel and almost overnight GM soy monocropping and its consequences became a public issue. The Solidary Soy Fund became a very concrete way to show the general population how they also benefited from soy production and exports (as well as a strategy to quell dissent). The Fund establishes the distribution of soy export taxes from the federal to the province and town governments (thus the national government "co-participates" local governments in the soy-based revenue). For local governments, in particular small rural towns, soy-derived money is a very significant part of their budget (either as direct income as Fund co-participation or through the federal government, in the form of subsidies for social programs or social infrastructure investment). Hence, the local governments are tied to and dependent on GM soy production, as soy revenue is used to pave dirt roads, bring clean water, build sewers, and to maintain or renovate the main *plaza*, schools, and hospitals; as well as to directly sustain a part of the population, by handing out monthly payments – as part of cash transfer programs – or new homes – as part of housing projects (*programas de vivienda social*). Consequently, it becomes very difficult for local governments to support or encourage alternative types of agricultural production, for it means risking a very significant percentage of their meager budgets, as well as votes. The complicity of indebted local governments is thus another important dimension of GM soy expansion in Argentina.

5. Conclusions

Argentina has been cited as a recurrent "success story" in studies on agricultural transformations based on GM crop adoption (Chudnovsky, 2006; Trigo and Cap, 2003; Qaim, 2005). These studies emphasize the smoothness of the transition and the benefits it has brought, as the adoption of the technological package of GM soy increases both production and profits. However, set in context, the transition was not so straightforward that the GM soy model can easily be replicated in other countries, nor are its consequences all beneficial.

The particular institutional and ideological framework in a specific domestic and international political economy, that of Argentina in the neoliberal 1990s, became the most conducive context of adoption of the new technological package of GM RR soy. In the first decade of the 21st century, the expansion of the *modelo sojero* occurred despite a change in Argentina's domestic political economy. The rise of a self-proclaimed anti-neoliberal and progressive government, the Kirchners', has in fact not dismantled the mode of production set in place by the previous neoliberal administration. To the contrary, the Kirchners' administrations have created favorable conditions for the expansion of GM soy. Driven by debt, both neoliberal and post-neoliberal governments have relied on state policy to intensify Argentina's comparative advantage.

In terms of economic growth, the results of the *modelo sojero* have been outstanding. Yet the overall impacts of the GM soy model are less positive. The GM soy-based agrarian transformation has implied radical changes in socio-ecological dynamics in Argentina: increased inequality due to concentration of landholdings and agribusinesses, rural displacement through a violent politics of dispossession, the loss of food security, and health hazards due to agrochemical exposure add to the disruptions at the ecosystem level, including deforestation, loss of biodiversity, emergence of glyphosate-resistant superweeds, nutrient depletion, and air pollution. Economic gains thus create socio-ecological unsustainability, threatening the continuity of the model itself.

In the last few years, the Kirchners' National-Popular model has offset the negative social impacts associated with GM soy. Increased social spending and infrastructure investment certainly improve people's wellbeing, in particular that of the poorest. In an interesting twist, the success story of GM soy becomes legitimized under the Kirchners' model, as the expansion of production and profits now allegedly benefits all instead of being appropriated by an elite now that the government directly intervenes to redistribute soy-derived revenue. However, the potential of the National-Popular model to fully address social problems is questionable. As funding for the National-Popular model relies heavily on soy export taxes, at least as it is currently configured, its continuity requires the continuous expansion of GM soy production, an already unsustainable practice. The constant search for increased revenue ends up undermining the project itself, in a destructive treadmill where the natural resource base is even more rapidly depleted to allegedly increase social wellbeing (Gould et al., 2008; O'Connor, 1998; Schnaiberg, 1980; Schnaiberg and Gould, 1994).

Within this model, commodity exports remain at the core of Argentina's development strategy, repeating Latin America's colonial pattern of dependent development (see Cardoso and Faletto, 1979). Dependence on natural resource extraction is hardly a new phenomenon for Argentina, or Latin America. Pressured by external debt, and under the ideals of progress and modernization, governments in the region have promoted technological innovation to increase productivity of the export-commodity sector (whether it is soy, fruits, sugar, coffee, oil, or gold). In the short and medium term, this is a highly unstable model as it is subject to cycles of boom and bust. GM soy production in Argentina is driven by constantly expanding demand in China and India, which caused international prices to spike and absorbs increasing production at home. As with any cycle of boom and bust, however, the question is not if demand will ever slow down or even end, but rather when it will happen, and how hard it will hit.

In the long run, the quest for growth and profits through constant technological innovation implies faster extraction and, thus, faster degradation of the social and ecological base (Gould et al., 2008; O'Connor, 1998; Schnaiberg, 1980; Schnaiberg and Gould, 1994). There is a tradeoff between immediate rewards and the long-term consequences of a model of development based on natural resource extraction, where the promise of material wealth is prioritized even at the cost of increased environmental degradation (Gould and Lewis, 2009; McMichael, 2007; Redclift, 1992). Transgenic crops have been at the core of Argentina's development model as they are presented with the promise of dynamism, efficiency, and increasing yields and profits; a technology particularly fit and necessary to exploit Argentina's "potential" for feeding the world. At the same time however, the constant expansion of production allowed by the technological package of GM soy, under structural conditions that privilege GM soy over other agricultural possibilities, accelerates socio-ecological degradation. In this way, the GM soy-based agro-export model as currently configured in Argentina is a socially and ecologically unsustainable model of development.

GM crops have been presented to the world as representing the promise of modernization, progress, and development, a "success" narrative that has held up well in Argentina. However, under close scrutiny, this study shows that the potential of transgenic crops to improve livelihoods in the Global South is less straightforward than GM supporters suggest. For GM soy in Argentina, beneficial outcomes have depended on the socio-economic, institutional, and environmental setting on which GM biotech was disseminated. Moreover, these outcomes have been defined as beneficial

[40] *Fondo Federal Solidario, Decreto* 206/2009.

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in very limited terms, solely in relation to production, exports, and profits. These conclusions suggest that in order to fully and properly evaluate the promise and potential of new agrarian technologies it is necessary to use a broader analytical framework: one that aims to appraise the technology not by itself but as it is embedded in its social context (Glover, 2010; Russell, 2008; Schnurr, 2012), as well as to consider the multiple and varied ways in which technological innovation transform societies and ecosystems (Gould et al., 2008; O'Connor, 1998; Schnaiberg, 1980; Schnaiberg and Gould, 1994). These considerations are urgent as transgenic crops are adopted throughout the Global South, as the rapid expansion of Argentina's GM soy model in South America exemplifies.

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