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"Blighted Futures: The Soybean Assemblage and Argentina's Agro-extractive Turn"

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ABSTRACT

Argentine GM soybean producers find themselves in an untenable situation. They must produce more even though pressures like weed resistances, global commodities price fluctuations, and an unpredictable tax regime pose ever greater challenges. Meanwhile, public sentiment has largely turned against the rural sector for its opposition to tax increases and the under-regulated use of agrochemicals. There are, however, no easy alternatives now that producers find themselves in the grips of this agro-economic complex. Argentine GM soybean producers' experiences of how they arrived at a point of agro-extractivist lock in is the focus of this article. To better understand their perspectives, this article elaborates the "soybean assemblage." This consists of histories, politics, actors, and more-than-human agents that stabilized the GM soybean industry in Argentina, keep it in place, and render it fragile. This includes how autogamous soybeans and an intellectual property regime function in Argentina, the country's famously fertile land and its position within the national imaginary, Kirchnerist politics that rely on soybean exports to fund social programs, producers' economic interests and sense of duty to the nation, the discipline of agronomy as a site of agrochemical knowledge production, and how agrochemicals, namely glyphosate, created long-term dependence under the guise of safe use.

1. Introduction

In the southern summer of 2020, Argentina's federal government proposed a new way to address the country's worsening economic divide: a one-time tax on its wealthiest citizens. Law 27,605, the *Aporte Solidario y Extraordinario* also known as the "millionaire's tax" targeted individuals and estates that exceed 200 million Argentine pesos. According to one of the bill's co-sponsors, it would affect only about 0.02 % of the population. But for soybean producers who might be forced to sell land or farm equipment to pay, this proposed tax was a step too far.

It wasn't the first time the Center-left Partido Justicialista (PJ) had taxed the rural sector to finance a redistributive political agenda. Nor was it the first time the rural sector opposed a PJ tax hike. The Vice President of the Confederación Rurales Argentinas' (CRA) summed up this longstanding opposition in 2021 remarks to the *Washington Post*: "This attempt to build equality flattens us all…Instead of rewarding merit, hard work and study, they simply want people to become reliant on the state" (Laje and Faiola 2021). For producers like this, becoming "reliant on the state" translates to becoming reliant on GM soybean exports.

With criticism now coming from many directions, why is it that so much time and energy and so many resources have coalesced around a GM soybean export model for so long? Or, "why does it take this form, and not another" (Li 2014)? One way to answer this question, also the project I take up in this article, is to look to the "soybean assemblage"—the political, economic, agricultural, and more-than-human actors and forces that, together, stabilized GM soybean production and exports at the center of Argentine economic life, transforming agrarian structures and rural communities in the process. For Tania Li, using assemblage theory helped "tease apart the elements that make such largescale investments thinkable" (Li 2014, 591). That is why I also find it useful. Pampean producers traffic in hegemonic discourses surrounding GM soybeans, are most likely to economically benefit from the GM soybean trade, and are in key decision-making roles about what to plant. Yet even they find it difficult to break out of the GM soybean model. Attention to how the soybean assemblage stabilized is of vital importance as those invested in and troubled by the reliance on soybean exports imagine new agro-economic futures.

Ever since the 1940 s when Latin American structuralists wrote of the perils of relying on raw material exports, scholars from across academic

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disciplines have traced the model's far-reaching damages (Leguizamón 2020). Nonetheless, Argentina has been a leading exporter of GM soybeans and their derivatives for over a quarter century. In that time, soybean exports have become a key feature of the country's economic profile. This raw material dependency, as the opening vignette points out, has since become a matter of serious concern for producers. Several rural producers have explained to me that yes, they oppose higher taxes because they worry the money is being wasted through corruption and clientelism. They're also tired of being scapegoated for the seemingly endless string of economic crises when, in their view, they've become locked into an agro-extractivist model by forces greater than themselves. Rural producers such as those interviewed by the Washington Post are, however, among those who stand to benefit the most from the GM soybean trade. As such, they have a singular angle of critique that is distinct from activists and communities affected by rural unemployment, agrochemical exposure, and land grabs who have long been vocal opponents of the GM soybean-dominated agro-industry.

Other scholars looking to explain agricultural transformations have similarly turned to assemblage theory. Werner et al., for instance, use it to understand how glyphosate became the world's most ubiquitous agrochemical-and one that, as I will explain, has been critical for the stabilization of GM soybeans in Argentina (2021). Julie Guthman also mobilizes assemblage theory to tease apart how California's strawberry industry got locked into a mode of farming even while the efficacy of fumigations diminished (Guthman 2019). Her concluding argument is especially apropos: "solutions have become the problem" (Landecker quoted in Guthman 2019). Yet, while Guthman draws attention to how fumigations were a repair for certain ecological and economic problems facing growers in the United States, the introduction of GM soybeans in Argentina were seen by the state and at least some rural producers as a path toward repairing the national economy. This coming together of agricultural and statist interests is what laid the groundwork for the era of agro-extractivism in which Argentina now finds itself. Detailing the constitutive social and material relations of the "soybean assemblage" helps make sense of how this dynamic developed and the fragility therein.

The article makes three additional contributions. First, bringing assemblage theory to bear on Argentina's GM soy boom emphasizes its material and non-human aspects. This enriches a literature on agro-extractivism that has largely relied on political economy analyses. Second, this article adds to literature on Argentina's soy boom by "studying up" or examining the perspectives of producers and those within their networks (Nader 1972).[2] Attention to how those in positions of power decide what to plant and their grievances sheds new light on how some producers believe they have become locked in and what alternatives they perceive to be available to them. Lastly, others have drawn on assemblages to look at industry, while this article contributes to development studies with its attention to an agricultural assemblage. Together, these contributions elaborate how Argentina's soybean assemblage took hold, the perceived limits of the model, and why it is so difficult to find a way out.

Much of the ethnographic data supporting this article comes from my research and interviews (60) with individuals working in the agricultural sector including producers, agronomists, agrochemical purveyors, and others working in and affected by agribusiness. The "producers" are mostly, though not exclusively, middle-aged men working at the heart of soybean cultivation in Buenos Aires province. Many have grown up with a rural ethos that emphasizes the centrality of agricultural exports to the Argentine economy and national identity, and a sense of resentment that their industry is made to fund the redistributionist policies of many political leaders from the last century. Their worldviews reflects their positionality in an agrarian structure where 6 % of soybean producers account for 54 % of all production (Gras and Hernández, 2016). Many of these producers have benefitted from access to large tracts of land held by their families since emigrating to Argentina from Europe a century or more ago, as well as from the political power their landed status affords them. I have drawn from my original ethnographic material to put forward their perspectives, the knowledge production of agronomists, as well as from scientific literature on how soybean monocropping has affected land and soil.

The article begins with an overview of agro-extractivism in Latin America, how Argentina is an exemplary case, and what assemblage theory can add to existing literature. Next, I focus on six elements of what is undoubtedly a more expansive assemblage. First is the GM soy itself—the political economic conditions that allowed easy uptake, controversial practices of seed saving, and a global economy that always wants more. Then I turn to the land upon which GM soy is grown and how this famously fertile land and soil has been used to grow soybeans. Next, I examine GM soybean producers who are most familiar with daily farming practices, self-cast as saviors following the 2001 economic crisis, and advocated against industry regulations. After that, I show how producers understand the Kirchner administrations' Center-left politics (2003–2015) to have become partly reliant on revenue generated from GM soybean exports. I follow these by discussing how Argentine agronomy developed knowledge practices around GM soybean production. Lastly, I turn to the agrochemicals that have been sprayed on landscapes, making their way into the bodies of those living along the soy belt to devastating effect. I conclude with reflections on the fragility of the soybean assemblage.

2. Agro-extractivism in Argentina

Even though Argentina has long been recognized as an important agricultural exporter, it was not a foregone conclusion that it would become a major player in what has been dubbed "the united Republic of soybeans." Soybeans are not, for instance, native to Argentina but rather have been imported via transnational corporations. With developments in genetic engineering, Monsanto developed a soybean that could tolerate glyphosate applications. This meant that farmers around the world could streamline and standardize their practices by spraying entire fields rather than having to target select weeds. Weeds died from glyphosate and later other agrochemicals, but GM soybeans survived these applications. This technology helped Argentina emerge as a world leader in GM soybean production and exports with producers quickly dedicating upwards of 60 % of the country's arable land to soy (Sly 2017).

Changes to Argentina's agricultural-economic complex have settled into a dynamic sometimes described as agro-extractivism (Gudynas 2009; Svampa 2013). Agro-extractivism highlights the capital demands of a Center-left political agenda that depends on natural resource extraction. The new Latin American left was resurgent amid a region-wide refutation of neoliberal economic policies during the 1990s, and colonial legacies before that. But as Gudynas points out, the progressive social and economic agendas depended on extracting and exporting natural resources. This included industries traditionally thought of as extractive, like mining, but grew to encompass a new mode of extractivism taking place across agrarian landscapes with the advent of agricultural biotechnology. Gudynas writes:

> A substantial change in agriculture has taken place, orienting it toward monoculture for exportation. These new practices represent an agricultural extractivism. One sees this, especially in the cultivation of soy based on varieties of transgenics, and in the great use of machinery and of chemical herbicides, the use of little or no processing, and exportation of the produce as a commodity. These are practices which have expanded and been strengthened with the blessing and

[2] This article builds on Amalia Leguizamón's recent contributions. Her focus, however, is on acquiescence of those "caught in between," namely "agribusiness employees and landowners who rent out their land" (2020, 21).

support of the administrations of Kirchner, Lula da Silva, and Vázquez. (2010, 2).

Since Gudynas, others have elaborated the concept to important effect. For instance, Carla Poth emphasizes how the biotechnological agrarian model expresses "the origins of capital reproduction in Latin America" (Poth 2021, 27). Others have drawn attention to the ways international development agencies and think tanks pushed for the region-wide production of primary goods as a promising path toward economic development (Burchardt and Dietz 2014). But as North and Grinspun argue, there is little new about neoextractivism (North and Grinspun 2016). Instead, these so-called "new policies" promoted by progressivist regimes across Latin America are in fact modeled on a long-standing paradigm that generates revenue through natural resource exports (North and Grinspun 2016). This came to be viewed as an "extractive imperative" whereby states' primary means of remedying the poverty wrought by neoliberalism was through natural resource extraction (Arsel, Hogenboom, and Pellegrini 2016). Meanwhile on the environmental side, as Alonso-Fradejas points out, extractivism is also being heralded as a necessary part of sustainable energy transitions (Alonso-Fradejas 2021).

Despite promise ascribed to this development model "based on the appropriation of nature" (Burchardt and Dietz 2014, 478), multiple forms of economic dispossession and ecological damage have been linked to agro-extractivism. In fact, these negative consequences, what Svampa might describe as the "limits of existing progressivism" (Svampa, 2013, 2), such as "sectoral disarticulation," "environmental degradation," and "the deterioration of labor opportunities" are central to McKay's more recent definition of "agrarian extractivism" (McKay 2017, 203). Others, meanwhile, have argued for an expanded definition that includes smallholders whose livelihoods have also been negatively affected but who may not be growing products "destined for export with little or no processing" (Tetreault, McCulligh, and Lucio 2021). Following this reformulation is Tetreault et al.'s important point that scholars ought to "focus on the negative social and environmental consequences…taking into consideration the technologies employed, the social relations of extraction and evolving regulatory frameworks" (Tetreault et al. 2021, 222). Attention to these negative consequences highlights the fragility of agricultural assemblages.

In many ways, Argentina's transition to agricultural biotechnology has been a textbook case of agro-extractivism. Until the 1930's, Argentine landowners continually pushed back the agricultural frontier through oftentimes violent means. The "killing and displacement of indigenous peoples and the expropriation of their land made agrarian capitalism possible," according to Leguizamón (2020). These processes created surpluses, stimulated tremendous economic growth for the country, and fomented hopes for "unlimited progress" (Giarracca 1999), transforming Argentina into the "granary of the world" (Cortés Conde 1979). The period also saw "8.5 million hectares passed into the hands of only 391 individuals" as the countryside was transformed into a profit engine through meat and grain exports while still being able to produce enough food for domestic consumption (Leguizamón 2020). The Pampas was then populated by newly arrived European immigrants who oftentimes supplied the labor for the expansive *estancias* that owned much of the land, and were part of a nation building strategy that sought to "civilize" the Pampas by remaking its racial and ethnic composition in a European image (Sarmiento 1993; Shumway 1991). Then, however, this expansion stalled leading to a phase called the Pampas stagnation which lasted until the 1970s. Producers began experimenting with soybeans in the 1970s, which helped lay the groundwork for widespread uptake with the arrival of GMOs. Also, during this period the *Sociedad Rural*, the country's oldest and most powerful farming association, began advocating for greater technical advancement of the farming sector to help make up ground lost to economic crisis and war. The exceptionally violent period from 1976 to 1983 when the military dictatorship disappeared close to of 30,000 so-called dissidents, including agricultural experts from across government agencies, marked an increase in production and exports, as well as the agriculturalization of land outside the Pampas. This is also the period when long-standing state interventions meant to secure families' land access began to weaken (Gras 2009). With the 1983 return to democracy, products grown for export continued to find markets whereas domestic markets contracted (Giarracca 1999).

With the arrival of transgenic soybeans, the ongoing process of agriculturalization accelerated in ways that pushed out many small and mid-sized farmers. It was an effect of major land consolidation with the advent of "sowing pools" (Urcola et al. 2015). Investment funds sought to maximize economic profit while diversifying risk by increasing the area of production (Hernández 2020). Meanwhile, leasing land to large agribusinesses became an increasingly common practice as labor demands shrank but upfront investment costs grew (Gras 2009). This coincided with a drastic reduction in small and mid-sized family farms as many faced skyrocketing debts and bankruptcy after adopting the new technological package (Gras 2009). Argentine producers also benefitted from the high global commodities prices that led to a period of strong economic growth in the region at the turn of the century (Svampa 2019).

The rise of Kirchnerism coincided with the expansion of GM soybean exports (Lapegna 2017).[3] Their center-left agenda sought to rebuild after the 2001 economic collapse with the help of GM soybean export revenue. For a time, there was widespread enthusiasm for both the Kirchnerist political agenda and the transition to agricultural biotechnology. Under Néstor Kirchner (2003–2008), the economy grew at a rate of up to 9% which helped to resurrect the country's social safety net. Meanwhile, Argentine producers were being heralded as agricultural innovators for their enthusiastic uptake of genetically modified crops (Leguizamón 2014). There was also a sense, at least among many of my interlocutors, that betting on GMOs was supporting the country's beleaguered economy. Everyone would benefit. But when global commodities prices took a downturn shortly thereafter, many progressive regimes doubled down on extractive practices just as the limits of the model were becoming apparent.

Scholars of Argentina's GM soy boom have done significant work to point out the "negative social and environmental consequences" of agro-extractivism (Tetreault et al. 2021). Daniel Cáceres, for example, describes this model that redistributes revenue generated by soybean extractivism for social policies as "accumulation by dispossession" (2015). It's the "dark side of the soy boom," as Pablo Lapegna puts it, when peasant farmers are driven from their land by soybean producers seeking to expand production (Lapegna 2016), or when the deforestation of supposedly unproductive regions disrupts the lives of peasant and Indigenous peoples (Langbehn and Schmidt 2019). Unemployment also climbed throughout the rural interior as producers mechanized their operations. As many as 200,000 rural laborers lost work within a matter of years (Verner 2006). One of the most pronounced dimensions of this "collateral damage" has been agrochemical exposure to nearby residents (Arancibia and Motta 2019; Leguizamón 2020), as well as the effects of sustained agrochemical use on other forms of life (Giarracca and Teubal 2014). Afterall, "violence is at the heart of extractivism" as Poth makes clear (2021, 24). This article's attention to producers' doubts will add to understandings.

The political economy of Argentina's agro-extractivist turn has been well documented. What is still missing is attention to more-than-human aspects including the material qualities of the GM soybeans, the soil, and agrochemicals, as well as the narratives and politics that elaborate various positionalities and explicate how the soybean assemblage stabilized. Many nodes of the assemblage, as I will go on to explain, point both to how it stabilized but also to its inherent fragility. An assemblage's fragility stems from the fact that "the relationship among the elements in an assemblage is not stable; nor is their configuration

[3] GM soybean export revenues are 31.8% of Argentina's export income (Sly 2017).

reducible to a single logic" (Collier 2005). Producers expressing worries about being locked-in to GM soybeans, new political economic developments, and evolving ecologies each signal the possibility for the limited lifespan of the soybean assemblage, and maybe even the possibility for alternative agro-economic futures.

3. The Soybean Assemblage

3.1. GM Soy: Deregulation, Seed Saving, and Global Consumption

At the center of the soybean assemblage are the soybeans themselves. Their genetic modification, treatment under Argentine patent law, and widespread use in overseas food and feed industries all help explain how the assemblage stabilized.

In 1996 the Secretary of Agriculture Felipe Solá deregulated glyphosate tolerant soybeans. It's a process that can take years but for Roundup Ready (RR) soybeans, it was only months (81 days to be exact) before producers were putting seeds in the ground (Aranda 2011). Resolution 167 authorized the production and commercialization of glyphosate tolerant soybeans. But for some it all happened too fast. Norma Sánchez, professor of ecology at National University of La Plata (UNLP), described the process that led to the deregulation as "biased, arbitrary, and unscientific." "In this case all the knowledge came from studies done in the United States and from researchers, the vast majority, with ties to the interested industry" (Lavaca 2011). Even though Argentina has one of the oldest biotech regulatory bodies in the region (Pellegrini 2013), it seemed to succumb to political pressures for an expedited review based on findings from the U.S. Food and Drug Administration and Monsanto scientists rather than on in-country reviews.

Unlike in Europe and the United States, however, deregulation did not come with patent protection. Plants, according to Argentine law backed by international treaties,[4] cannot be patented. Moreover, Monsanto's RR soybean wasn't necessarily a novel invention in Argentina. In a rare move, the Argentine government refused Monsanto's patent request based on how glyphosate tolerant soybeans were first introduced years earlier. Notably, Argentina is the only country in the world to have refused Monsanto's patent request (Sly 2017). When Monsanto eventually filed for patent protection, RR soybeans were already circulating (Delvenne, Vasen, and Vara 2013; Leguizamón 2014).

This standoff between Monsanto and Argentine producers hinged on the question of seed saving, a right that has for decades been codified in Argentina's *Ley de Semilla* (Seed Law). Soy is an autogamous plant meaning it can self-fertilize making seed saving an appealing practice (Filomeno 2013). If producers save seeds, however, Monsanto loses out on repeat clients because producers spend less each year. One producer who has grown soybeans for many years but who recently decided to begin raising a small number of bulls as well explained it like this: "The companies that produce seeds tell me, 'this must be paid every year'… we [producers] say, 'no, I buy it from you this year and the seed is mine.'" Typically, a producer can only save a seed for one maybe two years before it loses its potency. Nonetheless, therein lies the reason that Monsanto took out a full page add in the country's largest newspaper defending its interest in patenting soybeans, threatened to withdraw from the Argentine market entirely, and had an Argentine cargo ship suspected of carrying soybean meal with traces of Monsanto's genetic material boarded by international inspectors at its European destination. Through all that, and a case brought before the European Court of Justice, the Argentine state backed by its producer associations held firm (Filomeno 2013). Monsanto would not, for many years to come, be able to collect royalties through a state sanctioned IP regime.

An agronomist at *Grupo Reflexión Rural* wants onlookers to "ask yourself why Monsanto, with all its lawyers, never got a patent for RR gene in Argentina?" (Hearn 2006). Monsanto's inability to secure a patent is sometimes framed as a tactic rather than legal ineptitude. With low-priced seeds flooding the market early on, Argentine producers were paying much less than American producers who were subject to the United States' strong patent protection. With RR soybeans in the public domain, Argentine producers were able to adopt the whole technology package for a significantly reduced rate. In response, the American Soybean Association went so far as to ask Monsanto to refund American farmers $300 m who they believed were unfairly losing out on profits (Hearn 2006). Compounding this was the robust black market for seeds coming from Brazil and Paraguay that further drove down the price for Argentine producers to less than half what U.S. farmers paid (Leguizamón 2013; Qaim and Traxler 2005).

Meanwhile, Chinese and European demand for Argentine soy continued to grow in part because of soy's high protein content and the many uses of soybean oil. China's appetite for raw materials has grown steadily for decades and it now leads the world in soybean imports where it is used primarily for pork feed and edible oils (Sly 2017). As the Chinese economy grew, so did meat consumption (Richardson 2008). Meanwhile, European demand for soybean imports also increased perhaps in part because growing GM crops in Europe was highly controversial (Aldridge 2008).

3.2. Land and Soil

The long-standing centrality of land within the Argentine national imaginary further explains how GM soybeans have become so important in the country's contemporary political economy. Land can be many things (Li 2014); here I draw particular attention to the historically fertile soil as well as to land as a form of property.

The land is Argentina's most famous and arguably most important natural resource. If one were to ask a producer, as I did when speaking with a man whose family grows soy and corn on roughly 1000 ha, why Argentina is perennially among the world's leading producers and exporters of GM soybeans, they might respond: "we have the most fertile land in the world." JourneyLatinAmerica.com offers this stereotypical depiction: "it's a region of endless yawning plains, the fertile soils of which support succulent pasture for the country's revered beef cattle, along with golden wheat and sunflowers."

The importance of land in national imaginaries stretches back to debates about what sort of political experiment Argentina would be. Discussions about Argentina's land haven't always been in the triumphalist terms so common now. Former president Domingo Sarmiento likened uncultivated land to the "evil that afflicts the Argentine Republic," blaming political unrest on the land itself (Sarmiento 1993). For many of Sarmiento's generation, "capitalist development would not only bring prosperity to the Pampas; it would also end the 'barbarism' of the Pampas' natural inhabitants" (Shumway 1991). In Sarmiento's account, the land needed to be divided up into private property for cultivation. Only then would it, and the Argentine republic, be able to reach their potential.

The Pampas, home to the "endless yawning plains," supported cattle ranching as early as the 16th century, and agriculture for the last century (Piquer-Rodríguez et al. 2018; Pengue 2005). Until the introduction of GM soybeans in 1996 crop and cattle rotation kept "the nutrient budgets of the Pampas…relatively stable" (Pengue 2005). As the country's most productive soil, it was rarely fertilized (Rubio, Pereyra, and Taboada 2019). The fallow period, crop rotation, and cattle grazing enabled a long-term farming model (ibid.). One longtime grain producer who has been an outspoken critic of the pressures Kirchnerism placed on the rural economy explained it like this:

[4] Such as the World Trade Organization's Trade-Related Aspects of Intellectual Property Rights (1994) and the International Union for the Protection of New Varieties of Plants (1991), which have served to back Argentine producers' seed-saving.

> Argentina had a mixed productive development. Livestock and agriculture where there was crop and production rotation…and that is one field, so, cows were here, you planted this every-two or three years, or four, later it became cattle pastures. Cows passed through here and the land was cultivated. And this was a cycle that allowed the land to be protected, to create an ecological equilibrium.

This, in agricultural scientist Walter Pengue's terms, is why the Pampas before soy was "considered to be well supplied" (Scheiner, Lavado, and Alvarez 1996 cited in Pengue 2005).

However, as producers switched from rotational grazing to more intensive forms of agriculture beginning in the 1970s (Trigo 2021), concerns about degraded soil intensified. Institutional research programs spearheaded by the Instituto Nacional de Tecnología Agropecuaria (INTA) and the Food and Agricultural Organization (FAO) followed by the work of Proyecto de Agricultura Conservacionista (PAC) laid the foundation for what would become an almost entirely no-till soybean industry. This information sharing later solidified into the highly influential Asociación Argentina de Productores de Siembra Directa (AAPRESID). The problem of weeds, which had been the main obstacle to widespread uptake, was seemingly solved with the introduction of herbicides like 2,4-D and later glyphosate (Trigo et al. 2009). Meanwhile, a no-till machinery industry emerged, and the seed sector reorganized as firms began to sell technology packages that included seeds, agrochemicals, and equipment (Ekboir in Trigo 2009). As Alvarez et al. write, no-till was widely expected to improve soil quality through "better erosion control, water conservation, and nutrient cycling, time savings, reduction in the use of fossil fuels, and increased soil C sequestration" (2009). Trigo et al. describe the possibilities of "virtuous intensification" whereby producers have the possibility of "environmentally friendly increases in productivity, through coupling zero-till planting techniques with herbicide-tolerant soybeans." The farming techniques that eventually make GM soybean monocropping successful in Argentina were already in place.

No-till has had mixed effects, however. This is partly attributable to the fact that soybeans have been primarily grown without fertilizing the soil (Scheiner, Lavado, and Alvarez 1996 cited in Pengue 2005). "Argentina exports around 3,500,000 metric tons of nutrients yearly" (Pengue 2005), and with those nutrient exports the "ecological equilibrium" was disrupted within just a few years of GM soybeans' introduction. For instance, soy extracts significant amounts of phosphorous, leaving the "zona Pampas" deficient in that nutrient. But "phosphorous is very expensive" for Argentine producers according to one INTA agent. Another agronomist lamented: "But afterwards comes the period…when if you don't make money with this and the only thing left to make money is this, you do all soybeans. And today, you are trying to get out of this because there's no way to do it sustainably, soybeans on top of soybeans on top of soybeans, 20 years.".

This problem has been exacerbated by sowing pools. Many small and mid-size farmers that entered bankruptcy before the 2001 crisis because of high debt from the technology transition, entered into lease agreements with a handful of large-scale agribusinesses (Gras 2009; Lapegna 2016). "It's a big problem for the soil," that same agricultural extension agent explained to me. "The landowners don't sow the soil. A renter is the one who sows the soil…and they rent for only a year. If it doesn't go well in one place, they go somewhere else. Every-one knows they should rotate their crops, but no one does it because they only have the land for a short time." What had been a several yearlong time horizon was significantly shortened with the arrival of soybeans and sowing pools. The sowing pool model diminishes the soils' fertility while the availability of new terrain for cultivation allows it to continue.

Finding new land has been a sometimes violent and sometimes ecologically devastating process. Soy is now grown far beyond the "yawning endless plains" of the Pampas as more ecologically complex land undergoes a process called "pampeanisation," meaning that the practices and technologies successful in the Pampas are exported to other regions (Pengue 2005). According to sociologist Pablo Lapegna, agribusinesses looking for more land have moved northward to the poorer, less developed provinces of Formosa, Chaco, and Santiago del Estero where free range cattle herding remained a vital industry and forest cover is still intact.

3.3. *Kirchnerism: Export taxes and Economic Repair*

Kirchnerism is widely known for its social programs. According to some producers, funding social programs was possible because of the policies that both heavily taxed and incentivized soybean production. These producers believe that Kirchnerism locked them into soybeans.

"Argentina transforms soybeans into 'green gold" was the headline of a 2007 profile on the effects of GM soybeans (Gualdoni 2007). "It's the president's petty cash and he can dispense with this money how he likes: public subsidies, social programs, aid to industries, and political allies" (ibid.). The article was written in the heady days of the soy boom when export tax revenue was flooding the economy.

It was also early days of what has been dubbed Latin America's pink-tide, a post-neoliberal moment when the legacies of Euro-American imperialism and the economic legacy of neoliberalism launched a region-wide political shift. In Argentina this took the form of Kirchnerism (2003–2015). Central to Néstor (2003–2008) and his successor and wife Cristina Fernández de Kirchner's (CFK) (2008–2015) model was a redistributive politics that aimed to bring back the social safety net. Proponents of Kirchnerism tend to cite the tremendous economic growth early on and its inclusionary politics. Critics, meanwhile, see yet another episode of authoritarian populism plagued by corruption (Peruzzotti 2017). A father and son team who began growing conventional soy before transitioning to transgenic varieties on their several thousand-hectare farm explained that "*Modelo K"* depended, at least somewhat, on income garnered from GM soybean export taxes.[5]

This relationship crystallized with Resolution 125/2008 (Hora 2010). In the opening days of her presidency, CFK announced her plan: if the price of soybeans per ton fell below $200 on the Chicago Stock Exchange, then the export tax would immediately drop to zero. If, however, the value reached $400 per ton, the approximate price of soybeans at the time, the export tax would rise to 35.75 %. If it reached $600 per ton, the export tax would jump to 49.33 %. Producers responded by shuttering the rural economy for three months. "The president was very hostile, very aggressive. Then the producers became a little more hostile. They built roadblocks," one producer who serves as a rural advisor and farms GM soybeans on about 100 ha explained to me. In an adage I heard repeatedly, the tax would have amounted to more than 70 % once provincial and municipal taxes are taken into account. Small and mid-sized producers like him would suffer most, he protested. While this alone doesn't explain how soybeans stabilized, it reflects the fact that soybeans had become central to understandings of Argentine economic health. "The country lives off of soybeans" that father and son agreed.

The heavy taxes placed on soybean exports were not an isolated reimagining of the country's tax code. In fact, the Kirchners also raised taxes on wheat and corn making it economically impractical to grow those, according to a producer whose in-laws operate a 7000-hectare soybean farm as well as others. This followed the government's 2006 temporary ban on exporting beef so Argentines would again be able afford it. But this had the effect of reducing the profit margins for beef to almost nothing. Producers in turn wound up cutting back on corn, wheat, and beef. This went so far, according to one agronomist, that Argentina had to import wheat for the first time ever.

There were intense economic pressures in the form of taxes driving producers to soybeans. An employee at a regional agricultural interest group, put it like this:

[5] Lapegna questions the degree to which this was the case (2020).

> They would speak about us destroying the environment because we soyified agriculture and we made everything soybeans, but on the other hand, they put taxes on our wheat and corn, and they made it so that these two crops weren't viable. If they had wanted us to grow fewer soybeans, they would have removed the taxes, like this government [Macri's] did, they removed the taxes on wheat and corn, they were then more profitable crops and we started growing more wheat and corn and not as many soybeans.

The president of a local producer cooperative said this: "the last twelve years of the Kirchner government, they criticized soybeans but they didn't incentivize us to grow, for example, corn or wheat. They incentivized only soybeans, no matter how much they criticized it." An INTA agronomist told me it was a "vicious cycle. The government needs resources and consciously or unconsciously they incentivize people to grow soybeans." Or, as the president of the *Sociedad Rural* put it during his opening remarks at *La Expo Rural 2019* "policy can only allocate resources that the economy produces.".

The first wave of Kirchnerism ended amid accusations of domestic corruption, global conspiracy, and another economic downturn. Meanwhile, a social fracturing was underway in a phenomenon called "*la grieta*" or the crack. "There's a war and there are sides," a cabinet secretary in CFK's government once explained to me. Out of this came the election of Mauricio Macri in 2015. Of particular interest for producers was Macri's promise to roll back grain export taxes by 5 % each month until they reached zero. By the end of his single term in office though, Argentines were living through yet another financial crisis and Macri had long since abandoned his plan to reduce soybean export taxes.

3.4. Producers: Profits and Identity

Producers, both large and small, have been key agents of the soybean assemblage. Part of what drove so many to adopt soybeans early on was profitability. Also, as I discovered during fieldwork, many felt a renewed sense of purpose. Helping resurrect Argentina's perennially troubled economy with soybeans became part of their identities as those "who must feed them all."

Not far from the capital city where the effects of the 2001 crisis were in high relief, soybean producers were enjoying record profits. Early adoption and deregulation of GMOs certaintly contributed, but moreso it was the economic crisis that fueled the sector's tremendous growth. The collapse of the Argentine peso meant producers could export products for exceptionally low prices, while the global commodities boom when European and Chinese importers had a new thirst for soybean products ensured ample export markets. Because there is very little domestic consumption, most soybeans are produced for export. Before long, soybeans were generating three times more revenue than wheat and beef combined (Richardson 2008).

The success of the industry provided a lifeline for an otherwise stumbling economy, at least that's how some producers tell it. There was a brief but productive moment of synergy when Kirchnerism flourished alongside the agricultural sector. It was a convergence for the sake of rebuilding the economy and the country after the 2001 economic collapse. Soybeans were at the center of this renewal. In remembering this period, a small-scale soybean producer who resents how negatively his industry has been represented proudly recalled, "[the government] called up agricultural institutions and proposed putting a 5 % tax on everything because it's what the country needed. We told them that it is very little, and that we could probably contribute more. I think we doubled it." He describes himself and other producers as partners in a measured agricultural shift towards soybeans to capture an emergent global market. But it was more than that, agricultural producers were going to help restore Argentina's economy and image on the world stage. This would be a partnership.

There is a sense among many producers that they are doing their part, a critical part, in keeping the country headed on the right economic path. At La Rural there's a banner that hangs above the open-air amphitheater where fattened bulls are led around by men wearing traditional gaucho garb. It reads, "*cultivar el suelo es servir a la patria*" (to cultivate the land is to serve the nation). It's not that different a message than one from a Land o' Lakes video I was sent by an agrochemical salesman and an amateur historian whose nephew grows soy who wished to impart their perspectives on me. Narrated against a montage of men working and high-tech farm equipment floating through windswept fields of commodity crops, a disembodied voice recounts the importance of farmers. "The farmer he must feed them all," she says,

> The farmer's trade is one of worth. He's partner with the sky and earth. He's partner with the sun and air and no man loses for his gain. And men may rise and men may fall but the farmer he must feed them all. God bless the man who sows the wheat who finds us milk and fruit and meat. May his purse be heavy, his heart be light, may his cattle and corn and all go right. God bless the seeds his hands let fall, for the farmer, he must feed them all.

It's a story even older than the country. When Argentina was still a Spanish colony, Mariano Moreno wrote a letter on behalf of cattle ranchers pleading for investment from the Crown. "It is our destiny to be cultivators of fertile fields," he wrote in 1809 (Moreno cited in (Nouzeilles et al. 2002).

But in 2003, explained one producer who grows soybeans on the small remaining portion of his family's once more substantial landholdings, "'[Néstor Kirchner] started to raise [export taxes] and that's when, one day, producers exploded and said 'Well, no. Enough.'" By 2008 when the global commodities boom was fizzling, national sentiment was turning against those who CFK called the "*piquetes de la abundancia*" (protesters of abundance), and the controversy surrounding Resolution 125 was never fully resolved. Many producers walked away from the experience with newfound clarity: the Kirchners and their supporters had no idea what it took to produce. "'The countryside has a lot of money because it's easy, because they don't put anything into it,' that is to say. The ignorance about what it means to produce in the countryside is profound," said another producer whose family once had a mix of agriculture (wheat and corn) and livestock on their 650-hectare farm. As the land was passed down and conflicts ensued, this producer and his son were ultimately left to farm soybeans on 100 ha. He was lamenting what he believed to be a common misperception that producers are raking in easy money and opposed to sharing their success through redistributive policies.

Producers' stated desire to help the country sits uneasily with another opinion shared by many: that their hard work is being taken for granted by a government only interested in handouts for votes. "In this country there is a financial hunger that leaves no resources for private activities or the genuine growth of citizens. They drown out private enterprise and generate poverty for populism." This semi-retired producer wanted me to know that the Kirchner model was hindering its citizens' innovative spirit when it used revenue generated by GM soybean exports for social programs. As this logic goes, if the government stopped giving "handouts," more Argentines would be forced discover their ingenuity anew. "Agriculture is the most competitive sector in Argentina by far. When they discover a new technology, they adopt it immediately, they are passionate and innovative because the situation demands it of them," Carlos Becco, an agricultural advisor, recently said in an interview (AgrofyNews 2021). Although there is indeed an enormous body of scholarship and activism that troubles this perspective, producers' narratives are noteworthy as it reflects a sense of pride in their ability to innovate and profit despite fiscal pressures created by high taxes, and in a belief that their entrepreneurial spirit ought to be an example for the rest of the country. In their accounting, Argentina became the "most advanced agriculture in the world" because they have done so much with so little.

3.5. Agronomy: Glyphosate, Technology, and Recipes

The field of agronomy has gone through significant changes ever since the introduction of GM soybeans. This includes the professionalization of the field as well as increased responsibility for how agrochemicals are used. According to some, the field of agronomy has become increasingly dedicated to understanding the changing ecological conditions required to keep growing GM soybeans.

"When I was starting my career, an uncle said to me: 'do you know the two reasons agronomists die?' No, I said. He tells me, 'the first is from car accidents, and the second is from hunger.'" This joke of sorts was relayed to me by an agronomist for AACREA, a consortium where "agricultural entrepreneurs share experiences, general knowledge, and promote ideas about sustainable development for companies and the country" (https://www.crea.org.ar). I wasn't sure what he meant by hunger. The agronomists I knew seemed rather well off. He spelled it out for me: "Because there wasn't any work." During my fieldwork, it seemed like nearly every-one I met was an agronomist or wanted to be one, and I often saw them driving brand new trucks from field to field. Before GM soy, another agronomist explained, a man might want to become an agronomist to manage his own family's estate. But as a lucrative career field at the cutting edge of technology? This was something new. It was a change that came with GM soybeans.

Ever since the introduction of GM soybeans, agronomy has undergone substantial changes (Urcola et al. 2010). Importantly, extension services delivered by INTA, which were defunded during the 1990 s as part of structural adjustment, have resumed (ibid.). Today there are 24 colleges of agronomy that have produced around 15,000 working agronomists (IPNI), of which INTA hired about 500 during Néstor Kirchner's presidency. This included developing and disseminating new knowledge that pertains specifically to GM soybeans and a push to professionalize (Poth 2021). Agronomists are now key actors in what Leguizamón describes as a "knowledge-based-network model" (2020, 66). Selling advice and products is at the heart of this profession (Albaladejo, Sartre, and Gasselin 2012). Monsanto even underwrote the Master's program at UBA (Poth 2021). The ubiquitous "sowing pool" model that typically consists of a landowner, agronomist and machinery operators solidified these relationships (Binimelis, Pengue, and Monterroso 2009). Agronomists have been both producing knowledge about agrochemical use and are responsible for regulating it.

Part of what agronomists are tasked with is keeping up with changing ecosystems and new technologies. Two significant changes have been the introduction of RR soybeans and later the agrochemical recipes required now that new weed resistances are appearing each year. Early on, though, knowing how to use glyphosate was sufficient. "The agronomists of our generation are called the 'glyphosate generation,'" an agronomist explained to me over coffee one afternoon. "Why?" I asked. "When glyphosate and transgenic soy came, it greatly simplified the system, because you controlled everything with a single product. But nature is wise." They were taught to know and treat problems with glyphosate because not only was it remarkably effective, but it was also widely considered safe. But as the years passed, the effectiveness of glyphosate waned. "Nature is wise" as that agronomist warned. New resistances have since emerged and agronomists have had to adjust.

Agronomists are now largely responsible for agrochemical "*recetas*" (recipes), a process that has only recently started to be standardized. An agronomist explained the changing regulatory landscape. "Right now, in the province of Buenos Aires, they are increasingly standardizing the use of what is called an agricultural recipe. It's like a doctor's prescription where the agronomist is obligated to list what product is going to be used and put his signature on it. It's just like a doctor. If that product is applied badly, the agronomist will be the one with the problem." This is a responsibility supported by agronomy departments. "Presidents of professional associations agreed to define the role of agricultural engineers in Argentina because of its close relationship with health and with the production of agri-foods. '**The agronomist must be the guarantor of both things**,' they assured" (Infocampo 2020). It's the agronomists who decide when to spray, where to spray, and how much. According to one agronomist, this is oftentimes done in close consultation with representatives from input suppliers like Monsanto. Nonetheless, many agronomists have dedicated their careers to amassing the knowledge necessary to grow GM soybeans and use the requisite agrochemicals. The production of this agronomic knowledge as part of the broader extractive program further entrenches those practices (Poth 2021).

3.6. Agrochemicals: Safety and the "Transgenic Treadmill"[6]

The cheapness and presumed safety of glyphosate helps further explain the soybean assemblage. However, glyphosate's waning effectiveness as well as growing concerns about exposure risks for both humans and environments underscore the fragility of the soybean assemblage.

With the 1996 deregulation of GM soybeans came a marked increase in the use of glyphosate. In order to grow RR soybeans, producers needed Roundup and a lot of it. It's part of what is known as the "technological package." Yet while much of the rest of the world was concerned with whether GMOs were safe for release into the environment and food chain, the issue never gained much traction in Argentina (Leguizamón 2020). Instead, the explosion in glyphosate use and then other agrochemicals brought forward another set of concerns: was glyphosate used so regularly and in such high quantities actually safe, and according to whom?

By the time GM soybeans were introduced in Argentina, SENASA, the agency tasked with regulating phytosanitary products, had long ago classified glyphosate as class IV with a green band and "caution" label, meant to convey it poses few risks to human health and the environment (La Nacíon 2020). It was first authorized in Argentina in 1977 and then reauthorized in 1999 with SAGPyA resolution 350/99 based on the World Health Organization's finding that it "*normalmente no ofrece peligro*" (it doesn't normally present a risk) (La Nacíon 2009).[7] According to the prevailing international standards at the time, glyphosate posed few risks when used correctly.

There were also studies coming out, like the one from Viglizzo et al., attesting to the relative innocuousness of glyphosate because it persists in the soil for no longer than 60 days, it has a low risk of polluting ground water, and it doesn't "bioaccumulate" in animals (Viglizzo et al. 2011; Trigo et al. 2009). But to understand how it is that glyphosate was considered a safe agrochemical, maybe even the world's safest, requires a closer look at its institutional history. What this reveals is how Monsanto actively sought to limit the types of studies allowed. It was part of their strategic approach to growing the global glyphosate market. For example, Monsanto worked with the U.S. Environmental Protection Agency (EPA) to limit the types of exposure-related studies scientists can do (Warren 2014). The strategy was made public with the 2015 leak of a trove of internal Monsanto emails published by Dewayne Johnson's attorneys in the middle of a trial alleging that his non-Hodgkin's Lymphoma was a direct result glyphosate exposure. This is made clear in an email from Monsanto toxicologist Donna Farmer: "It cannot be stated that Roundup is not carcinogenic…We have not carried out the necessary studies on the formulation to make such a statement." Note that any such studies might also lead to findings that support glyphosate-as-carcinogen. Limiting the types of studies that can be conducted has the effect of ensuring there is scant data to prove or disprove glyphosate's carcinogenicity.

Under the auspices of safety, glyphosate use in Argentina has risen to 350 million liters per year (Pomar 2018). As agronomists of the so-called

[6] Binimelis et al. 2009.

[7] In 1987, Monsanto's glyphosate patent expired in Argentina leading prices to fall from $40/liter to just $3/liter by 2000 (Trigo and Cap 2009; Werner et al. 2020). As a result, glyphosate use rose quickly (Werner et al. 2020).

"glyphosate generation" turned increasingly to glyphosate, the number of glyphosate-resistant weeds also began to increase. This in turn required higher levels of agrochemicals. Between 1997 and 2011 there was a 90 % increase in agrochemical use in Argentina (Gillam 2017). This development was, however, unexpected based on studies suggesting weed resistances were not likely to develop (Werner et al. 2020). According to one agronomist, "It was used massively for everything without product rotation, all the time the same remedy, the weeds became resistant and today there's an enormous problem like there is in the United States, there are resistant weeds and now glyphosate doesn't do anything to them." To treat the first glyphosate-tolerant weeds producers and agronomists were forced to increase the amount of glyphosate used (Pengue 2005). Glyphosate resistant johnsongrass, for example, appeared in Argentina in 2002 and covered 10,000 ha by 2009 (Binimelis et al. 2009). This cycle, in which glyphosate is used, glyphosate resistant weeds crop up, and then producers use higher quantities of glyphosate and older broad-spectrum agrochemicals like 2,4-D, is what some are calling the "transgenic treadmill" (Binimelis et al. 2009). A small-scale producer who is also the leader of his local chapter of the *Sociedad Rural* lamented, "today, it doesn't work like it used to…Before, glyphosate killed everything.".

4. Conclusion

When the economy collapsed in 2001, The Economist, among other global news outlets, declared that Argentina had just lived through a "century of decline" (2014). The country seemed perpetually plagued by hyper-inflation, military coups, and corruption. It was an all too familiar (though misleading) narrative. GM soybeans promised a way forward; one that could resurrect the economy, enable economic sovereignty from global financial institutions blamed for the economic collapse, and cement Argentine producers as world-leading innovators (Leguizamón 2020). In this article, I have mapped the key histories, disciplines, actors, and more-than-human agents that Argentine producers and others in their networks believe led them to and are keeping them, and the national economy, locked into soybeans. Drawing these elements together explicates the foundational more-than-human relations, the perspective of the powerful, and the role of agricultural assemblages for development studies.

The soybean assemblage is a complex of human and more-than-human actors and agents that together have brought Argentina to a place where a future without GM soybeans is almost hard to fathom. GM soybeans and their attendant policies created economic conditions whereby Argentine producers were positioned to dominate the global marketplace quickly. This was possible because Pampean soil was well suited for GM soybeans while the land's historical importance made it a logical place for economic development. Producers enthusiastically adopted GM soybeans in part because of profitability but also because the work expressed a desire to be economic saviors. Meanwhile, some producers felt disdain for the Kirchners and their policies for relying too heavily on their industry, while also noting that the Kirchners' export tax regime made it difficult to grow anything other than soy. This emerging assemblage was further stabilized by the production of knowledge taking place within the discipline of agronomy where a new generation of experts amassed the knowledge to expand profits while limiting the cost of inputs through agrochemical use. Further entrenching the soybean assemblage is the "transgenic treadmill" whereby agrochemicals get used and resistant weeds develop, then resulting in higher quantities of agrochemicals with few off-ramps. Together, these elements have kept GM soy at the center of politics, economics, and production for more than two and a half decades.

What is at stake, then, for producers and others who while sustaining and being sustained by the soybean assemblage signal an interest in alternatives? To a certain extent, there is a convergence on the idea that there are inherent limits to a GM soybean monoculture, though these are experienced unevenly and understood in vastly different terms. The degraded soil, producers' political discontent, the Kirchners uneasy reliance on revenue from GM soybean exports, the "extractivist imperative," and the waning effectiveness of agrochemicals all point to the fragility of the assemblage. Nonetheless, there is no easy replacement. Producers expressed interest in a more diverse assortment of transgenic crops but were under no illusions that they might return to the crop and livestock rotations that once kept the Pampas' soil well-supplied. Argentina's burgeoning agroecology movement seems similarly outside the realm of producers' interests and unlikely to provide the export tax revenue relied upon to keep the economy afloat. But these "elements act together and on one another, and no one node is the source or recipient of all transformations," as Guthman writes (2021, 201). The question becomes whether there will be crisis point whereby one or more of these nodes destabilizes the assemblage thus opening up, for better or worse, new agro-economic futures—or if the soybean assemblage will strengthen, foreclosing the possibility for alternatives (Djelantik and Bush 2020).

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